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Bureau of Mines Information Circular/1983

In Situ Copper Leaching in the United States: Case Histories of Operations

By Jon K. Ahlness and Michael G. Pojar

UNITED STATES DEPARTMENT OF THE INTERIOR

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IN SITU COPPER MINING IN THE UNITED STATES: CASE HISTORIES OF OPERATIONS

By Jon K. Ahlness[1] and Michael G. Pojar[1]

ABSTRACT

The copper industry has had a long and interesting history associated with leaching, involving vat, dump, heap, and in situ methods. The Bureau of Mines has also had an interest in copper leaching and has researched the techniques of solution recovery, particularly concentrating on in situ methods. In situ mining is a relatively low cost method and has been proven commercially successful by nine operations. It has been most commonly used for final recovery in old workings at the conclusion of conventional mining operations.

This report brings together information about 10 commercial in situ operations as well as 14 experimental projects. These 24 sites comprise most of the in situ copper mining activities that have taken place in the United States. Background information, geology, ore preparation, solution application, and recovery and processing are provided for each operation. Production data and tables summarizing the engineering statistics for each operation and an extensive in situ mining bibliography are included.

[1]Mining engineer, Twin Cities Research Center, Bureau of Mines, Minneapolis, MN.

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FREEPORT

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FREEPORT EXPLORATION COMPANY
A Division of Freeport Minerals Company

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November 2, 1984

Mr. F.T. Graybeal
Chief Geologist
ASARCO Incorporated
180 Maiden Lane
New York, New York 10038

Re: In Situ Leach Tests, Santa Cruz Project, Arizona

Dear Fred:

This is to advise that Freeport would be willing to discuss a proposal for in-situ leaching tests by the U.S.B.M. as discussed in your letter to Mr. J.D. Sell. We have concerns, however, on the following matters:

(1) We must consider carefully the environmental risks and liabilities of such an operation. Also, such a test should not adversely affect the extractibility of copper by conventional mining methods.

(2) We would appreciate any thoughts you may have on how to characterize the in site leaching tests so as to avoid stigmatizing the Santa Cruz project as being a "marginal leach deposit."

However, for our part, we are interested in expressing a general interest in this concept.

Very truly yours,

Douglas R. Cook

DRC/cr
cc: [redacted]

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JDS

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

October 10, 1984

Mr. J. D. Sell, Manager
Southwestern Exploration Division
Tucson, Arizona

In Situ Leach Tests
Santa Cruz Project, Arizona

Dear Mr. Sell:

I received a call from Bill Larsen of the U. S. Bureau of Mines laboratory in Minneapolis. Following the Reagan denial of the ITC petition for relief from copper imports, several meetings were held in the USBM regarding low cost, low capital techniques for copper recovery and Larsen indicated there is a low key, but broadly-based support within the USBM for in-site leach research on copper deposits. He called to determine whether we were interested in this work.

I told him we had an extremely large, moderately well-drilled oxide copper deposit at depths in excess of 1,000 ft. which would be amenable to such work. I advised that we manage exploration on the project for a joint venture and that I would approach our partners to determine whether they would be willing to have in-situ test work conducted on the deposit. I made it clear that Asarco had no funds available for this work.

Larsen said they will be considering several deposits for a test and that the kind and amount of work remained to be determined. Funding, if it is available at all, might not be forthcoming until 1986.

Would you please inquire of Freeport if they are interested in a 100% USBM - funded in-place leach research program at Santa Cruz. Advise them this is merely an expression of general interest in the concept as a great number of details would remain to be determined (extent to which our exploration data would be made public, involvement of Hanna-Getty and environmental problems).

Very truly yours,

F. T. Graybeal

F. T. Graybeal

Telephone 10/15 [illegible] in Sudbury to them - JDS

Doug R. Cook
(702) 323-2251

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Reno, NV 89505

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cc: W. L. Kurtz

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ASARCO Southwestern Exploration Division

JDS

March 8, 1985

FILE MEMORANDUM

In-Place Leaching Review
Santa Cruz Project
Arizona

Mr. Colen, et al (see memo to R.L. Brown, Feb. 7, 1985, attached), will be in Casa Grande the week of March 11, 1985, to review the Hanna-Getty data.

They wish to review the Asarco-Freeport data at that time.

Asarco will show them The Lands data only with logs, assays, cross-section, and plan map of drill holes in the NE quarter of Sec. 13, T6S, R5E only, i.e., holes involved are SC-19, 22, 24, 35, 36, 37, 38, 39, 40, 46, 47, 49, 51, and 52 (14 holes). No other data at this time. No copies to be given to them nor can they make copies.

They can look at the available core, but they cannot take any of the core.

Though they may verbalize about many things, the present Asarco-Freeport status is:

1. we will not give up any equity in the deposit, and
2. if Colen, et al, can present a proposal and raise the necessary funds for 100% of the proposed work, i.e., suggested ten million dollars for the on-going research, then the deposit may be made available for that research.

No further information should be given to them at this time, nor promise in the future, nor even verbalizing of what other data (reports) Asarco may have on the deposit.

None of the data we show them should have any Hanna-Getty information, nor is it our desire to mention any knowledge of any Hanna-Getty information.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: W. L. Kurtz

SC Graybeal 6/7/85

A. Cohen et al in-place leach

B. Davidson - Northrup Sen . . . .

Government funded 5 hole test $ 10 mill test.

C. Momentum Government lobbist. for ASARCO is involved with funding the movies.

D. Government wants to "own" land.

for elec. Govern. (5-8 page single spaced resume of what in-place leaching is + 1-3 page of diagrams. Playing Davidson results.

down play "rubblized block caving"

explain the straight in-place leaching as of SC

FTG will send Congressional question & answer statements.

FILE MEMORANDUM

In-Place Leaching Review
Santa Cruz Project
Arizona

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James D. Bell

Attachment

Table 1. Data for review.

Plan, Sections, Logs, Assays of drill holes:
SC - 19, 22, 24, 35, 36, 37, 38, 39, 40, 44, 47,
49, 51, & 52. (14 holes).

February 7, 1985

ASARCO Incorpora

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SW Exploration

MEMORANDUM FOR: R. L. Brown

Santa Cruz Project
Arizona

I met today with Henry R. Colen, Joe Wargo, Frank M. Monninger, and Dave Baughman regarding in-place leaching of oxide copper at Santa Cruz. Mr. Colen and Mr. Wargo are both principals in the San Francisco Mining Associates. They propose formation of a company based on the Santa Cruz deposits and possibly the Casa Grande deposits of Hanna-Getty. This company would sell a certain amount of stock with proceeds used to finance a $10 million in-place leach test. The technology would partly incorporate Occidental's techniques developed at Van Dyke for which a modest royalty would be paid. Supervision would be through Ray Huff Associates and an associated company called ISL Ventures, Inc. ISL is at least partly bankrolled by Coeur d'Alene Mines.

I showed these gentlemen a number of cross sections and a drill map from The Lands. They were not shown any data relating to the Casa Grande Deposit. Mr. Colen has talked briefly with Tom Osborne regarding the proposed company and, although Asarco does not presently wish to give up equity in the Santa Cruz deposits there is no harm done by letting Mr. Colen proceed at his own risk with these discussions.

Mr. Colen has not yet seen the Hanna-Getty data but hopes to in the near future and would do so in Casa Grande. At the same time he would come to Tucson to review Asarco's data in greater detail at which time we would have him sign a Confidentiality Agreement. I have phoned Doug Cook of Freeport to advise him that Colen and Wargo have briefly seen limited data and that we will protect all further reviews with a Confidentiality Agreement.

F. T. Graybeal

F. T. Graybeal

Attach.

cc: W. L. Kurtz w/encl.
J. D. Sell w/encl.

ISL

ISL VENTURES, INC.

IN SITU LEACHING OF GOLD AND SILVER

235 MONTGOMERY ST., SUITE 2300, SAN FRANCISCO, CA 94104

TEL. (415) 433-7491

31 January 1985

In-Situ Leaching

Because of the very serious situation that exists today in the United States with regard to its mining industry, there is a strong feeling that something practical must be done to alleviate the problem.

To many of us professionals, one logical approach is the in-situ leaching of metals, bringing capital and operating costs down to where we can be competitive internationally in metal productions.

The application of ingenuity, high technology and the willingness to assume risks is what made the mining industry great in the past. Our reluctance to continue in this fashion has done much to exacerbate our problems today.

The importance of in-situ leaching of metals is emphasized by the following:

1) Potentially lower capital and operating costs.

2) Considerably reduced environmental impact since the only ground disturbance is the drilling of holes. The earth is not opened, nor the waste rock removed.

3) The time of development of a mining area is considerably reduced.

4) The strict definition of the term "ore" is greatly expanded and our metal resources may thereby be enlarged.

Our group is involved in this field with regard to precious metals (ISL Ventures, Inc.) and copper (The Copper Company). We will be seeking additional assistance from private industry and from the U.S. Government to make this approach a reality and to make our mining industry healthy once more.

Henry R. Colen

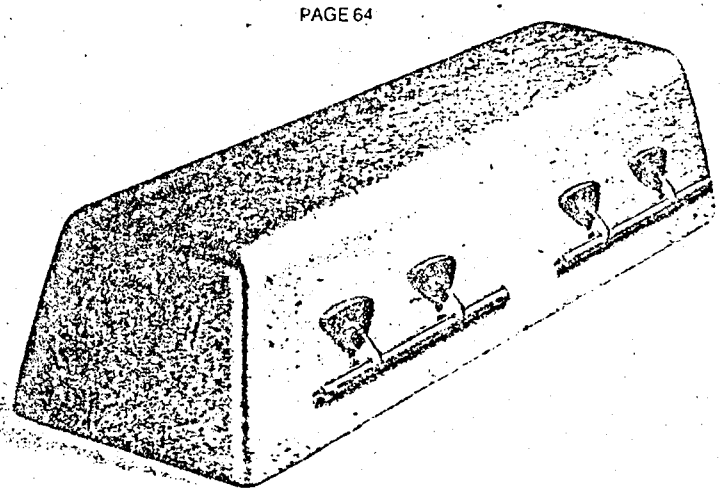
TONY O'REILLY OF HEINZ: HIS DAY HAS 57 VARIETIES PAGE 72

BusinessWeek

DECEMBER 17, 1984 A McGRAW-HILL PUBLICATION $2.00

THE DEATH OF MINING

PAGE 64



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February 7, 1985

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Attach.

cc: W. L. Kurtz w/encl.
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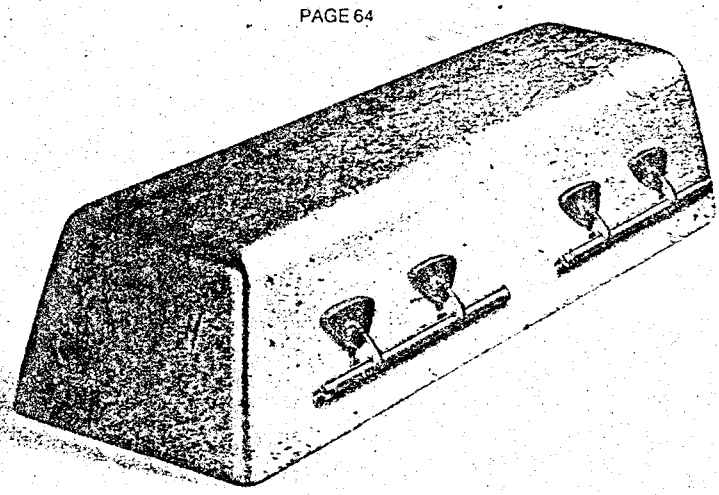

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P.O. Box 1310
Golden, CO 80402 Telex: 450661

ASARCO

W~~K~~K — JDS ~~JDS~~

Exploration Department
Frederick T. Graybeal
Chief Geologist

June 7, 1985

Mr. J. D. Sell, Manager
Southwestern Exploration Division
Tucson, Arizona

In-Place Leach Resume

Dear Mr. Sell:

As we discussed today over the phone, you will ask Mr. Kreis to prepare a draft resume of the in-place leach process as it relates to oxidized porphyry copper deposits. I'm thinking of something which is 5-7 pages long, single spaced, with all the appropriate diagrams. Mr. Kreis should feel free to plagiarize from any report in the Tucson Office files including those by Don Davidson.

Once Mr. Kreis has prepared the first draft, which he should begin without delay, it should be circulated to you, Mr. Kurtz, Mr. Brown, and I for review. I may also send a copy to Don Davidson. The final version will be sent to John Howerton, for distribution to various congressional staff members who are evaluating the possibility of government funding for in-place leach research. A transcript of a recent hearing involving Senator DeConcini and Bureau of Mines Engineers which was provided by John Howerton is attached for your general interest. This provides some idea of what has been said - not all of it correct.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

ATTACH.

CC: W. L. Kurtz
John B. Howerton
R. J. Muth

ASARCO Incorporated
JUN 10 1985
SW Exploration

ASARCO

Washington Office

June 7, 1985

F.T.G.
JUN 6 1985

Messrs. R.J. Muth
T.C. Osborne
R.L. Brown
F.T. Graybeal
NEW YORK OFFICE

VIA TELECOPY

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Attached are the responses from the Bureau of Mines to questions posed by Senator DeConcini at the time of the hearings on the Bureau's appropriations.

John B. Howerton

Attachment
(4 pages)

HRCR 16

QUESTIONS SUBMITTED BY SENATOR DENNIS DECONCINI

Question: What can you tell me about a process of mining copper called, "solution mining," that is, pumping water out of drill holes?

Answer: Solution mining, or in situ mining as it is commonly called in copper recovery operations, is a mining method where leach solutions are injected from the surface into an ore body in its original geologic setting. The leach solution dissolves the soluble minerals in the ore which are then pumped to the surface for processing. In situ mining is a broad term that describes both "true" in situ mining which recovers unmined underground deposits from a surface operation using drill holes to inject and recover the leach solutions, and the "modified" in situ technique that is used to increase resource recovery from previously mined operations where mineral values still remain in the deposit after underground mining is completed.

"True" in situ mining has a number of important advantages over conventional open-pit methods. There is no major surface disturbance with this technology; it is potentially safer, less energy intensive, and affects the environment in fewer ways than conventional methods. In situ mining has the potential to bring currently uneconomic, low-grade deposits into production at today's copper prices.

Question: Are there any copper deposits in the United States that could be dissolved or recovered by using this process? If so, where? How large are these resources?

Answer: Yes, the traditional copper producing states of Arizona, Nevada, New Mexico and Utah all have deposits that are prime candidates for in situ mining methods. Arizona alone has at least two billion tons of 0.4 percent copper ore with the potential for recovery by in situ mining methods. There are currently two operations in Arizona that are recovering copper by modified in situ leaching methods. The Lakeshore and the Miami Mines are recovering copper by in situ mining of previously block caved (underground mined) areas. A third operation, the San Manuel Mine, is actively pursuing plans to implement a modified in situ leach program to recover copper in the caved oxide materials located over the main sulfide ore body. While none of these are true in situ mining operations, i.e., recovery of mineral values from an unmined deposit from the surface, they do present a means to economically recover mineral values not recovered by underground mining methods. In addition, most active Arizona, New Mexico, Nevada, and Utah copper operations have a heap leaching copper recovery circuit in their processing plants or have copper oxides that are amenable to recovery by leaching technology. An estimated 6.6 million short tons of copper is contained in Arizona oxide deposits and approximately 20 million short tons of copper is contained in mixed sulfide-oxide deposits, located in Arizona. An additional 7.2 million short tons of copper is estimated to be contained in oxide resources in other Western states. In addition, because the in situ

mining method can be used at both large and small deposits, there are significant reserves in presently uneconomic smaller deposits that could be mined by in situ methods.

In-situ mining of copper has generally been limited to oxide ores. Sulfide copper minerals are generally much more difficult to leach. Sulfide mineral deposits, such as the common porphyry copper deposits, are also much more impermeable than oxide mineral deposits, inhibiting the circulation and recovery of leach solutions.

Question: Are we speaking of sizeable amounts of copper that could be recovered by this procedure?

Answer: Yes. We are not privy to all ore reserve estimates but believe the quantity is in excess of 25 million short tons of copper. Since 1980 copper production from heap and dump leach operations have accounted for 15 to 20 percent of Arizona's total copper production. The trend is for increased usage of leaching technology in general and in situ leaching in particular because of the relatively low production costs associated with this method.

Question: Is this a technology that has any future?

Answer: Yes. In situ mining has potential for recovering certain forms of copper, uranium, gold, and other mineral commodities.

Question: Has the Bureau or anyone else done any appreciable research on "solution mining?" If not, why not?

Answer: The Bureau has long recognized the potential of solution mining and the need for research to overcome the technical obstacles limiting the use of this new mining method. The Bureau began research in this area in 1972, first concentrating on advancing blasting technology to improve in situ copper leaching efficiency. From 1977 to 1983, the Bureau's effort focused on improving technology and restoration methods for the recovery of uranium by in situ mining. More recently the Bureau's program has emphasized a more fundamental research effort related to fluid flow in rock, to understand the in situ leaching process and to conceptualize advanced in situ mining systems.

Several of the major copper companies have conducted limited, site specific in situ mining research. In the early 1970's, Kennecott had major research program to develop in situ mining technology for its copper deposit near Safford, Arizona. The Kennecott research was discontinued because of unresolved technical obstacles such as sustaining an adequate concentration of copper in the recovered solutions; confining the leach solutions within the ore body; and a depressed copper market. Ranchers Exploration and Development Company, Phelps Dodge Corporation, Anaconda Minerals Company, and Cyprus Mines Corporation have done in situ research but it was site specific for the development of a particular deposit. Modified in situ mining is being conducted at the Lakeshore and Miami mines in Arizona.

Occidental

Question: Assuming adequate technology can be developed, is it possible that in situ mining of copper could be carried out more economically than the present method of operating U. S. open pit copper mines?

Answer: The mining of copper by in situ methods could be more economical compared to present open pit mining methods if technical obstacles to achieving an acceptable percent of copper recovery can be overcome. In situ leaching would have basic cost advantages because it does not require the loading, hauling and crushing of ore, moving and storage of waste materials, and extensive milling operations that conventional surface and underground mining require.

Question: Has the Bureau sponsored any research and development in this field in the past? Is further R & D required? Do you presently have any funds budgeted to continue these R & D efforts. If not, what would it cost to test the process at some particular site? What kind of research would this entail?

Answer: Since the early 1970's, the Bureau has augmented its in situ research effort with numerous cooperative agreements with industry to help advance this technology. Currently, the Bureau is conducting long-term investigations of the technical obstacles which must be resolved before field tests could be undertaken. It is planned that these investigations will continue over the next several years at the current level of funding of approximately $500K per year. No demonstration projects are planned at this time. If it were determined that a demonstration project would be appropriate, the planned laboratory tests would still have to be completed before starting any small scale pilot tests and later pre-commercial stage demonstration to prove technical feasibility. Estimating the future costs of such small-scale pilot tests and pre-commercial stage demonstrations is not possible at this time because the costs would depend on the outcome of the laboratory investigations aimed at overcoming currently known technical obstacles.

Question: In your view, could in situ leaching prove to have fewer adverse environmental effects than present recovery methods? Please explain the environmental benefits and/or concerns relative to solution mining.

Answer: In situ copper mining has the potential to be safer, less energy intensive, and have fewer environmental effects than conventional technology. For example, there are no tailings disposal areas developed by in situ methods, and no open pits or dumps would be created. Since the copper is in solution and ready for modern hydrometallurgy techniques, no smelting or refining would be required.

The biggest technical concerns with in situ mining are the ability to recover and contain the leach solution so as to prevent groundwater contamination and to sustain adequate metal concentrations in the recovered solution. A significant portion of recent Bureau research has addressed this problem for both copper and uranium. The objective of this research is to contain the leach solutions within the mineralized zone during in situ and to flush

the zone free of leach solutions at the conclusion of mining in order to minimize the impact on the quality of the surrounding groundwaters and maximize resource recovery.

Question: Are there any known mineral deposits in Southern Arizona that might lend themselves to in situ leaching?

Answer: The copper resources of Southern Arizona have the greatest potential for advancing in situ mining technology. Large scale "oxide" deposits are appropriate for advancing this technology in copper by using modified in situ technology to recover copper from Noranda's Lakeshore Mine, Inspiration's Miami Mine, Newmont's San Manuel Mine, Phelps Dodge's Safford Mine, ASARCO's Casa Grande Mine, and the Hanna-Getty Oil Joint Venture at Casa Grande. In addition to copper, other Arizona mineral deposits such as gold, silver, and uranium may lend themselves to in situ mining methods.

Question: Could you provide for the record an estimate of the cost of the recovery of copper per pound by solution mining versus open pit mining?

Answer: It is very difficult to estimate the costs of a commercial scale true in situ mining operation; however, if the technology were developed and R&D costs not included, the Bureau believes that the costs of recovery of copper per pound by true in situ mining would be 25 to 30 percent less than by open pit mining. In situ mining technology has the potential to be competitive at today's copper prices.

Question: What is the likelihood of the transferral of knowledge from other applications or techniques in the movement of fluids?

Answer: The transferral of advanced knowledge from other applications and the evaluation of techniques to in situ mining has been an ongoing and integral part of the Bureau's research program. For example, the Bureau has utilized advanced oil field drilling and completion technology in its research, which resulted in five Bureau patents. In addition, results of this research have potential applications in other areas. Research on the movement of fluid through fractured crystalline materials would have potential application to the radioactive waste disposal problem. Results obtained through Bureau research on in situ mining could be used in conjunction with research results from other government agencies and private industries to gain an understanding of fluid flow in mineral deposits. Information gained from understanding and controlling fluid movement in rock could have significant and direct application for reducing mine dewatering problems in metal, non-metal and coal mining operations. There is also a significant potential for the development of advanced geophysical techniques to locate fluids in fractured rock which would have direct application to the detection and location of fluid movement in hazardous waste dumps.

JDS

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

June 7, 1985

Mr. J. D. Sell, Manager
Southwestern Exploration Division
Tucson, Arizona

In-Place Leach Resume

Dear Mr. Sell:

As we discussed today over the phone, you will ask Mr. Kreis to prepare a draft resume of the in-place leach process as it relates to oxidized porphyry copper deposits. I'm thinking of something which is 5-7 pages long, single spaced, with all the appropriate diagrams. Mr. Kreis should feel free to plagiarize from any report in the Tucson Office files including those by Don Davidson.

Once Mr. Kreis has prepared the first draft, which he should begin without delay, it should be circulated to you, Mr. Kurtz, Mr. Brown, and I for review. I may also send a copy to Don Davidson. The final version will be sent to John Howerton, for distribution to various congressional staff members who are evaluating the possibility of government funding for in-place leach research. A transcript of a recent hearing involving Senator DeConcini and Bureau of Mines Engineers which was provided by John Howerton is attached for your general interest. This provides some idea of what has been said - not all of it correct.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

ATTACH.

CC: W. L. Kurtz
John B. Howerton
R. J. Muth

ASARCO Incorporated
JUN 10 1985
SW Exploration

JDS

Henry G. Kreis
ASARCO Incorporated

June 24, 1985

SOLUTION COPPER MINING

Throughout the twentieth century the American Mining industry has sought and developed lower and lower cost methods of recovering copper from the ground. With the current, severely depressed copper prices, the need for lower cost methods is more critical than ever. The American mining industry needs a radically lower cost method, and it needs it now before such a method is developed and implemented by foreign competition.

Solution mining of copper from soluble copper deposits is such a low cost method, and it has been used to a limited degree in conjunction with conventional mining methods. Solution mining is the only type of domestic copper mining that is profitable at today's severely depressed copper prices. But, for the most part, current day solution mining technology limits its use to extracting soluble copper from rocks broken up but not consumed by conventional mining operations. Thus its present and continued use is strongly dependent on the continuing use of conventional mining methods. For without a continual supply of broken up rock to process, solution copper mining would no longer be feasible using today's technology.

The future of solution copper mining, and perhaps that of the American copper mining industry, rests in developing the technology of applying solution mining to rocks undisturbed by conventional mining methods. That is to say, soluble copper would be extracted from rock in its natural state; and after solution mining ceased, the rock would still be in its natural state less, of course, its former copper content. Developing the technology to solution mine copper from rock in its natural state would free solution copper mining from its dependence on conventional mining techniques that are currently unprofitable. Most importantly, it would allow the development of a large number of soluble copper deposits in the western U.S.A. that are sitting idle because they are not profitable with conventional mining methods, nor are they in a situation that will cause them to be broken up by an adjoining conventional mining operation.

This paper is being written to encourage further interest in the field of solution mining; and, more specifically, to encourage developing the technology to solution mine copper from rock in its natural state. An understanding of the technology and applications of solution copper mining is most easily achieved starting with some of the basic geologic characteristics of a copper deposit.

Geology

The geologic characteristics of a copper deposit are a contributing factor to how the deposit is to be mined. There are, for example, two general classifications of copper minerals that determine how the copper is to be recovered from the rock.

The most important classification, with respect to the topic of this paper, is a group of minerals in which the contained copper metal can be dissolved in water containing 1% acid. The mining industry calls this group of soluble copper minerals--"oxide" minerals. It is from this group of minerals, the oxide minerals, that present day solution mining recovers copper, and this process is called "leaching" by the mining industry. Commonly leached, oxide minerals are chrysocolla, azurite, malachite, atacamite, and chalcocite.

The second copper mineral classification is that of the "sulfide" group. All of the sulfide minerals, with the exception of chalcocite, are insoluble in water containing 1% acid. The most common minerals of this group are chalcopyrite, bornite, and chalcocite. It is from these minerals that conventional mining recovers copper. In the future, technology may find a way to dissolve these minerals so that these minerals too can produce copper by solution mining methods.

Besides the types of copper minerals, there is another geologic feature of importance to solution mining. It is the presence of fractures. Without fractures the copper bearing rocks would be totally impervious to water, and solution mining would be impossible unless the rock was mined and crushed to the size of sand. The fractures allow the ingress-egress of the water solution so that it can make contact with the copper minerals, dissolve the copper, and move the dissolved copper outside the rock to a place where the copper can be recovered from the solution.

All copper bearing rocks are naturally fractured to some degree, and it is this fracturing upon which the future of solution mining rests. Too little is known about natural fracturing in copper deposits, to know if it will allow solution mining of its copper. We do know that rocks fractured, broken, and moved during mining operations readily allow the ingress-egress of leach solutions and, thus, are very amenable to solution mining. Whether or not natural fracturing is suitable for solution copper mining can only be determined by field test work. This will be discussed later in this paper.

Solution Mining Methods

Solution copper mining today is a simple and inexpensive process. It involves putting water with 1% acid on top of copper bearing rock that has been fractured, broken, and moved during conventional mining operations. The solution flows by gravity through the rock pile, dissolving copper as it passes. The copper bearing solutions flow out the bottom of the rock pile where they are collected and sent to a processing plant. The most popular, large-scale processing plant is a solvent extraction-electrowin plant. This type of plant removes the copper from solution and puts it in a directly saleable form of copper, and it does this at low cost.

Adapting this solution copper mining to natural rock, rock not broken by a mining operation, will require developing new techniques of solution application and recovery. Because most copper deposits are 100's of feet beneath the surface of the ground, solution application and recovery would most likely be done with the use of drill holes, say six to twelve inches in diameter. Solutions would be put into the copper bearing rocks with injection drill holes, and the resulting copper bearing solutions would be collected in recovery drill holes.

The actual solution mining process would be as is shown in Figure 1. In this figure the water solution of weak acid leaves the injection drill hole and moves out into the rock through natural fractures, Step A. In Step B the solution comes in contact with the soluble copper minerals (oxide copper minerals), and the copper is dissolved. The solution, now loaded with copper, continues through the fractures, Step C, and collects in the recovery well where it is pumped to the surface of the ground, Step D. In Step E a plant, most likely a solvent extraction-electrowin plant, extracts the copper from solution, and the copper free solution is returned to the injection well, Step F, where it will repeat the process.

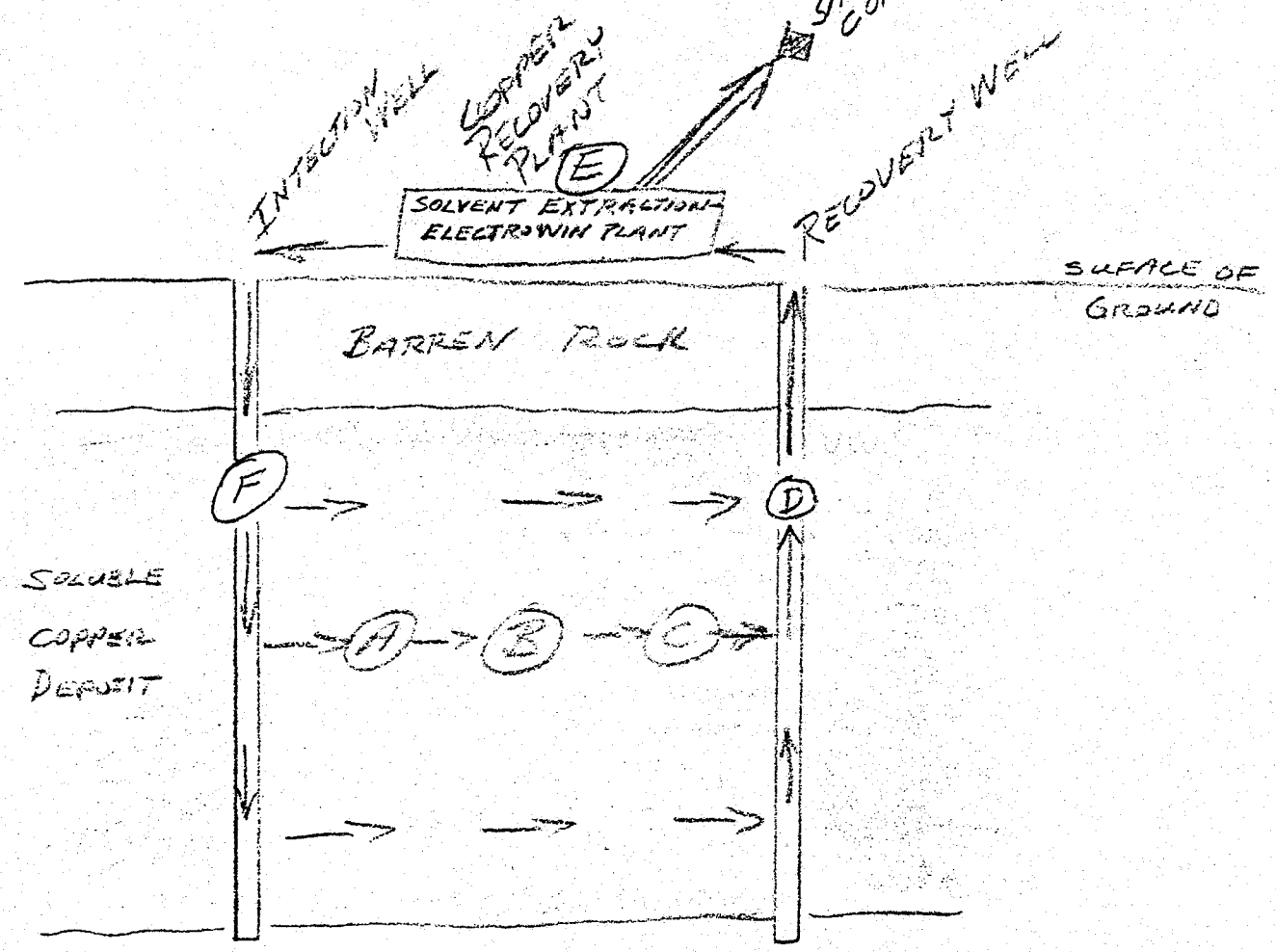
The solution mining process is a relativey simple process, but not all of the steps shown in Figure 1 have been proven to work. Both the copper recovery plant (Step E) and the dissolving of copper (Step B) are proven processes widely used in the mining industry today. While injection and recovery wells have not been used in the commercial production of copper, there is sufficient technology in the minerals and petroleum industry to believe they will work satisfactorily. What remains to be proven is: (1) the fractures are such that they will allow commercial quantities of solution to move through the rock (Steps A and C), and (2) the solution will move through the rock in a sufficient abundance of fractures to make contact with most of the copper minerals. These two factors are very poorly known in our current state of knowledge, and only field testing and pilot plants will demonstrate whether they will work on a commercial basis.

Developing the Technology

The American copper mining industry has made attempts to develop solution mining of copper from rock in its natural state, but these attempts were never carried out with sufficient work to determine whether or not the process is commercially feasible. The attempts were made by large corporations on big, Arizona copper deposits. In one case, at Miami, Arizona, solutions from an injection well moved through the rock dissolving copper and collected in a recovery well. The test was successful and justified plans for a more comprehensive, fifteen million dollar continuation of test work. However, falling copper prices and an adverse land situation caused the termination of test work in 1980.

Since the termination of that test, there has been little or no follow-up work on that deposit or any other American copper deposit. The reason being the depressed copper prices and the flood of imported foreign copper. American companies have been scrambling to get out of the copper business, and those remaining in it, are struggling to survive. Those surviving in the copper mining business will recognize the inherent difficulties of developing a new mining technique such as solution mining copper from natural rock.

FIGURE 1 SOLUTION COPPER MINING SHOWN IN CROSS SECTION.



STEP (A) Solution from recovery well goes into natural fractures.

(B) Solution contacts copper mineral and dissolves copper.

(C) Copper-bearing solution moves to recovery well.

(D) Copper-bearing solution goes to copper recovery plant.

(E) Copper is recovered in saleable form.

(F) Solution is returned to recycle through steps (A) to (E).

(Rough draft)

One obvious answer to this problem is for a number of companies to pool their soluble copper deposits and some risk capital in a joint venture to develop and operate solution copper mines. But the times are not conducive to initiating such a venture. Alternative answers to this situation would have to include some sort of direct or indirect help from the United States Government. In formulating answers to the problem, industry and/or government will need to know about the step-by-step process involved in developing solution copper mining and the cost of each step.

Development Test Program

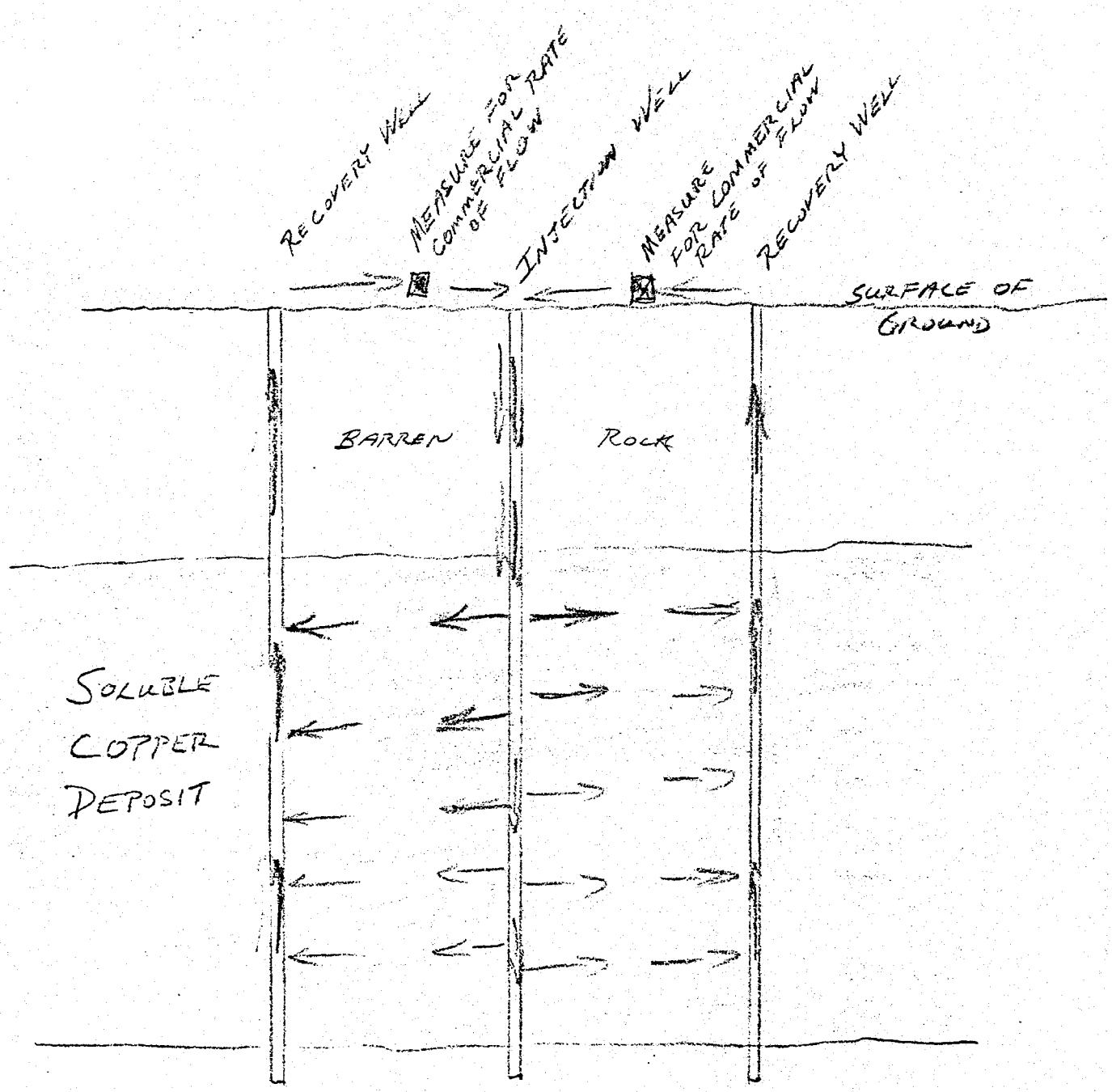
Solution copper mining can only be developed and tested on a soluble copper deposit in the field. There is no way it can be simulated on a computer, done in a laboratory, or done in the ground where a copper deposit does not exist. A suitable soluble copper deposit must be selected. Once this task has been accomplished, test work will proceed in two distinctly separate steps with the success of the first step, Phase I, justifying the second, Phase II.

Phase I will establish that commercial amounts of solution can move through the fractures in the natural rock from the injection well to the recovery well. Once this is accomplished, Phase II will evaluate how well the solution is going through the rock and recovering copper. Both Phase I and Phase II will take five years to complete, and the total cost will be $18,000,000. The completion times and costs of each phase are summarized in Table 1. The actual test setup for each phase is displayed in Figure 2 and Figure 3. Success in Phase II would lead directly into a small scale solution copper operation that would gradually develop into a full scale operation commensurate with the size of the copper deposit.

Table 1. Development Test Program

Phase	Objective	Test Setup	Time	Cost
I	Establish and measure the flow of solution from the injection well to the recovery well.	One injection well and two recovery wells set in copper bearing rocks.	1½ yrs.	$3,000,000
II	Demonstrate ability of solution to recover commercial amounts of copper.	Two injection wells and six recovery wells.	2½ yrs.	$15,000,000
		Total	5 yrs.	$18,000,000

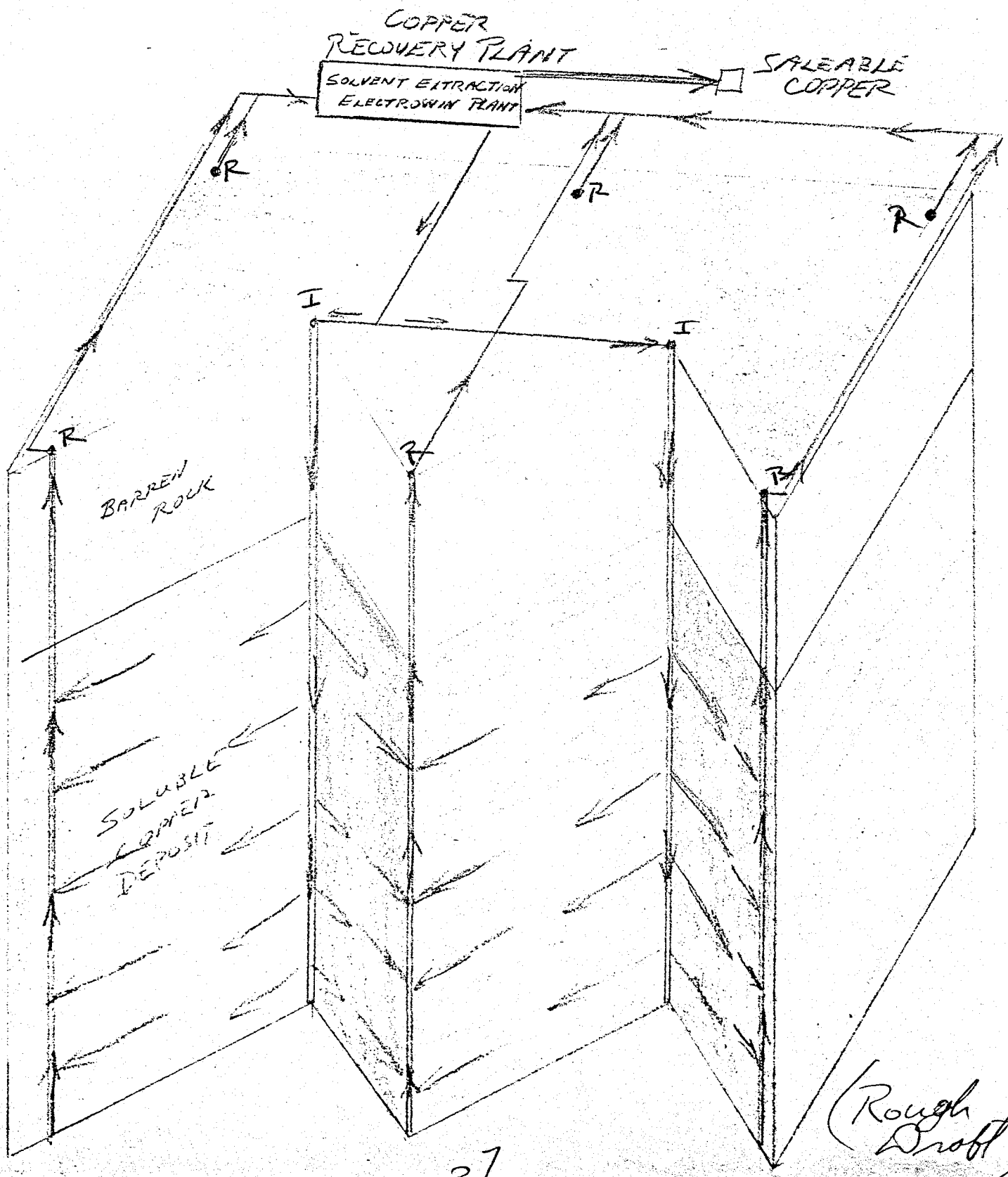
FIGURE 2 PHASE I TEST OF SOLUTION FLOW



(Rough Draft

FIGURE 3 TEST OF COPPER RECOVERY

• I INJECTION WELL
• R RECOVERY WELL
⟶ COPPER BEARING SOLUTION
⟶ WATER WITH 10% ACID



(Rough Draft)

Full Scale Operation

A typical full scale operating solution copper mine is envisioned as having 300 injection and recovery wells. In addition there would be several dozen monitor wells about the periphery of the operation to insure safeguarding the environment and preventing the loss of valuable copper bearing solutions. From 10,000 to 40,000 tons per year of saleable copper would be produced. The actual amount of production would be determined by the size of the deposit and the rate at which the solution can extract the copper from the rocks.

The total capital cost to develop such a mine is estimated at $50,000,000 to $100,000,000. Unlike the all-at-once lay out of capital for developing a conventional mine, a solution copper mine would develop with an expenditure of $20,000,000 at a time as solution copper mining proved itself commercially successful.

The operating costs of a solution copper mine are estimated at 20% to 40% less than the cost of conventional mining. More importantly, solution copper mining offers the potential of operating profitably at today's depressed copper prices.

The cost efficiency of solution copper mining is due to the simplicity of the method. Compared to a conventional copper mine, one ton of saleable copper from a solution copper mine will eliminate the need to mine 750 tons of waste rock and copper ore, the milling of 150 tons of copper ore, and the costly smelting and refining of copper from 3 tons of concentrated copper minerals. Since there are tremendous amounts of soluble copper reserves in the western United States, the total cost savings of utilizing solution copper mining could be enormous.

A Test Deposit

Choosing a soluble copper deposit for the test development of solution copper mining will be a relatively easy task since there are dozens of such deposits in the western United States. In Arizona alone, there are more than a dozen large deposits collectively amounting to well in excess of 15,000,000 tons of copper. Owners of these deposits include the Kennecott Copper Corporation, ASARCO Incorporated, Phelps Dodge Corporation, Freeport Copper Company (Freeport - McMoRan), Newmont, Hudson Bay (acquired Inspiration Consolidated Copper Company), Van Dyke Copper Company, Getty Oil, and Hanna Mining Company.

Amongst all the soluble copper deposits, the best suited deposit is in central Arizona just west of the town of Casa Grande. It has ideal technical characteristics including a highly soluble copper mineralogy (atacamite and chrysocolla), fracturing, a favorable host rock lithology, isolation from acquifers, and an excellent location. Furthermore, it contains in excess of 5,000,000 tons of copper in soluble form which makes it the largest known soluble copper deposit in the world. The ownership of this deposit is divided between two joint ventures composed of Asarco-Freeport and Hanna-Getty. The Asarco-Freeport joint venture is known to be interested in solution copper mining. In fact ASARCO Incorporated allowed the U.S.B.M. to conduct some very preliminary solution mining test work on its soluble copper reserves. So it is

highly likely that most or all of this deposit could be made available for the test development of solution copper mining.

Summary and Conclusion

Solution mining of soluble copper from undisturbed natural rock would be a tremendous technological and economical breakthrough for the mining industry. It has the potential of being economic at today's copper prices, and could make profitable mining operations out of many copper deposits that would never have been mined conventionally, even at high copper prices.

The technology of solution mining copper from natural rock has yet to be totally proven. Steps B and E in Figure 1 have been proven to work time and again in the solution mining of copper from rocks broken during conventional mining operations. Steps D and F are widely used in industrial operations other than solution copper mining, and are expected to be readily adaptable to solution copper mining. Steps A and C have yet to be tested and proven. Steps A and C are simply the process of moving the solution through the fractures in the rock in such a way that commercial amounts of copper become dissolved in the solution.

The only way to test and prove Steps A and C is to conduct test work on a soluble copper deposit. A two phase test is proposed. Phase I (Figure 2) will test the amount of solution that can move through the rock fractures. Phase I will take 1½ years to complete, and it will cost $3,000,000. If Phase I is successful, Phase II (Figure 3) will be conducted to prove commercial amounts of copper can be recovered by the solution mining process. Phase II will cost $15,000,000 and take 2½ years of time to complete. If Phase II is successful, the test work program will be gradually upscaled with continuing success until a full scale solution mining operation is achieved.

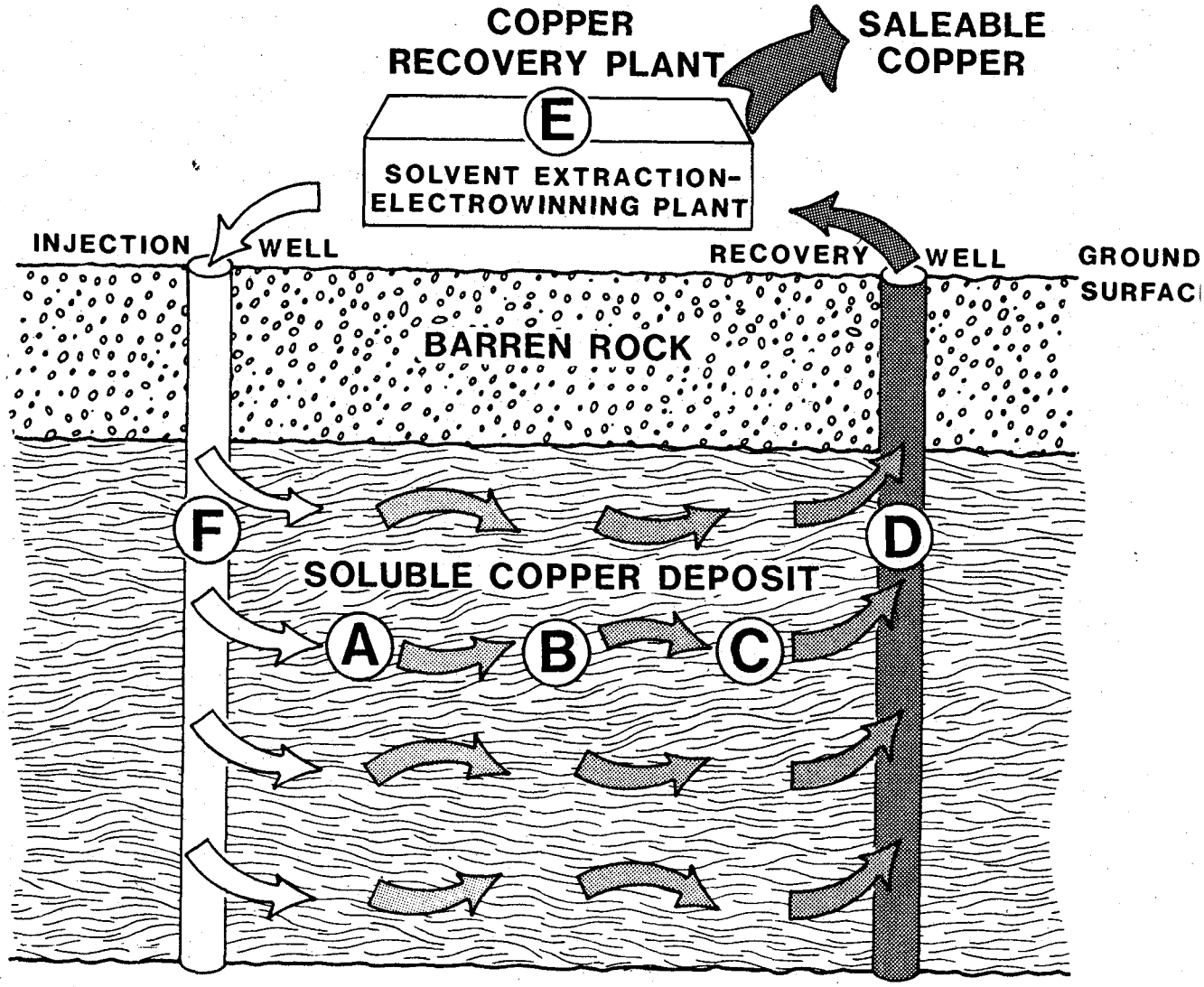
The best and largest soluble copper deposit upon which to conduct Phase I and Phase II test work is located near Casa Grande, Arizona. This deposit contains over 5,000,000 tons of copper in highly soluble copper minerals. A joint venture of Asarco-Freeport owns a large portion of this copper deposit and is interested in solution copper mining. The joint venture would consider any proposals to allow Phase I and Phase II to be conducted on its property.

It is recommended that the copper industry and/or the U.S. Government find a way to conduct Phase I and Phase II test work. There are basically three ways for the test work to proceed. First is for one company having sufficient financial resources and a sufficiently large soluble copper deposit to justify taking the risk. But, the chances of this happening are highly unlikely, for no one company or joint venture has undertaken this challenge or has indicated the intent to do so. A second way is for a half dozen companies to pool their soluble copper deposits and financial resources in a large joint venture. Unfortunately, such a joint venture is as difficult and risky to organize and operate as is the task of developing a new mining technique. A third way is for the U.S. Government to develop the technology to a point where industry is willing to invest in the utilization of such technology. This point would

be at the successful completion of Phase II. While it will cost $18,000,000 to reach this point, the Government stands to reap the benefits of this expenditure many times over and over. For, if solution copper mining of natural rock is as profitable as it potentially can be, there will be plentiful amounts of profits for taxation. Additional benefits would include a return to profitability in the domestic copper industry, and lower cost copper for the consumer.

FIGURE 1

SOLUTION COPPER MINING
SHOWN IN CROSS SECTION



STEP: (A) SOLUTION FROM INJECTION WELL GOES INTO NATURAL FRACTURES.

(B) SOLUTION CONTACTS COPPER MINERAL AND DISSOLVES COPPER.

(C) COPPER-BEARING SOLUTION MOVES TO RECOVERY WELL

(D) COPPER-BEARING SOLUTION GOES TO COPPER RECOVERY PLANT

(E) COPPER IS RECOVERED IN SALEABLE FORM.

(F) SOLUTION IS RETURNED TO RECYCLE THROUGH STEPS A THROUGH F.

FIGURE 2

PHASE 1 TEST OF SOLUTION FLOW

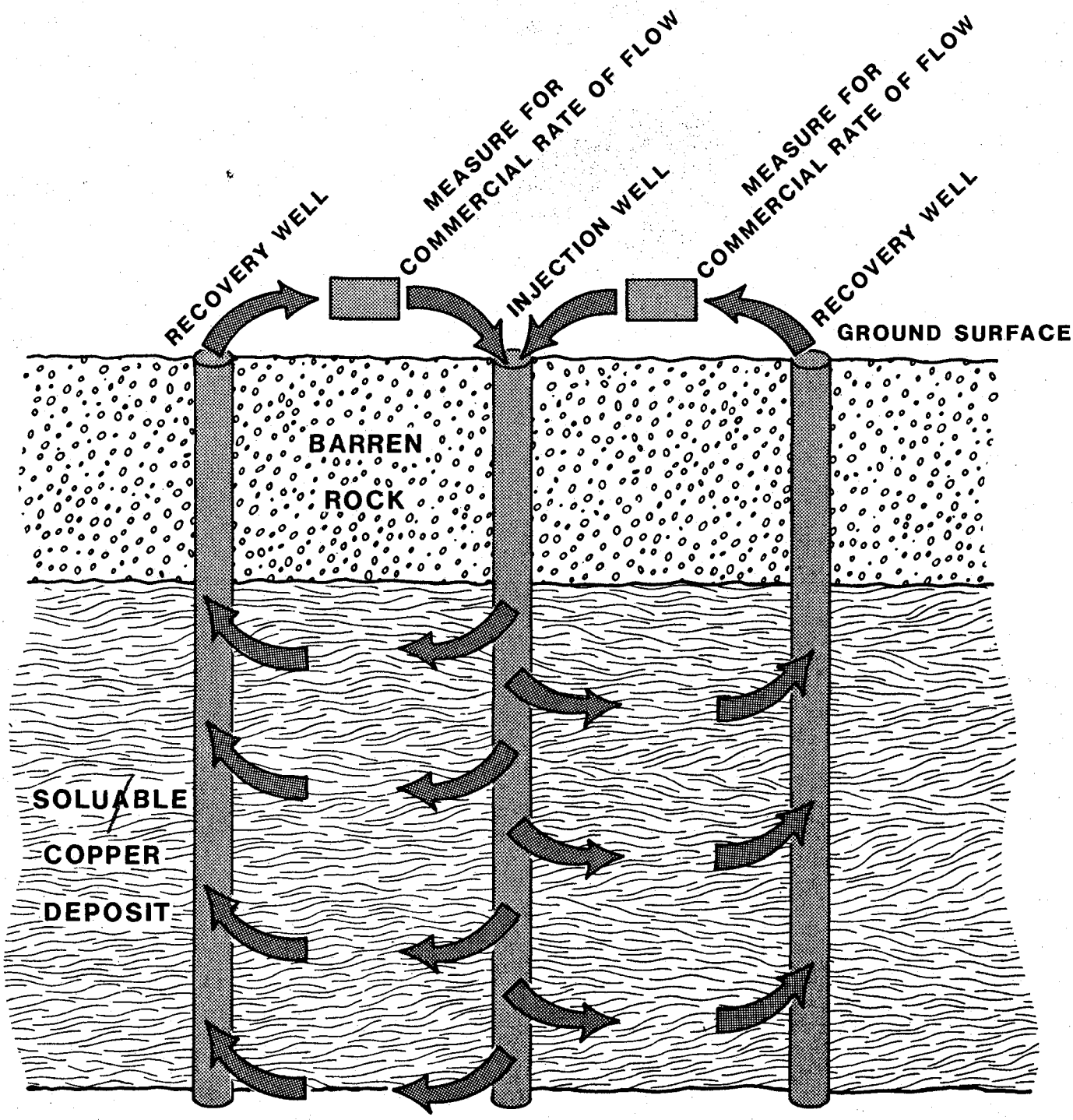
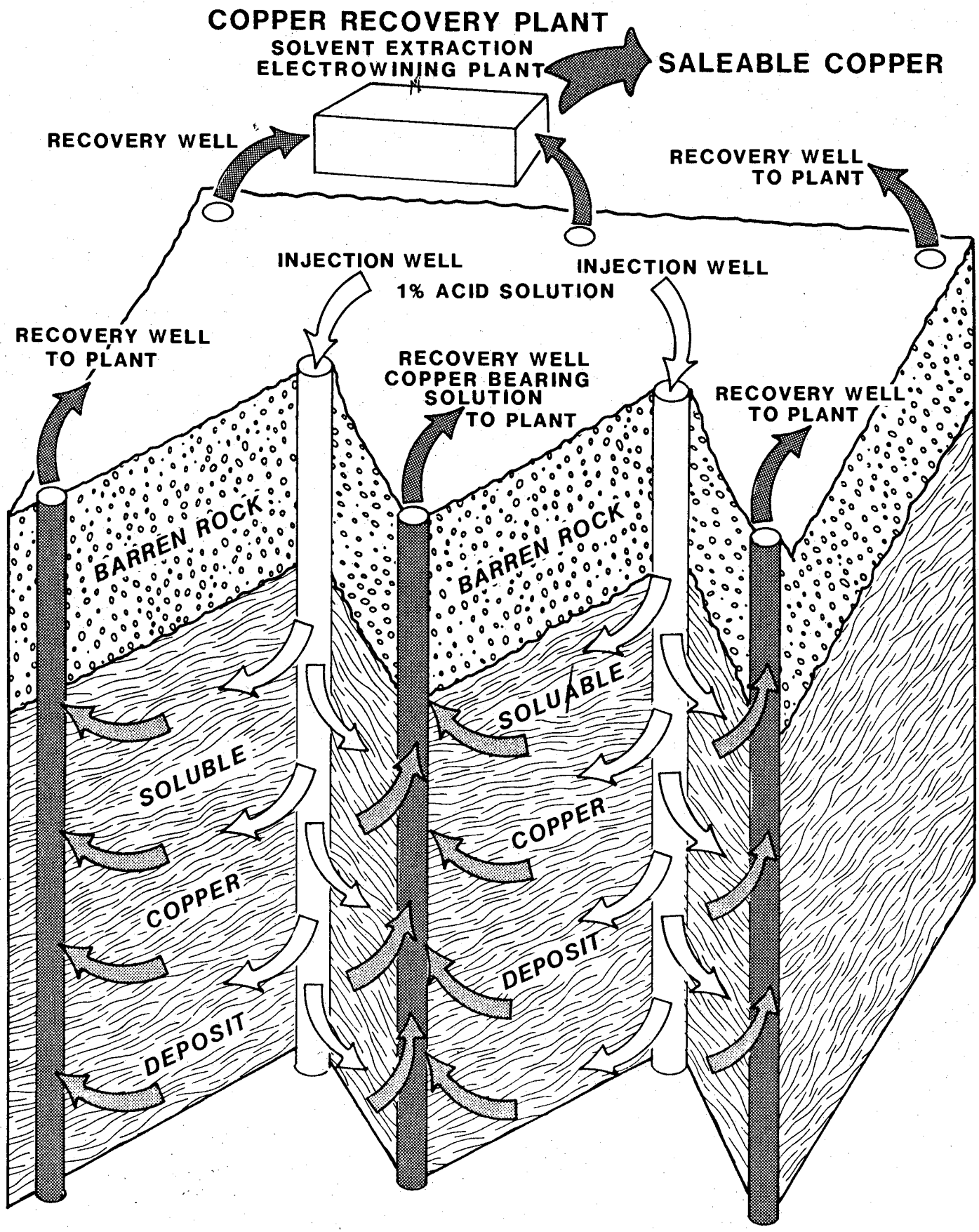


FIGURE 3

TEST OF COPPER RECOVERY



ASARCO

Southwestern Exploration Division

JDS

July 2, 1985

F. T. Graybeal
New York Office

H. G. Kreis' Report
Solution Copper Mining

Attached is H. G. Kreis' report on Solution Copper Mining in reply to your request.

Kreis has covered the whole ball of wax and I'm not sure this is what you wanted. However, I believe the Figures show the process quite well.

James D. Sell

James D. Sell

JDS:mek
Att.

cc: W. L. Kurtz
H. G. Kreis

Henry G. Kreis
ASARCO Incorporated

June 24, 1985

SOLUTION COPPER MINING

Throughout the twentieth century the American Mining industry has sought and developed lower and lower cost methods of recovering copper from the ground. With the current, severely depressed copper prices, the need for lower cost methods is more critical than ever. The American mining industry needs a radically lower cost method, and it needs it now before such a method is developed and implemented by foreign competition.

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The future of solution copper mining, and perhaps that of the American copper mining industry, rests in developing the technology of applying solution mining to rocks undisturbed by conventional mining methods. That is to say, soluble copper would be extracted from rock in its natural state; and after solution mining ceased, the rock would still be in its natural state less, of course, its former copper content. Developing the technology to solution mine copper from rock in its natural state would free solution copper mining from its dependence on conventional mining techniques that are currently unprofitable. Most importantly, it would allow the development of a large number of soluble copper deposits in the western U.S.A. that are sitting idle because they are not profitable with conventional mining methods, nor are they in a situation that will cause them to be broken up by an adjoining conventional mining operation.

This paper is being written to encourage further interest in the field of solution mining; and, more specifically, to encourage developing the technology to solution mine copper from rock in its natural state. An understanding of the technology and applications of solution copper mining is most easily achieved starting with some of the basic geologic characteristics of a copper deposit.

Geology

The geologic characteristics of a copper deposit are a contributing factor to how the deposit is to be mined. There are, for example, two general classifications of copper minerals that determine how the copper is to be recovered from the rock.

The most important classification, with respect to the topic of this paper, is a group of minerals in which the contained copper metal can be dissolved in water containing 1% acid. The mining industry calls this group of soluble copper minerals--"oxide" minerals. It is from this group of minerals, the oxide minerals, that present day solution mining recovers copper, and this process is called "leaching" by the mining industry. Commonly leached, oxide minerals are chrysocolla, azurite, malachite, atacamite, and chalcocite.

The second copper mineral classification is that of the "sulfide" group. All of the sulfide minerals, with the exception of chalcocite, are insoluble in water containing 1% acid. The most common minerals of this group are chalcopyrite, bornite, and chalcocite. It is from these minerals that conventional mining recovers copper. In the future, technology may find a way to dissolve these minerals so that these minerals too can produce copper by solution mining methods.

Besides the types of copper minerals, there is another geologic feature of importance to solution mining. It is the presence of fractures. Without fractures the copper bearing rocks would be totally impervious to water, and solution mining would be impossible unless the rock was mined and crushed to the size of sand. The fractures allow the ingress-egress of the water solution so that it can make contact with the copper minerals, dissolve the copper, and move the dissolved copper outside the rock to a place where the copper can be recovered from the solution.

All copper bearing rocks are naturally fractured to some degree, and it is this fracturing upon which the future of solution mining rests. Too little is known about natural fracturing in copper deposits, to know if it will allow solution mining of its copper. We do know that rocks fractured, broken, and moved during mining operations readily allow the ingress-egress of leach solutions and, thus, are very amenable to solution mining. Whether or not natural fracturing is suitable for solution copper mining can only be determined by field test work. This will be discussed later in this paper.

Solution Mining Methods

Solution copper mining today is a simple and inexpensive process. It involves putting water with 1% acid on top of copper bearing rock that has been fractured, broken, and moved during conventional mining operations. The solution flows by gravity through the rock pile, dissolving copper as it passes. The copper bearing solutions flow out the bottom of the rock pile where they are collected and sent to a processing plant. The most popular, large-scale processing plant is a solvent extraction-electrowin plant. This type of plant removes the copper from solution and puts it in a directly saleable form of copper, and it does this at low cost.

Adapting this solution copper mining to natural rock, rock not broken by a mining operation, will require developing new techniques of solution application and recovery. Because most copper deposits are 100's of feet beneath the surface of the ground, solution application and recovery would most likely be done with the use of drill holes, say six to twelve inches in diameter. Solutions would be put into the copper bearing rocks with injection drill holes, and the resulting copper bearing solutions would be collected in recovery drill holes.

The actual solution mining process would be as is shown in Figure 1. In this figure the water solution of weak acid leaves the injection drill hole and moves out into the rock through natural fractures, Step A. In Step B the solution comes in contact with the soluble copper minerals (oxide copper minerals), and the copper is dissolved. The solution, now loaded with copper, continues through the fractures, Step C, and collects in the recovery well where it is pumped to the surface of the ground, Step D. In Step E a plant, most likely a solvent extraction-electrowin plant, extracts the copper from solution, and the copper free solution is returned to the injection well, Step F, where it will repeat the process.

The solution mining process is a relativey simple process, but not all of the steps shown in Figure 1 have been proven to work. Both the copper recovery plant (Step E) and the dissolving of copper (Step B) are proven processes widely used in the mining industry today. While injection and recovery wells have not been used in the commercial production of copper, there is sufficient technology in the minerals and petroleum industry to believe they will work satisfactorily. What remains to be proven is: (1) the fractures are such that they will allow commercial quantities of solution to move through the rock (Steps A and C), and (2) the solution will move through the rock in a sufficient abundance of fractures to make contact with most of the copper minerals. These two factors are very poorly known in our current state of knowledge, and only field testing and pilot plants will demonstrate whether they will work on a commercial basis.

Developing the Technology

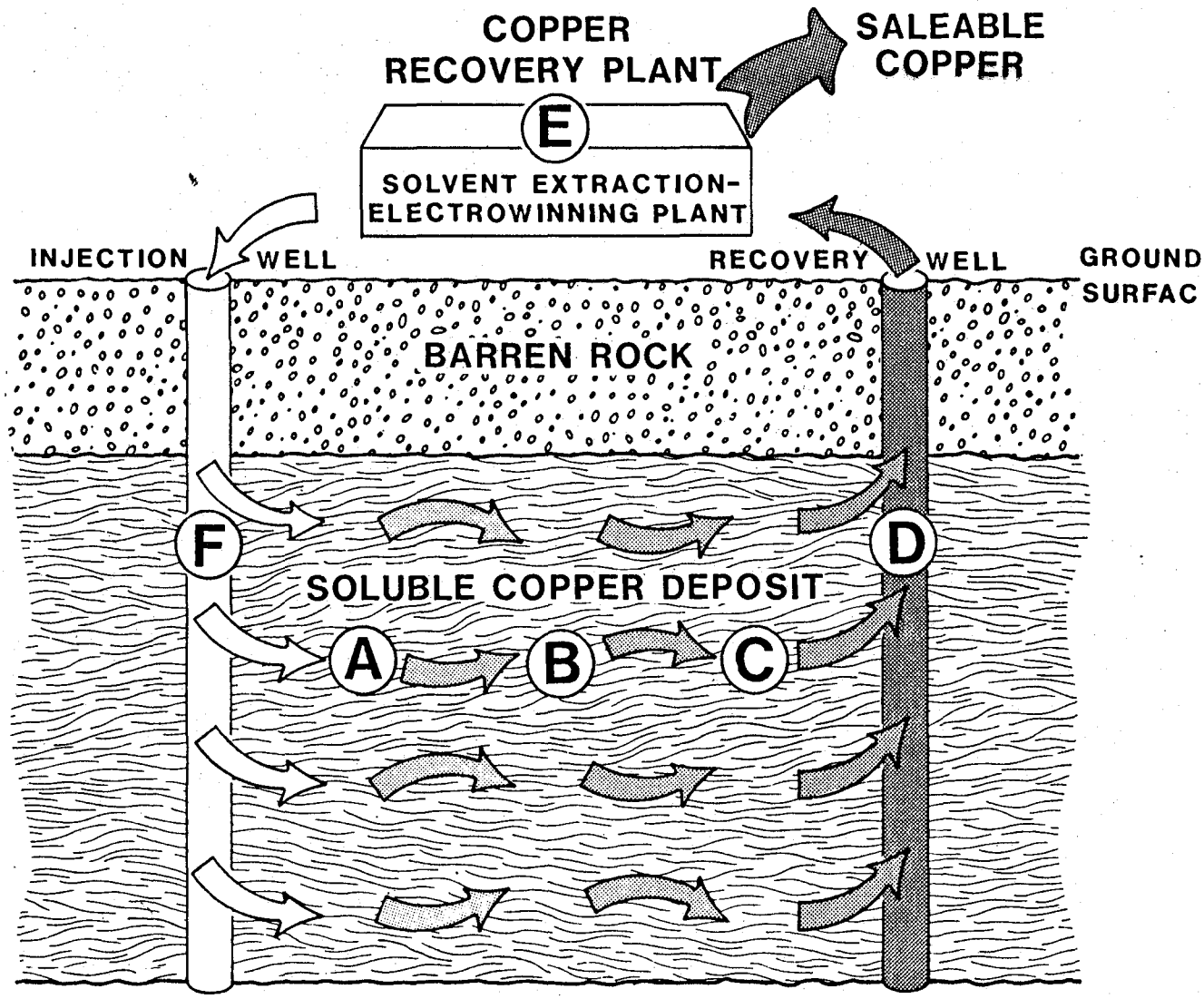
The American copper mining industry has made attempts to develop solution mining of copper from rock in its natural state, but these attempts were never carried out with sufficient work to determine whether or not the process is commercially feasible. The attempts were made by large corporations on big, Arizona copper deposits. In one case, at Miami, Arizona, solutions from an injection well moved through the rock dissolving copper and collected in a recovery well. The test was successful and justified plans for a more comprehensive, fifteen million dollar continuation of test work. However, falling copper prices and an adverse land situation caused the termination of test work in 1980.

Since the termination of that test, there has been little or no follow-up work on that deposit or any other American copper deposit. The reason being the depressed copper prices and the flood of imported foreign copper. American companies have been scrambling to get out of the copper business, and those remaining in it, are struggling to survive. Those surviving in the copper mining business will recognize the inherent difficulties of developing a new mining technique such as solution mining copper from natural rock.

FIGURE 1

FILE

SOLUTION COPPER MINING
SHOWN IN CROSS SECTION



STEP: (A) SOLUTION FROM INJECTION WELL GOES INTO NATURAL FRACTURES.

(B) SOLUTION CONTACTS COPPER MINERAL AND DISSOLVES COPPER.

(C) COPPER-BEARING SOLUTION MOVES TO RECOVERY WELL

(D) COPPER-BEARING SOLUTION GOES TO COPPER RECOVERY PLANT

(E) COPPER IS RECOVERED IN SALEABLE FORM.

(F) SOLUTION IS RETURNED TO RECYCLE THROUGH STEPS A THROUGH F.

One obvious answer to this problem is for a number of companies to pool their soluble copper deposits and some risk capital in a joint venture to develop and operate solution copper mines. But the times are not conducive to initiating such a venture. Alternative answers to this situation would have to include some sort of direct or indirect help from the United States Government. In formulating answers to the problem, industry and/or government will need to know about the step-by-step process involved in developing solution copper mining and the cost of each step.

Development Test Program

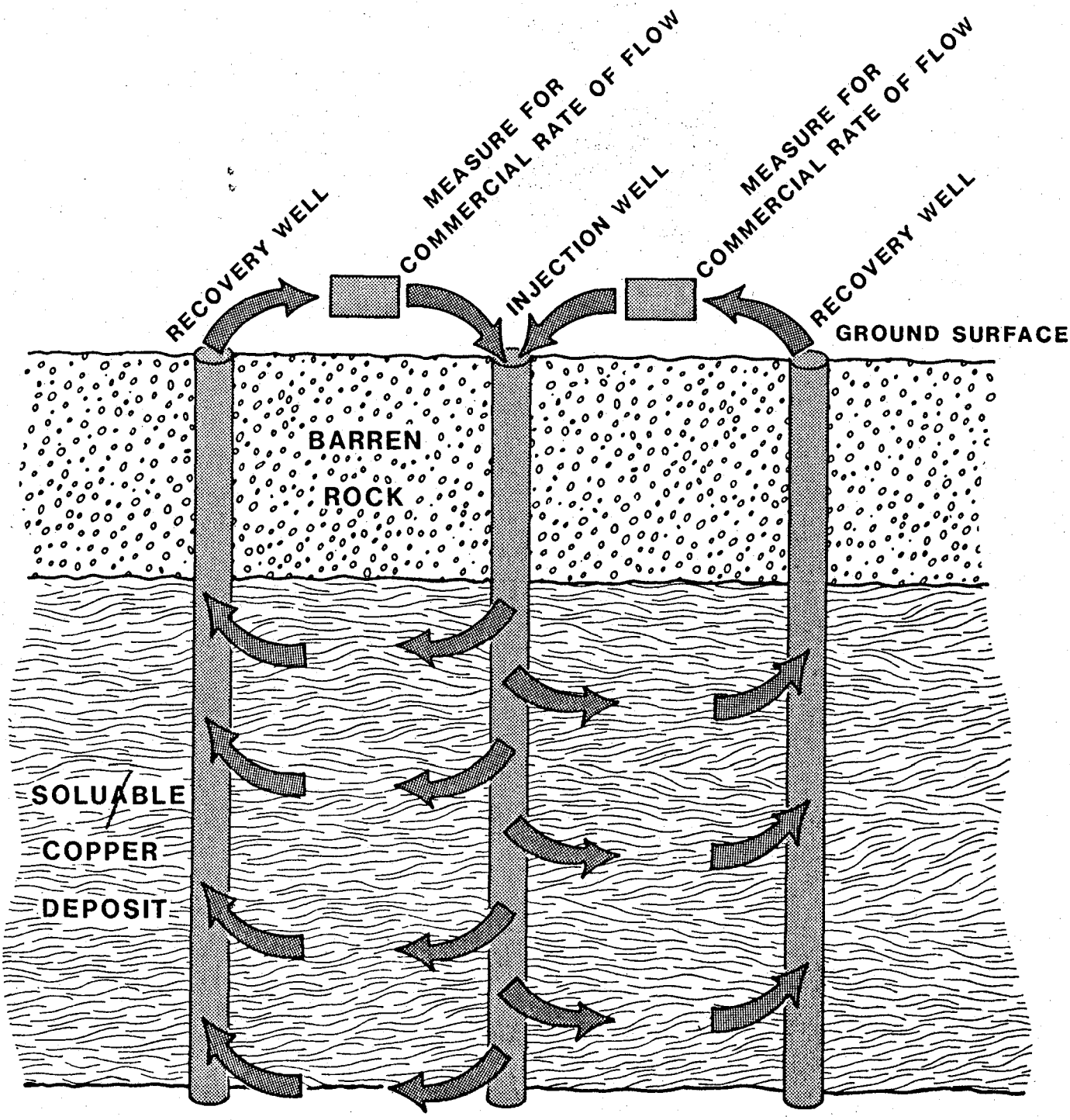
Solution copper mining can only be developed and tested on a soluble copper deposit in the field. There is no way it can be simulated on a computer, done in a laboratory, or done in the ground where a copper deposit does not exist. A suitable soluble copper deposit must be selected. Once this task has been accomplished, test work will proceed in two distinctly separate steps with the success of the first step, Phase I, justifying the second, Phase II.

Phase I will establish that commercial amounts of solution can move through the fractures in the natural rock from the injection well to the recovery well. Once this is accomplished, Phase II will evaluate how well the solution is going through the rock and recovering copper. Both Phase I and Phase II will take five years to complete, and the total cost will be $18,000,000. The completion times and costs of each phase are summarized in Table 1. The actual test setup for each phase is displayed in Figure 2 and Figure 3. Success in Phase II would lead directly into a small scale solution copper operation that would gradually develop into a full scale operation commensurate with the size of the copper deposit.

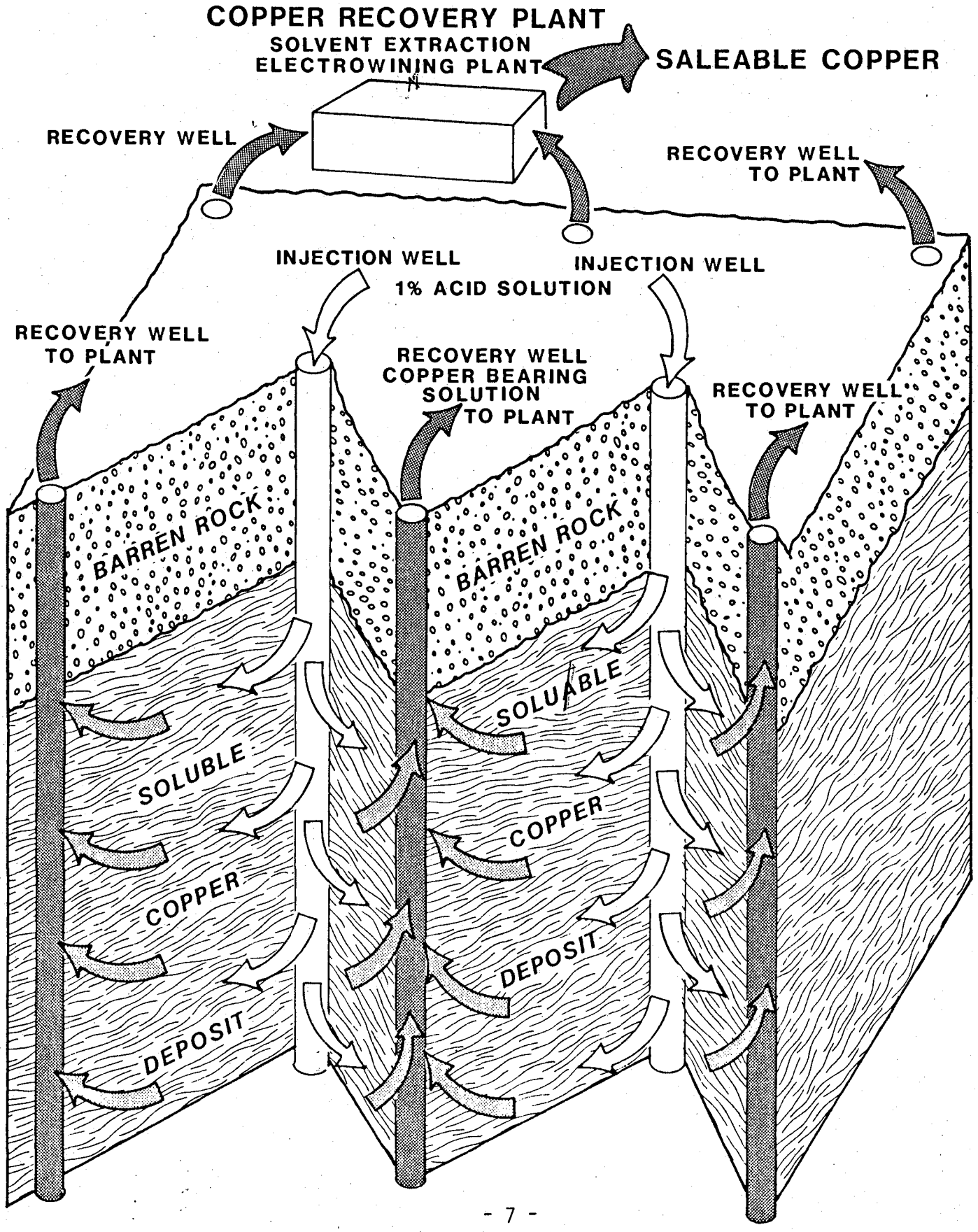
Table 1. Development Test Program

Phase	Objective	Test Setup	Time	Cost
I	Establish and measure the flow of solution from the injection well to the recovery well.	One injection well and two recovery wells set in copper bearing rocks.	1½ yrs.	$3,000,000
II	Demonstrate ability of solution to recover commercial amounts of copper.	Two injection wells and six recovery wells.	2½ yrs.	$15,000,000
		Total	5 yrs.	$18,000,000

PHASE 1 TEST OF SOLUTION FLOW



TEST OF COPPER RECOVERY



Full Scale Operation

A typical full scale operating solution copper mine is envisioned as having 300 injection and recovery wells. In addition there would be several dozen monitor wells about the periphery of the operation to insure safeguarding the environment and preventing the loss of valuable copper bearing solutions. From 10,000 to 40,000 tons per year of saleable copper would be produced. The actual amount of production would be determined by the size of the deposit and the rate at which the solution can extract the copper from the rocks.

The total capital cost to develop such a mine is estimated at $50,000,000 to $100,000,000. Unlike the all-at-once lay out of capital for developing a conventional mine, a solution copper mine would develop with an expenditure of $20,000,000 at a time as solution copper mining proved itself commercially successful.

The operating costs of a solution copper mine are estimated at 20% to 40% less than the cost of conventional mining. More importantly, solution copper mining offers the potential of operating profitably at today's depressed copper prices.

The cost efficiency of solution copper mining is due to the simplicity of the method. Compared to a conventional copper mine, one ton of saleable copper from a solution copper mine will eliminate the need to mine 750 tons of waste rock and copper ore, the milling of 150 tons of copper ore, and the costly smelting and refining of copper from 3 tons of concentrated copper minerals. Since there are tremendous amounts of soluble copper reserves in the western United States, the total cost savings of utilizing solution copper mining could be enormous.

A Test Deposit

Choosing a soluble copper deposit for the test development of solution copper mining will be a relatively easy task since there are dozens of such deposits in the western United States. In Arizona alone, there are more than a dozen large deposits collectively amounting to well in excess of 15,000,000 tons of copper. Owners of these deposits include the Kennecott Copper Corporation, ASARCO Incorporated, Phelps Dodge Corporation, Freeport Copper Company (Freeport - McMoRan), Newmont, Hudson Bay (acquired Inspiration Consolidated Copper Company), Van Dyke Copper Company, Getty Oil, and Hanna Mining Company.

Amongst all the soluble copper deposits, the best suited deposit is in central Arizona just west of the town of Casa Grande. It has ideal technical characteristics including a highly soluble copper mineralogy (atacamite and chrysocolla), fracturing, a favorable host rock lithology, isolation from acquifers, and an excellent location. Furthermore, it contains in excess of 5,000,000 tons of copper in soluble form which makes it the largest known soluble copper deposit in the world. The ownership of this deposit is divided between two joint ventures composed of Asarco-Freeport and Hanna-Getty. The Asarco-Freeport joint venture is known to be interested in solution copper mining. In fact ASARCO Incorporated allowed the U.S.B.M. to conduct some very preliminary solution mining test work on its soluble copper reserves. So it is

highly likely that most or all of this deposit could be made available for the test development of solution copper mining.

Summary and Conclusion

Solution mining of soluble copper from undisturbed natural rock would be a tremendous technological and economical breakthrough for the mining industry. It has the potential of being economic at today's copper prices, and could make profitable mining operations out of many copper deposits that would never have been mined conventionally, even at high copper prices.

The technology of solution mining copper from natural rock has yet to be totally proven. Steps B and E in Figure 1 have been proven to work time and again in the solution mining of copper from rocks broken during conventional mining operations. Steps D and F are widely used in industrial operations other than solution copper mining, and are expected to be readily adaptable to solution copper mining. Steps A and C have yet to be tested and proven. Steps A and C are simply the process of moving the solution through the fractures in the rock in such a way that commercial amounts of copper become dissolved in the solution.

The only way to test and prove Steps A and C is to conduct test work on a soluble copper deposit. A two phase test is proposed. Phase I (Figure 2) will test the amount of solution that can move through the rock fractures. Phase I will take 1½ years to complete, and it will cost $3,000,000. If Phase I is successful, Phase II (Figure 3) will be conducted to prove commercial amounts of copper can be recovered by the solution mining process. Phase II will cost $15,000,000 and take 2½ years of time to complete. If Phase II is successful, the test work program will be gradually upscaled with continuing success until a full scale solution mining operation is achieved.

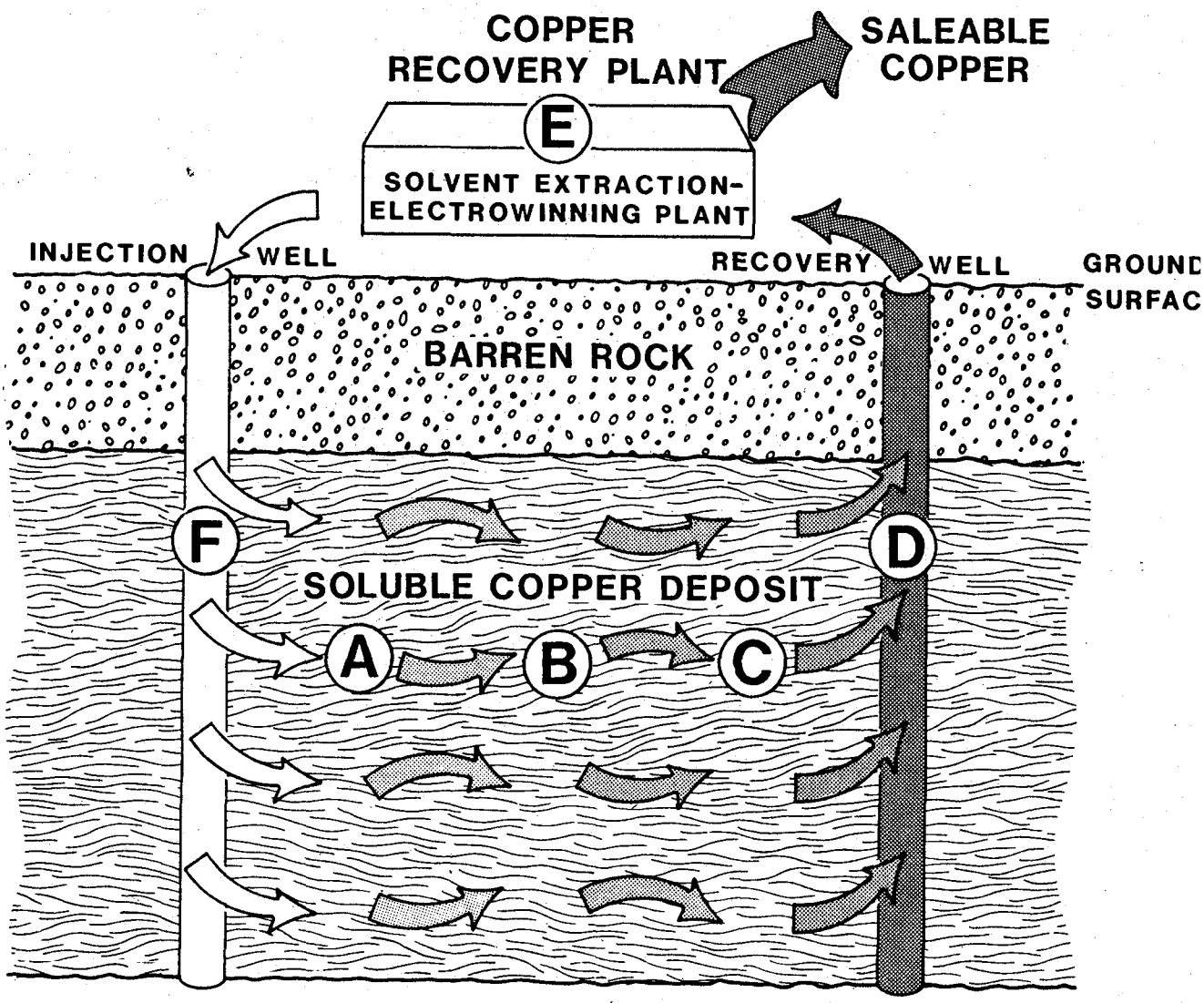
The best and largest soluble copper deposit upon which to conduct Phase I and Phase II test work is located near Casa Grande, Arizona. This deposit contains over 5,000,000 tons of copper in highly soluble copper minerals. A joint venture of Asarco-Freeport owns a large portion of this copper deposit and is interested in solution copper mining. The joint venture would consider any proposals to allow Phase I and Phase II to be conducted on its property.

It is recommended that the copper industry and/or the U.S. Government find a way to conduct Phase I and Phase II test work. There are basically three ways for the test work to proceed. First is for one company having sufficient financial resources and a sufficiently large soluble copper deposit to justify taking the risk. But, the chances of this happening are highly unlikely, for no one company or joint venture has undertaken this challenge or has indicated the intent to do so. A second way is for a half dozen companies to pool their soluble copper deposits and financial resources in a large joint venture. Unfortunately, such a joint venture is as difficult and risky to organize and operate as is the task of developing a new mining technique. A third way is for the U.S. Government to develop the technology to a point where industry is willing to invest in the utilization of such technology. This point would

be at the successful completion of Phase II. While it will cost $18,000,000 to reach this point, the Government stands to reap the benefits of this expenditure many times over and over. For, if solution copper mining of natural rock is as profitable as it potentially can be, there will be plentiful amounts of profits for taxation. Additional benefits would include a return to profitability in the domestic copper industry, and lower cost copper for the consumer.

FIGURE 1

SOLUTION COPPER MINING
SHOWN IN CROSS SECTION



STEP: (A) SOLUTION FROM INJECTION WELL GOES INTO NATURAL FRACTURES.

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FIGURE 2

PHASE 1 TEST OF SOLUTION FLOW

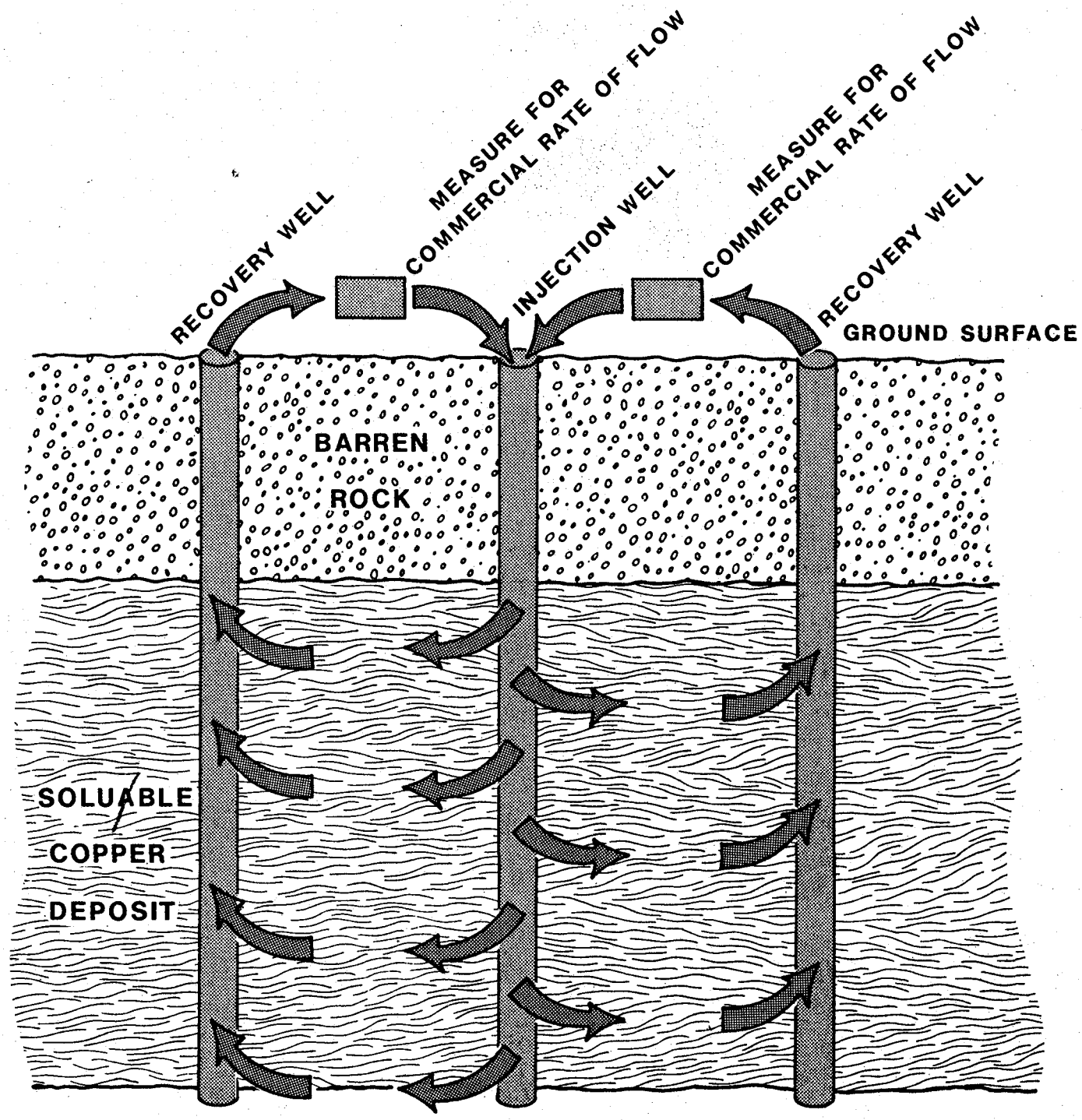
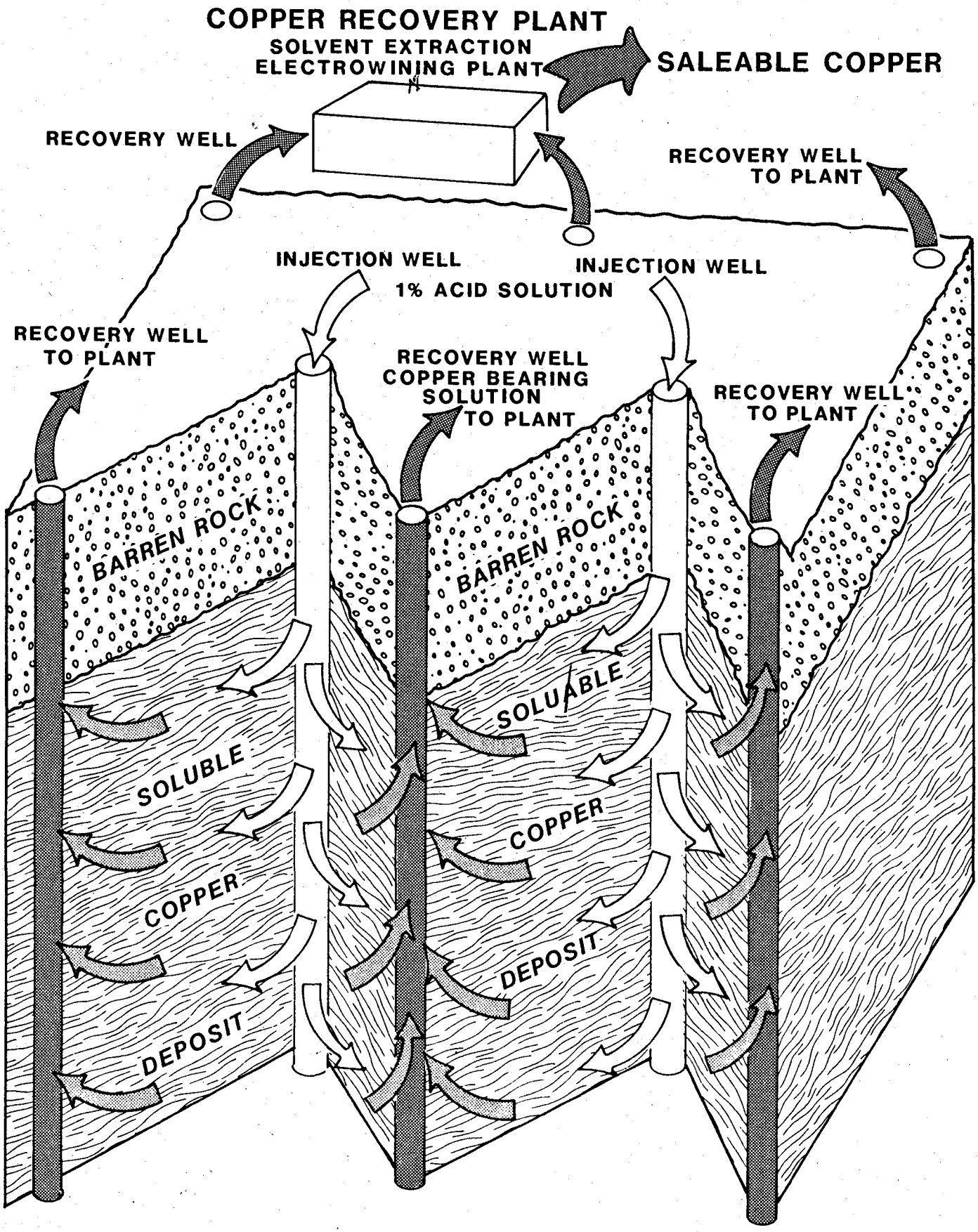


FIGURE 3

TEST OF COPPER RECOVERY



VDS

August 9, 1985

RECEIVED
AUG 12 1985
EXPLORATION DEPARTMENT

MEMORANDUM TO: Mr. R. L. Brown

USBM In Situ Leach Test
Santa Cruz Project, Arizona

Funds may be available through the U. S. Bureau of Mines (USBM) for a government-funded, field-based, production-scale, in situ leach research program on one or more oxide copper deposits. Senator DeConcini (D, Ariz.) is attempting to have such funds expended on a deposit in Arizona. A proposal to do this work would be included in the Department of Interior Appropriations Bill to be drafted this September by the Interior Subcommittee (McClure of Idaho is chairman) of the Senate Appropriations Committee. The expenditure would start in October 1986.

An in situ research program apparently has some support among other senators on the Interior Subcommittee, but a site for the program has not yet been selected. Two criteria seem important in the selection. First, Congress and USBM personnel view the mission of the USBM as one of pure research; applied research is considered to be the responsibility of industry. Horton, Director of the USBM. has stated that the companies involved should do or pay for this sort of research and DeConcini has replied that the companies don't have the money. Because the research program will benefit the owners of the deposit to be tested a second criterion is that the owners make an in-kind contribution to the project of financial value beyond merely providing the deposit. Other items to be considered include the extent to which the deposit is typical of other oxide copper deposits (so the data can be applied widely) and the nature of environmental impact.

Messrs. Muth and Howerton have brought the Santa Cruz property to the attention of the DeConcini staff as a possible candidate for the in situ research project. Points in favor of Santa Cruz are as follows:

1.) Typical. The deposit is typical of the majority of copper oxide deposits in the western USA in terms of rock types, copper mineralogy, and grade. Thus, the data from a research project might be more widely applicable than from other deposits.

2.) Size. Santa Cruz may be the largest oxide copper deposit known. If research demonstrated that a full scale operation could be economic the project would provide long term employment. Further, the size of the project permits a small part to be dedicated permanently to research without impacting the remaining reserve, a concept which will be discussed below in greater detail.

3.) Grade. The grade is low enough so it is unlikely that the deposit will ever be physically mined at a reasonable copper price; there are no options to produce copper from Santa Cruz other than by in situ leaching. This may also be construed negatively because lower grade means less copper produced and reduced profitibility. However, the unusual length of the oxide copper intersections may generate a higher volume of solution flow than in other deposits offsetting the low grade.

4.) History. Santa Cruz is undisturbed by previous mining. Leaching of copper from the rubble above numerous former block cave operations as at Miami, Lakeshore, and elsewhere has been demonstrated to be an economic process and operating data are available. However, there is no in situ production of copper from undisturbed oxide copper deposits and to my knowledge in situ tests have been made on only 3 undisturbed porphyry copper deposits utilizing wells for both injection and recovery (Bluebird, Van Dyke, and Safford). None of these data are available. Most known large oxide copper deposits are undisturbed and in situ research on these is still required. Results from this research would likely yield data applicable to the numerous undisturbed sulfide deposits present in Arizona, N. Mexico, Utah, Nevada, California, Montana, Washington, Maine, Wyoming, and perhaps other states.

5.) Environment. Oxide copper mineralization at Santa Cruz is isolated from the aquifers in the Casa Grande Valley by an impermeable conglomerate. Thus, it is anticipated there will be no communication between the dilute acid solution used to leach copper and the near-surface aquifers.

6.) Ownership. Perhaps a minor point, but Santa Cruz is owned by 2 companies, both U. S. corporations, so the immediate benefit would accrue more widely than in some of the other deposits.

Several other oxide copper deposits have been mentioned as candidates for in situ research including:

1.) Johnson Camp. The presence of the Cyprus SXEW plant is mentioned as an important cost-saving in a research project. However, surface plant components to treat pregnant solutions from an in situ test are available as off-the-shelf items with some salvage value, so some of the front end cost may be recaptured at the end of the project. Further, much of the Johnson Camp ore is somewhat atypical, occuring in a carbonate gangue and in shale. Leaching of copper in carbonate host will generate gypsum - anhydrite and reduce permeability and high acid consumption will increase costs. Also, much of the Johnson Camp ore has the option of physical mining at reasonable copper prices.

2.) Lakeshore. Lakeshore is favored by Gordon Miner, Deputy Director of the USBM (and former Hecla engineer who worked at Lakeshore) due to the presence of a SXEW plant, relatively high grade, and an active leaching operation. Copper is presently recovered by leaching rubble above a block cave zone and a quasi-in situ research program has reportedly been approved for another part of the deposit from which solutions would be recovered by induced artesian flow into underground workings. However, Lakeshore is somewhat atypical because of the higher grade (the quasi-in situ test is in a zone defined by a 0.7%Cu cutoff) and at reasonable copper prices has the option of being physically mined. Finally, Noranda, the operator at Lakeshore, is not a U. S. company and from a nationalistic viewpoint it seems U. S. tax dollars should benefit domestic corporations where reasonable.

3.) Casa Grande. In many respects Casa Grande would be a reasonable candidate and might have a better chance of being economic by in situ due to its high copper grade. The grades however are atypically high and since the oxide zone overlies a high grade sulfide zone block caving is an option at reasonable copper prices. Also the oxide copper zones are not as broken or as thick as the Santa Cruz zones which might reduce the apparent attraction of Casa Grande based on grade alone.

4.) Sacaton. The underground block at Sacaton is high grade and might also stand a better chance of success by in situ than Santa Cruz. However, grades at Sacaton are higher than most other oxide copper deposits and it has the option of possible underground development at a good copper price.

There is no single oxide copper deposit which is outstanding in all aspects, but on average Santa Cruz seems as attractive as any for an in situ research project. I recommend a proposal be made for the USBM to conduct an in situ research project at Santa Cruz as follows:

1.) Asarco-Freeport would donate a 200x200 ft. block within the area of oxide copper mineralization to the U. S. Government for research by the USBM on in situ leaching of copper. (perhaps the option of several smaller blocks should be proposed).

2.) Asarco-Freeport would donate the services of a geologist and/or engineer to the project as needed for a 4 year period.

3.) The USBM would guarantee to conduct a 4 year in situ research program to leach oxide copper including operation of two 5-spot leach tests at a cost of $15.8 million, not including government overhead (20% for the USBM alone). The design, cost, and scheduling of this test is outlined on Table I and is the same as

that outlined by Dr. Donald Davidson in 1980 with costs escalated by 42%. The purpose of the test would be to demonstrate economic feasibility of the technology. The USBM may conduct research of its own design for as long as desired. Further, the USBM is entitled to all proceeds from the sale of all copper recovered from the 200x200 ft. block (a 200x200x1000 ft. block from which 0.20% Cu is recovered will produce 14 million lbs. Cu).

4.) All data would be available to Asarco-Freeport when obtained and the USBM would be free to publish or otherwise make public any and all data as they see fit.

Asarco and Freeport will need to have obtained internal approval and have delivered the proposal (previously reviewed by Messrs. Muth and Howerton) to the DeConcini staff prior to September 6th when Congress returns from recess. There is fair optimism that an in situ research program will be included in the Interior Appropriations Bill and at the moment Santa Cruz seems to have strong backing of the DeConcini staff, basically because Messrs. Muth and Howerton approached them with the idea before anyone else. I am strongly in favor of a full in situ leach test of the type outlined on Table I and I presently see no alternative for a near-term test other than by the proposal described above. Actual costs to Asarco and Freeport would be the geologist and engineer.

There are obvious uncertainties. The USBM may propose alternatives to the 4 year test outlined on Table I or want to make changes during the 4 year project. Additionally, it seems probable to many that the USBM will get funding for a full-scale field test, but it is not clear that the site will be part of the Interior Appropriations Bill. If funding is approved without a site it is likely that numerous groups will appear with proposals to test their own oxide deposits. My opinion is that a permanent field laboratory in the middle of a world class oxide copper deposit might provide strong inducement to select Santa Cruz. The amount of the deposit given under the above proposal to the Government would be about 1% of the area within the 500 ft. drill grid and more like 0.2% of the total volume of known oxide mineralization.

I have previously reviewed all of the above with you and Mr. Kupsch. If the proposal is acceptable as outlined we should contact Freeport immediately and, if necessary, I can stay in Reno on Thursday, August 23rd, to discuss specifics with Freeport staff.

F. T. Graybeal

F. T. Graybeal

cc: R. J. Muth
J. B. Howerton
W. L. Kurtz/J. D. Sell

attach.

TABLE I: IN SITU LEACH TEST PROGRAM FOR SANTA CRUZ PROJECT

PHASE 1: Objectives are to measure permeabilities of different rocks; determine injection and production rates; assess effect of acid strength on permeability; test effect of hydraulic fracturing on permeability; develop correlations between geologic logging and permeability.
8 months - $1,199,000.

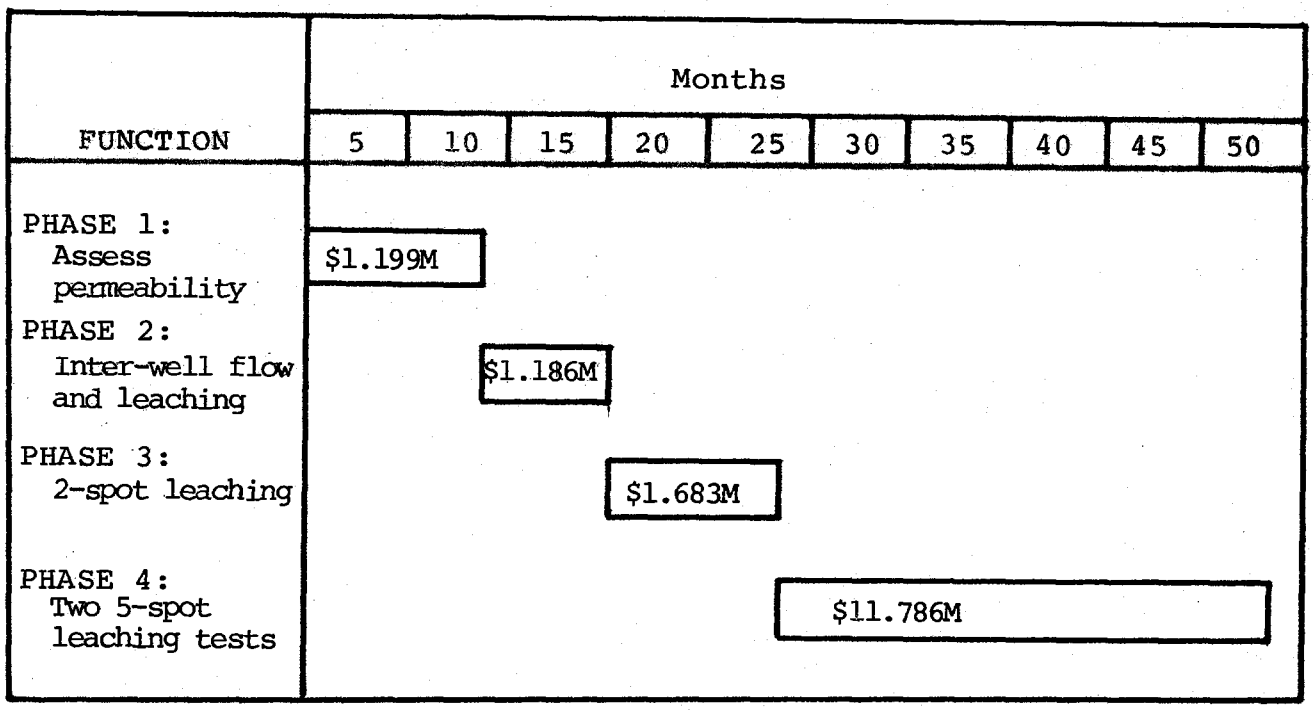
PHASE 2: Objectives are to determine directional variations in permeability; demonstrate communication between two 10 inch wells; test chemistry of copper leaching.
7 months - $1,186,000.

PHASE 3: Objectives are to demonstrate that with continuous acid injection and fluid production adequate copper loading can be achieved and maintained; measure solution recovery, obtain data on long term leaching chemistry and experience with corrosive fluids; all tests conducted in two 2-spot patterns.
8 months - $1,683,000.

PHASE 4: Objectives are to operate two 5-spot patterns and surface solution process facility capable of handling 50-100gpm flow; demonstrate long term copper loading and solution flow rates; obtain cost and design data for integrated subsurface - surface extraction; assess economic feasibility.
24 months - $11,786,000.

Time: 4 years

Cost: $15,854,000



August 1985

ASARCO

Exploration Department

August 27, 1985

F. T. Graybeal
New York Office

Santa Cruz Copper
USBM In-Situ Leaching

On Tuesday, August 13, 1985, Messrs. Anzalone, Crowell and I met with Patty Lynch, legislative assistant to Arizona Senator DeConcini.

According to Ms. Lynch the USBM does not want to name the Santa Cruz deposit as the place they will make a test, but rather will write a budget proposal that states they will conduct the test at a suitable site. Therefore, if the budget is approved, Asarco will need to lobby hard to convince the USBM that Santa Cruz is the test site.

WLK

W. L. Kurtz

WLK:mek

cc: S. A. Anzalone
D. E. Crowell
J. D. Sell

H.G. Kreis J.W.S
December 1985
Rev. 12/6/85

ASARCO-FREEPORT

Soluble Copper Reserves

High Grade Reserves

	Ore (>0.25% Cu)		Waste (<0.25% Cu)		Total		THICKNESS	GRADE IN FT-%
	Tons (Millions)	Grade (% Cu)	Tons (Millions)	Grade (% Cu)	Tons (Millions)	Grade (% Cu)		
Northwest	54	0.87	21	0.15	75	0.66	760	50
Southeast	35	0.65	5	0.17	40	0.58	440	25
Total	89	0.78	26	0.15	115	0.63	625	40

Moderate Grade Reserves

	Tons (Millions)	Grade (% Cu)	Thick. (Ft.)	Ft.-% Cu	Top (Depth)	Mineralogy Atac. (%)	Chry. (%)	Cc (%)
Northwest	150	0.50	700	350	1500	30	55	15
Southeast	50	0.56	400	220	2000	45	45	10
Total	200	0.51	600	300	1700	35	50	15

Mineral Inventory

	Tons (Millions)	Grade (% Cu)	Thick. (Ft.)	Ft.-% Cu
Total	800	0.43	461	198

District Wide Inventory of Soluble Copper

(All Owners)

Known Inventory	1.1 billion tons at 0.6% Cu (6.5 million tons Cu)
Potential Inventory	0.9 billion tons at 0.8% Cu (7.2 million tons Cu)
Total	2.0 billion tons at 0.7% Cu (13.7 million tons Cu)

H.G. Kreis J.R.D.
December 1985
Rev. 12/6/85

ASARCO-FREEPORT

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(up-grading SC-19)

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↑ Santa Cruz WHL ?
↓ all of District & exclude SC for tailings #'s.

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H.G. Kreis J.DS
December 1985 (Correction of typo error)

ASARCO-FREEPORT

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Total	89	0.71*	26	0.15	115	~~0.68~~ 0.58

*Grade of SC-19 ore cut in half

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H.G. Kreis
December 1985

J.V.S.

ASARCO-FREEPORT

Soluble Copper Reserves

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*Grade of SC-19 ore cut in half

Moderate Grade Reserves

	Tons (Millions)	Grade (% Cu)	Thick. (Ft.)	Ft.-% Cu	Top (Depth)	Mineralogy Atac. (%)	Chry. (%)	Cc (%)
Northwest	150	0.50	700	350	1500	30	55	15
Southeast	50	0.56	400	220	2000	45	45	10
Total	200	0.51	600	300	1700	35	50	15

Mineral Inventory

	Tons (Millions)	Grade (% Cu)	Thick. (Ft.)	Ft.-% Cu
Total	800	0.43	461	198

District Wide Inventory of Soluble Copper

(All Owners)

Known Inventory	1.1 billion tons at 0.6% Cu (6.5 million tons Cu)
Potential Inventory	0.9 billion tons at 0.8% Cu (7.2 million tons Cu)
Total	2.0 billion tons at 0.7% Cu (13.7 million tons Cu)

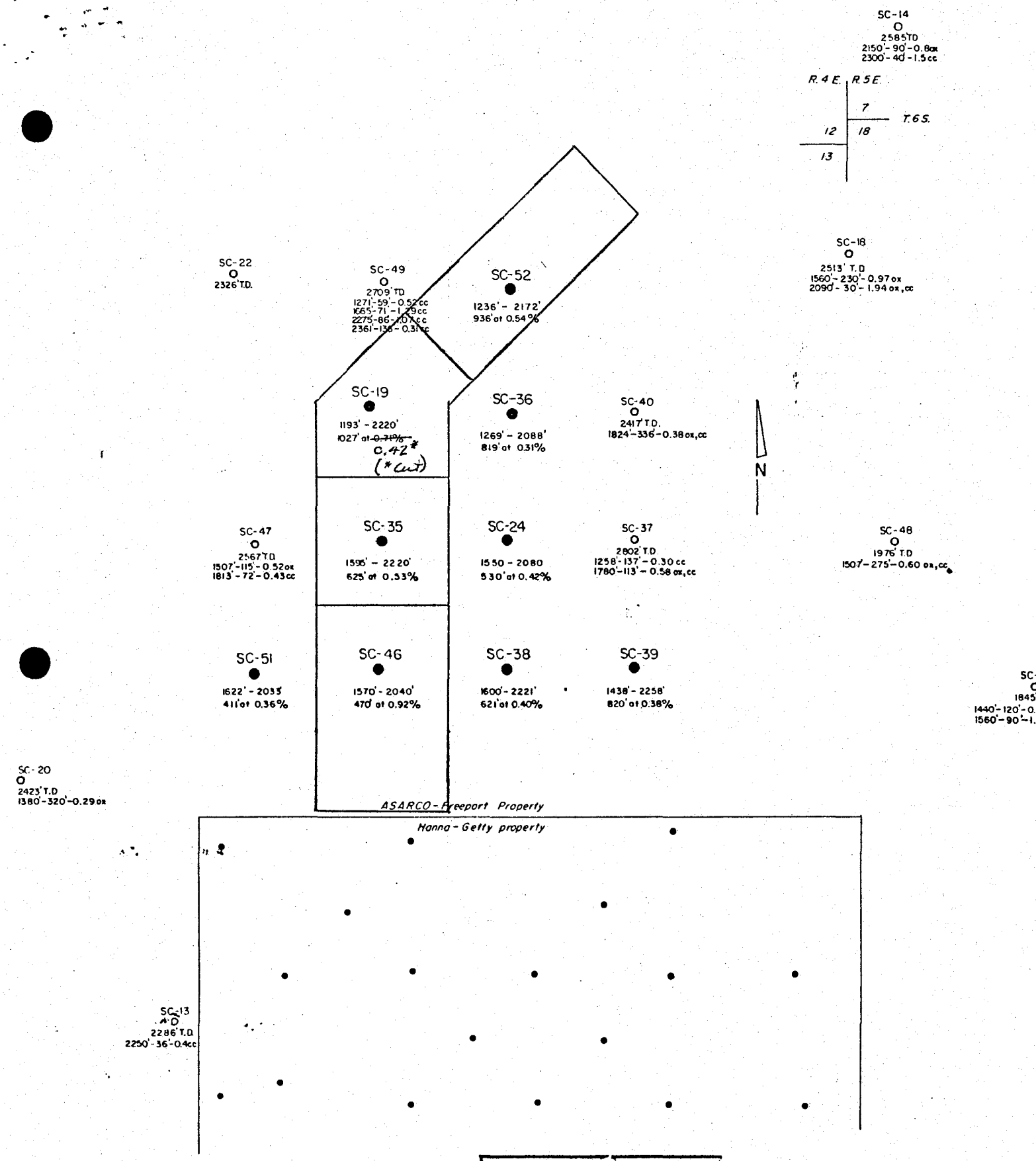
J.D.S.
H.G. KREIS
11-25-1985
REVISED 11-27-1985

HIGH GRADE ACID SOLUBLE COPPER RESERVE

POLYGON				ORE (> 0.25% Cu)		WASTE (< 0.25% Cu)		TOTAL		
HOLE	FROM	TO	INTERVAL	TONS (Millions)	GRADE (% Cu)	TONS (Millions)	GRADE (% Cu)	TONS (Millions)	GRADE (% Cu)	FT.-% Cu
NORTHWEST AREA										
SC-52	1236'	2172'	936'	19.7	0.67	6.4	0.15	26.1	0.54	505
SC-19	1193	2220	1027	10.3	0.75*	11.9	0.14	22.2	0.42*	431
SC-35	1595	2220	625	9.0	0.66	3.5	0.18	12.5	0.53	331
SC-46	1570	2040	470	15.0	0.92	0	-	15.0	0.92	432
		TOTAL		54.0	0.75	21.8	0.15	75.8	0.58	
NORTHWEST AREA			SAY	54	0.75*	21	0.15%	75	0.58*	

*Grade of SC-19 ore is the average grade of ore in SC-52, 35 & 46 so it is now ½ it's calculated grade of 1.38% Cu.

SOUTHEAST AREA										
SC-58	2021	2614	593	15.6	0.65	-	-	15.6	0.65	385
SC-60	2018	2515	497	329' 10.5	0.43	168' 5.4	0.17	15.9	0.34	171
SC-61	1973	2199	226	9.0	0.90	-	-	9.0	0.90	203
				35.1	0.65	5.4	0.17	40.5	0.58	
SOUTHEAST AREA			SAY	35	0.65	5	0.17	40	0.58	
TOTAL BOTH AREAS				89	0.71	26	0.15	115	0.58	



EXPLANATION

SC-24 — Drill hole used in possible reserve. Shows depth, thickness, and grade of the copper intercept used in reserve calculation.
1550'-2080'
530' at 0.42%

SC-48 — ASARCO-Freeport drill holes peripheral to possible copper reserve. Shows depth, length, % copper, and copper mineralogy of significant intercepts.
1976'TD.
1507'-275'-0.60 ox,cc

TO ACCOMPANY _____

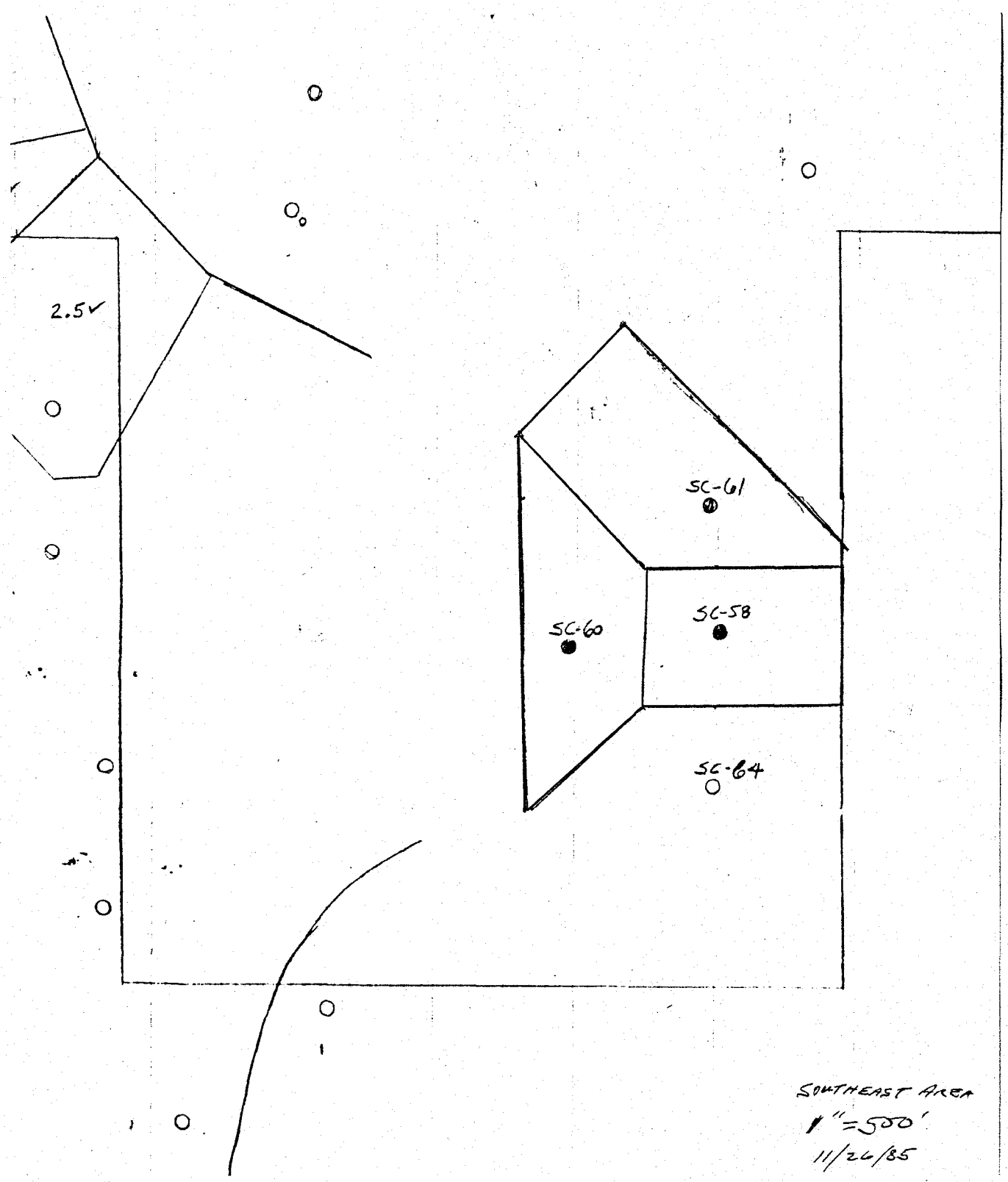
DATED _____

BY H.G. KREIS

SANTA CRUZ PROJECT
PINAL COUNTY, ARIZONA

POSSIBLE COPPER RESERVE
FOR
BULK MINING CONSIDERATION

H.G.K. 1" = 500' 7-78

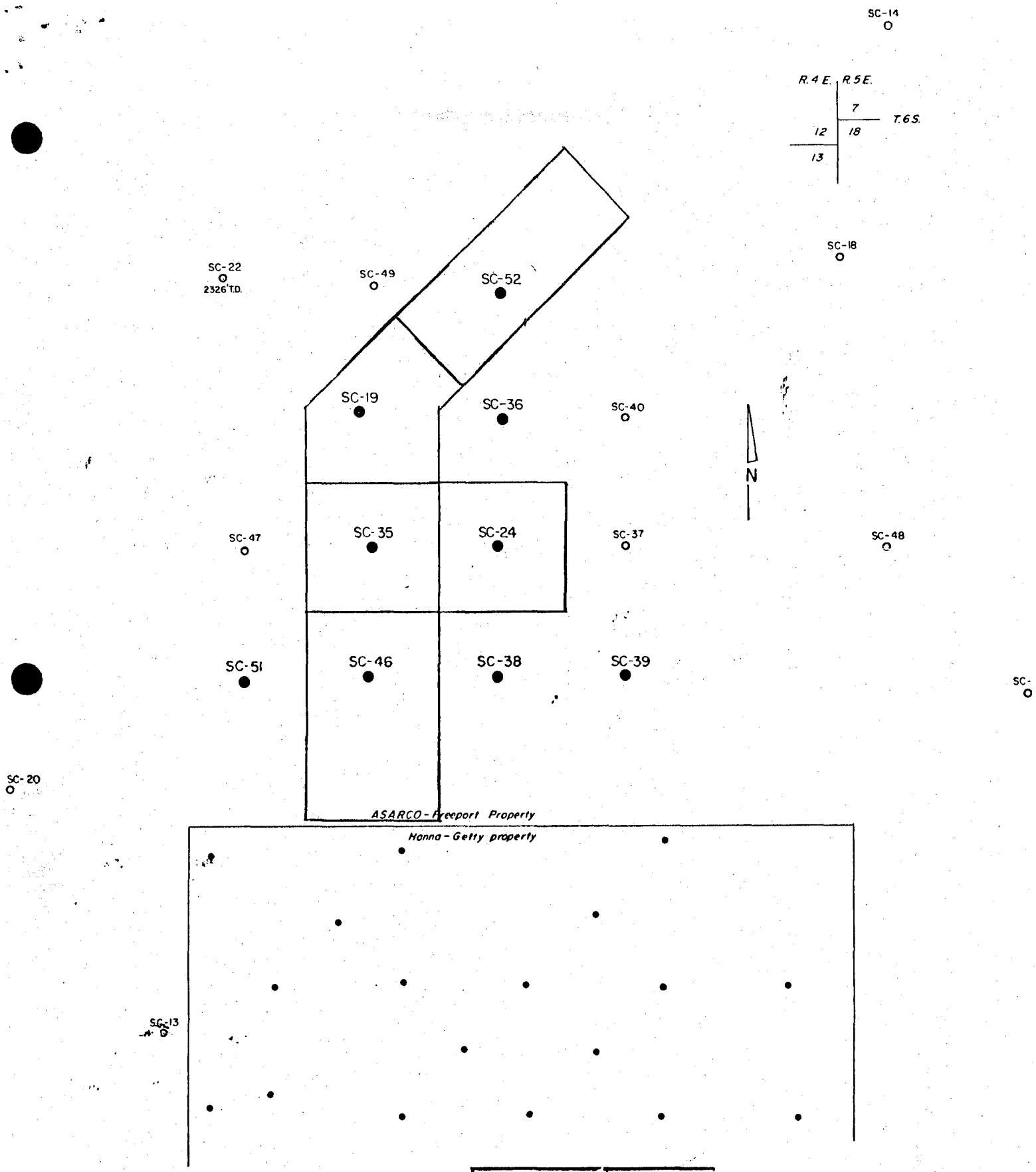


SOUTHEAST AREA
1" = 500'
11/26/85

H.G.K.
11-26-1985

HIGH GRADED RESERVES*
(F.T.G. REQUEST)
(*QUESTIONABLE CONTINUITY)

POLYGON				ORE (>0.25%Cu)			WASTE (<0.25%Cu)			TOTAL		
HOLE	FROM	TO	AREA (000 ft²)	THK.	TONS (MILLION)	GRADE (%Cu)	THK.	TONS (MILLION)	GRADE (%Cu)	THK.	TONS (MILLION)	GRADE (%Cu)
NORTHWEST AREA												
SC-46	1570	2040	400.0	470	15.0	0.92	–	–	–	470	15.0	0.92
SC-35	1898	2220	250.0	322	6.4	0.70	–	–	–	322	6.4	0.70
SC-19	1193	1770	270.0	337	7.3	1.79	240	5.2	0.14	577	12.5	1.10
SC-52	1236	1547	348.8	311	8.7	0.80	–	–	–	311	8.7	0.80
SC-24	1550	1820	250.0	190	3.8	0.94	80	1.6	0.09	270	5.4	0.69
	SUB TOTAL				41.2	1.02		6.8	0.13		48.0	0.89
SOUTHEAST AREA												
SC-58	2021	2333	330.0	312	8.2	0.84	–	–	–	312	8.2	0.84
SC-60	2018	2303	400.0	217	6.9	0.49	68	2.2	0.17	285	9.1	0.42
SC-61	1973	2199	500.0	226	9.0	0.90	–	–	–	226	9.0	0.90
	SUBTOTAL				24.1	0.76		2.2	0.17		26.3	0.71
	TOTAL				65.3	0.92		9.0	0.14		74.3	0.83



EXPLANATION

SC-24 — Drill hole used in possible reserve. Shows depth, thickness, and grade of the copper intercept used in reserve calculation.
1550' – 2080'
530' at 0.42%

SC-48 — ASARCO-Freeport drill holes peripheral to possible copper reserve. Shows depth, length, % copper, and copper mineralogy of significant intercepts.
1976' T.D.
1507'-275'-0.60 ox, cc

TO ACCOMPANY _____

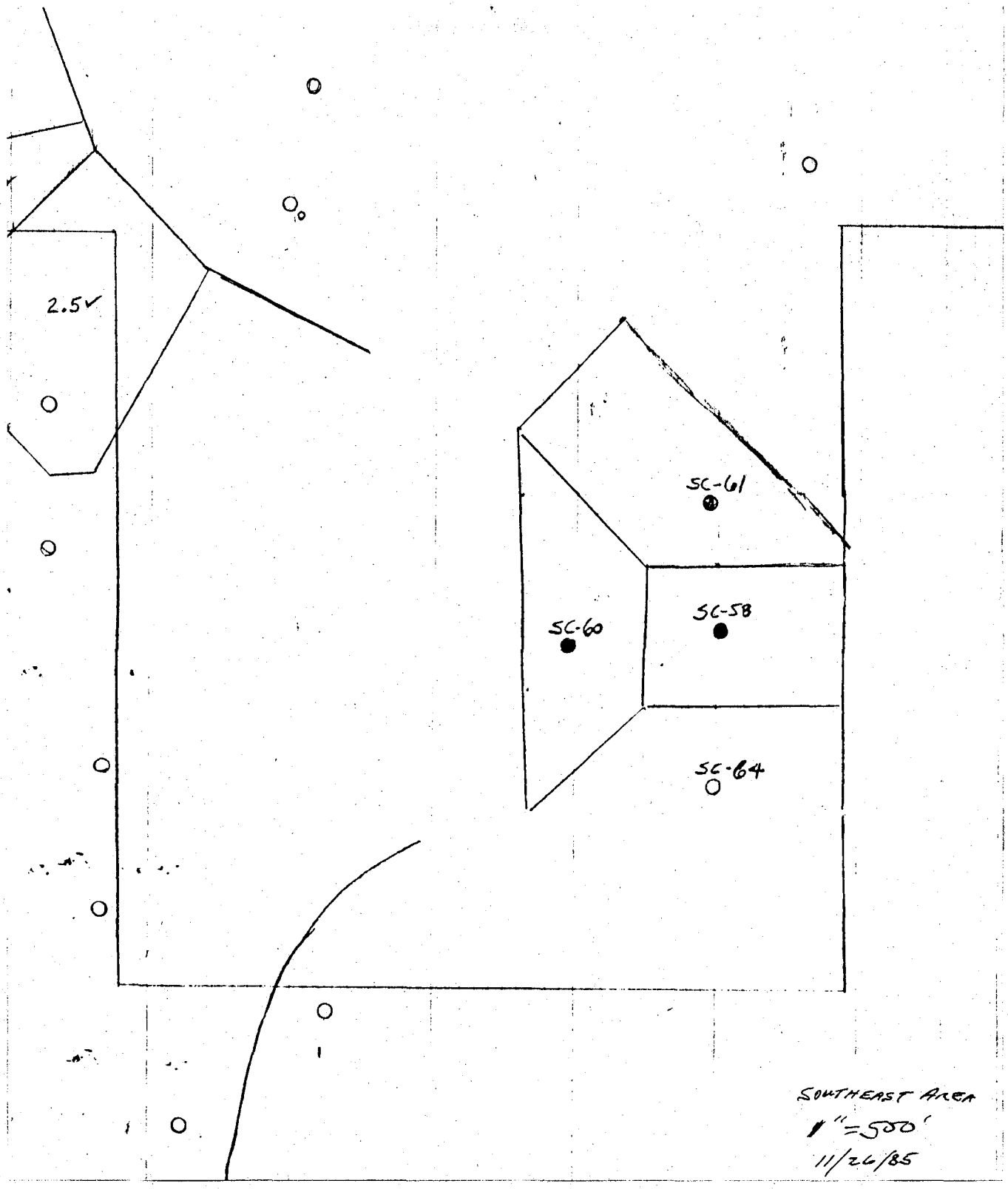
DATED _____

BY A.G. KREIS 11/26/85

SANTA CRUZ PROJECT
PINAL COUNTY, ARIZONA

POSSIBLE COPPER RESERVE
FOR
BULK MINING CONSIDERATION

H.G.K. 1" = 500' 7-78


2.5
SC-61
SC-60
SC-58
SC-64
SOUTHEAST AREA
1"=500'
11/26/85

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

December 20, 1985

Dr. William C. Larson
United States Department
of the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Santa Cruz Copper Deposit
Pinal County, Arizona

Dear Bill:

There was some discussion at the December 6, 1985 in situ meeting in Tucson whether sufficient data were available to select a site for an in situ demonstration project. It is Asarco's opinion that more than enough data are available to support the selection of Santa Cruz and to demonstrate its superiority to all other sites proposed for testing. To be of maximum assistance, we are providing you with additional information which you did not have available to you for detailed study prior to the meeting. Some of this information including all geologic and structural logs will be forwarded to you by Mr. H. G. Kreis from our Southwestern Exploration Division in Tucson.

Regarding the grade of Santa Cruz, attendees at previous in situ meetings have been inclined to emphasize the singular importance of high grade. While we do not agree with this opinion, we emphasize that within the Santa Cruz reserve of 800 million tons averaging 0.43% Cu there is a high grade zone which contains 54 million tons averaging 0.87% Cu. Standing alone, this internal zone is the highest grade of all suitable candidates on the list you distributed at the December 6th meeting. As we had not stressed this aspect of Santa Cruz in previous meetings, we would ask that you consider it carefully now.

Following review of data from sites proposed by other companies at the December 6th meeting, we are more convinced than ever that Santa Cruz is the outstanding candidate. Your list clearly demonstrates that the majority of all deposits would be leached by pumping solvent down from a surface installation, not up from underground workings. Your list also demonstrates that the majority of deposits would be subjected to Class 3 well permitting procedures. Santa Cruz falls with the majority in both cases, emphasizing the wide applicability and general benefit to the copper industry of data from a research project at Santa Cruz.

Several attendees at the December 6th meeting also commented on the advisability of drill hole or core permeability tests to determine the best candidate for full scale research. Our view is that these data would not in any way identify which deposit is the most likely to succeed economically, but would at best serve only to establish design parameters for the full scale test. We believe that economic viability can only be determined after completion of a 1-2 year full scale 5 spot test designed to measure solution loading and recovery as a function of time. We also believe this to be the perception of the Congressional sponsors of the appropriation. Perhaps too much emphasis has been put on selecting a deposit which has the best chance to succeed; we agree that such a result would be desireable for many reasons, but this is a research project and an important aspect of the data collected from the project is that they be useful - not just of interest - to the copper industry as a whole. Santa Cruz stands far above the other deposits in fulfilling the dual objectives of economic success and wide utility of the data. And, since we believe the intent of the program is to focus expenditures on a single site, Santa Cruz seems the logical choice.

Finally, I received your note of December 13 and appreciate your comments. I will talk to Hank Kreis about getting core to you for lab work. With best wishes,

Very truly yours,

F. T. Graybeal

F. T. Graybeal

cc: Gordon Miner

bcc: R. J. Muth w/att
T. C. Osborne w/att
R. J. Kupsch w/att
W. L. Kurtz/J. D. Sell/ H. G. Kreis w/att
J. B. Howerton w/att
T. E. Scartaccini w/att

Blind Note: We will discuss but not send core as requested in Larson's letter until at least early January 1986. I don't want site selection based on a few permeability measurements of an infinitesimal part of the deposit when the gross aspects are those of greatest relevance.

F.T.G.

F. T. G.

DEC 1 8 1985

United States Department of the Interior

BUREAU OF MINES

TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55417

RECEIVED
DEC 18 1985
EXPLORATION DEPT.

December 13, 1985

Mr. Fred Graybeal
Chief Geologist
ASARCO Inc.
180 Maiden Lane
New York, New York 10038

Dear Fred:

I certainly enjoyed our discussions on in situ mining last week. Hank Kreis did an excellent job in briefing me on the Santa Cruz deposit. He must have spent a significant amount of time preparing the cores for display. I really appreciated his efforts, and yours, for putting the presentation together.

I don't see any problems from a technical point of view in preparing and conducting whole core tests as we discussed at the core warehouse on Thursday. Sample preparation on selected split cores would require some special handling before leaching tests could begin, but we would like to start conducting tests when you are ready. Our lab is essentially ready to go. One or two core boxes from selected locations would be more than sufficient to begin experiments. Maximum of 10 ft. needed - 3-4" pieces about smallest needed

Fred, I appreciated your comments at the end of the meeting on Friday. I would like to see this technology advanced to the commercial level as quickly as possible, especially for copper.

Thank you again for your hospitality on Thursday and for hosting the industry meeting on Friday.

Sincerely,

William C. Larson

WILLIAM C. LARSON, Group Supervisor
In Situ Mining

J.D.S

ASARCO

Exploration Department
Southwestern United States Division

January 31, 1986

Dr. William C. Larson
United States Department of the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, MN 55417

ASARCO Incorporated

FEB 3 1986

SW Exploration

Dear Bill:

Santa Cruz Copper Deposit
Pinal County, Arizona

During the past couple of weeks I have been obtaining core for your laboratory tests. I made a trip to the Santa Cruz storage building and selected pieces of Santa Cruz core. These pieces of core accompany this letter. I also went to the Sacaton Mine and obtained several pieces of whole, NC-HQ sized core with copper oxide mineralization. This Sacaton core will be sent to you if you want it for testing.

During the month I tried to locate some large diameter core (6" diameter) of Sacaton copper oxide mineralization. This core was not consumned by the metallurgical work that was being done on the sulfide mineralization at the time. Consequently, it ended up as decorative pieces in offices and homes. I have not been able to find any of it yet, but there is probably a piece that has been sitting in someone's back yard for the last 15 years.

Finding pieces of core suitable for your test work was more of a problem than I had expected. As you know, the core was broken to begin with and then it was split for assay. Consequently, a 4" long piece of core with a uniform diameter throughout its length is a rarity.

These pieces of core are not at all representative of the permeability of of the Santa Cruz copper deposit. They are the hardest, most solid pieces of core that were obtained during the drilling program. They are representative of less than 2% of the Santa Cruz core, and they are representative of the least permeable looking core. Unfortunately, there is no way to obtain a piece of core that would be representative of the permeability. This gets back to the fact that all of us agree on -- the permeability can only be determined from tests on rock in place.

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

The selected pieces of core were chosen to give a variety of combinations for rock type, copper mineralogy, and copper grade. These combinations are summarized in the following table:

Santa Cruz Core Samples

Hole	Depth	Rock Type	Copper Mineralogy	Est. Cu Grade	Core Size
SC-19	1260	Granite	Chrysocolla	Average	NX
	1270	Granite	Atacamite	High	NX
	1279	Granite	Atacam. & Chry.	Av.-High	NX
	1686	Granite	Atacamite	Av.-High	NX
	1750	Granite	Atacamite	High	NX
SC-46	1622	Porphyry	Atacam.>> Chry.	High	HQ
	1727	Porphyry	Chrysocolla	Av.-High	HQ
	1786	Porphyry	Chrysocolla	Av.-Low	HQ
SC-52	1266	Granite	Chrysocolla	Av.-High	HQ
	1289	Granite	Atacamite	Average	HQ
	1361	Granite	Chrysocolla	Low	HQ
	1390	Granite	Chry.>>Atacam.	Av.-Low	HQ
SC-61	2171	Granite Breccia	Atacamite	Av.-Low	NX

The green copper oxide mineral in Santa Cruz core is generally atacamite; but the mineralogy should be checked for the possibility of dioptase or brochantite. Both dioptase and brochantite are green minerals that look like atacamite.

Bill, if you need more core or if there is anything else I can do to help you, please let me know.

Sincerely,

Hank

Henry G. Kreis

HGK/gb

Enclosure

cc: FTGraybeal
WLKurtz
JDSell

JDS

ASARCO

Exploration Department
Southwestern United States Division

February 12, 1986

Dr. William C. Larson
U.S. Department of the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, MN 55417

Dear Bill:

In regard to our telephone conversation of February 10, the following information may be of help to you.

Permission to drill wells in the State of Arizona is obtained by applying to the Arizona Department of Water Resources in Phoenix. Mr. Dick Gessner at 602-255-1581 is the person to whom inquiries should be directed. Tom Carr, at 836-4857 in Casa Grande, is a good contact to help expedite applications for drilling in the Casa Grande area.

Water quality permits must be obtained from both the Arizona Department of Health Services (ADHS) and the EPA. The contact at ADHS in Phoenix is Lyndon Hammon, 602-257-2262. The EPA Region IX contact in San Francisco is Carol Truitt, 415-974-8347.

Sincerely,

Hank

Henry G. Kreis
Senior Geologist

HGK:mek

bl.cc: F. T. Graybeal
W. L. Kurtz/ J. D. Sell

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

J.D.J. If you or Bill are interested let me know
H.G.K.

H.G.K
3-11-1986

copy W.L.K.

Meeting with Steve Paulson & Linda Dahl of USBM
(612-725-4585)

at AMAX Inc. office, 9AM March 26th
concerning results on USBM test work of Santa Cruz core.

Steve -- Geochemist working on leaching of core
Linda -- Geologist (microprobe type)

Agenda: 1) presentation on results to date
2) " on next stage of testing

bottom — should HGK be aware of this?
JDS
Note sent to HGK bottom

New York, March 20, 1986

ASARCO Incorporated

MAR 2 4 1986

SW Exploration

MEMORANDUM FOR: J.D. Sell

In Situ Test
Santa Cruz Project
Arizona

The attached advertisement was published to alert potential contractors that the USBM will issue a detailed description of the design and engineering study in April. Because the Casa Grande area is mentioned and ASARCO is known to have several copper deposits in this area it is possible that ASARCO may be contracted by potential contractors for geologic data. This could lead to a possible conflict of interest or other situation in which selection of Santa Cruz as the test site could be compromised if some, but not all, contractors ask for and receive data from ASARCO.

I called David Askin, the contract specialist, for advice; he commented that Bureau personnel had discussed this subject at length and suggested that all inquiries be directed to him at the Bureau of Mines. Please inform me of any inquiries the Tucson office may receive.

F.T. Graybeal

F.T. Graybeal

Attachment

cc: W.L. Kurtz
R.J. Muth
J.B. Howerton
J.L. Woods

ASARCO

copy for HGK by [illegible]

Exploration Department
Frederick T. Graybeal
Chief Geologist

April 30, 1986

ASARCO Incorporated
MAY 5 1986
SW Exploration

Mr. J. D. Sell
Manager, Southwestern
Exploration Division
Tucson Office

In Situ Affairs
Santa Cruz Project, Arizona

Dear Mr. Sell:

I called Bill Larson of the USBM in Minneapolis yesterday and asked that all requests to H. G. Kreis for advice, core, reports, or any support work be directed to you. You would then determine whether and how much time Mr. Kreis should devote to these requests.

I asked Mr. Larson to advise his staff of this change in communication linkage. It is likely that some USBM staff may still call Mr. Kreis directly and Mr. Kreis should be told to report all requests from the USBM to you. Any or all of you, Mr. Kreis, Mr. Kurtz, and myself would then decide how to proceed.

I would like to cooperate with the USBM in all possible ways on this project and at the same time get Mr. Kreis' Superior East work completed and summer work assignments settled. Once the USBM in situ Request For Proposal is issued and various contractors have received it, hopefully by mid-May, we will have a better perspective.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mr

cc: W. L. Kurtz

5/5/86 verbally to HGK (he's on "time off" from the Nevada work); he may call the USBM guys & tell them of the new set-up & clear with Larson.

JDS.

April 28

JD Sell—

You should make sure that HGK stays at Eureka until released by GBED and does not use USBM as an excuse to leave before staking is completed.

Kurtz

4/29/86

FROM: W. L. KURTZ

TO: JDSell

Call from FTGraySeal:

1) In situ USBM: Larsen will call you to request data (also GraySeal will visit USBM next month I 12 May and inform Larsen than that HGKocis will be gone for the summer.

2) Smith wants to map Ark so FTG told him to go ahead.

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

July 18, 1986

RECEIVED
JUL 21 1986
EXPLORATION DEPARTMENT

Mr. Lewis V. Wade
Research Director
U.S. Department of the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Ave. S.
Minneapolis, MN 55417

Memorandum of Agreement
Santa Cruz Project, Arizona

Dear Mr. Wade:

Enclosed are 5 signed copies of the Memorandum of Agreement covering the Santa Cruz Project. Please note that pages 1 and 5 have been revised to reflect that the Memorandum of Agreement is between the USA and the Santa Cruz Joint Venture. This joint venture is a project in which ASARCO Santa Cruz Inc. and Freeport Copper Company each hold a 50% interest. Accordingly, representatives of both companies have signed the Memorandum of Agreement.

Asarco is manager of the Santa Cruz Joint Venture, and correspondence should continue to be addressed to our offices. Would you please return two of the signed copies to me after approval by the Assistant Director.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mr
Att.

cc: W. L. Kurtz (w/att.)
R. J. Muth (w/att.)
A. Park

ASARCO Incorporated 180 Maiden Lane New York, N.Y. 10038 (212) 510-2000
Telex:ITT 420585 RCA 232378 WUI 62522 Cables: MINEDEPART Telegrams: WU1-25991

MEMORANDUM OF AGREEMENT
BETWEEN
THE UNITED STATES OF AMERICA
AND
THE SANTA CRUZ JOINT VENTURE

This agreement, made and entered into this _____ day of _____, 1986, between the United States of America, acting through the Department of the Interior, Bureau of Mines (hereinafter referred to as the Bureau), and The Santa Cruz Joint Venture (hereinafter referred to as the Cooperator), witnesseth that it is agreed and understood as follows:

1. Cooperation: The Bureau and the Cooperator agree to cooperate and collaborate for the purpose of conducting data acquisition field tests at the Santa Cruz site near Casa Grande, Arizona.

2. Description of the Work: Field tests will be conducted at the Santa Cruz site by a Bureau selected Contractor. This field testing will include, but shall not be limited to the following:

a. Down-hole permeability tests, such as double-packer water injection tests or multiwell drawdown tests.

b. Core drilling (minimum core diameter 1.75 inches). Approximately 200 feet of core will be obtained.

c. Multiwell hydrology tests for understanding the site hydrology.

d. Downhole geophysical logs as may be required to characterize the deposit.

The data acquired from these tests will be used by the Contractor to design commercial scale and pilot scale in situ copper mining operations for the Santa Cruz site. The results of the data acquisition tests and the commercial and pilot scale mine designs will be published by the Bureau or its Contractor.

3. Bureau's Contribution: The Bureau will select, and provide funding for, a Contractor to conduct the data acquisition field tests and develop the in situ mine designs.

4. Cooperator's Contribution: The Cooperator shall provide access to the Bureau's Contractor for the purpose of conducting data acquisition field tests at the Santa Cruz site. The Contractor, however, shall be required to provide advance written notice to the Cooperator of the exact field tests to be conducted and the proposed testing timetable so that an agreeable schedule can be worked out. The Cooperator shall also assist the Contractor, as needed, in obtaining any and all permits required for conducting the data acquisition field tests.

5. Title to Property: Any and all property and equipment of whatever nature or kind furnished by either party in connection with work under this agreement is and shall remain the property of the party furnishing such property and equipment.

6. Ownership of Data and Records: All original notebooks, data sheets, record charts, graphs, or other records maintained by the Bureau which are kept during, or arise out of, the work done pursuant to this agreement shall be the property of the Bureau. Copies of such materials may be released outside the Bureau upon approval by the Director.

The Freedom of Information Act (FOIA) and its amendments have resulted in an increasing number of requests from outside the government for copies of information and data submitted to Federal agencies. If information and data provided by the Cooperator to the Bureau under this agreement contain information that the Cooperator believes should be withheld from such requestors, under the FOIA, on grounds that it is "trade secrets and commercial or

confidential" ((b) (4) of the FOIA), the Cooperator should identify all such information so that if the information and data are ever the subject of an FOIA request, the decision by the responsible Federal official to disclose or withhold can be made promptly. If the Cooperator considers parts of the information and data withholdable under the FOIA, the Cooperator shall put the following notice on the title page:

> "Some parts of this document, as identified on individual pages, are considered by the submitter to be privileged or confidential trade secrets or commercial or financial information not subject to mandatory disclosure under the Freedom of Information Act. Material considered privileged or confidential on such grounds is contained on pages (specify page numbers)."

The Cooperator shall mark each individual item considered privileged or confidential under the FOIA with the following notice:

> "These data or information are considered confidential or privileged, and not subject to mandatory disclosure under the Freedom of Information Act."

All information and data which are not so designated may be subject to automatic public disclosure if it is requested under the FOIA. It must be emphasized that under the FOIA no information is automatically exempt from public disclosure. However, no disclosures under FOIA will be made without a careful and exacting evaluation by the Bureau, giving due regard to the need for safeguarding material considered by the submitter to be privileged or confidential. The Bureau's policy is to withhold whenever possible, material that is genuinely privileged or confidential.

7. Publication: It is understood that a major purpose of the work

performed by the Bureau is to obtain information that may be made available by the Bureau to industry and the public through publications or otherwise. The Cooperator shall not announce, publish, or otherwise disclose information or conclusions resulting from the work performed or observed by the Bureau or by the Cooperator under this agreement, until after review for technical accuracy by the Bureau. Such review will not be unreasonably delayed.

Any announcement or publication of work under this agreement by either party shall recognize and give credit in the text and on the title page to the cooperation of the other party, unless requested otherwise.

8. Officials Not to Benefit: No member of or Delegate to Congress shall be admitted to any share or part of this agreement or to any benefit that may arise therefrom.

9. Liability: The Cooperator agrees to be responsible for its own acts and the results thereof, and will assume all risk and liability to itself, its agents or employees, for any injury to persons or property resulting in any manner from the conduct of its own operations and the operations of its agents or employees under this agreement and for any loss, cost or damages, or expenses resulting at any time from any and all causes due to any act or acts, negligence, or the failure to exercise proper caution, or by itself or its employees while occupying or visiting the premises under and pursuant to this agreement. Furthermore, the United States Government agrees to be responsible as to and under this agreement to the extent of and by the authority set forth in the Federal Tort Claims Acts, as amended (28 U.S.C. 2671-80 (1976)) and will have no other liability.

10. Termination: This agreement shall expire on September 30, 1987 but may be extended for additional periods by written agreement between the

parties hereto, provided, however, that it may be terminated at any time by either party giving written notice of termination to the other party at least thirty (30) days prior to the date fixed in such notice.

Where the operation of this agreement extends beyond the current fiscal year, this agreement is expressly conditioned and contingent upon the Congress making appropriation for necessary expenditures hereunder after such current year shall have expired. In case such appropriation as may be necessary to carry out this agreement is not made, the Cooperator hereby releases the Bureau from all liability for failure to perform due to the failure of Congress to make such appropriation.

IN WITNESS WHEREOF, the parties hereto have made and executed this agreement as of the day and year first above written.

THE UNITED STATES OF AMERICA

By _____
LEWIS V. WADE, Bureau Representative
Research Director
Twin Cities Research Center

THE SANTA CRUZ JOINT VENTURE
ASARCO Santa Cruz Inc.

By F. T. Graybeal

Name F. T. Graybeal

Title Vice President

Freeport Copper Company

By _____

Name _____

Title _____

APPROVED:

_____

Assistant Director--Mining Research, Bureau of Mines

Jim Sell 10-3-86

JOHN Ahlness
DON DAVIDSON
RAY HUFF

THEY WANT TO MEET AT SANTA CRUZ SITE ±2:00 P.M.
THURSDAY OCT 9. Francisco Grande

Please call Ray HUFF 303-278-7634 to firm up
On Wednesday HUFF/Davidson in Phoenix at ? Sargent Beckwith
et al ? offices 602-272-6848

Steve

EITHER YOU OR HANK KREG SHOULD MEET THEM.
HANK IS SCHEDULED (BUT DOES NOT HAVE TO BE) AT
MISSION 8:00 am Thursday. That tour would probable
end at noon. (previous day the 8th HGK at
Silver Bell with Guy + Dave Lovell.

~~2 bus~~

To ~~WLK~~ JDS

Date 10/3 Time 8:20

WHILE YOU WERE OUT

M John Ahlness

of USBM - Minneapolis

Phone 612-725-3465

Area Code Number Extension

TELEPHONED	✓	PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	

RETURNED YOUR CALL	

Message Will be out for a couple of hours for lunch but in the rest of the day

Mary
Operator

AMPAD EFFICIENCY® 23-006 50 SHEET PAD

Santa Cruz
In-Situ Project
OSBM

Prindle & Gormann

Arthur B. Waller, President

10/15/86

Waller Advertising & Public Relations
3320 N. Campbell Ave, Tucson, AZ 85719
ph. (602) 323-7000

54 MT .87 % Cu

80 MT .43 % Cu

See to them
- Location Map
- Idealized diagram of an in-situ mining operation.
- Cross-section of Santa Cruz.

Waller
Advertising and Public Relations

T.E.S.
OCT 2 7 1986
JDS

MEETING REPORT

Client: ASARCO Incorporated
Meeting Location: Asarco Tucson
Attending Agency: Art Waller, Prindle Gorman
Attending Client: Tom Scartaccini, William Kurtz, Verle Martz, James D. Sell
Attention: William K. Murray, Agency Staff
Date: October 15, 1986

The purpose of the meeting was to provide agency personnel with background on the new leaching operation and landfill project near Casa Grande.

Oxide Leaching

This is a research project which is being done by Asarco and Freeport McMoRan, Inc. as the Santa Cruz Joint Venture. It is being funded by the Bureau of Mines. The project is called "in situ mining technology." The process involves injecting a leach solution (in this case diluted sulfuric acid) into the earth to extract minerals (in this case, copper oxide) from an ore body that remains essentially intact.

The basic technology has been used to mine uranium but has never been used in the copper industry. If the research project is successful, it will result in a new method of non-labor intensive mining of quality copper (see attached news release for specifics.)

The basic exploration and determination of the size of the ore body has already been done. A company known as SAI will be doing the actual work. Initially, they will dig two drilling wells. Fluid will be injected into one well and (hopefully) pumped up through an adjacent (75 - 100 ft away) well, after having passed through the rock. The initial studies will be done only with water and are meant to establish whether or not there can be "communication" between the two wells. Tests will then be done with diluted sulfuric acid which will dissolve the minerals and then be pumped up through the adjacent well. What is not known is whether or not the fluid may spread throughout the ground instead of traveling to the exit well. However, the water table in the area is of very poor, non-potable quality and Asarco's exploration department feels that the chances of contamination are very meager, since present theories indicate that fluids will move to where sucking (pumping) is.

ASARCO Incorporated
OCT 2 7 1986
SW Exploration

Sacaton Landfill
Page 2

3320 N. Campbell Ave.
Tucson, Arizona 85719
(602) 323-7000

If this is successful, it would be possible to mine 800 million tons of .43% copper and 54 million tons of .87% copper from this site. When the ore body has been exhausted, the site would be closed down and there would be no evidence of a mining project. During the mining process a solvent extraction-electrowinning plant would be built on-site to extract the ore and form copper cathodes which can then be sent to be made into copper rods or wire. (The smelting process becomes unnecessary.)

The research project was set in motion by Senator Deconcini after President Reagan turned down trade restrictions on foreign copper imports. It is an effort to find a way to make the American copper industry competitive with foreign copper producers. However, the foreign copper producers are also beginning to conduct research into this type of mining.

Drilling is scheduled to begin in January, possibly sooner. Results from the initial testing should be available in April or May of 1987. The entire testing procedure will take about 14 months and development of a handbook will begin in September of 1987. However, the overall program is actually a five-year program. This is the pilot testing section.

Different types of leaching procedures are already being done at San Manuel and Morenci. At Casa Grande there will be evaporation ponds, but no tailings ponds or a pit.

Sacaton Landfill

The second hour of discussion was devoted to the Sacaton landfill and what had been done on the project thus far.

The initial idea for turning Sacaton into a landfill was not Asarco's but that of a private individual. However, no one can remember who it was. Asarco dismissed it at first, since they were in the metal and mining business and not the garbage business. But the more they thought about it and got into it, the better the idea sounded.

At this point, they have hired experts in the fields of geology and hydrology (and hydrogeology) to investigate and analyze the site looking for possible problems. While the full report is expected next month, initial findings are that the site is perfect to function as a landfill.

The pit is 3,000 feet in diameter and 1,000 feet deep. It would take 35 - 58 years to fill it up. The pit is completely surrounded by impermeable rock and the nearest water table is a mile away. It would take 15,000 to 20,000 years for any pollutants (if any managed to penetrate the granite) to reach that water, which is of low quality anyway.

ASARCO

Southwestern Mining Department

FILE

JDS

October 27, 1986

MEMORANDUM

TO: T. E. Scartaccini

FROM: V. C. Martz

RE: Waller Advertising and Public Relations, Santa Cruz In situ

On October 27, 1986, Jim Sell and I met with Art Waller and Prindle Gorman of Waller Advertising and Public Relations. Mr. Waller indicated that he had been directed by W. K. Murray to develop a press release on behalf of Asarco in regards to the Santa Cruz in situ leaching project. Mr. Sell gave a brief overview of the project explaining that the Santa Cruz Joint Venture was essentially involved in this project only through providing the site. The contractor for the formation testing phase of this project will be SAIC. This came as a surprise to Mr. Waller and Ms. Gorman who prior to this meeting, believed Asarco would be performing the work. It was also pointed out that acid would not be used in this phase of the project. The purpose of this phase is to determine formation characteristics using potable water as the media. Mr. Sell suggested William Larson and Daniel Millenacker of the U. S. Bureau of Mines be contacted for further information. Mr. Waller indicated that he would also contact Senator DeConcini to incorporate his involvement in the development of this project for the forthcoming news release.

I pointed out to Mr. Waller that it was very important that the release be carefully worded in order to eliminate the possibility of negative interpretations in the Casa Grande area. I pointed out that this was not Asarco's project but Asarco was cooperating with the U. S. Bureau of Mines in their project. Mr. Waller indicated he would make every effort to word it in such a manner that it would be interpreted in a positive sense but could make no guarantees as to what would actually be printed by the news media.

V. C. Martz

V. C. Martz

VCM/kh

cc: JDSell

ASARCO Incorporated

OCT 28 1986

SW Exploration

To JDS

Date 11-3 Time 10:20

WHILE YOU WERE OUT

M Prindle Gorman

of Waller Advert.

Phone 323-7000

Area Code Number Extension

TELEPHONED		PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	
RETURNED YOUR CALL			

Message Occoti will call for appointment
Prindle available any time.

Operator

AMPAD EFFICIENCY® 23-006 50 SHEET PAD

The Arizona Daily Star, Tucson, Friday, November 7, 1986, p. B19.

Contract let for study of copper extraction techniques

ASARCO Southwestern Exploration Division

JDS

October 16, 1986

To: J.D. Sell

From: H. G. Kreis

U.S.Bureau of Mines Meeting
October 9, 1986
Santa Cruz Project
Pinal County, Arizona

On October 9th I met with Don Davidson, Ray Huff, Jon Ahlness, Dan Millenacker, Ralph Weeks, and John Edwards (see attached list of business cards). I showed them the Lands area of the Santa Cruz Project and the locations of the holes with the best copper oxide intercepts. After that I gave them a review of the Santa Cruz geology and showed them some representative copper oxide core. Following my presentations, they brought me up to date on their activities.

The only new information concerns Hanna-Getty. Hanna-Getty is making their deposit available to the Bureau of Mines for test work, and the Bureau of Mines notified our New York office of a meeting they had with Hanna-Getty. The Bureau of Mines is aware of the abundant data Hanna-Getty has developed, particularly groundwater data. It was mentioned that the Bureau of Mines would consider doing test work on the Hanna-Getty deposit just to get their data. The Hanna-Getty groundwater data would save the Bureau of Mines a lot of time and money. Furthermore, the Bureau of Mines wants a comprehensive knowledge of the groundwater situation, because the potential for groundwater pollution is the foremost environmental concern of the Bureau of Mines.

The U.S. Bureau of Mines' proposed in situ test work may affect our ability to acquire the Hanna-Getty deposit. Test work on the Santa Cruz deposit and now possibly on the Hanna-Getty deposit may help Hanna-Getty in their efforts to sell their deposit. If the U.S. Bureau of Mines' test work demonstrates the commercial viability of in situ leaching, it will be substantially more difficult for Asarco-Freeport to acquire the Hanna-Getty deposit than it is right now. I think we should review the feasibility of acquiring the Hanna-Getty deposit at this time.

H. G. Kreis

H. G. Kreis

HGK:mek
Attachment (Business Cards)

cc: W. L. Kurtz

R L Brown

DANIEL J. MILLENACKER
HYDROLOGIST

U.S. BUREAU OF MINES
TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVE. SOUTH
MINNEAPOLIS, MINNESOTA 55417
(612) 725-4588
725-4500

Dr. Donald H. Davidson, P.E.
Section Manager, Technology Development
Applied Technology Division

SAIC™
Science Applications International Corporation
8400 Westpark Drive, McLean, Virginia 22102 (703) 821-4833

JON K. AHLNESS
MINING ENGINEER

U.S. BUREAU OF MINES
5629 MINNEHAHA AVE. SOUTH
MINNEAPOLIS, MINNESOTA 55417
PHONE: 612-725-3465
725-4500

Telephone: (303) 278-7633

RAY V. HUFF, P.E.
President

P.O. Box 1310
Golden, CO 80402
Telex: 450661

RAY V. HUFF & ASSOCIATES, INC.
IN-SITU LEACHING ENGINEERS

SHB — Consulting Geotechnical Engineers

Ralph E. Weeks, P.G.
CHIEF GEOLOGIST
VICE PRESIDENT

Sergent, Hauskins & Beckwith
3940 West Clarendon, Phoenix, Arizona 85019
(602) 272-6848
PHOENIX • ALBUQUERQUE • SANTA FE • SALT LAKE CITY • EL PASO

Davy

JOHN EDWARDS
Senior Process Engineer

Davy McKee Corporation
2303 Camino Ramon
P.O. Box 5500
San Ramon, CA 94583
Tel: (415) 866-1166
Telex: 470670

10-9-86
Santa Cruz Meeting

ASARCO Southwestern Exploration Division

JDS

October 16, 1986

To: J. D. Sell

From: H. G. Kreis

Permeability Tests
Hanna-Getty Deposit
Santa Cruz Project
Pinal County, Arizona

As you know, Hanna-Getty performed a permeability test(s) on its Casa Grande West Deposit, and the results showed a permeability unfavorable to in situ leaching. I discussed this test work with Dave Lowell.

Dave Lowell researched the permeability test work that Hanna-Getty performed on their copper deposit. He talked with the people that ran the permeability tests, and they said the test was very poorly done. These people told Dave that the test results were not meaningful because of the poor work. Dave has concluded the results were meaningless, and he believes the Hanna-Getty deposit remains an ideal candidate for in situ leaching.

H. G. Kreis

H. G. Kreis

HGK:mek

cc: W. L. Kurtz
R L Brown

ASARCO Southwestern Exploration Division JDS

October 16, 1986

To: W.L. Kurtz

From: H.G. Kreis

Gold Deposits/Prospects
Codelco, Chile

I spoke with Orlando Alvarez C., Superintendent of Geology, and Roman Flores V., Chief Exploration Geologist, both from the Chuquicamata Division of Codelco. According to them, it is Codelco company policy not to develop gold deposits. Consequently, they have some gold deposits and prospects that will be farmed out to other companies. They have a 20 million ton deposit averaging 0.06 opt Au, which I believe is at El Salvadore. They also have a good prospect at Chuquicamata.

Codelco uses A.S. Radtke as a consultant for work on gold deposits and J.D. Lowell for copper deposits. Lowell goes to Chile three to four times a year and spends 30 to 40 days a year consulting for Codelco.

H. G. Kreis

H. G. Kreis

HGK:mek
Attachment (Business Cards)

cc: J. D. Sell

10/30/56

FROM: J. D. SELL

TO: HG Kreis

Santa Cruz et al

Mr. Brown has read your note on the Bur. of Mines visit & conversations etc on Santa Cruz & Stone's comment on Hanna & Getty. Brown reemphasizes that SWED & you are NOT to talk about H-G & cross-boundary minerals etc, even on a casual basis with the Bureau or others such as SAIC.

JD Sell

The Arizona Daily Star, Tucson, Friday, November 7, 1986, p. B19.

Charles W. Hulsey, Jr., A.I.C.P.
Assistant Vice President
Planning

2075 North Sixth Avenue
Tucson, Arizona 85705
(602) 624-7401

CELLA BARR ASSOCIATES

Offices in Tucson, Phoenix & Nogales, AZ
Engineering • Planning • Surveying
Landscape Architecture • Hydrology

November 13, 1986
1:30 PM meeting
w/ Art Walker
Brandt Gorman
TE Scarbrough

Hulsey is point man for landfill, rezoning etc + was concerned that the notices about the in-situ work was undermining his "ASARCO safe" landfill approach.

He was told that the sites were far apart.

That ore bodies are unique for the concentrated that can be leached, but the wall rock is inert (as now at Sacaton).

Next CG meetings:

Wed Nov. 19 Area Plan Thought

Mon Dec. 1 Rezoning meeting (Baldwin)

Wed Dec 3 Area Planning Preliminary Draft

1987 Funds etc.

ASARCO

Exploration Department
Southwestern United States Division

November 18, 1986

Mr. Ray V. Huff, President
Ray V. Huff and Associates
P.O. Box 1310
Golden, Colorado 80402

Dear Mr. Huff:

As you requested, I have reviewed the Santa Cruz drill hole information and have selected an appropriate interval in which to cut core for the USBM. It is in drill hole SC-46 from 1506' to 1800'. The interval contains both chrysocolla and atacamite-brochantite type copper mineralization in biotite-quartz-feldspar porphyry.

One of the major deciding factors was hole diameter. Most of the holes were drilled with NX(NQ) size. Only SC-46 and SC-52 offer HQ(NC) size core holes in the better acid soluble copper reserves. Drill hole SC-46 also offers rock that drills with a minimum of problems and is good for setting a wedge.

The attached information on drill hole SC-46 gives some of the pertinent facts about the past drilling events and present condition of the hole. The map shows the location of SC-46, the location of neighboring drill holes, and a survey of the corners of the NE/4 Section 13.

I talked with Ralph Weeks on November 14th, the day after I talked with you. He will obtain a drilling permit from the Arizona Dept. of Water Resources. The permit will be for the NE/4 Section 13 rather than one for a specific drill hole.

Sincerely yours,

Hank Kreis

Henry G. Kreis
Senior Geologist

HGK:mek
Atts.

cc: J.D. Sell - Asarco
J.K. Ahlness, USBM
D.H. Davidson, SAIC
V.C. Martz

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

H.G. Kreis
Nov. 17, 1986

DRILL HOLE SC-46

Coordinates: 64483.5' North
49496.5' East
1314.2' Collar Elevation
Directional survey report available (0'-2490')

Drilling Statistics:

? how cemented?

0-1084' 4" or 4½' casing in rotary drill hole
1084'-2325' HQ(NC) sized diamond drill core
2325'-2669' T.D. NQ sized diamond drill core
1080'-1313' (and below?) used oversized reaming shell

Mud Program: My-Lo-Gel, CMC, soda ash; added Dick's Mud Seal at 1100', D-D at 1250', and diesel at 1850'. Circulation: 1084'-2540', 85-95%; 2540'-2564', 40%; 2564'-2669', 0%.

Drilling Conditions:

No problems reported in shift reports of HQ portion of drill hole. Magcobar mud reports available for comments on drilling and mud program (Asarco file data).

Casing Pulled:

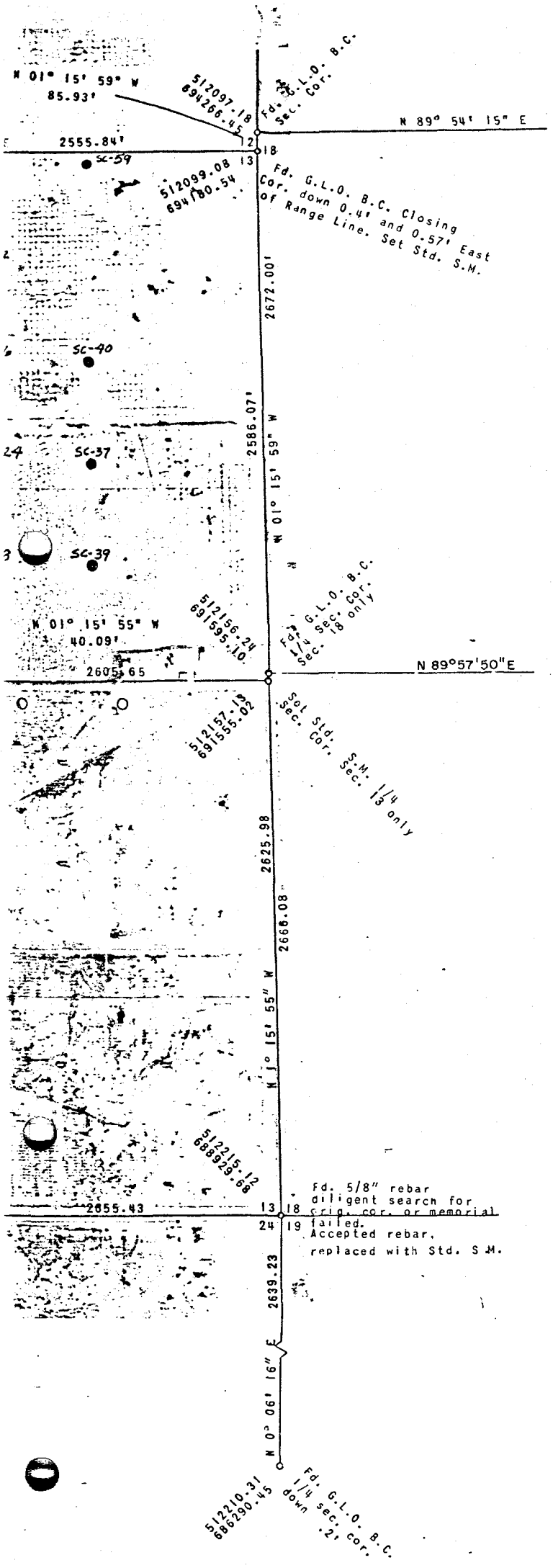
All the casing used in the HQ hole for NQ drilling was recovered.

Geophysical Logs:

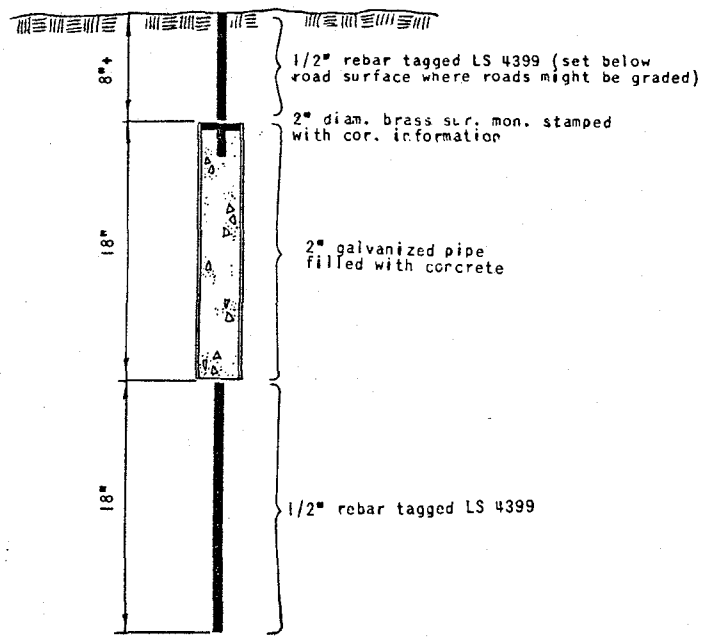
Available for 0-1087'; Birdwell. Suggest running geophysical logs before the placement of a wedge eliminates reentry into the lower part of the drill hole.

Geology:

1506'-1800', biotite-quartz-feldspar porphyry with chrysocolla and brochantite-atacamite. Copper grades vary from 0.2 to 6% Cu. See detailed geologic log.



STANDARD SURVEY MONUMENT DETAIL



NOTES

This survey was conducted primarily to find the center of Section 13. T. 6 S., R.4 E. It was extended to obtain additional corner information in T.6 S., R.5 E. Numerous pins and pipes were found, some as near as 0.5 feet to a G.L.O. brass cap. These questionable monuments have been ignored in setting missing corners and reliance was placed on proportioning. Occupation was not a factor in determining missing corner positions.

Coordinate values of this plat are based on photo panel values obtained from the Army Map Service as follows:

PANEL NO.	EAST	NORTH	ELEV.
W-43	512.133.27	688.843.44	1324.63
X-43	517.296.91	688.839.34	1328.92
W-45	512.269.18	678.431.60	1339.53

Coordinates, bearings and distances are State Coordinate values, Central Zone, Arizona.

Distances given are grid values. To convert to ground value, multiply grid value by 1.0001611.

Bearings are grid values. To convert to astronomic value, rotate grid bearing 0°01'17" counterclockwise.

The statement 'Std. Sur. Mon." indicates monumentation as shown on the sketch hereon, the intent being to preserve the monument on a stage basis in the event of road construction which would destroy the upper portion.

Reduction

STATE OF ARIZONA
SS
COUNTY OF PINAL

Witness my hand and official seal

Indexed	Paged	Blotted

I hereby certify that the within instrument was filed for record in Pinal County, State of Arizona

Date:
County Recorder Request of:

No.
Book Page

RECORD OF SURVEY

STITZER & ASSOC., INC.
TUCSON ARIZONA
SURVEYORS & ENGINEERS

SCALE			
1" = 500'			5444-7

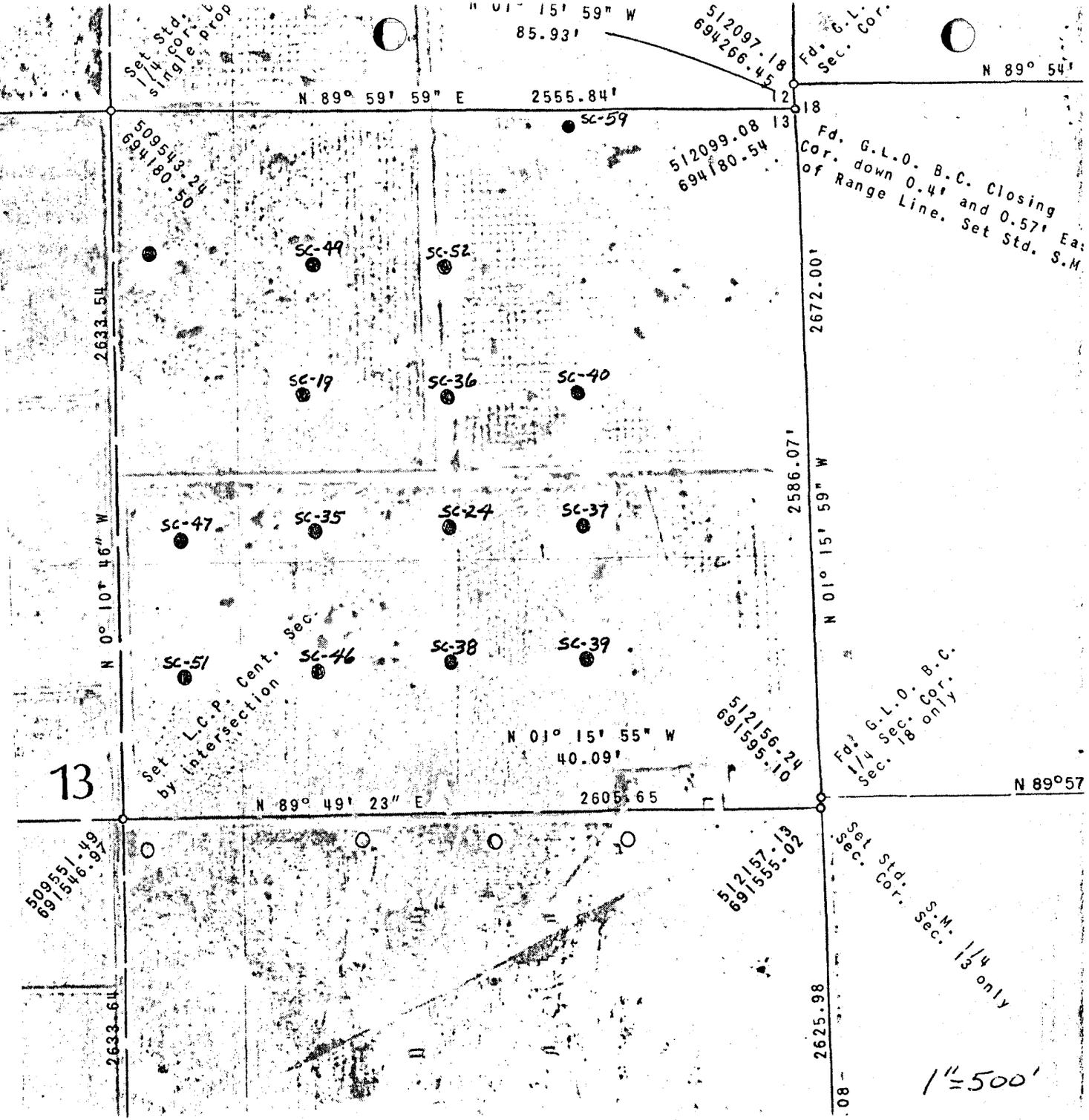
COORDINATE TIES* (ON W-43)		NORTH	EAST
	ASARCO-FPT Coordinates	61217.61	51341.63
	ARIZ STATE	688843.44	512133.27

10/1986

*Via phone, Stitzer to Crist, 2-5-71

COORDINATES OF SOME ASARCO-FREEPORT DRILL HOLES** IN THE LANDS AREA
SANTA CRUZ PROJECT

	Coordinates North	Coordinates East	Collar Elevation
SC-19	65520	49459	1310.9
SC-24	65000.1	50000.1	1312.9
SC-35	64997.3	49503.7	1313.7
SC-36	65498.7	50009.3	1311.5
SC-37	65011.0	50502.1	1312.5
SC-38	64505.6	49998.4	1314.3
SC-39	64505.8	50504.2	1315.4
SC-40	65505.5	50488.2	1312.0
SC-46	64483.5	49496.5	1314.2
SC-47	64974.9	49002.7	1313.2
SC-49	66000.7	49509.4	1310.4
SC-51	64470.4	49000.9	1314.0
SC-52	65986.6	50007.6	1310.1
SC-58	62558.8	53534.6	1321.8
SC-59	66494.3	50499.7	1309.7
SC-60	62500.7	53000.0	1321.3
SC-61	63001.7	53496.6	1320.6
SC-64	62013.3	53518.2	1323.0



To VCM

Date 11/20 Time 230

WHILE YOU WERE OUT

M Roy Davidson

of Science Applications

Phone 703-821-4832

Area Code Number Extension

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WANTS TO SEE YOU		URGENT	
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Operator

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56 63118N

DATE 11/20

AIRBILL NUMBER 2326094562

1 From (Your Name): D. Davidson

Your Phone Number (Very Important): 703 821-4832

Company: SAIC

Department/Floor No.:

Street Address: 8400 WEST PARK DRIVE

City: MCLEAN State: VA

ZIP® Zip Code Required For Correct Invoicing: 22102 3522

2 To (Recipient's Name): U. Martz

Recipient's Phone Number (Very Important): (602) 792 3410

Company: Hughes Tucson Corp

Department/Floor No.:

Exact Street Address (Use of P.O. Boxes or P.O. ® Zip Codes Will Delay Delivery And Result in Extra Charge.): 1150 North 7th Avenue

City: Tucson State: AZ

ZIP Street Address Zip Required (No P.O. Box ® Zip Code): 85703

3 YOUR BILLING REFERENCE INFORMATION (FIRST 24 CHARACTERS WILL APPEAR ON INVOICE.): 2-827-03-427-01

PAYMENT ☒ Bill Sender ☐ Bill Recipient's FedEx Acct. No. ☐ Bill 3rd Party FedEx Acct. No. ☐ Bill Credit Card ☐ Cash

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6 ☒ OVERNIGHT LETTER (Our Packaging) 9½"x12½"

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2 ☐ Courier-Pak Overnight Envelope 12"x 15½"

3 ☐ Overnight Box 12½"x 17½"x 3" A ☐

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PRIORITY 1 - Delivery is scheduled early next business morning in most locations. It may take two or more business days if the destination is outside our primary service areas.

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1 ☐ HOLD FOR PICK-UP (Fill in Section H at right)

2 ☒ DELIVER WEEKDAY

3 DELIVER SATURDAY (Extra charge) ☐

4 ☐ RESTRICTED ARTICLES SERVICE (P-1 and Standard Air Packages only. Extra charge)

5 ☐ CONSTANT SURVEILLANCE SERVICE (CSS) (Extra charge) (Do Not Complete Section 5)

6 ☐ DRY ICE _____ Lbs.

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8 ☐

9 ☐ SATURDAY PICK-UP (Extra charge)

10 ☐

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PART #106001 FEC-S-751-1000 REVISION DATE 7/86 PRINTED U.S.A. GBFE

S.W. MINING DEPT.
NOV 21 1986
TUCSON

Science Applications International Corporation

V. C. M.
NOV 21 1986

November 20, 1986

Mr. Bill Kurtz
Manager, Western USA Division
ASARCO Incorporated
1150 North 7th Avenue
Tucson, Arizona 85703

Subject: Santa Cruz Deposit Case Grande area of Arizona

Reference: Bureau of Mines Contract No. J0267001 SAIC Project No. 2-827-03-427

Dear Mr. Kurtz:

SAIC as the prime contractor for the U.S. Bureau of Mines project to develop a Generic In Situ Copper Mine Design Manual is tasked to work with the site owner to obtain permits for field tests (coring, geophysical logging, and permeability testing) to be conducted under Phase II Task B of the contract.

Ray V. Huff and Associates (RHA), our sub-contractor team member responsible for well field design has identified specific tests and described how they are to be conducted. For these tests our sub-contractor team member responsible for permit applicaitons, Sergent, Hauskins, and Beckwith (SHB) made an initial assessment of the responsible permitting agencies to be contacted and the permits that will be required to conduct these tests. The RHA and SHB reports are enclosed for your review and comments.

Based on this work it is SAIC's and SHB's recommendation that ASARCO initiate the Intent to Drill application procedure with assistance of SHB. SHB's contribution to the process will be in the form of supplying the technical data required to complete the application, and will also be available to discuss the details of the proposed field program with the ADWR.

Mr. Ralph Weeks of SHB will report to me for this work activity. He is responsible for SHB permitting work on the contract, and should be ASARCO's working point of contact. He can be reached at (602) 272-6848. Mr. Ray Huff of RHA will support Mr. Weeks with regard to technical issues relating to test methods and procedures. He can be contacted at (303) 278-7634. Please contact me at (703) 821-4832 pertaining to any issues that you believe could impact SAIC's contractural responsibilities to the U.S. Bureau of Mines.

If you are in agreement with our proposed test program and approach to permitting these tests I would appreciate your responding in writing to this effect to both SAIC and Mr. Jon Ahlness the Bureau of Mines Technical Project Officer.

8400 Westpark Drive, McLean, Virginia 22102
(703) 821-4600

I look forward to working with you and ASARCO on this project and am very excited about the prospects of developing in situ copper mining as a viable commercial process for producing copper.

Sincerely,

Donald D. Davidson
Manager, Technology Development and SAIC
Project Manager for U.S. Bureau of Mines
Contract J 0267001

cc: J. Ahlness-U.S. Bureau of Mines
F. Graybeal-ASARCO
R. Huff-RHA
J. Weeks-SHB
J. Standish-SAIC

DDD/ms

ENVIRONMENTAL PERMIT REQUIREMENTS
PHASE II FIELD TESTING PROGRAM
ASARCO-SANTA CRUZ PROPERTY
USBM CONTRACT NO. J0267001

1. Introduction

This document describes SHB's current understanding of the environmental permit requirements for the performance of the Phase II field testing program at the ASARCO-Santa Cruz property under a USBM Contract No. J0267001. The details of the testing program are described in an attached submittal by Ray V. Huff & Associates, Inc.

It is our understanding that the proposed field program will be conducted within the NE1/4 of Section 13, T6S, R4E on private property under the legal possession of ASARCO. Any variation in the location, scope of field work or ownership of the property may cause the permit requirements discussed herein to be insufficient for obtaining regulatory permission to proceed.

2. Permit Requirements

The subject property lies within the Pinal Active Management Area (PAMA), one of four regions in Arizona established by the Groundwater Management Act of 1980. Relative to the issue of acquiring permission to perform the subject field tests, the 1980 enabling act instituted a system of groundwater rights and a 45-year

management program. The resulting management plan (ADWR, 1985)* identifies several rights to withdraw groundwater in the PAMA. These rights range from exempt withdrawals, to grandfathered water rights, to service area rights. As stated by Mr. Thomas G. Carr, Area Director of the PAMA staff of the Arizona Department of Water Resources (ADWR), the subject ASARCO property holds a Type 1 Non-Irrigation grandfathered right (Lawyers Title Trust No. 58-110104; 12/70). Due to this water right and the minimal amount of groundwater to be withdrawn (about 14,400 gallons), the ADWR will only require the owner to apply for and receive authorization to withdraw by filing a Notice of Intention to Drill with their agency.

The Notice of Intention to Drill procedure is relatively simple, and according to Mr. Carr, will not take over 60 days for the ADWR to approve or reject the application. The ADWR has a standard application form available which requires, at a minimum, the following information:

- Location by sectional description.
- Owner of land and well; name, address and telephone number.
- Name of contact person with telephone number.

*ADWR (Arizona Department of Water Resources), 1985, Pinal Active Management Area - Management Plan for First Management Period 1980-1990.

- Purpose for well and withdrawal.
- Signature of owner.
- Proposed method of abandonment.
- Type of pump; pump capacity.
- Well construction details and drilling method.

The drilling operation must be under the supervision of an Arizona licensed water well driller and the drilling must occur within one year after the date of the application. The driller is responsible to file a Well Drillers Report (DWR-55-6-5/83) with the ADWR within 30 days after completion of drilling activities. Construction and abandonment standards shall be in accordance with ADWR rules R12-15-811 and R12-15-816.

Mr. Roger Kennett of the Arizona Department of Health Services (ADHS) was contacted to determine whether the proposed action would require any permits through the ADHS. After describing the proposed field program to Mr. Kennett, he concluded that no ADHS regulatory requirements apply for the field testing program. His agency would like to be informed as to the results of field activity as a courtesy.

An initial contact was made with the U.S. Environmental Protection Agency, (EPA) Region 9 in San Francisco. The nature of the field testing program was discussed with Mr. Nathan Lau of the EPA. Mr. Lau's initial impression

was - that the field testing program will not require well Class 5 (miscellaneous) permitting through the EPA-UIC program. He stressed, however, that the EPA will not pass judgement on the EPA permit requirements prior to receiving a written description of the proposed action.

From our experience with related field testing programs throughout Arizona, we believe that the permit requirements, or lack thereof, that are discussed above encompass all the environmental permit constraints that will be placed on the testing program at ASARCO-Santa Cruz property. We will notify all project participants upon receipt of additional information concerning EPA requirements.

$$P = kC_1 \ln \frac{r}{r_w} - C_2 B \left[\frac{1}{r} - \frac{1}{r_w} \right]$$

RAY V. HUFF & ASSOCIATES, INC.
P. O. Box 1310, Golden, CO 80402
303/278-7633 TELEX: 450661

Field Activities to be Conducted

under

USBM Contract No. J0267001

Introduction

Ray V. Huff and Associates, Inc. (RHA) is a subcontractor to SAIC for USBM Contract No. J 0267001. Part of RHA's responsibilities is to provide input to Sergent Hauskins & Beckwith (SHB) for obtaining permits for field tests to be conducted under this contract. This document will inform SHB of the proposed field tests.

Field Tests

Field activities to be designed and conducted by RHA at Lakeshore and Santa Cruz are as follows:

Core Hole Reentry

* One hole will be cleared-out at each deposit to a point at or below the top of the ore.
* Revert (or similar type mud or water) will be used during clean-out.
* A bridge plug will be set at the bottom of the cleaned-out portion of the hole.
* A wedge will be set on the bridge plug.
* A new hole will be started by drilling off the wedge.

Coring

* At least 200 ft of core will be obtained at each deposit.

* While coring, Revert (or similar type) mud will be employed.

Pumping Test

* If possible, an injection test will be conducted by injecting water into the hole.

* If pumping is not possible, a pump will be installed in the hole after coring and fluid pumped from the ore zone.

Geophysical Wire-Line Logging

* Logs will be run to obtain porosity and water saturation information.

* Flow profile log will be run while injecting water to identify zones of fluid exit from the hole.

* Temperature log will be rn to determine temperature gradients.

RHA expects these activities to be conducted between mid-July and mid-August 1987 or earlier.

Equipment and Methods

During clean-out of hole a rock bit and drill rods will be used. Drilling fluid will be water or mud. A conventional mineral core rig will be employed throughout the field testing activities.

In order to bridge the hole it may be necessary to plug back with sand. However if a suitable mechanical bridge plug is available it will be employed instead of using sand. If the bridge plug is employed a small amount of Cal-Seal (plaster of Paris type material) will be placed on top. Cal-Seal will be placed using a dump bailer. The dump bailer will be run into the hole using a wireline on the core rig.

A conventional wedge will be set on the plug using drill rods. Subsequently a deflected hole will be started using a rock bit and drill rods. After the hole has been drilled some 30 or 40 feet from the top of the wedge coring will commence. A core bit and triple-tube core barrel and rods will be employed. Core (and core barrel) will be retrieved with a wireline. Sufficient coring will be done to obtain 200 ft of core from each deposit.

Upon completion of the coring operation a pump will be

installed in the hole. This pump will be a progressive-cavity type with a stator at the bottom of the drill rods and a rotor installed through the rods on a drive shaft. The pump will be placed near the bottom of the corehole.

If fluid from the deposit cannot be produced at a sufficient rate for a suitable time period, the pumping equipment will be removed. Subsequently a pneumatic packer will be installed by running it in the hole on the bottom of drill rods. When properly placed near the top of the mineralized zone, the packer will be inflated to isolate the zone from the annulus above the packer. A water injection test will be conducted. This test will provide data for calculating permeability and "skin effect".

After the injection test is completed conventional wireline geophyical logs will be obtained. These logs will include:

* Bulk density
* Neutron
* Sonic velocity
* Resistivity
* Caliper

These logs should provide information on porosity, water saturation and hole diameter variation. In addition a "spinner" log will be run during injection of fluid to determine zones of fluid exit from the hole. A temperature log will be run to determine temperature gradient.

ASARCO

Southwestern Mining Department

November 26, 1986

TO: W. L. Kurtz

FROM: V. C. Martz

RE: Santa Cruz In Situ - SAIC Proposal

On November 25, 1986, Don Davidson of SAIC called in reference to the proposal submitted to you dated November 20, 1986. Mr. Davidson requested that a letter indicating Asarco's approval of the proposed test program and approach to permitting be submitted to both SAIC and USBM. This approval is necessary prior to any further work on these items.

I have reviewed the SAIC proposal and agree with the approach to permitting.

Ralph Weeks and Dan Millenacker desire a meeting on December 9, 1986, at 10:00 a.m., at the Asarco Tucson office. This meeting will be to review the proposal and begin work on the Intent to Drill Application. If this date and time do not fit your schedule, please advise.

V. C. Martz

VCM/kh

cc: TEScartaccini
JDSell

RECEIVED
DEC 1 1986
EXPLORATION DEPARTMENT

ASARCO

Exploration Department
Western USA

W. L. Kurtz
Manager

December 4, 1986

Mr. Donald D. Davidson
Manager, Technical Development
SAIC
8400 Westpark Drive
McLean, Virginia 22102

Dear Mr. Davidson:

I have just returned from an extended trip and have read your letter of November 20, 1986, Subject: Santa Cruz Deposit Casa Grande area of Arizona, Reference: Bureau of Mines Contract No. J0267001 SAIC Project No. 2-827-03-427. I agree to your proposed test program and permitting.

Very truly yours,

W. L. Kurtz

W. L. Kurtz

WLK:mek

cc: J. Ahlness - USBM
R. Weeks - Sergent, Hauskins & Beckwith
F. T. Graybeal - Asarco
V. C. Martz - Asarco
J. D. Sell - Asarco
R. V. Huff - Ray V. Huff & Assoc., Inc.

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703
1150 North 7th Avenue (602) 792-3010

H. G. [illegible]is
Dec. 5, 1986

INTERVALS CONSIDERED FOR WEDGE-OUT CORING

Santa Cruz Project, Pinal Co., Arizona

Hole	From	To	Interval	Cu	Copper Mineral	Rock Type	Remarks
SC-19*	1205'	1460'	255'	0.63%	Chry.,Atac.	Gr	NX drill hole
	1620	1770	150	2.98	Atac.	Gr	NX drill hole.
SC-35	1898	2220	322	0.70	Chry.	Qmp	NQ hole not usable--cased surface to 2286'.
SC-46	1506	1800	294	1.01	Chry., Atac.-Broch.	Qmp	HQ drill hole
SC-52	1236	1297	61	1.05	Chry.	Gr	HQ drill hole
	1462	1547	85	1.61	Chry.,Cc	Gr	HQ drill hole. Substantial chalcocite
	1776	1980	204	0.53	Chry.,Cc	Gr, Qmp	HQ drill hole. Some chalcocite.

Remark: Substantial lost circulation problems in SC-52 between 1200' and 2060'.

*Of these drill holes only the core of SC-19 was photographed. However, there are detailed structural logs available for all the other drill holes.

H.G. Kreis
Dec. 4, 1986

DRILL HOLE SC-19

Coordinates: 65520' North, 49459' East
1310.9' Collar Elevation
Directional survey report available (0-1300')

Drilling Statistics:

0-1205' 3½" I.D. casing, cemented at base, in rotary drill hole
1205'-2436' NX size diamond drill hole
2436'-2826' T.D. BX size diamond drill hole
Remark: At 2436' the NX rods were dropped and became stuck. The NX rods were used for casing during the BX drilling.

Casing Pulled:

The NX rods (casing) were cut at 2400', 2350', and 2340'. The NX rods became free above the cut at 2340', and apparently 2340' of NX rods were recovered. Thus, 96' of NX rods were left in the hole from 2340' to 2436'.

Mud Program:

Mud Gel and Dextrid with local use of Cellex, QBroxin, and caustic.

Drilling Conditions:

No drilling problems were reported above 2436'. Lost circulation problems reported at 1368'-1383', 1393'-1408', 1530'-1536', and at various depths below 2436'. Bridging occurred at about 2100' when the hole was 2436' deep.

H.G. Kreis
Dec. 4, 1986

DRILL HOLE SC-35

Coordinates: 64997.3' North, 49503.7' East
1313.7' Collar Elevation
Directional survey report available (0-2200')

Drilling Statitics:

0-923' 3½" I.D. casing, cemented at base, in rotary drill hole
923'-2286' NQ size diamond drill hole
2286'-2330' T.D. BQ size diamond drill hole
Remark: At 2265' the rods twisted off and were recovered. Hole was cased at 2286', and after the hole was advanced with BQ drilling, the NQ rods (casing) slipped at least a couple more feet down the hole. The hole was lost at 2330' because of bad ground conditions.

Casing Pulled:

The NQ rods (casing) were cut at 1800', 1600', 1392', 1000', 940', 900', and 800'. The cut at 800' allowed 800' of rods to be recovered. The rods below 800' were stuck and could not be recovered. Consequently, the hole is cased from the collar to a few feet below 2286', and none of the NQ rods (casing) can be recovered.

Drilling Conditions:

From 0' to 2283' no drilling problems were reported. A bridge at 1550' to 1620' was encountered when the hole was at 1705'. Apparently, hole problems started at 2283'. From 2286' to 2330' there was a severe sanding problem and a lost circulation problem, and the hole was lost at 2330' because of these problems. From 923' to 1870' the circulation varied from 70% to 90% return. From 1870' to 2330' T.D. there was typically no circulation, but several times slugs changed the circulation from no return to 50% return.

H.G. Kreis
Nov. 17, 1986
Dec. 4, 1986 (Rev.)

DRILL HOLE SC-46

Coordinates: 64483.5' North, 49496.5' East
1314.2' Collar Elevation
Directional survey report available (0'-2490')

Drilling Statistics:

0-1084' 4" or 4½" casing, cemented at base, in rotary drill hole
1084'-2325' HQ (NC) sized diamond drill core
2325'-2669' T.D. NQ sized diamond drill core
1080'-1313' (and below?) used oversized reaming shell

Casing Pulled:

All the casing used in the HQ hole for NQ drilling was recovered.

Mud Program:

My-Lo-Gel, CMC, soda ash and walnut flour. Added Dick's Mud Seal at 1100', 2550', and 2640'; D-D at 1250', and diesel at 1850' and 2560'.

Drilling Conditions:

No problems reported in shift reports of HQ portion of drill hole. Magcobar mud reports available for comments on drilling and mud program (Asarco file data). Circulation: 1084'-2540', 85-95%; 2540'-2564', 40%; 2564'-2669', 0%. The driller's reports made no mention of using plugs to increase circulation.

Geophysical Logs:

Available for 0-1087'; Birdwell. Suggest running geophysical logs before the placement of a wedge eliminates reentry into the lower part of the drill hole.

Geology:

1506'-1800', biotite-quartz-feldspar porphyry with chrysocolla and brochantite-atacamite. Copper grades vary from 0.2 to 2.5% Cu (one 7' sample at 5.76% Cu). See detailed geologic log.

H.G. Kreis
Dec. 4, 1986

DRILL HOLE SC-52

Coordinates: 65986.6' North, 50007.6' East
1310.1' Collar Elevation
Directional survey report available (0-2450')

Drilling Statistics:

0-758' 4" or 4½" I.D. casing, cemented at base, in rotary drill hole
758'-2040' HQ size diamond drill hole
2040'-2497' T.C. NQ size diamond drill hole

Casing Pulled:

All 2040' of NQ casing were pulled out of the hole.

Mud Program:

Mud made up of My Lo Gel, CMC, walnut flour, and soda ash. From 1450' to 2497' feet about 50 gallons of diesel were used for every 50' to 75' of core. Plugs of Hyseal and/or Quickseal were used many times to maintain circulation.

Drilling Conditions:

No significant drilling problems were encountered. An 80' buildup of debris occurred at a depth of 1382' when the hole was shut down over a two-day weekend. A 12' buildup occurred at 1830' after a two-day weekend. The circulation was difficult to maintain, and plugs (slugs) were run down many times. The circulation is summarized as follows:

From	To	Return	Remarks
763'	871'	90%	Plug was run at 857' or 871'
871	960	60	
960	1200	80-90	
1200	1370	0-30	On several occasions plugs increased return from 0% to 30-60%
1370	1585	35	
1585	1602	0	Plug was run at 1602'
1602	1700	30	
1700	2060	10-15	Cased at 2060'
2060	2190	90	
2190	2497 T.D.	0	

Memo to Bill Kurtz + Verle Martz - Asarco SHB JobNo. E86-27

From REW SHB 12/8/86

Re: Generic In Situ Copper Mine Design Manual

Task 10 Permit Acquisition for Phase II test program

In pursuit of your acquisition of an Notice of Intention to Drill which will be approved by ADWR, we have been discussing the nature of this action with Mr. Robert Fifield of ADWR. We suggest that the completed ADWR form be accompanied by a cover letter which describes the test program, and is directed to Mr Richard Gessner of ADWR. The nature of the intended actions may require a permit variance; a minor complication if the information provided is deemed adequate.

The ADWR monitor/piezometer well form was the one suggested by Mr. Fifield for use in the case of the Santa Cruz test program. A copy of this form is attached.

It would be advisable that the actual exploratory hole to be reentered be identified prior to submission of the ADWR form. However, we probably could ask for a variance and generally describe the construction of the existing holes and the nature of the testing program.

To assist you in completing and supplementing the ADWR

request for information, the following is provided:

* Location of wells - NE¼ Section 13, T6S, R4E. (The form requests a more specific subdivision)
* Purpose of well - "monitor" (could be construed to mean "test".
* Construction will start - June 15, 1987
* Period well will remain in use - 1 month
* Pump equipment to be installed - progressive cavity type with a stator at the bottom of the drill rods and a rotor installed through the rods on a drive shaft. A temporary installation.
* Design pump capacity - 5 gallons per minute
* use for water - pumped to waste
* method of abandonment - cement grout plug inside casing from top of casing to twenty feet below land surface, with surface seal in annular space outside casing extending from surface to a depth of at least 20 feet.

  or, preferably

  welding of steel cap on well and surface seal (This would conform to exploratory well section R12-15-817)

* Drilling firm - indicate that AOWR will be notified as to sucessful contractor upon award, and request that the drilling card be held until such time.
* purpose of well - investigate hydrologic properties of ore body
* our agency contacts - Mr. Richard Gessner + Mr. Richard Fifield.

* well construction plans - suggest we provide AOWR the following information concerning construction of existing boreholes:
  - depth range to top of ore body
  - general, brief description of geologic profile
  - casing details; size, type & depth
  - borehole diameter
  - method of drilling
  - surface seals, if any.
  - state that no gravel packs or casing perforation exist.

then provide description of proposed action by enclosing or summarizing Ray/Huff & Associates submittal which describes proposed field tests. In brief, the tests include the following:

  - borehole reentry, install bridge plug and set wedge.
  - off wedge, core at least 200 feet into orebody.
  - install pump; pump @ about 5 gpm for 48 hours
  - If pumping is unsuccessful, perform inflow test using potable water and borehole packer to isolate ore-bearing zone. Injection rate estimated at 20 gpm for 24 hours.
  - conventional wireline geophysical logging.

not in Huff's generic

Suggested format of request for variance:

* Cover Letter

Arizona Department of Water Resources
99 East Virginia
Phoenix, Arizona 85004
Attention: Mr. Richard Gessner
Re: Notice of Intention to Drill - Request for Variance
U.S. Bureau of Mines In Situ Test Program
Asarco / Freeport-McMoRan Santa Cruz Mine Property
Pinal County, Arizona

Gentlemen,

In accordance with Arizona administrative rules and regulations concerning well construction (Title 12 Chp. 15 Art. 8), we are hereby requesting a variance from the minimum construction standards established in the stated regulations. As expressed by your agency representatives, Mr. Richard Gessner and Mr. Richard Fifield, a variance is deemed necessary due to the site specific nature of the proposed action, and the investigative nature of the testing program. This testing program will be conducted by a U.S. Bureau of Mines (USBM) contractor in order to obtain data on the hydrogeologic properties of the Santa Cruz copper ore body. This investigative effort is in support of an ongoing USBM effort to develop generic designs for the extraction of copper utilizing in-situ methods.

The intent of this submittal is to provide sufficient information concerning the proposed action in order to

obtain approval for the completion of the USBM field program. The details of the USBM program are described in the attached submittal by Ray V. Hutt and the Notice of Intention to Drill form.

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specifics on variance

- after testing - leave hole to allow reentry - welded plate only.
- ~~No surface annular seal to 20 feet - this is exploratory hole only.~~
- notify BLWR of drilling firm after bid selection

If additional information on the testing program is needed, please contact Ralph Weeks of Sergent, Hauskins & Beckwith (602-272-6348), environmental permit subcontractor to the USBM.

H. G. [illegible]eis
Dec. 5, 1986

INTERVALS CONSIDERED FOR WEDGE-OUT CORING

Santa Cruz Project, Pinal Co., Arizona

Hole	From	To	Interval	Cu	Copper Mineral	Rock Type	Remarks
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SC-46	1506	1800	294	1.01	Chry., Atac.-Broch.	Qmp	HQ drill hole
SC-52	1236	1297	61	1.05	Chry.	Gr	HQ drill hole
	1462	1547	85	1.61	½ Chry.,Cc ½	Gr	HQ drill hole. Substantial chalcocite
	1776	1980	204	0.53	⅔ Chry.,Cc ⅓	Gr, Qmp	HQ drill hole. Some chalcocite.

Remark: Substantial lost circulation problems in SC-52 between 1200' and 2060'.

*Of these drill holes only the core of SC-19 was photographed. However, there are detailed structural logs available for all the other drill holes.

Passed on to USBM 12/19/86

H.G. Kreis
Dec. 4, 1986

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Mud Program:

Mud Gel and Dextrid with local use of Cellex, QBroxin, and caustic.

Drilling Conditions:

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H.G. Kreis
Nov. 17, 1986
Dec. 4, 1986 (Rev.)

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1080'-1313' (and below?) used oversized reaming shell

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Geophysical Logs:

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H.G. Kreis
Dec. 4, 1986

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1310.1' Collar Elevation
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758'-2040' HQ size diamond drill hole
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All 2040' of NQ casing were pulled out of the hole.

Mud Program:

Mud made up of My Lo Gel, CMC, walnut flour, and soda ash. From 1450' to 2497' feet about 50 gallons of diesel were used for every 50' to 75' of core. Plugs of Hyseal and/or Quickseal were used many times to maintain circulation.

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From	To	Return	Remarks
763'	871'	90%	Plug was run at 857' or 871'
871	960	60	
960	1200	80-90	
1200	1370	0-30	On several occasions plugs increased return from 0% to 30-60%
1370	1585	35	
1585	1602	0	Plug was run at 1602'
1602	1700	30	
1700	2060	10-15	Cased at 2060'
2060	2190	90	
2190	2497 T.D.	0	

From the desk of:

12-16-1986

H. G. KREIS

Santa Cruz
USBM Visit

T.D.S.

Sterling Cook, USBM, called for you. Since you were out of town, he asked for me.

He was wondering if you got his letter. He told me of his plans for a visit on Jan 5th. I will discuss his plans with you when you are back in Tucson.

H.G.K.

ASARCO

JDS

Exploration Department
Southwestern United States Division
James D. Sell
Manager

December 12, 1986

Sterling S. Cook
Geologist, In Situ Mining
U.S. Dept. of the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Ave. South
Minneapolis, Minn. 55417

Santa Cruz Project
Pinal County, AZ

Dear Dr. Cook:

Your letter of Dec. 3, 1986, has arrived. It is good to hear that you and Linda Dahl will be down to review and collect additional data during early January.

As Asarco only has permission to store the core in the Casa Grande Copper warehouse, we can only supply a key to the door as we did last time. Any further fix up of the facilities at this time would have to be handled by yourselves.

Hank's involvement in other work will preclude his working with you, but we would hope that he could stop by during the late stages of your stay to catch up on the progress and tentative findings.

Mr. Sal Anzalone, Chief Geologist of Mines, of which Sacaton is a part, sees no problem on your examining the Sacaton pit area.

We also anticipate that when the drilling starts, some office facilities will be available at the Sacaton office.

Please contact Sal Anzalone (extension 232) and this department on any other consideration.

Sincerely,

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
S.A. Anzalone
F.T. Graybeal

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703
1150 North 7th Avenue (602) 792-3010

work comment FILE

United States Department of the Interior

BUREAU OF MINES

TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55417

Santa Cruz Proj
Pinal Co., AZ

December 3, 1986

Mr. James D. Sell
Manager, Southwestern
Exploration Division
ASARCO Inc.
1150 North 7th Avenue
Tucson, Arizona 85703

ASARCO Incorporated
DEC 5 1986
SW Exploration

Dear Jim:

Linda Dahl and I would like to come down to Casa Grande during the first 2 weeks of January. The purpose of our visit is to relog several diamond drill cores and do some regional fracture mapping. We feel the relogging of cores is important because our knowledge of in situ leachability has advanced since the original logging of the core and many Santa Cruz holes haven't been examined with leachability as a primary concern.

The Casa Grande Copper Company has done extensive rock mass characterization in their parts of the deposit. We want to know how extensive the fracture system they identified is because the orientation of joints will affect the regional hydrology. As part of this effort we would like to examine the Sacaton deposit. Could you arrange a 1- or 2-day period around January 8-11 when we could work at Sacaton?

Since this visit will be much longer than our previous one, we hope it will be possible to fix up the core shed a little bit. Electricity, logging benches, a binocular microscope, and water are the minimum necessities for our work but we anticipate the need for desks, chairs, files, and toilets when work starts on the contract. Can ASARCO prepare these facilities?

maybe office use at Sacaton

Finally, we hope it will be possible for Hank Kreis to work with us during part of our stay. Our schedules are somewhat flexible and we are eager to work with you to find an optimum period for a 10- to 12-day visit during January. Please don't hesitate to call me if you have any questions about our proposed visit or the progress of our research at (612) 725-4552.

we do not own core shed and do not really want to start electricity for 10 days

Sincerely,

Sterling Cook

STERLING S. COOK, Geologist
In Situ Mining

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

December 18, 1986

Mr. W. L. Kurtz
Tucson Office

Atacamite
Santa Cruz Project, Arizona

Dear Mr. Kurtz:

The December 9, 1986 note by Mr. Kreis mentions several unnamed copper SXEW operations which either use sea water or which leach Atacamite in addition to Chuquicamata. It might be useful for Mr. Kreis or Mr. Sell to identify these operations as this subject will arise during discussions leading to selection of a site for the full scale USBM in situ test.

Mantos Blancos in Chile is, I believe, one property which recovers copper from Atacamite. When this list is compiled, please send me a copy.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mr

copies given to JBS & HGK.
JBS

RECEIVED
DEC 23 1986
EXPLORATION DEPARTMENT

See: International Mining Journal
May 1986, p. 42-46
Non-conventional Peruvian processing
Brine-leaching Precious metals.

ASARCO Incorporated 180 Maiden Lane New York, N.Y. 10038 (212) 510-2000
Telex:ITT 420585 RCA 232378 WUI 62522 Cables: MINEDEPART Telegrams: WU1-25991

ASARCO

Southwestern Exploration Division

December 9, 1986

To: J.D. Sell

From: H.G. Kreis

Atacamite Leaching
Santa Cruz Project
Pinal County, Arizona

Today I talked with Roshon Bhappu at the Mountain States Mineral Enterprises Technical Seminar, and I gained some of his opinions on the leaching of atacamite and the Santa Cruz Project. Mr. Bhappu believes the chloride ion will be a serious problem in the leaching of atacamite. Because of Bhappu's concerns, Mountain States' Santa Cruz proposal to the Bureau of Mines was based on ammonia leaching of copper rather than sulfuric acid leaching.

During the Technical Seminar, Gary Kordosky, Technical Director of the Minerals Industry Division of the Henkel Corporation, gave a comprehensive talk on solvent extraction - electrowinning. Mr. Kordosky was asked by Mr. Bhappu about the effect of the chloride ion on the SX-EW process. Mr. Kordosky said the chloride ion presents no problem. He went on to say that some copper SX-EW leaching operations use sea water.

A month ago I spoke with Orlando Alvarez, Superintendent of Geology for the Chuquicamata Division of Codelco, about leaching atacamite at Chuquicamata. Mr. Alvarez said that the chloride ion is not a problem with their SX-EW plant. The solution is more corrosive, but the corrosive nature is successfully handled with PVC and fiberglass pipe and fiberglass pumps. Mr. Alvarez also mentioned the use of sea water at some unspecified SX-EW plant.

A month ago one or two of the Bureau of Mines people (or consultants) expressed a serious concern about the chloride ion problem at Santa Cruz. I explained that we were also concerned about the potential problem early in our evaluations but found out there is no evidence of such a problem.

The concerns about the chloride ion need to be addressed. We should encourage the Bureau of Mines to research operations in which the chloride ion is a factor. Furthermore, it would be advantageous to find out the types of materials that will withstand its corrosive effects. If the Bureau of Mines does not choose to do this research, then we should consider doing it ourselves. I don't care to see the integrity of the Santa Cruz or the Hanna-Getty deposit compromised by a lack of information.

H. G. Kreis

H. G. Kreis

HGK:mek

cc: WL Kurtz
DE Crowell

ASARCO

Southwestern Exploration Division

JDS

December 22, 1986

Staff

In Situ Group - USBM
Santa Cruz Project

Dr. Sterling Cook and Dr. Linda Dahl of the In Situ group of the USBM, Minneapolis, MN, will be in Tucson the afternoon of January 5, 1987.

They will present a slide show and discussion of their results on the study of the Santa Cruz core.

You are all welcome to attend at the Asarco conference room, 3rd floor.

D. A. Melhado will supply the slide projector and screen.

James D. Sell

JDS:mek

James D. Sell

cc: W.L.Kurtz
S.A.Anzalone

Sterling Cook & Linda Wohl 1/5/87

Kalt = Brochantite.

serici-clay chrysocolla

Higgle Cu + Kalt = fracture hosted Brochantite
Outlined by clay alt ~~outlines~~ chrysocolla

Dan White - study.

Santa Cruz
granite fracture chrysocolla
granite alaunite stockwork
porphyry " "
porphyry disseminated ore

Permeability (Laboratory).

SC-1962 stockwork 0.01 millidarcy
5" alaunite 0.02 md

SC-86 porphyry
disseminated 0.0001 md
stockwork alaunite 0.02 md.

"Stockwork ore only leachable material
Disseminated poorly leached.

Stockwork best developed in granite
(also in porphyry)

ASARCO Southwestern Exploration Division

JDS

January 8, 1987

To: J.D. Sell

From: H.G. Kreis

USBM Test Work
Santa Cruz Project
Pinal Co., AZ

On January 5, 1987 Sterling Cook and Linda Dahl gave the Tucson Office, including you, a presentation on the results of their Santa Cruz core leach tests. On the basis of the results Mr. Cook concluded that porphyry with disseminated chrysocolla, such as in SC-46 from 1500' to 1850', can not be leached. This conclusion has caused some discussion between you, Mr. Graybeal, Mr. Kurtz, and me. We plan to have further discussions with Mr. Cook on this matter for reasons which we have all discussed.

H.G. Kreis

H. G. Kreis

HGK:mek

cc: F.T. Graybeal
W.L. Kurtz

Stirling Cook-Leidal Dobl relations 1/15/87

Buchenite ≅ K zone & along contact of porp & wallrock as stockwork

Chrysocolla zone ≅ disseminated in mafic sites, clay site of feldspars & in limonite sites, in either porphyry or volc wallrock outside the buchenite zone.

Late shearing & deep leach zones (along structures) then leaches the fracture zone mineralization but leaves the absorbed Cu in clay, feldspars sites

granite fracture hosted chrysocolla-alunite ① "fresh" ② "altered"
Porphyry fracture hosted chrysocolla-alunite ③ ④ "altered"
Porphyry disseminated chrysocolla ⑤ "altered"!?

(magnesium phosphate - post leach pot spots)

SC-46
1-15-1987

DEPTH from	DEPTH to	int'vl	% CORE RECOV.		ASSAY Cu %	COMPOSITE Cu %	Au oz/TON	Ag oz/TON	MO %	Chrysocolla	Atacamite ~~Brochantite~~	% of T Cu NOT IN PLAG SITES	% of T Cu IN PLAG SITES	
1407	1417	10	100		0.06									
1417	1427	10	100		0.06									
1427	1438	11	100		0.10				.0081					
1438	1448	10	100		0.05									
1448	1458	10	100		0.07									
1458	1468	10	100	✓	0.06					Tr				
1468	1476	8	100	✓	0.07									
1476	1486	10	100		0.21					0.21				
1486	1496	10	100		0.14					0.14				
1496	1506	10	100		0.18					0.18				
1506	1516	10	100	✓	0.21					0.21				
1516	1526	10	100		0.21				.0152	0.21				
1526	1536	10	100		0.28					0.28				
1536	1546	10	100		0.39					0.39				
1546	1552	6	100	✓	0.26					0.26				
1552	1562	10	100	✓	0.20					0.20				
1562	1570	8	100	✓	0.29					0.29	X			1570
1570	1580	10	100		1.57					0.40	1.17	90	10	
1580	1586	6	100	✓	0.39					0.39		90	10	
1586	1590	4	100	✓	2.52					0.60	1.92	90	10	
1590	1600	10	100		1.23		1.19	.002	0.11	.0175	0.20	1.03	90	10
1600	1610	10	100	✓	1.00						0.60	0.40	90	10
1610	1619	9	100	✓	1.41						0.90	0.51	90	10
1619	1629	10	100	✓	1.11						0.31	0.80	90	10
1629	1639	10	100	✓	0.90						0.30	0.60	90	10
1639	1649	10	100	✓	0.56						0.56	—	0	100
1649	1659	10	100	✓	1.56						0.30	1.26	35	65
1659	1664	5	100	✓	2.16	(Reassay)					0.16	2.00	80	20
1664	1671	7	100	✓	5.96	(Reassay)	1.79	.001	0.11	.0143	0.20	5.76	100	0
1671	1680	9	100	✓	2.51						0.80	1.71	90	10
1680	1690	10	100	✓	1.72						0.20	1.52	100	0
1690	1699	9	100	✓	0.88						0.20	0.68	80	20
1699	1706	7	100	✓	1.05						0.20	0.85	100	0
1706	1716	10	100	✓	0.20						0.20	—	100	0
1716	1725	9	100	✓	0.17						0.17	—	100	0
1725	1735	10	100	✓	1.28						.608	0.20	50	50
1735	1745	10	100		0.76		0.81	TRACE	0.06	.0207	0.76	—	50	50
1745	1755	10	100		0.84						0.84	—	75	25
1755	1765	10	100	✓	1.98						1.58	0.40	80	20
1765	1775	10	100	✓	0.56						0.40	0.16	80	20
1775	1785	10	100	✓	0.78						0.78	—	90	10
1785	1790	5	100	✓	0.38						0.38	—	75	25
1790	1800	10	100	✓	0.32						0.32	—	90	10

1785

1570 - 1785
All Porphyry
215' @ 1.28% Cu

Non Plag Site 1.02% (80%)

Plag Site 0.26% (20%)
Total 1.28% (100%)

Hard to classify, but easy to leach

SC-35 H.O.K 1-15-1987

DEPTH from	to	int'vl	% CORE RECOV.	ASSAY Cu %	COMPOSITE Cu %	AU oz/TON	Ag oz/TON	MO %	(Kolb) Chrysocolla	(Vogt) Brochantite Atacamite	% of T Cu NOT IN PLAG SITES	% of T Cu IN PLAG. SITES
1898	1902	4	100	0.67					3	← Cu		
1902	1912	10	98	0.52					1½	¼		
1912	1922	10	100	0.19	0.33	.003	0.12	.0034	1	—		
1922	1932	10	100	0.17					1			
1932	1942	10	100	0.26					1½			
1942	1947	5	100	0.29					¾			
1947	1957	10	100	0.50					1½			
1957	1965	8	100	0.43					1½			
1965	1970	5	100	0.48	0.69	.002	0.15	.0104	4			
1970	1980	10	100	1.13					1½			
1980	1990	10	100	0.26					1½			
1990	2000	10	90	0.24					¾			
2000	2011	11	100	0.30	0.45	TRACE	0.07	.0037	1			
2011	2021	10	94	0.70					2 (?+)			
2021	2031	10	96	0.61					2 (?+)			
2031	2041	10	100	0.34					3			
2041	2048	7	100	0.30	0.43	.003	0.17	.0027	2			
2048	2056	8	100	0.50	—				3			
2056	2065	9	100	0.51					4			
2065	2075	10	100	0.85					4		90	10
2075	2085	10	100	0.86					4		85	15
2085	2095	10	100	1.17	1.01	.004	0.18	.0028	4+?		* (90) 70	30
2095	2103	8	100	1.23					5		90	10
2103	2110	7	100	0.79					5		90	10
2110	2120	10	100	0.24					1½		100	0
2120	2127	7	100	0.27	0.31	.006	0.21	.0024	1½		100	0
2127	2133	6	100	0.48					1		100	0
2133	2140	7	100	0.24					¾		100	0
2140	2150	10	100	0.70					3		* (95) 85	15
2150	2160	10	100	0.70					2½		* (80) 70	30
2160	2170	10	100	1.58	1.28	.007	0.22	.0030	3		* (70) 50	50
2170	2180	10	100	1.61					2½		* (85) 60	40
2180	2190	10	100	1.63					4		* (65) 50	50
2190	2200	10	100	1.85					7		70	30

2065

2065 - 2200
All Porphyry

135' @ 0.99% Cu

Non Plag Site 0.79% Cu (80%
Plag Site 0.20% Cu (20%
Total 0.99% Cu (100

2200

*( ) ← HGK Estimate

Table 18. Sulfuric Acid-Bottle Leach Tests, Acid Strength of 30 gpl

				Head Assays		Calculated Head		Sulfuric Acid Consumption		Copper Mineralogy			Rock Type		
Hole	From (Ft.)	To (Ft.)	Interval (Ft.)	Cu (%)	N.S.Cu (%)	(Cu %)	Copper Recovery (%)	Lbs. H_2SO_4 per Lb. Cu Rec.	Lbs. H_2SO_4 per Ton	Chryso-colla (%)	Green CuOx (%)	Chalco-cite (%)	Granite (%)	Porphyry (%)	Diabase (%)
SC-19	1205	1460	255	0.61	0.55	0.58	83	3.9	38	63	37	0	94	0	6
	1620	1770	150	3.15	2.74	2.70	97	1.5	79	6	94	0	99	1	0
SC-24	1550	1820	270	0.77	0.67	0.75	84	3.7	47	77	14	9	55	44	1
SC-46	1570	1706	136	1.44	1.39	1.38	91	2.2	55	26	74	0	5	95	0
	1706	1900	194	0.53	0.46	0.52	74	4.5	35	92	8	0	0	100	0
	1900	2040	140	0.79	0.21	0.80	29	6.3	29	0	0	98	56	44	0

chrysocolla consumes twice as much acid as does Green Ox ?! (atacamite).

JDS

ASARCO

Southwestern Exploration Division

January 20, 1987

To: J.D. Sell

From: H.G. Kreis

U.S.B.M. Santa Cruz
Presentation of
January 5, 1987

On January 5, 1987 Sterling Cook and Linda Dahl, both of the U.S. Bureau of Mines, gave a presentation to J.D. Sell, S.A. Anzalone, D.E. Crowell, W.D. Gay, and me at the Tucson office. During that presentation they gave the results of their permeability test work and their microprobe work. Very little was said about the actual leach tests that have been performed on the core.

During their presentation I became very concerned with the conclusions that were being derived from the laboratory data on the Santa Cruz core. It became very evident that the laboratory data results were being interpreted with the intent of distinguishing ore from non-ore material. For example, it was said that the only ore in the SC-46 copper oxide mineralization between 1500' and 1800' was in the atacamite stockwork between depths of 1660' and 1692'. Their conclusion was based on the premise only the interval from 1660' to 1692' was amenable to in place leaching and the rest of the interval between 1500' and 1800' consisted of impermeable, disseminated copper mineralization (copper in plagioclase and biotite sites). The data base upon which this conclusion was made is summarized in the attached sheet.

After the meeting it was obvious we needed to spend more time with the Bureau of Mines people in order to understand their data base and to give them the benefit of our experience with copper oxide deposits. On January 14, 1987 I went to Casa Grande and met with Mr. Cook and Mrs. Dahl. We spent hours discussing the laboratory data, the interpretation of the laboratory data as it applies to the rock in the ground, examining core, and logging core. All in all it was a very friendly and informative meeting for all of us.

Mr. Cook and I spent a couple of hours logging the distribution of the copper mineralization in the porphyry of SC-46 from 1570' to 1800' and in SC-35 from 2065' to 2200'. We examined each assay interval and determined the abundance of copper in non-plagioclase sites and the abundance of copper in plagioclase sites. For our logging purposes, the abundance of copper in plagioclase sites also includes the abundance of copper in biotite sites. The results of our logging are shown in the attached logs, and the values shown represent a mutually agreeable estimate. I noted a few intervals in SC-35 where my estimate was significantly different from Mr. Cook's, and my estimates are shown in parentheses.

The results of the logging show that in SC-46 from 1570' to 1785' 80% of the copper exists in non-plagioclase sites while 20% of the copper exists in plagioclase sites. The same was found to be true in SC-35 from 2065' to 2200'. The abundance of copper in plagioclase sites is relatively small, only 20%. I suppose such a value is on par with many heap leach operations, and I see no reason at this time to believe it presents a troublesome situation for in situ leaching.

I could not agree with the USBM conclusion of January 5, 1987 that the SC-46 copper oxide mineralization in porphyry is impermeable. The USBM's conclusion was based on the laboratory permeability tests of those pieces of core listed in the attached sheet. They ran permeability tests on 4 pieces of core, and one of those pieces crumbled during testing which invalidated the test results of that piece of core (SC-46, 1699'). It is interesting to note that two-thirds of the samples taken for permeability test work and microprobe work were taken from a 4' thick interval in which 100% of the copper occurs in plagioclase sites, and the remaining samples were taken of porphyry with 40% of the copper in plagioclase-biotite sites. It appears that none of the samples taken are truly representative of the interval in SC-46 from 1500' to 1800'.

More importantly though, the permeability test work probably represents the permeability of the porphyry between fractures. Although I have not seen the porphyry samples taken by the U.S. Bureau of Mines in SC-46, I strongly suspect that none of them would give permeability test data representative of the fracture permeability of the core. I am inclined to think that the USBM permeability test work may be representative of the solid rock between the fractures, and I made my thoughts clear to Mr. Cook and Mrs. Dahl. I went on to say that there is no way we can test the permeability of the Santa Cruz copper deposit in the laboratory, and the only way it can be done is in the field. This has been Asarco's position from the start, and it will continue to be Asarco's position until the field test work tells us otherwise.

On January 15, 1987, Mr. Cook and Mrs. Dahl returned to the Tucson office, and they gave a repeat of their presentation for the benefit of Bill Kurtz. During this repeat presentation, very little was said about the absolute leachability of the Santa Cruz copper oxide mineralization. The conclusion was that the chrysocolla and atacamite stockwork mineralization in the granite of SC-19 would be more amenable to in situ leaching.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
S.A. Anzalone
D.E. Crowell

H.G. Kreis Notes
From Meetings
With USBM On
January 5 & 14, 1987

USBM DATA BASE AND CONCLUSIONS ON SC-46

		Permeability Test	Microprobe Work	Results
SC-46	1646	X	X	0.8% tot.Cu, 90% of Cu in plag. sites
	1649		X	1.1% tot.Cu, 90% of Cu in plag. sites
	1649.5	X	X	1.1% tot.Cu, 90% of Cu in plag. sites
	1650		X	1.2% tot.Cu, 100% of Cu in plag. sites
	1699	X	X	40% of Cu as atacamite in biot. sites
	1752	X	X	40% of Cu in biot. sites

SC-19 (did not obtain this information)

USBM logging of core from 1500' to 1800' in SC-46 and SC-19.

Conclusions of Permeability Test Work:

SC-19 Granite with chrysocolla stockwork 0.01 millidarcy
Granite with atacamite stockwork 0.02 millidarcy

SC-46 Porphyry with atacamite stockwork 0.02 millidarcy
Porphyry with diss. Cu in plag. and bio. sites 0.001 millidarcy

~~Lakeshore ores have 0.01 to 0.02 millidarcy~~ → See revision

On 1-5-1987 USBM told us the only leach ore in SC-46 is the atacamite stockwork from 1660-1692. All the rest of the interval between 1500' and 1800' is "sorbed" Cu with Cu in the plagioclase and biotite sites of impermeable porphyry; and, therefore, is not leach ore material.

SC-46
1-15-1987
Copy to USBM 1-15-87

DEPTH from	DEPTH to	int'vl	% CORE RECOV.		ASSAY Cu %	COMPOSITE Cu %	Au oz/TON	Ag oz/TON	MO %	Chrysocolla	Atacamite Brochantite	% of T Cu NOT IN PLAGIS SITES	% of T Cu IN PLAGIS SITES	
1407	1417	10	100		0.06									
1417	1427	10	100		0.06									
1427	1438	11	100		0.10				.0081					
1438	1448	10	100		0.05									
1448	1458	10	100		0.07									
1458	1468	10	100		0.06					Tr				
1468	1476	8	100		0.07									
1476	1486	10	100		0.21					0.21				
1486	1496	10	100		0.14					0.14				
1496	1506	10	100		0.18					0.18				
1506	1516	10	100		0.21					0.21				
1516	1526	10	100		0.21				.0152	0.21				
1526	1536	10	100		0.28					0.28				
1536	1546	10	100		0.39					0.39				
1546	1552	6	100		0.26					0.26				
1552	1562	10	100		0.20					0.20				
1562	1570	8	100		0.29					0.29				
1570	1580	10	100		1.57					0.40	1.17	90	10	1570
1580	1586	6	100		0.39					0.39		90	10	
1586	1590	4	100		2.52					0.60	1.92	90	10	
1590	1600	10	100		1.23		1.19	.002	0.11	.0175	0.20	1.03	90	10
1600	1610	10	100		1.00						0.60	0.40	90	10
1610	1619	9	100		1.41						0.90	0.51	90	10
1619	1629	10	100		1.11						0.31	0.80	90	10
1629	1639	10	100		0.90						0.30	0.60	90	10
1639	1649	10	100		0.56						0.56	—	0	100
1649	1659	10	100		1.56						0.30	1.26	35	65
1659	1664	5	100		2.16	(Reassay)					0.16	2.00	80	20
1664	1671	7	100		5.96	(Reassay)	1.79	.001	0.11	.0143	0.20	5.76	100	0
1671	1680	9	100		2.51						0.80	1.71	90	10
1680	1690	10	100		1.72						0.20	1.52	100	0
1690	1699	9	100		0.88						0.20	0.68	80	20
1699	1706	7	100		1.05						0.20	0.85	100	0
1706	1716	10	100		0.20						0.20	—	100	0
1716	1725	9	100		0.17						0.17	—	100	0
1725	1735	10	100		1.28						.608	0.20	50	50
1735	1745	10	100		0.76		0.81	TRACE	0.06	.0207	0.76	—	50	50
1745	1755	10	100		0.84						0.84	—	75	25
1755	1765	10	100		1.98						1.58	0.40	80	20
1765	1775	10	100		0.56						0.40	0.16	80	20
1775	1785	10	100		0.78						0.78	—	90	10
1785	1790	5	100		0.38						0.38	—	75	25
1790	1800	10	100		0.32						0.32	—	90	10

1785

1570 - 1785
All Porphyry
215' @ 1.28% Cu

Non Plag Site 1.02% (80%)

Plag Site 0.26% (20%)
Total 1.28% (100%)

Hard to classify, but easy to leach

SC-35 H.O.K 1-15-1987

DEPTH fr	to	int'vl	% CORE RECOV.		ASSAY Cu %	COMPOSITE Cu %	Au oz/TON	Ag oz/TON	Mo %	(Vol%) Chrysocolla	(Vol%) Brochantite Atacamite	% of T Cu NOT IN PLAG SITES	% of T Cu IN PLAG SITES
1898	1902	4	100		0.67					3 < Cu			
1902	1912	10	98		0.52					1½	¼		
1912	1922	10	100		0.19	0.33	.003	0.12	.0034	1	—		
1922	1932	10	100		0.17					1			
1932	1942	10	100		0.26					1½			
1942	1947	5	100		0.29					¾			
1947	1957	10	100		0.50					1½			
1957	1965	8	100		0.43					1½			
1965	1970	5	100		0.48	0.69	.002	0.15	.0104	4			
1970	1980	10	100		1.13					1½			
1980	1990	10	100		0.26					1½			
1990	2000	10	90		0.24					¾			
2000	2011	11	100		0.30	0.45	TRACE	0.07	.0037	1			
2011	2021	10	94		0.70					2 (?)			
2021	2031	10	96		0.61					2 (?)			
2031	2041	10	100		0.34					3			
2041	2048	7	100		0.30	0.43	.003	0.17	.0027	2			
2048	2056	8	100		0.50	—				3			
2056	2065	9	100		0.51					4			
2065	2075	10	100		0.85					4	90	10	
2075	2085	10	100		0.86					4	85	15	
2085	2095	10	100		1.17	1.01	.004	0.18	.0028	4 (?)	* (?) 70	30	
2095	2103	8	100		1.23					5	90	10	
2103	2110	7	100		0.79					5	90	10	
2110	2120	10	100		0.24					1½	100	0	
2120	2127	7	100		0.27	0.31	.006	0.21	.0024	1½	100	0	
2127	2133	6	100		0.48					1	100	0	
2133	2140	7	100		0.24					¾	100	0	
2140	2150	10	100		0.70					3	* (95) 85	15	
2150	2160	10	100		0.70					2½	* (85) 70	30	
2160	2170	10	100		1.58	1.28	.007	0.22	.0030	3	* (70) 50	50	
2170	2180	10	100		1.61					2½	* (85) 60	40	
2180	2190	10	100		1.63					4	* (55) 50	50	
2190	2200	10	100		1.85					7	70	30	

2065

2200

2065 - 2200
All Porphyry

135' @ 0.99% Cu

Non Plag site 0.79% Cu (80%
Plag site 0.20% Cu (20%
Total 0.99% Cu (100

* ( ) ← HGK Estimate

JDS

1/21/87

To: J.D. Sell

From: H.G. Kreis

Attached is a revised copy of attachment to my memorandum of January 20, 1987, "U.S.B.M. Santa Cruz Presentation of January 5, 1987."

cc: F.T. Graybeal
W.L. Kurtz
S.A. Anzalone
D.E. Crowell

H.G. Kreis Notes
From Meetings
With USBM on
January 5 & 14, 1987
(Revised Copy 1/21/87)

USBM DATA BASE AND CONCLUSIONS ON SC-46

		Permeability Test	Microprobe Work	Results
SC-46	1646	X	X	0.8% tot.Cu, 90% of Cu in plag. sites
	1649		X	1.1% tot.Cu, 90% of Cu in plag. sites
	1649.5	X	X	1.1% tot.Cu, 90% of Cu in plag. sites
	1650		X	1.2% tot.Cu, 100% of Cu in plag. sites
	1699	X	X	40% of Cu as atacamite in biot. sites
	1752	X	X	40% of Cu in biot. sites

SC-19 (did not obtain this information)

USBM logging of core from 1500' to 1800' in SC-46 and SC-19.

Conclusions of Permeability Test Work:

SC-19 Granite with chrysocolla stockwork 0.01 millidarcy
Granite with atacamite stockwork 0.02 millidarcy

SC-46 Porphyry with atacamite stockwork 0.02 millidarcy
Porphyry with diss. Cu in plag. and bio. sites 0.001 millidarcy

Lakeshore porphyry ores have 0.01 to 0.02 millidarcy in disseminated ore (30% of Cu in plag. and bio. sites) and inferred to be higher in brochantite stockwork.

On 1-5-1987 USBM told us the only leach ore in SC-46 is the atacamite stockwork from 1660-1692. All the rest of the interval between 1500' and 1800' is "sorbed" Cu with Cu in the plagioclase and biotite sites of impermeable porphyry; and, therefore, is not leach ore material.

FILE

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

March 17, 1987

Mr. J. D. Sell
Tucson Office

USBM In Situ Contract
Santa Cruz Project, Arizona

Dear Mr. Sell:

The attached letter from Mr. Ahlness of the USBM which requests that all written materials from Asarco to SAIC be directed through the USBM is self explanatory. Please circulate this letter to all members of your staff and others in the Tucson Office (including Mr. Martz) who are involved with the project.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mr
Att.
cc: W. L. Kurtz (w/o Att.)

Copy for:
WL Kurtz
HG Kreis
WD Gay
SA Anzalone
VC Martz
JD Sell

ASARCO Incorporated
MAR 23 1987
SW Exploration

United States Department of the Interior

BUREAU OF MINES

TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55417

March 10, 1987

Mr. Frederick T. Graybeal
Chief Geologist
Exploration Department
ASARCO, Inc.
180 Maiden Lane
New York, New York 10038

Dear Mr. Graybeal:

The purpose of this letter is to inform ASARCO of the routing procedures to be followed during Phase II of Contract No. J0267001, titled "Generic In Situ Copper Mine Design Manual." This routing procedure will be used to ensure the Bureau's internal coordination of all phases of the project.

After this date, all written materials from ASARCO directed to the Bureau's contractor (Science Applications International Corporation--SAIC), related to the administrative activities of Contract No. J0267001 (notifications, requests, transfer of collected field data, etc.), should be submitted to the Bureau's Twin Cities Research Center to my attention. The Bureau shall then be responsible for providing this information to SAIC. Similarly, all such incoming (administrative) actions to ASARCO from SAIC will be funneled through the Bureau, which will in turn distribute this information to your office.

With regard to permitting activities related to Phase II field work, ASARCO should continue its close cooperation with SAIC and the regulatory agencies. There is no need to funnel permitting correspondence and documents through the Bureau for subsequent distribution. I request, however, that copies of all permit-related correspondence be provided to the Bureau at the time of release.

Letters addressing this new routing procedure will be distributed to SAIC and the regulatory agencies. For all permitting correspondence, the regulatory agencies will be requested to provide the Bureau with a copy.

Please note that this letter should not be interpreted as discouraging verbal communication between ASARCO and SAIC.

If you have any questions, please feel free to call me at (612) 725-4289 or 4539.

Sincerely,

Jon K. Ahlness

JON K. AHLNESS
Technical Project Officer
In Situ Mining

RECEIVED
MAR 16 1987
EXPLORATION DEPT

New York, N.Y., May 29, 1987

ASARCO Incorporated

JUN 5 1987

SW Exploration

TO: R. L. Brown

U.S. Geological Survey Involvement
Santa Cruz Project, Arizona

Mr. Kreis has worried in a recent memo (May 13, 1987) that the USGS will have unrestricted access to Santa Cruz for their own purposes. I have had a verbal understanding with Bill Larson of USBM that his group would have access to all our geologic data and that certain geologic data relating to the in situ project would be published as part of the on-going project record. Our understanding, reached about a year ago, also recognized that if a thorough geologic review of the project were to become necessary it would be authored by Asarco geologists (Kurtz, Kreis and others if needed) and published in a prominent journal.

I sympathize with Mr. Kreis' concern for our proprietary exploration data, but given the lack of forseeable porphyry copper exploration activity by Asarco over the next decade, I'm not too concerned that our competitive edge will be compromised. I reviewed the situation with Bill Larson about one week ago, who recalled our verbal understanding, and noted the USGS tendency to get off track with their studies.

He commented that the USGS has money and equipment he wants to incorporate in the in situ project. I said we could consider allowing the USGS to do some geologic work, but any work not strictly related to the in situ project would not be approved for publication until after the Asarco paper had beeen written. Larson wanted to know when that might be, and I said I would not commission preparation of a manuscript until after Congress had approved a budget sufficient to begin the $14 million test. I did tell Larson that the USGS could do what geophysical work it wished when it wished, but that any work by the USGS or any other group not covered by the USBM-Asarco-Freeport Memorandum of Agreement be first reviewed for publication by Asarco. Larson said he would make our position known to Ahlness.

I don't like the idea of being pushed to do something by the USGS, but I anticipated roughly what is happening when I originally discussed the subject with Larson a year ago. Any work the USGS might do would potentially benefit Asarco, Freeport and the in situ project. I also have it in the back of my mind that we might start a University of Arizona MS thesis on supergene mineral zoning at Santa Cruz when we can afford it. Finally, I note in Mr. Kreis' memo that he would entertain a trade-off for USGS work not related to in situ, so I guess he is somewhat flexible on the subject.

F. T. Graybeal

F. T. Graybeal

FTG:mr

cc: W. L. Kurtz/J. D. Sell/H. G. Kreis

ASARCO

Southwestern Exploration Division

JDS

May 13, 1987

To: F.T. Graybeal

From: H.G. Kreis

USGS
Santa Cruz Project
Pinal County, AZ

Jon Ahlness of the USBM told me the USGS is interested in the geochemical and geophysical characteristics of the Santa Cruz Deposit. The USGS's interest goes beyond the groundwater study that the USGS is currently pursuing. The USGS wants to have our geochemical-geophysical data and permission to gather their own data from drill holes, core, etc.

Obviously, this gets into the realm of proprietary exploration data, and I am not in favor of opening up our deposit to such scrutiny. It has nothing to do with in situ leaching.

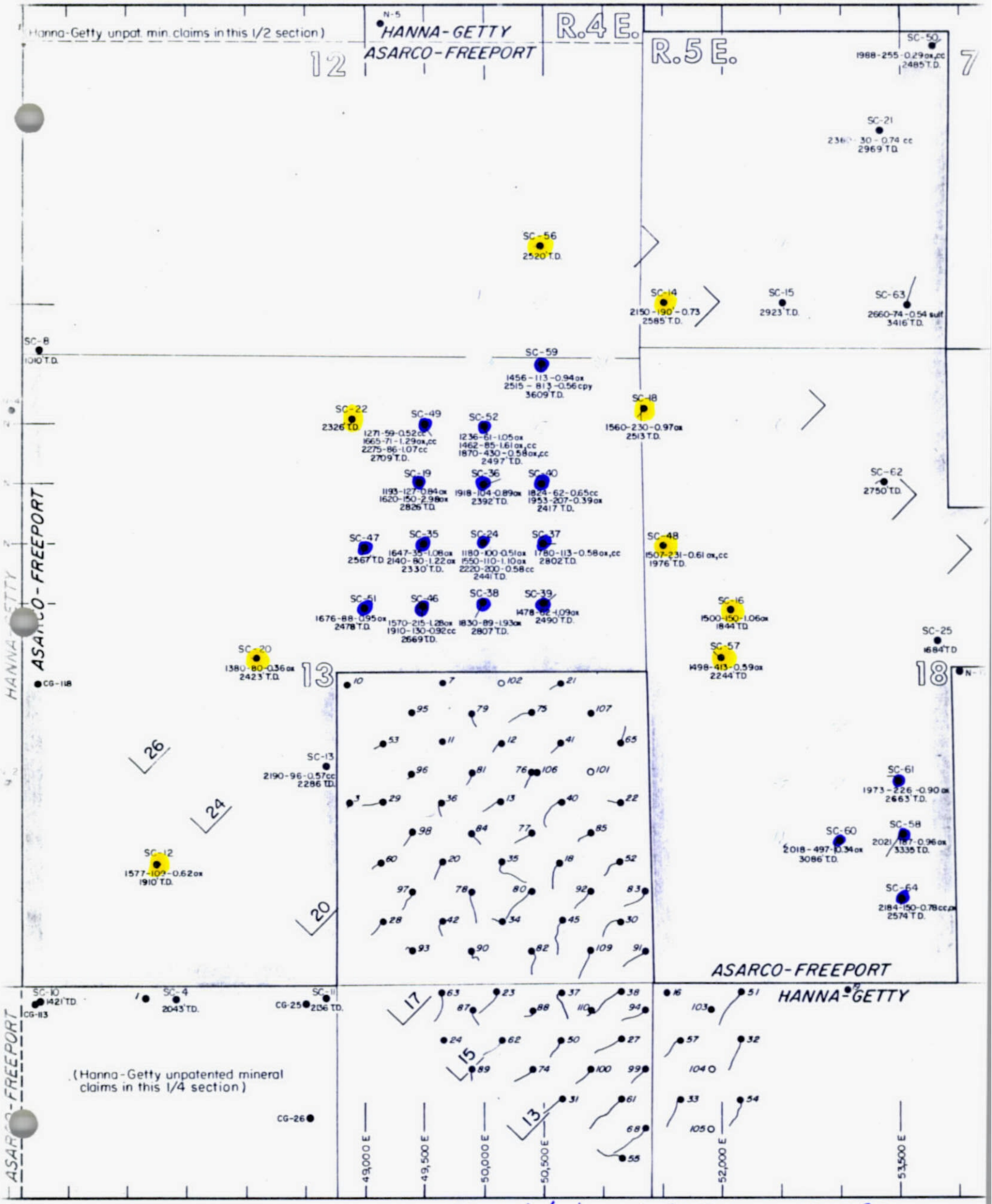
Jon Ahlness indicated to the USGS there would be no problem getting permission to obtain geochemical and geophysical data. Consequently, we should consider letting the USBM know Santa Cruz is not an open book, and data gathering is limited to in situ leach type information. Anything beyond would involve some sort of a trade off.

H. G. Kreis

H. G. Kreis

HGK:mek

cc: W.L. Kurtz/J.D. Sell



● Detailed logs to USBM, 12-19-1985

● Release of detailed logs under consider-
ation

HGK — needs Hanna Getty info input
as our is blob by itself.
How to implement.

ASARCO

Southwestern Exploration Division

June 9, 1987

To: W.L. Kurtz

From: H.G. Kreis

USBM Copper Reserve
Santa Cruz Project
Pinal County, Arizona

Linda Dahl and Sterling Cook have completed their copper reserve calculation for the Santa Cruz Project. Using a 0.25% copper cut-off grade and confining the reserve calculation to Area B of the Northwest Reserve, they came up with a figure of 73 million tons at 0.66% copper. This includes internal waste and some of the upper chalcocite mineralization. It does not include the lower chalcocite mineralization.

H.G. Kreis

H. G. Kreis

HGK:mek

cc: J.D. Sell

ASARCO

Exploration Department
Southwestern United States Division

June 26, 1987

Ms. Linda J. Dahl
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Santa Cruz Project

Dear Ms. Dahl:

Per your phone call today, enclosed is a copy of the Geologic Report on Santa Cruz Hole No. SC-22 that you had requested from H. Kreis.

Sincerely yours,

/s/

Mary E. Kavanagh
Secretary, SWED

mek
enc.

cc: W.L. Kurtz/J.D. Sell
H.G. Kreis

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

JDS

New York, N.Y., July 9, 1987

RECEIVED
JUL 13 1987
EXPLORATION DEPARTMENT

TO: R. L. Brown

In Situ Update
Santa Cruz Project, Arizona

Permitting. On June 9-10, 1987 three meetings were held in Phoenix involving Asarco, the USBM, contractors for the USBM, and the Arizona Department of Health Services (ADHS) which became the Department of Environmental Quality (DEQ) on July 1. A list of attendees at the meetings is attached. the purpose of these meetings was to select an environmental permitting process for the acid injection phase of the in situ copper mining field test from several alternatives advanced by the contractors. Evaluation of the alternatives was necessary because the permitting procedure will be published by the USBM as part of the in situ Program Plan for the field test, and we did not want an unreasonable permitting process in the literature which would set excessively difficult or costly precedents for this or future in situ efforts.

We involved the ADHS to avoid publication of a permitting process which the state, for whatever reason, might find unacceptable. Uncertainties over what might be acceptable result from formation of a new DEQ in Arizona, an Environmental Quality Act which has been passed as law but for which regulations to implement the law have not been written, and the absence of any previous/current in situ copper mines for which permitting procedures might have been established. Interim provisions do exist in the ADHS to issue permits for acid injection.

The proposed permit structure involves 1) applying for an Aquifer Protection Permit (APP) to pump leach solution through the Quaternary alluvium and to build the surface plant, 2) description of a mitigation plan to cover the surface facility and leakage of leach or pregnant solutions into the Quaternary alluvium, and 3) description of a monitoring program for the alluvium. The proposed permit specifically excludes the older conglomerate and all pre-mineral bedrock including the orebody from the APP to avoid designing restoration plans and costs into the program plan, which are difficult to anticipate, costly, and unnecessary.

During our meeting with the ADHS we noted that our proposed permit structure reflected Arizona not EPA envionmental statutes. The ADHS staff did not comment specifically on the permit structure or our view that bedrock was not an aquifer. They reviewed a schedule of activities for the in situ field test and said that the Program Plan being prepared by SAIC and Huff would constitute the permit application. They stated that no permit would be issued until the field program reached the actual acid injection stage and that data gathered up to that point would be used to evaluate and adjust the permit. The ADHS staff were generally receptive to the subject of in situ mining, but it is clear that the ultimate structure of the permit may differ from what we are now proposing. We later discussed privately the possibility of accellerating the permitting process by moving up the acid injection phase of the program while still providing the necessary data required to avoid an accident. In any case, the ADHS found our proposed permit structure reasonable and acceptable for publication in the Program Plan. A diagram of the permit which we drew for the ADHS is attached.

Responsibilities. Asarco advised the USBM that as owner of the Santa Cruz deposit, it would be the permittee. The USBM verbally advised that a first draft of the Program Plan will be made available to ASARCO for the permit application as soon as the plan is completed by SAIC, even though the plan will not have received formal government approval for publication.

The USBM advised it will accept all liability for accidents of any kind while directing and funding the program and during restoration (if required). If there is no on-going development, the USBM wants Asarco to conduct the post-closure monitoring as long as required by the permit. This might be a long-term activity and cost would likely be small. Asarco must respond to this request which will presumably be made in a Memorandum of Agreement covering the field test. We might do this, or possibly some academic group might do it (university, USGS) as part of a larger research project. If, after the USBM restores and leaves the site there is a leak, the USBM also wants Asarco to be responsible for cleaning up the problem. This would be a sub-surface event detected by monitoring wells and would likely be expensive to cure. We should not agree to this and see what the USBM says.

General Items. The Minneapolis-based project manager for this USBM in situ project is inexperienced, inflexible and unable to deal with changing situations. He doesn't understand how to administer a simple contract and has already caused several delays in the current project to drill two exploration-sized holes at Santa Cruz. The potential for contract delays of years and inefficient or overexpenditure of budgets for the far more complex field test is high. The growing impression of those outside the USBM is that the in situ field test will have to be protected from the USBM.

A new USBM senior Washington staff appointment has been made for all hard-rock mining projects. We know him to be a pragmatic-type who can think logically and who also has some field experience. He has discussed the potential contract management problems with one of the present contractors and the conversation, as related to me, was that the project might run more smoothly with Asarco as prime contractor. Such an arrangement would no doubt be vigorously fought from the USBM Minneapolis Office. There are apparently several options through which Asarco could become the prime contractor which I need to examine in detail if there is any interest. Although there would be an opportunity to employ one or a few Asarco people under such an arrangement, appearances would require that Asarco make little or no profit since the primary purpose would be to increase the efficiency of the project. If such an arrangement were put in place, Asarco would likely want a sub-contractor like Huff or SAIC to administer the paperwork, particularly that which related to government accounting systems which I am told are complex. Some elected officials might object to government funding of a project on a property which was also owned by the prime contractor, but these objections might be muted if a cost-sharing, cost recovery proposal of the type I described to you dated May 29, 1987 were advanced.

Using Asaco as the prime contractor might greatly accellerate the project which could start as early as October 1, 1987 if funding is provided. If the USBM runs the project, it might still start by October 1, 1987 if the Washington Office of the USBM would continue the current contract using existing contractors and, if Asarco decides not to become prime contractor, we should try to persuade the USBM to follow this option. The only other route is for the USBM to go through a new contractor procurement-bidding procedure in which case the field project would not start until January 1989 at the earliest. If Asarco is prime contractor, all liabilities for accidents would be our responsibility.

Another problem with the USBM is their tendency to be dazzled by the glamour of the U.S. Geological Survey (USGS). Several USBM staff are trying to involve the USGS because of their expertise, money and equipment. One example is the USGS Groundwater Division in Tucson. The USBM has verbally described a plan they have for the Groundwater Division to conduct a variety of research projects in three new diamond drill holes at Santa Cruz. The holes would not necessarily be drilled in or even near the two 5 spot locations to be used for the in situ program, and the tests described relate largely to lateral flow and regional research interests of the USGS staff. Funding would come out of the FY'88 in situ field test budget which has not been approved and which, if approved, will be only because of the Asarco-DeConcini Office initiative. It is my strong position that since the USGS test would be conducted on the Santa Cruz property using in situ funds that the USGS test be approved by and redesigned if necessary to suit the specific requirements of getting an ADHS permit. The USBM has given little consideration to this aspect of the USGS work, arguing that having the reputation of the USGS would enhance the project. My view is that if a USGS groundwater program is run that it be designed to provide information relevant to the permit; otherwise Asarco should not allow the test to be run.

The USBM is also dazzled by the USGS Denver-based Mineral Deposits group who have convinced the USBM that by applying surface and down-hole geophysical techniques that much better correlations of structure between holes can be obtained than by geological logging. There is also talk of doing some geochemical work related to detection of concealed orebodies, and I have been asked to provide all the geologic data between the Santa Cruz oxide zone (The Lands) and the Sacaton so the USGS can do some regional correlations. I had previously taken a somewhat ambivalent attitude toward USGS involvement based on previously-described lower key, more relevant studies. I am now taking a negative view regarding further USGS mineral deposits work at Santa Cruz of any kind. Mr. Kurtz attended a large meeting of USGS-USBM people a few weeks ago at which a number of irrelevant studies were proposed. Mr. Kurtz has asked for a written outline of all proposed USGS work. The USBM is simply unable to appreciate that irrelevant work is a waste of money or can't recognize irrelevant work to start with and doesn't understand we are simply trying to permit and test two 5 spot in situ injection patterns, not a square mile leach field.

Another subject of importance is publicity. The Aquifer Protection Permit application will be advertised by the ADHS in the Casa Grande and perhaps other newspapers. If there is significant public comment, there will be public hearings. The concept of injecting sulfuric acid near Casa Grande will likely attract attention, particularly in view of recent events concerning the Sacaton landfill proposal. We can't stay silent on the subject of in situ much longer, and I clearly recall Congressman Udall's comment to Mr. Romagnoli, Mr. Muth and I this May that we should "keep the folks informed". My thoughts would be to let an event such as formal publication of the Generic In Situ Manual, FY'88 funding, or completion of the first draft of the Program Plan (at least one of which will occur in August-September) trigger the first press release by the USBM and/or Senator DeConcini. The USBM has asked whether we would help with preparation of the release and I agreed. It would be best to keep Asarco-Freeport out of the release unless numerous other companies were also mentioned. Follow-up strategy would have to be designed, but will be important to help convince the public that in situ copper mining is safe and beneficial.

The USBM Minneapolis Office has written a formal recommendation to their Washington Office that Santa Cruz be selected as the site for the field test. All concerned must remember to refer to this project as in situ copper mining. The ADHS must know this is a mining project, because before they will issue a permit, they must be shown the project complies with local zoning regulations and in Arizona mining is exempt from zoning permits. Further, in situ copper mining should never be compared to in situ uranium mining because the latter was done in well developed aquifers in which extensive restoration was required.

I have listed several items on the attached table which will require attention over the next few months. Whether this project goes forward will depend on whether it is funded by Congress. In the interim a number of things are happening, most of which seem to require an increasingly active role by Asarco to keep focus on the objective.

F. T. Graybeal

F. T. Graybeal

FTG:mr
Att.

cc: T. C. Osborne
R. J. Muth
E. A. Romagnoli
W. K. Murray
D. M. Noyes
W. L. Kurtz/J. D. Sell

ATTENDEES AT JUNE 10-11, 1987 IN SITU MEETINGS

Asarco

Bill Kurtz
Bob Muth
Emil Romagnoli
Don Noyes
Verle Martz
Fred Graybeal

Bureau of Mines

Jon Ahlness
Dan Millenacker

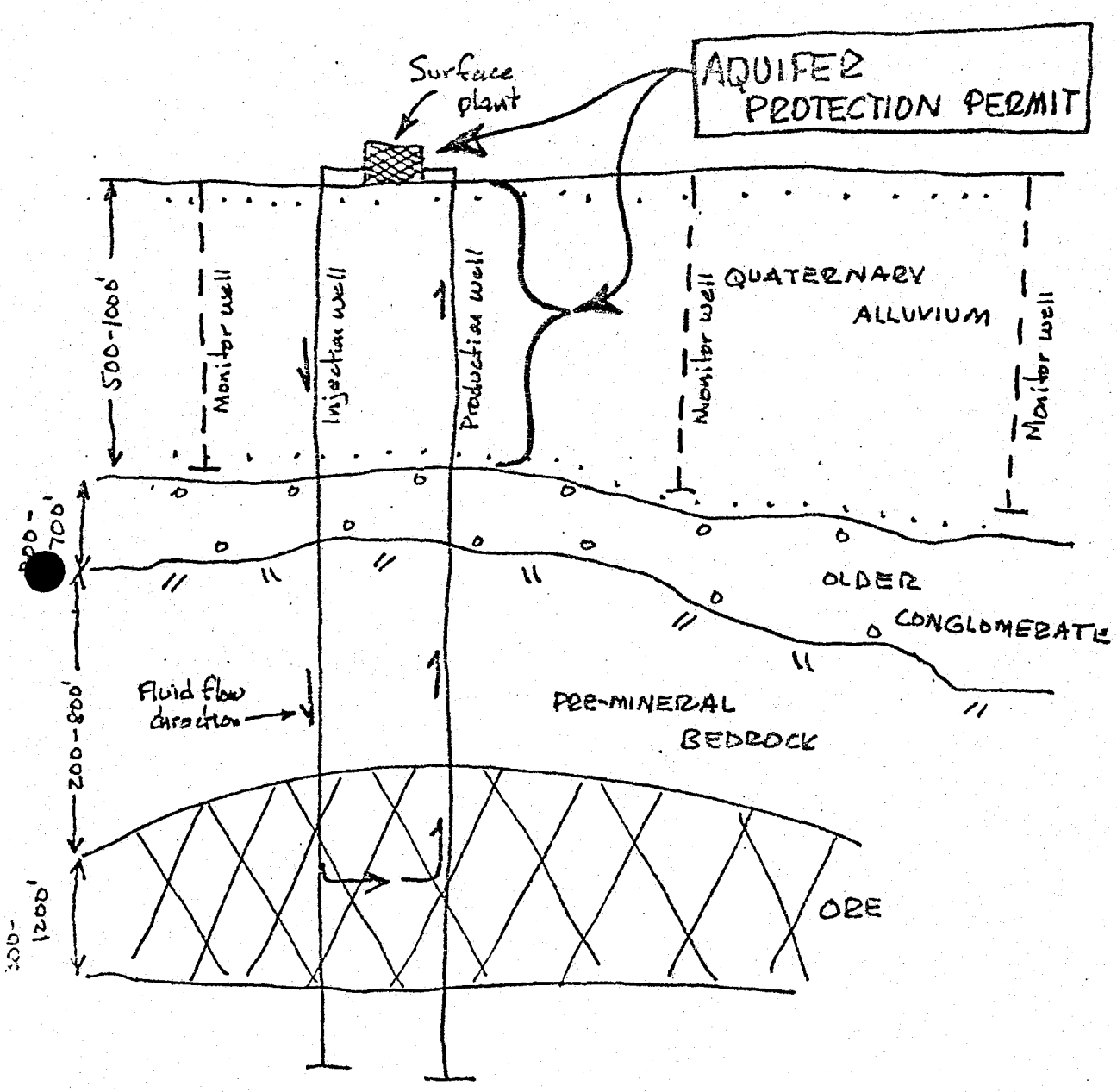
Contractors

Don Davidson - SAIC
Ray Huff - R. V. Huff and Assoc.
Ralph Weeks - Sergent, Hauskins and Beckwith

Arizona Department of Health Services

Roger Kennett - Environmental Engineering Specialist (senior ADHS person)
Debra Daniel - Hydrologist
Tony Potucek - Hydrogeologist

PERMIT DESIGN FOR IN SITU FIELD TEST



Item	Disposition
1) Freeport advised	Face to face
2) Cost recovery proposal	Use FTG proposal of May 1987; clear through normal channels; an Advisory Committee item?
3) Asarco prime contractor	Needs to be discussed internally by mid-late July, then with SAIC and Pete Chamberlain of USBM, then Patty Lynch. Depending on nature of contract, Asarco might have to be named in minutes of FY'87 budget.
4) Program Plan for field test, publicity	SAIC will complete first draft by mid-August. Possible USBM press release, assisted by Asarco. This might be delayed because Asarco and the Santa Cruz site will be named and a general release describing in situ issued by USBM (Asarco could write) for distribution to Paydirt and certain Arizona newspapers.
5) Fiscal Year 1988 funding	Perhaps completed by mid-September. If Asarco is not the prime contractor, then wording must be provided by Asarco to keep USBM in control. If funding is less than $2-2.5 million, the field test may be dead and most remaining items are moot.
6) Publicity	If FY '88 funding is sufficient to start field test, then DeConcini Office will issue first release. Asarco should discuss wording with press officer, because the new funding will be specific regarding the site and injecting acid. Casa Grande people will likely take a great interest.
7) Asarco-Freeport file permit to start test	This would occur as soon as FY'88 funding was approved using the first draft of the Program Plan.
8) Asarco review USGS proposals	USGS work to be strictly applicable to the in situ field test.
9) Asarco-Freeport sign USBM Memorandum of Agreement	This would be for the in situ field test as described by the Program Plan and might take different form or be eliminated if Asarco becomes the prime contractor. If Asarco is not prime contractor, the issue of whether Asarco monitors wells and accepts long term clean-up responsibility must be decided by this time. Possibly mid-October (1987).

ASARCO

JDS

Exploration Department
Southwestern United States Division

August 17, 1987

Ms. Linda J. Dahl
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Santa Cruz Project

Dear Ms. Dahl:

As requested in your phone call today, enclosed are copies of the "Rock Structure-Strength Log" for Drill Holes SC 38 and SC 39. We do not have "Rock Structure-Strength Log" for Drill Holes SC 22 and SC 24.

Sincerely yours,

/s/

Mary E. Kavanagh
Secretary, SWED

mek
encs.

cc: W.L. Kurtz/J.D. Sell
H.G. Kreis

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

Do not type

6/15

VDSell

Saturday

Call from San Ahluess USBM

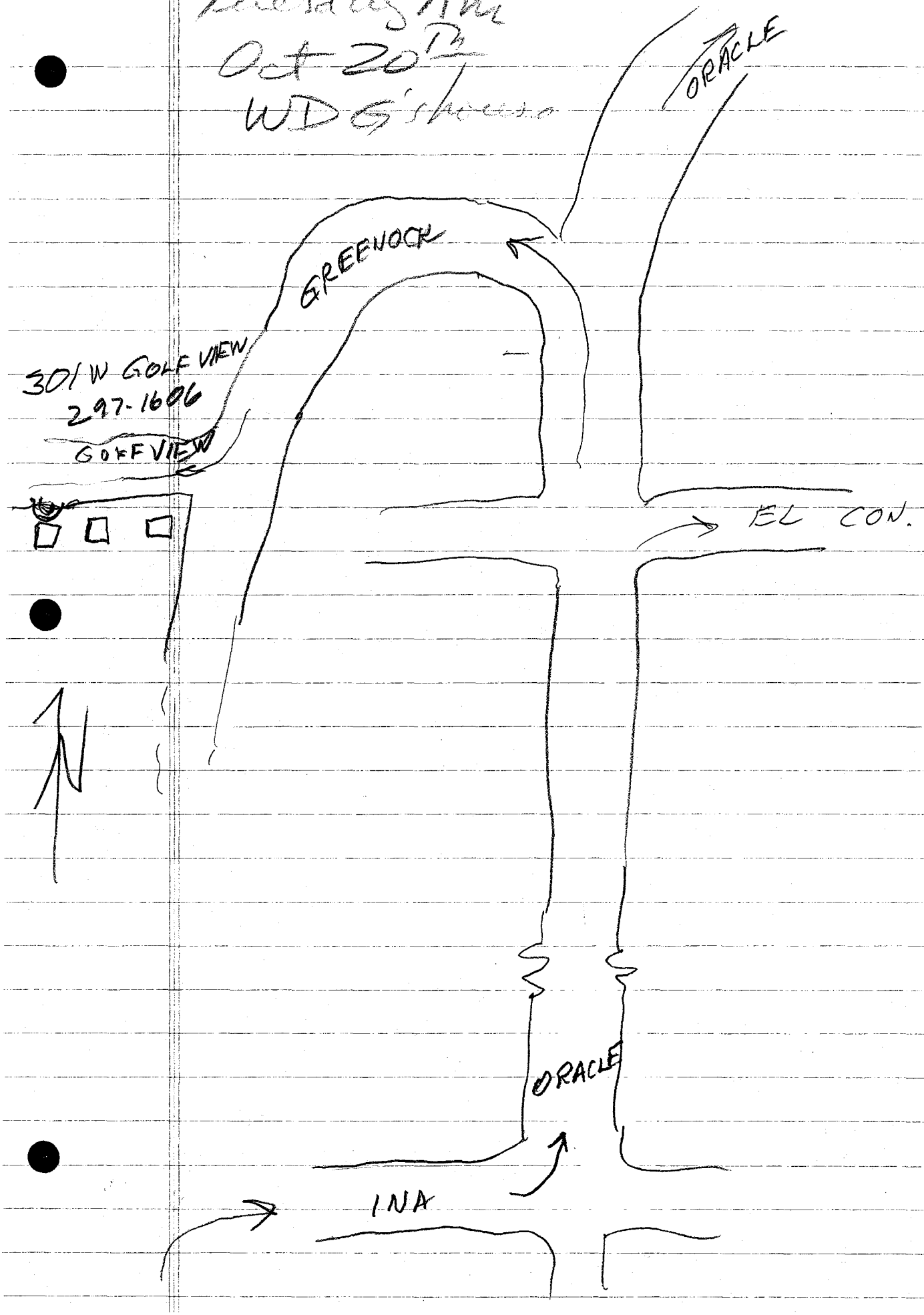
Supposed to start coring tomorrow.

Sterling Cook + Dahl are there; Ahluess may be there next week.

You might find out when they will start well tests

Think they all are staying at Francisco Grande

Tuesday AM
Oct 20th
WD Gishwa



FROM: W. L. KURTZ 12/15

TO: JD Sell

You might "look-in" on Steve Axen who is doing the work at Santa Cruz for Hutt and Davidson when you are in the area Tuesday

Also Penal Counties

Lee

ASARCO

Exploration Department
Western USA

October 15, 1987

FILE MEMORANDUM

Pollution - Drill Holes
Santa Cruz Project

In 1981 the State Department of Health Services had a Harold Bentley (graduate student/assistant professor at UofA) examine the 2.5 acre chromium dump site of Hexel. With Asarco's permission two Santa Cruz Project drill holes (SC-53 and SC-54) south of dump site on the Park-Salyer parcel and one Sacaton Unit drill hole (north of dump site) were sampled. Results were never received by Asarco. Tuesday, October 13, 1987, we learned from Bentley, who now runs Hydro Geo Chem Inc. (1430 N. 6th Avenue, Tucson, AZ - 602-623-6981) and is being retained by Hexel, that the two SC holes were contaminated with herbicides and solvents. He mentioned 2-4-D and 2-5-T. Rumors at that time were that Oxychem (Hooker Chemical) was responsible.

The State Department of Environmental Quality is now concerned about both the chromium dump and the drill holes.

Today I informed Simmons about the two drill holes.

W. L. Kurtz

WLK:mek

W. L. Kurtz

cc: R.L. Brown
J.L. Woods
T. Scartaccini
B. Apker
W.D. Gay/J.D. Sell

Ck if Oxychem is in CG phone book/Bend Co.
TES now called Casa Grande Chemicals
Get ph # 836-8286

Roddy Gott
836-1311

TES (in Calif 1-800-344-3400)

ASARCO

Southwestern Exploration Division

JDS

October 7, 1987

To: J.D. Sell

From: H.G. Kreis

USBM Test Work
Santa Cruz Project
Pinal County, AZ

Today I had lunch with Steve Axen of Huff & Associates and Jim Koontz of Joy Drilling Company. This is what I learned about the USBM plans for the field test work on the Santa Cruz Project. The USBM is planning to do the following.

- Clean out SC-46 down to about 1750'.
- Set a plug at the bottom of the cleaned out portion of SC-46 and fill the hole above the plug with impermeable clay.
- Set a wedge above the copper oxide zone to be redrilled.
- Wedge-out and core a couple of hundred feet of copper oxide mineralization using a split tube.
- Run geophysical logs in the open portion of the hole.
- Run various clear water packer tests of the permeability.
- Run spinner tests of the flow of clear water into the formation.
- Evaluate the data obtained in the above test work.

The above list of work is all the work that is planned in SC-46; and, if the budget permits, similar work will be done in SC-19. The core rig is expected to move onto SC-46 on October 8th.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz

FROM: W. L. KURTZ Santa Cruz 9/24/87

TO: JD Sell

For your info:

Renting of two holes to start October 8 with Steve Axen (Huff's man on site) and Doug.

ASARCO Southwestern Exploration Division

JDS

December 14, 1987

To FTG:
Whatever seems easy it
your comment requested
But, I'd not sign unless we (ASARCO)
really wants + will get into this type
operation otherwise we'll get it through
the test work
being done by
Huff-Billy

To: J.D. Sell

From: H.G. Kreis

Acquisition of Occidental's
In Situ Test Work
Van Dyke Deposit
Miami, Arizona

On December 7th I talked with Bill Patrick, a patent attorney for the Occidental Petroleum Corporation, about acquiring Occidental's Van Dyke in situ test work. Dr. Patrick then called Ray Huff of Ray Huff & Associates, Inc. Dr. Patrick asked Mr. Huff if he would serve as a middleman in transferring copies of the in situ data from Occidental Petroleum to Asarco, and Mr. Huff agreed to Dr. Patrick's request.

Mr. Huff called me on December 9th and explained the following proposal. Mr. Huff said Occidental Petroleum will give Asarco all the results of the Occidental test work that was done on the Van Dyke Deposit provided Asarco signs a secrecy agreement. Once the secrecy agreement is signed, Asarco can look at the data and make copies of it. If at some time in the future Asarco decides it wants to use the Occidental technology, Asarco will make an offer to Occidental Petroleum through Ray Huff.

I asked Mr. Huff what he thought the cost to use the technology would be to Asarco. Mr. Huff said he had discussed this with Dr. Patrick, and he told Dr. Patrick the Occidental information has decreased in value since it was sold to Codelco for $1.2 million about 5 years ago. Mr. Huff said the value today is considerably less because the U.S.B.M. had developed some of the same technology on its own.

Mr. Huff thinks it would be worthwhile for Asarco to acquire the Occidental data package. He sent a copy of Occidental's Confidentiality Agreement to our office, and a copy is attached. Several other companies signed this or a similar agreement before receiving the Occidental data package. Apparently, Codelco is the only company that eventually purchased the right to use the technology. Mr. Huff estimates it will cost between $1,000 and $1,500 for him to duplicate the data package and purchase the publications that come along with the data package.

I don't see any problem with signing the Confidentiality Agreement once it is reviewed by management and a lawyer, and I suggest we include a clause limiting Asarco's liability in using the technology to some amount less than $800,000.

H.G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz

CONFIDENTIAL DISCLOSURE AGREEMENT

AGREEMENT made on this _____ day of _____, 19__ between OCCIDENTAL RESEARCH CORPORATION, first party (hereinafter referred to as "ORC") and _____ residing or having offices at _____ _____, second party (hereinafter referred to as "RECIPIENT").

WHEREAS, ORC and its affiliates (hereinafter collectively referred to as "RESEARCH") have heretofore, at substantial expense acquired from its research and related activities data, processes, apparatuses, technology, know-how and information relating to in-situ leaching technology ("Data" herein).

WHEREAS, RECIPIENT desires to obtain such data in order to evaluate same to determine if RECIPIENT is interested in a non-exclusive license under the Data.

NOW, THEREFORE, in consideration of RESEARCH revealing such Data to RECIPIENT:

(1) RECIPIENT agrees that all such Data, as well as drawings, flowsheets, specifications, patent applications and all present or hereafter RESEARCH developed information relating to RESEARCH's activities, extent and scope of operations, plants, techniques and all other RESEARCH information (hereinafter collectively

referred to as "Information"), whether disclosed directly or indirectly by RESEARCH to RECIPIENT or otherwise becomes known to RECIPIENT, shall be maintained confidential and not published, disseminated, revealed in any manner, or to any person for ten (10) years from the date of disclosure and shall not be used except to evaluate same to determine if RECIPIENT is interested in a non-exclusive license under the Information; provided, however, that the confidentiality provision of this paragraph (1) shall not apply to any part of said Informaton which

(a) was known to RECIPIENT at the time same was obtained directly or indirectly from RESEARCH as evidenced by written documentation; or

(b) is acquired by RECIPIENT from a third party and such third party did not obtain such Information directly or indirectly from RESEARCH under an obligation not to disclose; or

(c) is or becomes published or otherwise in the public domain other than by violation of this Agreement by RECIPIENT.

RECIPIENT agrees that specific items of the Information which fall within the above recited exceptions shall not relieve RECIPIENT of its duties hereunder with regard to the Information; that specific items of Information shall not be considered to fall within any of the above recited exceptions merely because

such items are embraced by more general information which falls within one or more of such exceptions; or that a series of items of knowledge selected from unconnected sources and pieced together in view of the Information shall not cause such Information to fall within any of the above recited exceptions.

(2) RECIPIENT agrees to mark "CONFIDENTIAL" any Information received from RESEARCH or its Licensee if so requested within thirty (30) days of receipt of same and to hold same confidential.

(3) RECIPIENT agrees to permit access to such Information only to that limited number of RECIPIENT's key personnel and consultants as shall be necessary to permit RECIPIENT to evaluate same and determine if RECIPIENT is interested in a non-exclusive license under the Informaton and to require each and every employee, official, consultant, or other person having access to such Information to sign an agreement identical with the Form Exhibit A attached hereto and by this reference incorporated herein, or an agreement obligating such persons to maintain the Information confidential to the same degree that RECIPIENT is obligated to maintain the Information confidential under the terms of this Agreement.

(4) RECIPIENT will cause each of its employees and consultants, who receive Information of RESEARCH, to mark "CONFIDENTIAL" written copies and summaries and reports of and notes (collectively "Notes" herein) containing Information of RESEARCH which is to be maintained confidential pursuant to the provisions of paragraph (1) herein, and such Notes shall be maintained confidential and used only in accordance with the provisions of said paragraph (1).

(5) RECIPIENT agrees to return upon request all documents and other Information in written or graphic form submitted by RESEARCH to RECIPIENT under the provisions of this Agreement and all copies thereof, and also either destroy or include with such returned documents all Notes containing Information or RESEARACH and all copies thereof; provided that RECIPIENT may retain, and if retained shall maintain confidential pursuant to the term of this Agreement, one copy of such Information and Notes in its legal files for record purposes.

(6) An "affiliate" of ORC is a company or entity which controls, is controlled by, or is under common control with ORC. A company or entity controls another company or entity when such first-mentioned company or entity owns or controls more than fifty percent (50%) of

the stock entitled to vote for the election of directors to the Board of Directors of such other company or entity.

RECIPIENT will forward all correspondence for RESEARCH to RESEARCH at the following address:

OCCIDENTAL RESEARCH CORPORATION
10889 Wilshire Boulevard
Los Angeles, California 90024
Attn: Allan Sass
Telephone: 213/879-1700

This Agreement will be governed and construed in accordance with the laws of the State of California.

No license is hereby given by RESEARCH to RECIPIENT under any present or hereafter issued patent or the Information.

IN WITNESS WHEREOF, the parties have executed this instrument as of the day and year first above written.

RECIPIENT: _____

BY: _____

TITLE: _____

RESEARCH: _____

BY: _____

TITLE: _____

Exhibit "A"

SECRECY AGREEMENT

I have been informed and understand, that from time to time, during my employment by or association with _____ _____or its successors (referred to as "COMPANY" herein), as part of such employment or association, I have had or will have access to drawings, flowsheets, specifications, processes, technology, data, know-how, patent applications, and other information relating to _____ _____ (collectively referred to as "INFORMATION" herein) of OCCIDENTAL RESEARCH CORPORATION or its subsidsiaries or affiliated companies or Licensee (referred to jointly and severally as "RESEARCH" herein).

I understand that COMPANY has agreed to hold in confidence any and all such INFORMATION disclosed by RESEARCH in accordance with the provisions of a Confidential Disclosure Agreement between COMPANY and RESEARCH dated _____.

I agree to mark "CONFIDENTIAL" written copies and summaries of and notes (collectively "Notes" herein) containing such INFORMATION of RESEARCH.

I agree to hold in confidence any and all such INFORMATION and will not use such INFORMATION for any purpose other than as required by COMPANY; provided, however, that the provisions of this paragraph do not apply to that part of the INFORMATION which is published or otherwise becomes part of the public domain through no fault of mine.

I will at the time of leaving the employ of or association with COMPANY deliver to COMPANY, and not to keep or deliver to anyone else, any and all documents or INFORMATION of RESEARCH, and copies thereof, in my possession or control including any and all documents marked "CONFIDENTIAL" or "PROPRIETARY."

_____
Signature of Employee

Date _____

ASARCO

Mineral Beneficiation Department

JDS

VIA TELECOPIER

December 17, 1987

Mr. T. C. Osborne
Executive Vice President
NEW YORK OFFICE

Santa Cruz Project
In-Situ Copper Leach Experiment

As you requested and we discussed by phone, I have studied and evaluated the field in-situ copper leach test experiment as proposed by the United States Bureau of Mines. As you are aware, the intent of the USBM is to promote the development of "true" in-situ copper mining technology within the U.S. mining industry. The key factor in this process is providing industry with an operating data base to be used with scale up procedures for commercial facility design.

As the first step in the program, the USBM prepared a "Generic In-Situ Copper Manual" which would serve as a basis for designing and costing the required field experiments, estimating of operating parameters, and estimating of the capital requirements, operating costs and the economic viability of a commercial plant.

The second step was to select a suitable site to conduct a field experiment to provide information for the operating data base. In 1986, with an agreement between the USBM and ASARCO Incorporated, the Santa Cruz Project site, which is a joint venture between Asarco and Freeport, was selected.

The USBM has completed the design of the field experiment, estimated the cost, operating parameters, and economic viability of a commercial facility based on the "Generic Manual" and performed preliminary down hole permeability tests. My comments are addressed to these items.

1. The field experiment was designed and its costs estimated by manual methods based on site specific conditions and known governmental requirements. Total costs are estimated at $15.7 million with a duration of 44.5 months. Annual expenditures are $8.4, $2.3, $2.6, and $2.4 million. To assure government funding for the experiment, the Asarco-Freeport Joint Venture may contribute 25% of the project cost.

   My evaluation is that the field experiment is overdesigned and, if Asarco-Freeport can exert influence, the costs may be considerable reduced.

2. The commercial facility based on projected operating parameters was estimated to have a life of 15 years and produce 23,600 tons of cathode copper per year (4.0 million pounds per month). The initial capital investment was estimated at $28.1 million, with an annual ongoing capital requirement for new wells of $1.9 million ($0.04/lb Cu). Operating costs were $0.254/lb Cu. My evaluation, using the same operating parameters, is the initial capital would be between $35.0 and $40.0 million, annual ongoing capital would be $2.7 million ($0.057/lb cu) and operating costs would be up to $0.35/lb Cu. However, even with the increased capital and operating costs, the potential profit from the project is large.

3. The results of the initial down hole permeability tests were erratic. Tests were conducted in a hole drilled years ago and another in a newly drilled section wedged off of the existing hole. There was considerable difference in the results with the permeability of the old hole being considerably higher. Interpretation is that the drilling mud in the new hole was not broken down sufficiently and, therefore, reduced the permeability. This explanation is plausible.

I recommend that a contribution to the cost of the field experiment be given careful consideration and, if the in-situ leaching of copper meets Company goals, the contribution be made. Reasons are as follows.

1. Initial permeability tests gave a reasonably positive response.

2. The area of mineralization has sufficient tonnage and grade to make in-situ leaching attractive. If the adjacent land owned by the Hanna-Getty Joint Venture can be obtained, the proposition becomes very attractive.

3. Even though Asarco-Freeport would be liable for environmental difficulties, problems associated with the Santa Cruz site appear minimal.

4. Asarco would develop in-house expertise that may be applicable to other Asarco-owned properties (Florence) and perhaps provide the basis to seek similar properties.

5. Other mining companies are developing in-situ technology such as Cyprus at Lakeshore, Occidental Minerals at Miami, Arizona, etc.

Attached is selected information pertinent to the Santa Cruz "ore reserves" and the commercial scale plant capital and operating costs.

A Raihl

A. R. Raihl

ARR:brw

Attachments

cc: R. J. Kupsch w/att.

ATTACHMENT I

SANTA CRUZ PROJECT
MINERAL RESERVES

A preliminary reserve study was completed by Mr. H. G. Kreis and details of his study are included in his report dated August 27, 1982, entitled Geology and Copper Reserves of the Lands Area, Santa Cruz Project, Pinal County, Arizona.

The mineral inventory of acid-soluble copper including chalcocite on the Asarco-Freeport JV area and the Hanna-Getty JV area using a 0.2% Cu cut-off grade is as follows:

Area	Atacamite Lbs Cu (Billion)	Crysocolla Lbs Cu (Billion)	Chalcocite Lbs Cu (Billion)	Total Lbs Cu (Billion)
A-F	2.1	3.8	1.1	7.0
H-G	2.4	0.3	1.5	4.2
Total	4.5	4.1	2.6	11.2

Areas that show higher grade and continuity in the Asarco-Freeport JV area are as follows:

Reserve	Tons (Millions)	Grade % Cu	Average Thickness	Average Depth to Top of Reserve
Northwest	150	0.50	700 ft.	1,500
Southeast	50	0.56	400 ft.	2,000

Mineralogy of the reserves are as follows:

Reserve	Percent		
	Atacamite	Chrysocolla	Chalcocite
Northwest	30	55	15
Southeast	45	45	10

Acid-soluble reserves in the Hanna-Getty area based on a 0.6% cutoff are as follows. The oxide copper is primarily atacamite with minor chrysocolla.

Zone	Average Thickness	Tons (Million)	Grade % Cu
Oxide	315 ft	80	1.35
Chalcocite	185 ft	50	1.14

Chalcocite has been included in the acid-soluble inventory because, with the presence of an oxidizing agent such as ferric iron, chalcocite is soluble in dilute sulfuric acid.

ATTACHMENT II

COMMERCIAL SCALE PLANT CAPITAL COSTS

The estimated capital costs for the plant and well field to produce 23,600 short tons of copper was estimated to be $28.1 million and require three years to engineer and construct. I believe, without detailed study, that the plant and well field will cost between $35.0 and $40.0 million and shouldn't require more than 18 to 24 months to design and construct.

The cost estimate consists of $21.5 million for the plant and $6.6 million for the well field. The estimates are optimistic and generic in nature and not site specific. The cost of the wells completed was estimated at $47.00/ft. Mr. Steve Axen, Ray Huff and Associates, was questioned concerning this cost and, after a minor amount of study, he indicated that the Santa Cruz costs would be approximately $70.00/ft. This would increase the well field costs to approximately $9.8 million.

The plant cost estimate was based on being inside of battery limits. Therefore, the estimate does not include transformers and power lines to plant, roads into the plant, or a water well field and pipeline.

In addition to the initial plant and well field capital expense, an average of 17 new wells must be drilled annually. At a cost of $70.00/ft and an average depth of 2,200 feet, the annual capital cost would be $2,618,000.

COMMERCIAL PLANT OPERATING COSTS

Operating costs have been estimated at $11,938,00/year or approximately $0.253/lb of copper produced. These costs were further divided as follows:

Item	Annual Cost	Cost/Lb Cu
Labor	$ 4,273,000	$0.090
Electrical Power	2,925,000	0.062
Chemicals	3,407,000	0.072
Environmental Monitoring	80,000	0.002
Maint. Supplies Plant	645,000	0.014
Maint. Supplies Well Field	660,000	0.014
TOTAL	$11,990,000	$0.254

Labor costs appear reasonable. Electric power consumption appears reasonable but electric power costs were estimated at $0.05/kWh. Our preliminary estimate is $0.06/kWh which would add an additional $0.01/lb of copper produced.

Chemical costs are further subdivided into the following:

Item	Annual Cost	Cost/Lb Cu
Sulfuric Acid	$2,860,000	$0.060
Lime	363,000	0.008
Extractant	161,000	0.003
Kerosene	27,000	0.001
Cobalt	40,000	0.001
TOTAL	$3,451,000	$0.073

With the exception of sulfuric acid, the reagent costs could double with only a minimal effect. Sulfuric acid costs were based on a cost of $30.00/ton and a consumption rate of 4.04 lbs/lb of copper recovered. Consumption rate is somewhat high. Mr. G. P. Gillen, Acid Sales Department, is predicting that acid costs will increase to $25.00/ton F.O.B. Hayden in 1988 and increase to $35.00 to $50.00/ton in the future. With a $10.00/ton freight cost, acid cost in the future would be perhaps $50.00/ton which would increase production costs by $0.04/lb.

Estimated operating costs pertaining to environmental monitoring and maintenance supplies appear reasonable.

Costs not considered in the study are state taxes. Severance tax based on a copper price of $0.75/lb is estimated at $0.01. Property taxes are estimated at $1.2 million per year or $0.025/lb of copper. Miscellaneous overhead costs not including the SWMD or New York overheads can be estimated at $0.01/lb of copper.

A revised estimate of operating costs is as follows:

Original Estimate	$0.253/lb Cu
Additional Electrical Power Costs	0.010
Additional Sulfuric Acid Costs	0.040
Severance Tax	0.010
Property Tax	0.025
Miscellaneous Overheads	0.010
REVISED TOTAL	$0.348/lb Cu

Mr. T. C. Osborne
Santa Cruz Project
In-Situ Copper Leach Study
December 16, 1987

ATTACHMENT III

COMMERCIAL SCALE PLANT

SURFACE PLANT ESTIMATED CAPITAL

Electrowinning Plant @ 23,600 TPY $650/tx 23,600 TPY	$15,340,000
Solvent Extraction (2x2) $2,500/gpm x 1,076 gpm	2,690,000*
Injection Pumps 455 hp @ $150/hp	68,000
Solution Transfer Piping	874,000
Environmental Permitting	462,000
Monitor Wells	1,300,000
Restoration	90,000
Subtotal	$20,824,000
Items that could not be determined	676,000*
Total Plant Capital	$21,500,000

* The cost of solvent extraction facilities were based on two extraction stages and two strip stages. Indications are (but no specifics) that a three extraction-two strip circuit would be used. Ratioed additional cost for the extra stage would be $672,000.

ATTACHMENT IV

COMMERCIAL SCALE PLANT
WELL FIELD ESTIMATED CAPITAL

Total number of wells required		63
Number of injection wells		26
Number of production wells		27
Estimated depth of wells		2,220 ft.
Cost of wells		
Site Prep	$ 2,400/well	
Casing (4 inch) @ $17.73/ft	39,357/well	
Cementing @ $4.04/ft	8,972/well	
Drilling (7 inch) @ $5,80/ft	12,874/well	
Well Completion @ $4.58/ft	10,180/well	
Logging	9,094/well	
SUBTOTAL		$ 82,877/well
Injection Equipment	$18,181	
TOTAL COST - INJECTION WELL		$ 100,362
Production Equipment	$24,436	
TOTAL COST - PRODUCTION WELL		$ 107,313
Cost - 26 Injection Wells		$2,609,412
Cost - 37 Production Wells		3,970,581
TOTAL WELL FIELD ESTIMATED COST		$6,579,993

Note: Manual estimated cost was $6,598,139 for a difference of $18,146.

Average total cost per foot drilled = $47.18/ft.

Mr. T. C. Osborne
Santa Cruz Project
In-Situ Copper Leach Study
December 16, 1987

ATTACHMENT V

COMMERCIAL SCALE PLANT
LABOR - NUMBER AND COSTS

	Number	Average Total Cost/Person	Total Costs/Year
Plant Manager	1	$84,000	$ 84,000
Technical	4	63,000	252,000
Administrative Staff	14	42,000	588,000
Well Field			
Foremen	4	56,000	224,000
Employees	6	49,000	294,000
Solvent Extraction			
Foremen	4	56,000	224,000
Employees	6	49,000	294,000
Electrowinning			
Foremen	4	56,000	224,000
Employees	29	42,000	1,218,000
Maintenance			
Foremen	3	50,000	150,000
Employees	15	49,000	735,000
TOTAL	90		$4,287,000

The manning level and wages appear reasonable.

Manning of electrowinning plant indicates a highly automated plant with Mt. Isa cathode technology.

FACSIMILE MESSAGE

From

MOUNT ISA MINES LIMITED, MOUNT ISA, QLD. 4825

MINING DIVISION

Fax No. (077) 43 9858
Please report all transmission faults to phone no. (077) 44 2344

Sent to TK 9/13/88 mk

Video message

JDS

TO: ASARCO - TUCSON

ATTENTION: SAL ANZALONE, CHIEF GEOLOGIST

DATE: 1/9/88

FAX NO: 602 792 3010

NO. OF PAGES: 1

FROM: STEVE BYWATER, MINING RESEARCH

Dear Sal,

This is to confirm the visits by Peter Forrestal (Chief Geologist), Kit Clifford (Chief Mining Engineer), Steve Bywater (Mining Research Manager) and Ed Malouf (our leaching consultant) to your offices in Tucson in October. Our itinerary is as follows:

	Sunday, Oct 9 1988	Arrive Tucson.
Tuc. office	Monday - Wednesday Oct 10-12 1988	Discussions with ASARCO and USBM personnel and site visits to Silver Bell, Ray and Casa Grande operations.
Firm	Thursday, Oct 13 1988	Magma Copper. ok to photo
Firm	Friday, Oct 14 1988	Lakeshore - Cyprus.

Could you please book accommodation for three of us (Ed Malouf is staying with his daughter) at the Royal Sun Inn for Sunday, October 9 1988, to Friday morning, October 14 1988. We then depart for Miami, Arizona. We have contacted Magma Copper and will confirm the visit to Lakeshore forthwith. Ed Malouf will not accompany us to the Lakeshore operation.

Thanking you for your assistance and look forward to seeing you.

Regards,

Steve Bywater.

FILE

JDS

ASARCO

Exploration Department
Frederick T. Graybeal
Chief Geologist

January 29, 1988

ASARCO Incorporated

FEB 8 1988

SW Exploration

Mr. J. D. Sell
Tucson Office

Occidental In Situ Information
Van Dyke Deposit, Arizona

Dear Mr. Sell:

I have Mr. Kreis' memorandum of December 14, 1987 in which he appears to recommend that Asarco sign a confidentiality agreement and incur costs to purchase the Occidental in situ data pertaining to the Van Dyke copper deposit. I agree with your handwritten comment on Mr. Kreis' memorandum that we will have to redo much of this work which involves site specific questions and will obtain the expertise needed to do the work by retaining SAIC and Huff as consultants for the cooperative project with the USBM. The only other use to which this data might be put would be for a sales pitch to senior executives which is not necessary. Therefore, we should decline the opportunity to review and copy the Occidental data.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mc

cc: W. L. Kurtz
A. R. Raihl

JDS

New York, N.Y., February 1, 1988

TO: R. L. Brown

RECEIVED
FEB 3 1988
EXPLORATION DEPARTMENT

USGS Geophysical Studies
In Situ Field Test
Santa Cruz Project, Arizona

You recall that the USBM has expressed a very strong desire to involve the USGS Geology Division geophysicists in the in situ field test because the geophysical work required for hydrologic studies would be funded by the USGS and because the strong reputation of the USGS might enhance the project in general and facilitate permitting. In return the USGS wants to do a massive geophysical study of all geological aspects of the deposit and publish the results, including a detailed description of the geology of the deposit.

I have not discussed this with the USGS, but have told the USBM that if the USGS geophysical study goes forward, the initial publication of a paper on the geology of the Santa Cruz deposit will be written by Asarco geologists, not the USGS, and published in a peer review journal. Later geophysical work would use the Asarco paper as the standard geological reference. I also said that the USGS would not be allowed to publish anything until after the in situ field test was permitted for acid injection. Jon Ahlness (USBM-Minneapolis) advised on January 29, 1988 that the USGS has reluctantly agreed to those terms (the USBM is quite pleased). In return Asarco will attempt to publish a geologic paper on Santa Cruz in 2 years (or at least be in press) or subsequent to permitting will have a 4-week period to review proposed USGS publications. The USGS said they might have certain publications ready for publication in advance of permitting and would appreciate approval by Asarco on a case by case basis at Asarco's discretion.

In my opinion involvement of USGS geophysicists will be more trouble than it's worth, although the USBM is unanimous in their strong disagreement with my view point. I would rather involve the Department of Geology at the University of Arizona for Master of Science geological study on specific aspects of Santa Cruz. In the past, thesis support has been a low cost trouble-free and productive exercise. We need to discuss this and then review it with Freeport. I have asked Ahlness to start calling Mr. Raihl re in situ and told him Mr. Raihl will seek guidance if he needs it.

F. T. Graybeal

F. T. Graybeal

cc: R. J. Muth
W. L. Kurtz
A. R. Raihl

WLK-FTG
Jim Wilt is looking for a specific PhD project in Economic Geology. Would part of SC be available?
JDS

JDS — HCK — of interest → (in situ) COBM file

JDS

New York, N.Y., February 1, 1988

TO: R. L. Brown

RECEIVED
FEB 3 1988
EXPLORATION DEPARTMENT

In Situ Field Test
Santa Cruz Project, Arizona

Don Davidson called on January 29, 1988 to brief me on aspects of the USBM meeting held last week in Minneapolis to review draft reports on the current in situ contract. Of note was the comment that the Arizona DEQ has offically classified anything that produces 5 gallons of water per day as an aquifer. Under current regulations, this means that if the ore zone at Santa Cruz can produce that much water, and it will likely produce more, it will have to be reclassified as a non-aquifer before we can inject acid. Reclassification will involve public hearings, or at least advertisement that public hearings will be held if there is any interest. wow!

Ralph Weeks (SHB) and Don Millenacher (USBM) both believe that permits to inject acid will be forthcoming (if at all) following the initial tests in wells T1-3 and related hydrologic work and that we will not have to wait until the double 5-spot pattern is completed and surface plant constructed. This is the opposite of what DEQ employees told us last summer. As a result, the USBM has asked SAIC to build in a time gap of up to one year between completion of T1-3 work and initial drilling of the 5-spots and construction of the surface plant.

I have not had time to think through the implications of the above, but I know Congress will start discussing FY '89 budgets this April and if the USBM submits a minimal budget with no significant expenditures during 1989 permit negotiations it might be harder to restart the funding momentum for FY '90 (if any momentum exists). Alternatively, there may be a potential problem if FY '89 funding is sufficient to complete the double 5-spot and surface plant, but permits are not approved until after the start of FY '90 perhaps causing FY '89 funds to be lost and making it harder to fund the project in the future. If we wanted the USBM out altogether this might be a way. Alternatively, if we want to keep the project going, the Arizona DEQ would do us a favor by requiring that all wells be in place and tested before permits will be issued.

Finally, Sterling Cook, an inexperienced USBM geologist, made numerous comments at the meeting reflecting his opinion that chloride in alluvial groundwater in the Santa Cruz area may be coming from chloride in atacamite from the copper deposit.

His concern, apparently stated at the meeting, was that there may be an upward flow of water from the oxide copper zone which may make it hard to isolate the acid injection zone from the overlying gravels. Cook apparently argued that a computer study of fracture orientations in Santa Cruz core supported this argument.

Cook's inexperience, tendency to draw quick and erroneous conclusions, or carelessness has led him to incorrect conclusions in the past. On one occasion he argued to numerous people that Santa Cruz oxide copper would never leach because, as he saw it, most of the copper was disseminated and would be isolated from leach solutions. Mr. Kreis subsequently put Mr. Cook through a several day course of hands-on, nose-to-the-core instruction on Santa Cruz geology which demonstrated that a great deal more oxide copper was on fractures than Mr. Cook had thought. USBM lab work has subsequently shown Santa Cruz core leaches rather well.

Cook's current statements reflect an ignorance of the abundance of evaporites in mid-Tertiary basins in central Arizona, including thick halite deposits (Luke Salt). It is unquestionably due to <u>downward</u> flowing meteoric or saline lake water that chloride was introduced into the copper zone at Santa Cruz. Small amounts of chloride in modern groundwater undoubtedly represent a residual component of choride from the mid-Tertiary lakes not modern day dissolution of atacamite and upward flow of chloride-rich water. Further, and of greater importance, it is obvious that all enriched porphyry copper deposits such as Santa Cruz have been subjected to hydrologic communication with the surface, but this communication was established and maintained over geologically significant intervals of time involving at least several million of years. The life of a 5-spot leach, roughly 2 years is insignificant by comparison.

The presence of vertical fractures at Santa Cruz is hardly a surprise. Cook apparently assumes these fractures continue upward through the orebody into the gravels. The profound mid-Tertiary deformation to which Santa Cruz has been subjected makes it somewhat unlikely that any fracture system has a great deal of continuity. Further it is not clear the fracturing extends through the lavas and Whitetail-like older conglomerate from which we have no core.

I have not seen Cook's data and would not wish to argue any of the above geologic points until I have seen it. Nevertheless, Cook speaks at times like an unguided missile and spoken to widely to non-geologists his comments might unnecessarily complicate the permitting. His concerns will all be addressed, but it will take an Asarco staff geologist's time to do so.

ASARCO Mining Department

February 19, 1988

MEMORANDUM TO: V.C. Martz
D.A. Melhado
H.G. Kreis
J.D. Sell
B.R. Watts
J.L. McKee

Until accounting numbers are set up for the Santa Cruz In Situ Copper Leach Project, please charge time and materials to a fictitious account No. EA-900. For long distance telephone calls, use 150 as the code number.

A.R. Raihl

ARR:jm

RLB 3/7/08

Tom
Hallidbrand
Phil Nelson
& Bruce Smith

GP of OSGS
to review core etc.
including Sempliegle

Deck-back
of Pete Garcia
memo helps

reread Freeport agreement

Santa Cruz

route my copy to ARaihl HGKreis

copy to: FT Graybeal / RL Brown (mek)

ASARCO

Southwestern Exploration Division

This is not the best of either world; I still vote 100% In Situ or 100% Gold

March 8, 1988

To ~~J D Sell~~
~~A R Raihl~~
~~H G Kreis~~

Work Status
Gold vs. Santa Cruz
In Situ Project
Santa Cruz Area
Pinal County, AZ

ed your involvement with the In Situ project in
is you may be called upon by Mr. Al Raihl for
other than what was expressed in the January 20,
. Kurtz.

hru me or Mr. Kurtz before contacting you on

3/8/88

d exploration/drill target area of responsibility in the front running, it will be necessary to keep me informed of your schedule.

When in the field, I would suggest a 10-12 day out, 4 in. Mr. Raihl will not disturb you out in the field other than a day or two before you are due back, or perhaps will leave a note in your in-basket, as to any services needed the next time you are in town. So check your in-basket as soon as returning.

Of course, all time contributed to In Situ will be charged to In Situ.

I request that you do not build up any comp time and thus any time over that suggested by the Accounting Dept. will be for the good of the company each month.

Thus you should expedite any In Situ work, keep the gold program going forward, and keep your spare time on an even keel.

Please see me if any further discussion/clarification is necessary.

You should also move the Asarco core from the Hanna warehouse, as soon as possible, to the Sacaton property for safekeeping as requested verbally.

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
A.R. Raihl

Bill. Extensive geological input is required for the Santa Cruz Project. How this is accomplished is up to the Exploration Department. AR Not necessarily true - could be a consultant, could be [illegible] Decision / HTT

route my copy to JDS ARaihl HGKreis

✓ copy for FT Graybeal / RL Brown (sent 3/ mek)

ASARCO

Southwestern Exploration Division

This is not the best of either world; I still vote 100% In Situ or 100% Gold

March 8, 1988

H.G. Kreis

To ~~J D Sell~~ + [illegible]
AR Raihl
HG Kreis

Work Status
Gold vs. Santa Cruz
In Situ Project
Santa Cruz Area
Pinal County, AZ

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W.L. Kurtz.

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3/8/88 gold exploration/drill target area of responsibility
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When in the field, I would suggest a 10-12 day out, 4 in. Mr. Raihl will not disturb you out in the field other than a day or two before you are due back, or perhaps will leave a note in your in-basket, as to any services needed the next time you are in town. So check your in-basket as soon as returning.

Of course, all time contributed to In Situ will be charged to In Situ.

I request that you do not build up any comp time and thus any time over that suggested by the Accounting Dept. will be for the good of the company each month.

Thus you should expedite any In Situ work, keep the gold program going forward, and keep your spare time on an even keel.

Please see me if any further discussion/clarification is necessary.

You should also move the Asarco core from the Hanna warehouse, as soon as possible, to the Sacaton property for safekeeping as requested verbally.

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
A.R. Raihl

ASARCO Southwestern Exploration Division

JDS

March 8, 1988

H.G. Kreis

Work Status
Gold vs. Santa Cruz
In Situ Project
Santa Cruz Area
Pinal County, AZ

Mr. R.L. Brown has modified your involvement with the In Situ project in the Santa Cruz area. Thus you may be called upon by Mr. Al Raihl for additional contributions other than what was expressed in the January 20, 1988 memo to you from W.L. Kurtz.

Mr. Raihl will first go thru me or Mr. Kurtz before contacting you on what might be needed.

In order to keep your gold exploration/drill target area of responsibility in the front running, it will be necessary to keep me informed of your schedule.

When in the field, I would suggest a 10-12 day out, 4 in. Mr. Raihl will not disturb you out in the field other than a day or two before you are due back, or perhaps will leave a note in your in-basket, as to any services needed the next time you are in town. So check your in-basket as soon as returning.

Of course, all time contributed to In Situ will be charged to In Situ.

I request that you do not build up any comp time and thus any time over that suggested by the Accounting Dept. will be for the good of the company each month.

Thus you should expedite any In Situ work, keep the gold program going forward, and keep your spare time on an even keel.

Please see me if any further discussion/clarification is necessary.

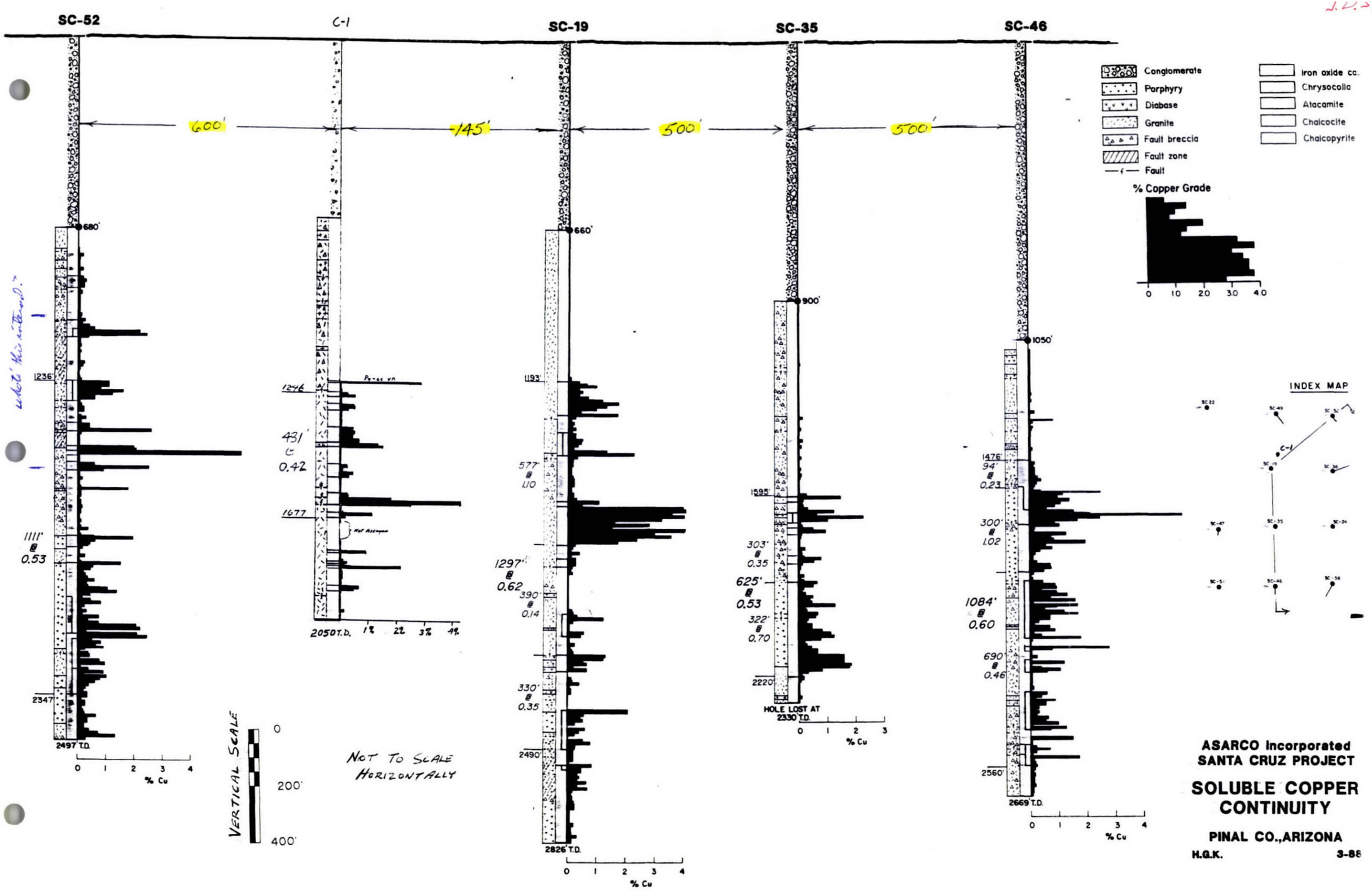
You should also move the Asarco core from the Hanna warehouse, as soon as possible, to the Sacaton property for safekeeping as requested verbally.

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
A.R. Raihl



ASARCO Incorporated
SANTA CRUZ PROJECT

SOLUBLE COPPER CONTINUITY

PINAL CO., ARIZONA

H.G.K. 3-88

ASARCO

Mining Department

March 14, 1988

Mr. J. D. Sell, Manager
SW Exploration
TUCSON OFFICE

Santa Cruz Project
Geologist

The Santa Cruz Project will require the services of Mr. H. G. Kreis for a considerable period of time between now and April 11, 1988. Some of the items which will be required of Mr. Kreis are as follows:

1. Conducting several people from the USBM and USGS on a tour of the Santa Cruz property, explaining geology, etc. Tentative dates are April 7 and 8.

2. Conduct geological portion of the dog and pony show for Freeport Copper Company. Tentative dates are April 4 and 5, but may be during the preceding week. Illustrations, cross sections, etc., may have to be prepared for this meeting.

3. Provide geological input to Errol Montgomery and Associates to help with their hydrological studies. Meeting planned during the week of March 14.

4. Review the overall Santa Cruz Project since Mr. Kreis has been away from it for 6-7 years.

5. Study and understand the five volumes of the Generic In-Situ Copper Mine Design Manual being published by the USBM and make comments.

6. Review the USBM Statement of Work and comment on geological aspects.

7. Review the Cost and Technical Proposals being prepared to answer the USBM Statement of Work and comment on geological aspects.

ASARCO Incorporated

MAR 1 4 1988

SW Exploration

JDS

ASARCO

Mining Department

March 18, 1988

Mr. H. G. Kreis
SW Exploration
TUCSON OFFICE

Santa Cruz Project
Leach Test Site Selection

The Bureau of Mines requires that Asarco submit a proposed leach test site location including data on its physical characteristics such as depth, geology mineralogy, structure, grade, etc., and site selection justification. This submittal will be required within two months after the signing of the contract between the USBM and the Santa Cruz Joint Venture. Please assemble the necessary information and perform the required studies including the preparation of cross sections, if needed. Also, make a proposal for the test site and be ready to defend your position. Mr. Brown and/or Mr. Graybeal will make the final decision, on Asarco's part, with regard to the site location.

Mr. Steve Axon, Ray Huff and Associates, in consultation with Ray Huff and Don Davidson made the site selection for the USBM Generic Design Manual. You may want to consult with him to help you in your determination.

It is realized that, since the area of mineralization at the Santa Cruz site appears to be quite variable in terms of grade, lithology, structure, etc., with the area being drilled on 500' centers, it may be impossible to establish continuity of anything except gross features.

Among others, the following items should be considered during your study:

1. Vicinity of ownership boundaries. Test site can be no closer than 300' to an ownership boundary and preferably 500'.

2. Interval of mineralization. The test is based on a 50 gpm injection rate. At the estimated rock permeability, an injection interval of approximately 300' will be required.

ASARCO Incorporated

MAR 1 8 1988

SW Exploration

3. Average grade of mineralized interval. The average grade of the mineralized interval should be in the rage of between 0.7% and 0.8% acid-soluble copper. During this test program, copper minerals that require an oxidant in order to dissolve such as chalcopyrite, chalcocite, native copper, etc., will not be considered. However, if this program is successful, the leaching of copper minerals requiring oxidation will be considered at a later time.

4. Copper mineralization. The two main copper minerals which will be leached are atacamite and chrysocola. The ratio of these minerals in the test area should be similar to the overall ore body.

5. Structure. If it can be determined, the structure in the test site should be documented to the best of our knowledge.

6. Lithology.

7. Depth of ore zone and its proximity to the top of bedrock.

8. Hydrogeology. Review existing hydrogeology.

If cross sections are required for your evaluation, they should be made in such a manner that they can also be used as an aid in the permitting process and for use in required dog and pony shows.

Depending upon your work schedule, your evaluation should be completed by April 15 and no later than May 1.

April 1, RLB
3/18/88

A. R. Raihl

ARR:brw

cc: R. L. Brown
J. D. Sell
W. L. Kurtz

New York, N.Y., March 21, 1988

VIA TELECOPIER

MEMORANDUM FOR Messrs. J. D. Sell
A. R. Raihl

I have today faxed the following memorandum to Henry Kreis.

MEMORANDUM FOR Mr. H. G. Kreis

Because Mr. Kurtz and Mr. Sell are both absent from the Tucson Office, I am informing you directly that you are as of the opening of business today, March 21, temporarily assigned until further notice to the "In Situ Project". You will report solely and exclusively to Mr. Raihl. You are relieved herewith of all Exploration Department responsibilities until such time as you can return to the Exploration Department. The duration of this assignment will be about 45 days, but may be extended. You will report to Mr. Raihl to whom you will look for day-to-day guidance and from whom you will receive work assignments.

ha!

R. L. Brown

R. L. Brown

RLB:mc

ASARCO Incorporated

MAR 21 1988

SW Exploration

cc: W.L. Kurtz

ASARCO

Southwestern Exploration Division

March 25, 1988

To: A.R. Raihl

From: H.G. Kreis

USBM Test Data
Santa Cruz Project

During the last two years the USBM has done a substantial amount of laboratory test work on leaching core samples. As you know, with the exception of a couple of verbal presentations and a computer print out of some microprobe analyses, Asarco has not received any factual and interpretive data from this work. I spoke with Jon Ahlness about this, and on November 16, 1987 he promised to send Asarco the core leach test information along with logs of the newly obtained core and the permeability field test results. He sent the permeability field test results (a section of SAIC's monthly report) and nothing else.

Yesterday I spoke with Steve Paulson, and he said he will sent out the core leach test results in two weeks. He also offered to come to Tucson to make a presentation.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: R.L. Brown
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

April 22, 1988

To: Files

From: H.G. Kreis

USBM Data
Given to Asarco
Santa Cruz Project

The attached list of items is all the information (in paper form) that the USBM has given to Asarco as of this date.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: R.L. Brown/F.T. Graybeal
A. R. Raihl
W. L. Kurtz
J. D. Sell

H.G. Kreis
4-22-1988

USBM Data Given to Asarco
As of April 22, 1988

Received 1-15-1987

Microprobe computer printout sheets for:
- SC-46, 1649.5', 1699', 1763'
- SC-19, 1260', 1289', 1686'

Received Mid 1987

Nine cross sections of Santa Cruz (2&3-1987)

Received 11-1987

Microprobe computer printout sheets for:
- Lakeshore Mine, pre-leach, PT-3 series of samples
- Lakeshore Mine, post leach, PT-3 series of samples
- SC-46, 1622', 1646', 1649', 1649.5', 1650', 1654', 1699', 1763'
- SC-35, 2105', 2168'
- SC-19, 1260', 1289', 1675', 1679', 1686', 1709'
- SC-49, 1560'
- SC-24, 1795'; SC-47, 1605'; CG-7, 1709'

Received 12-11-1987

SAIC's Monthly Technical Report, section on 11-1987 field tests.

Received 4-14-1988

Asarco core, leach test computer printout sheets:
- AS-1, -2, -3, -4, -5, -6

Lakeshore core, leach test computer printout sheets:
- 5, 15, and 25 g/l H_2SO_4 runs (unidentified sample)

Asarco core, thin section descriptions for:
- SC-19, -19A, -24, -35, -46A, -49, -51

Microprobe computer printout sheet for SC-19, 1384'

Copper distribution plot for SC-35

Copper distribution plot for CG-7

Six cross sections of Santa Cruz (1" = 270')

Field permeability test information:
- Logbook of work done on SC-19 and -46
- Geophysical logs (down-the-hole type)
- Driller's reports
- Engineer's reports
- Well mechanical diagrams
- Pressure test data
- Misc. calculations, notes, etc.

~~WLK~~/JDS

ASARCO

Southwestern Exploration Division

May 17, 1988

To: A.R. Raihl

From: H.G. Kreis

Stratigraphic
Nomenclature
Santa Cruz Project
Pinal County, Arizona

The following table summarizes the stratigraphic nomenclature for the Santa Cruz Project. This nomenclature was adopted for purposes of the in situ leach test DEQ application.

Formation	Remarks
Basin Fill Deposits	- Unconsolidated conglomerate, slightly tilted if at all, historic aquifer of Casa Grande basin. - "Unconsolidated Alluvium" of Hardt and Cattany (1965, USGS, open file report). - "Gasline Conglomerate" of Asarco, circa 1964.
Conglomerate	- Hydrologic bedrock of Hardt and Cattany. - Subdivided as follows: Sacaton Conglomerate and Burgess Peak Conglomerate. The Sacaton Conglomerate, the younger unit, has a tan colored matrix and is moderately consolidated (cemented or indurated). The Burgess Peak has a red to brown colored matrix and is strongly consolidated.
Andesite	- Typical mid-Tertiary andesite.
Volcanic Agglomerate	- Black to dark grey colored, fragmental volcanic unit at or near base of conglomerate.
Bedrock Complex	- Asarco's premineral bedrock. - Carry-over from hydrologic report of Sacaton (1986, Montgomery and Assoc.).

H. G. Kreis

H. G. Kreis

HGK:mek

cc: R.L. Brown/F.T. Graybeal
W.L. Kurtz/J.D. Sell
C. Barter - Montgomery & Assoc.

J.D.S.

ASARCO

Southwestern Exploration Division

May 24, 1988

To: A.R. Raihl

From: H.G. Kreis

In Situ Test Site
In Situ Copper Mining
Research Project
Santa Cruz Site

After review by all parties concerned, site SC-46 has been chosen for the in situ leach test site. Site SC-46 is the one Santa Cruz site which, if proven commercially viable by the in situ leach test, is more apt to demonstrate the commercial viability of the Northwest Reserve than any other site. The selection and geology of site SC-46 are described in the accompanying report, "Selection and Geology of the In Situ Leach Test Site."

If the Asarco-Freeport joint venture is successful in acquiring the Hanna-Getty deposit in the next few months, consideration will be given to locating the in situ test site in that portion of the copper oxide mineralization. If the Hanna-Getty deposit is acquired, but for some reason the in situ test site can not be located there, site SC-19 is a reasonable alternative. Site SC-19 has characteristics of the Santa Cruz Northwest Reserve and the Hanna-Getty deposit.

H. G. Kreis

HGK:mek

H. G. Kreis

ASARCO

JDS

Exploration Department
Frederick T. Graybeal
Chief Geologist

June 7, 1988

MINING DEPT

TUCSON

Mr. Sterling S. Cook
United States Department of
the Interior
Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

ASARCO Incorporated

JUL 14 1988

SW Exploration

GSA Abstract on Copper Mineralogy
Santa Cruz Project
Arizona

Dear Mr. Cook:

This confirms our telephone conversation of today that your GSA abstract forwarded to me on May 27, 1988 entitled Petrologic Studies of the Supergene Copper Mineralization ..... etc. is approved for presentation as written. This material is somewhat peripheral to the main publication clause in the Santa Cruz Joint Venture Memorandum of Agreement with the USBM, but the data were clearly gathered for the benefit of predicting in situ response of the various minerals at Santa Cruz.

As I've mentioned previously it is Asarco's intention to publish the first general geologic paper on the entire Santa Cruz system. Your work will certainly contribute to the bibliography of that effort and does not overlap with the planned content of our paper.

It's a bit too late to comment on the abstract, but if you plan to be in Tucson you might bring your slides and preview for the talk with Hank Kreis. Please continue to give us a chance to comment on material being submitted for publication. I'll see you in Denver at the GSA if not before.

Very truly yours,

F. T. Graybeal

F. T. Graybeal

FTG:mc

cc: A. R. Raihl (w/att.)
Blind note for AAR: Please forward to Freeport if you think necessary and circulate abstract to WLK, JDS, and HGK.

United States Department of the Interior

BUREAU OF MINES

TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55417
Telex: 362735 BOM TCRC UD

May 27, 1988

Dr. Frederick T. Graybeal
ASARCO, Incorporated
180 Maiden Lane
New York, New York 10038

Dear Dr. Graybeal:

The enclosed abstract summarizes a poster session I would like to present at the 1988 Geological Society of America annual meeting. The deadline for submission to GSA is June 10, 1988. July 30th is the last date that GSA will accept changes in approved abstracts. In order to meet the June 10 deadline I have sent this abstract to GSA.

Hank Kreis and I discussed this material over the telephone on May 25. Hank recommended I forward my abstract to you for ASARCO's permission to publish. I certainly will not present this material without ASARCO's permission. Furthermore, I would be grateful for any comments ASARCO might have which could improve my presentation.

Sincerely,

Sterling S. Cook

STERLING S. COOK, Geologist
In Situ Systems

725-4552

Enclosure

ABSTRACT FORM FOR ALL GSA MEETINGS IN 1988

Complete sections [1] through [7] below

[1] TYPE ABSTRACT within blue lines — they're absolute! Mail flat, reinforced.

№ 19419

PETROLOGIC STUDIES OF THE SUPERGENE COPPER MINERALIZATION AT THE SANTA CRUZ PORPHYRY COPPER DEPOSIT, PINAL COUNTY, ARIZONA

COOK, Sterling S., U.S. Bureau of Mines, 5629 Minnehaha Avenue South, Minneapolis, MN 55417

The supergene enrichment blanket of the Santa Cruz porphyry copper deposit is the largest known occurrence of atacamite in North America. The assemblages atacamite-alunite-leucoxene-clay and chrysocolla-jarosite-limonite-biotite constrained the activities of sulfate, chloride, aqueous silica, and pH in the groundwater system that created the deposit. No copper sulfates are present but, chalcocite is locally present beneath the atacamite and chrysocolla. There are two episodes of supergene mineralization. Atacamite veinlets crosscut chrysocolla mineralization in oxidized hypogene veinlets. In supergene veinlets atacamite and chrysocolla are the same age. Atacamite formed during a later enrichment episode in an environment with few oxidizing sulfides. Field relations are consistent with atacamite mineralization forming in a perched water table within a closed drainage basin after a mid-Miocene block faulting event.

Electron microprobe studies by the U.S. Bureau of Mines reveal up to 8 wt% Al_2O_3 in some atacamite. Cu-Al substitution in the octahedral sites of atacamite is indicated and may occur in clays. Chrysocolla, in both supergene veinlets and altered plagioclase phenocrysts, contains minor Al_2O_3 (<5 wt%). Copper-bearing clay minerals, with SiO_2:Al_2O_3 ratios similar to both smectite and kaolinite, contain up to 16 wt% CuO. Ternary plots (CuO-Al_2O_3-SiO_2) demonstrate there is no solid solution between the smectite-like copper-bearing clays, the kaolinite-like copper-bearing clays, and chrysocolla. X-ray diffraction reveals that the chrysocolla is amorphous and copper-bearing clays exhibit no structural distortion. The CuO contents of the clays apparently result from interlayering with amorphous chrysocolla.

[2] CATEGORIZE ALL ABSTRACTS —Check ONE discipline below in which reviewers would be best qualified to evaluate this abstract.

- ☐ 1 archaeological geology
- ☐ 2 coal geology
- ☒ 3 economic geology
- ☐ 4 engineering geology
- ☐ 5 environmental geology
- ☐ 6 general geology
- ☐ 7 geochemistry
- ☐ 8 geology education
- ☐ 9 geomorphology
- ☐ 10 geophysics
- ☐ 11 geoscience information
- ☐ 12 glacial geology
- ☐ 13 history of geology
- ☐ 14 hydrogeology
- ☐ 15 marine geology
- ☐ 16 micropaleontology
- ☐ 17 mineralogy/crystallography
- ☐ 18 oceanography
- ☐ 19 paleontology/paleobotany
- ☐ 20 petroleum geology
- ☐ 21 petrology, experimental
- ☐ 22 petrology, igneous
- ☐ 23 petrology, metamorphic
- ☐ 24 petrology, sedimentary
- ☐ 25 planetary geology
- ☐ 26 Precambrian geology
- ☐ 27 Quaternary geology
- ☐ 28 remote sensing
- ☐ 29 sedimentology
- ☐ 30 stratigraphy
- ☐ 31 structural geology
- ☐ 32 tectonics
- ☐ 33 tectonics/geophysics
- ☐ 34 volcanology

[3] TYPES OF SESSIONS AVAILABLE

A. SPECIAL — INVITED ABSTRACT FOR A SYMPOSIUM.
☐ This abstract was **invited** for the symposium titled _____

If you checked here, skip to item [4].

B. VOLUNTEERED ABSTRACTS

(1) SPECIAL—THEME SESSION, ANNUAL MEETING ONLY. I would like this abstract considered for oral presentation at the following Theme Session for the Annual Meeting, Denver, 1988.

- ☐ 1 Diagenesis of lacustrine rocks
- ☐ 2 Geology & Public Policy for the 21st Century
- ☐ 3 Geophysical patterns in North America
- ☐ 4 Global aspects of sedimentary geology
- ☐ 5 Organic compounds in ground water
- ☐ 6 Paleontologic constraints on accreted terranes
- ☐ 7 Physics and chemistry of mylonites
- ☐ 8 Secular variation in the sedimentary record

If not accepted for the Theme Session, do you want it considered for a regular technical session?
☐ Yes ☐ No

(2) ☐ ORAL SESSION ☒ POSTER SESSION ☐ EITHER TYPE
☒ I'll accept a change of session type (ORAL ⟷ POSTER) if necessary;
☐ Withdraw my abstract rather than change session type.

[4] % OF THIS PAPER PREVIOUSLY PRESENTED 0
Where and when _____

[5] CAN YOU BE A SESSION CHAIRMAN? ☒ Yes
Topic Economic Geology
Your name Sterling Cook
Telephone (late June/early July) 612 725 4552

[6] SPEAKER'S IDENTITY AND MAILING ADDRESS
Speaker's name _____
Address _____
Address _____
City _____ State _____ Zip _____
Country _____
Office Telephone: ( ) _____
Home Telephone: ( ) _____
Dates we can reach you: _____

[7] SEND ORIGINAL + 5 COPIES OF ABSTRACT TO APPROPRIATE ADDRESS SHOWN ON INSTRUCTION SHEET AND ON BACK OF THIS FORM. ALL ABSTRACTS MUST ARRIVE ON OR BEFORE DEADLINE SHOWN FOR EACH MEETING.

ASARCO

Exploration Department
Western USA

June 28, 1988

W.D. Gay
H.G. Kreis

Santa Cruz JV

Mr. Brown would like you both to attend the Santa Cruz Joint Venture Operating Committee meeting to be held in the Asarco Tucson Office July 13th.

Mr Gay should be prepared to discuss the well pollution program -- what, if anything, needs to be done.

Hopefully, a detailed discussion of the site selection for the in-situ test will not come up, but should it, Mr. Kreis should be prepared with maps, etc. to discuss it in detail.

WLK:mek

W. L. Kurtz

cc: A.R. Raihl
R.L. Brown
J.D. Sell

JDS

New York, N.Y., October 26, 1988

TO: R. L. Brown

Santa Cruz In Situ Project

Al Raihl phoned today to advise that the drilling on hole C-1 will start about November 15. Joy will be the prime contractor and will subcontract drilling through the overburden.

The hydrologic characterization hole will start about December 1. Montgomery & Associates has written the specifications and SAIC will assemble the bid package. Mr. Kreis will observe and supervise the drilling.

F. T. Graybeal

F. T. Graybeal

FTG:mc

cc: R. J. Muth
W. K. Murray
W. L. Kurtz/J. D. Sell

RECEIVED
OCT 28 1988
EXPLORATION DEPARTMENT

11-28-1988

HGK/J.D.S.) ~~MEK~~

Santa Cruz Proj.

In Situ

EA-0900 is now

EA-0438-00.

H.G.K.

As of Dec. 8, 1988 In-Situ is still in the ASARCO "900" for the earlier expenditures & now in EA-0438 for the present In Situ expenditures as of this date. No Resolution on "900" expenditures.

JDS via Cayrow.

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 546
January 6, 1989
SC-1 1212-1215 TO
SC-1 1637-1646
PAGE 1 OF 2

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 23 Core Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	SC-1 1212-1215	2.84
2	SC-1 1215-1225	.04
3	SC-1 1225-1235	.03
4	SC-1 1235-1246	.08
5	SC-1 1246-1250	.32
6	SC-1 1306-1316	.09
7	SC-1 1316-1326	.15
8	SC-1 1326-1336	.06
9	SC-1 1336-1346	.07
10	SC-1 1346-1356	.07
11	SC-1 1356-1366	.08
12	SC-1 1366-1372	.06
13	SC-1 1372-1382	.43
14	SC-1 1382-1392	.56
15	SC-1 1392-1402	.46
16	SC-1 1402-1412	.39
17	SC-1 1412-1422	.66
18	SC-1 1422-1430	1.33
19	SC-1 1430-1438	1.55
20	SC-1 1528-1536	.48

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EXPLORATION DEPARTMENT

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Tucson, Arizona 85703
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JOB NO. TAJ 546
January 6, 1989

ITEM	SAMPLE NUMBER	Cu (%)
21	SC-1 1617-1627	1.79
22	SC-1 1627-1637	4.25
23	SC-1 1637-1646	2.48

cc: Asarco Incorporated
Attn.: Mr. J.D. Sell
Mr. A.R. Raihl
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 547
January 6, 1989
C-1 1438-1448 TO
C-1 1685-1695

ASARCO INCORPORATED
Attn: Mr. H. G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 25 Core Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	C-1 1438-1448	.07
2	C-1 1448-1458	.06
3	C-1 1458-1468	.05
4	C-1 1468-1478	.03
5	C-1 1478-1488	.03
6	C-1 1488-1496	.03
7	C-1 1496-1504	.07
8	C-1 1504-1511	.26
9	C-1 1511-1519	.08
10	C-1 1519-1528	.10
11	C-1 1536-1547	.30
12	C-1 1547-1555	.06
13	C-1 1555-1565	.03
14	C-1 1565-1575	.03
15	C-1 1575-1586	.04
16	C-1 1586-1596	.07
17	C-1 1596-1607	.05
18	C-1 1607-1617	.23
19	C-1 1646-1656	.04
20	C-1 1656-1666	.08

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Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 547
January 6, 1989

ITEM	SAMPLE NUMBER	Cu (%)
21	C-1 1666-1673	.14
22	C-1 1250-1260	.55
23	C-1 1673-1677	1.14
24	C-1 1677-1685	.18
25	C-1 1685-1695	.06

cc: Asarco Incorporated
Attn.: Mr. J.D. Sell
Mr. A.R. Raihl
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

RECEIVED
JAN 9 1989
EXPLORATION DEPARTMENT

Charles E. Thompson
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Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
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Tucson, Arizona 85703
(602) 622-4836

JDS

REPORT OF ANALYSIS

JOB NO. TAJ 546
January 6, 1989
C-1 1212-1215 TO
C-1 1637-1646
PAGE 1 OF 2

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
APR 24 1989
SW Exploration

Analysis of 23 Core Samples

ITEM	SAMPLE NUMBER		Cu (%)
1	C-1	1212-1215	2.84*
2	C-1	1215-1225	.04
3	C-1	1225-1235	.03
4	C-1	1235-1246	.08
5	C-1	1246-1250	.32*
6	C-1	1306-1316	.09
7	C-1	1316-1326	.15
8	C-1	1326-1336	.06
9	C-1	1336-1346	.07
10	C-1	1346-1356	.07
11	C-1	1356-1366	.08
12	C-1	1366-1372	.06
13	C-1	1372-1382	.43*
14	C-1	1382-1392	.56*
15	C-1	1392-1402	.46*

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Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 546
January 6, 1989

ITEM	SAMPLE NUMBER		Cu (%)
16	C-1	1402-1412	.39*
17	C-1	1412-1422	.66*
18	C-1	1422-1430	1.33*
19	C-1	1430-1438	1.55*
20	C-1	1528-1536	.48*
21	C-1	1617-1627	1.79*
22	C-1	1627-1637	4.25*
23	C-1	1637-1646	2.48*

ASARCO Incorporated
APR 2 4 1989
SW Exploration

*NOTE: nsCu(%) analysis to follow as TAJ546-A.

cc: Mr. J. D. Sell
Mr. A. R. Raihl

4/21/89

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 552
January 13, 1989
C-1 1260 TO 2050

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
JAN 17 1989
SW Exploration

Analysis of 35 Core Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	C-1 1260-1270	.08
2	C-1 1270-1280	.10
3	C-1 1280-1290	.15
4	C-1 1290-1302	.53
5	C-1 1302-1306	.26
6	C-1 1764-1774	.03
7	C-1 1774-1784	.03
8	C-1 1784-1794	.03
9	C-1 1794-1804	.06
10	C-1 1804-1814	.91
11	C-1 1814-1824	.06
12	C-1 1824-1834	.04
13	C-1 1834-1844	.12
14	C-1 1844-1854	.24
15	C-1 1854-1860	.11
16	C-1 1860-1865	2.13
17	C-1 1865-1875	.06
18	C-1 1875-1885	.16
19	C-1 1885-1895	.09
20	C-1 1895-1905	.10
21	C-1 1905-1915	.05
22	C-1 1915-1924	.09
23	C-1 1924-1933	.53
24	C-1 1933-1942	.43
25	C-1 1942-1952	.14

FK - J DS - HGK

ASARCO

Mining Department
A. R. Raihl

January 16, 1989

Santa Cruz Project
Monthly Technical Report

Attached is a corrected copy of Table 1 (Labor Hours Expended by Task for the Month) for November 1988. Please substitute this corrected table for the one included in the November Technical Report.

A. R. Raihl

ARR:brw
Attachment

DISTRIBUTION

ASARCO Incorporated	
R. L. Brown/F. T. Graybeal, New York	1 copy
W. L. Kurtz/J.D. Sell/H. G. Kreis, Tucson	1 copy
R. J. Kupsch, New York	1 copy
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SAIC	
D. Davidson	1 copy

ASARCO Incorporated
JAN 17 1989
SW Exploration

ASARCO Incorporated P.O. Box 5747 Tucson, AZ 85703-0747
1150 North 7th Avenue (602) 792-3010
TELEX: WU 666413 FACSIMILE: (602) 792-3934

TABLE 1 - LABOR HOURS EXPENDED BY TASK FOR THE MONTH
November 1988 - CORRECTED

	Labor Category		
	Technical	Clerical	Administrative
Task A - Site Selection			
SAIC	---	---	---
ELM&A	---	---	---
LW&M	---	---	---
KD Eng	---	---	---
Other	---	---	---
Asarco Inc.	---	---	---
Total	-0-	-0-	-0-
Task B - Test Wells			
SAIC	421	25	77
ELM&A	---	---	---
LW&M	---	---	---
KD Eng	71	---	---
Other	---	---	---
Asarco Inc.	4	---	---
Total	496	25	77
Task C - Development of Procurement Documents			
SAIC	10	---	---
ELM&A	---	---	---
LW&M	---	---	---
KD Eng	---	---	---
Other	---	---	---
Asarco Inc.	---	---	---
Total	10	-0-	-0-
Task D - Environmental Permitting			
SAIC	52	3	67
ELM&A	274	---	---
LW&M	40	---	---
KD Eng	---	---	---
Other	---	---	---
Asarco Inc.	51	---	---
Total	417	3	67

TABLE 1 - LABOR HOURS EXPENDED BY TASK FOR THE MONTH
November 1988 - CORRECTED
(Continued)

	Labor Category		
	Technical	Clerical	Administrative
Task E - Final Report			
SAIC	---	---	---
ELM&A	---	---	---
LW&M	---	---	---
KD Eng	---	---	---
Other	---	---	---
Asarco Inc.	---	---	---
Total	-0-	-0-	-0-
Task F - Management			
SAIC	28	2	8
ELM&A	---	---	---
LW&M	---	---	---
KD Eng	---	---	---
Other	---	---	---
Asarco Inc.	76	58	137
Total	104	60	145
TOTAL	1,027	88	289

ASARCO

Southwestern Exploration Division

January 18, 1989

R.L. Brown
New York Office

Monthly Report
H.G. Kreis
December, 1988

During December drill hole C-1, the geologic characterization hole, was drilled to a depth of 1715'; and drill hole HC-1, the hydrologic characterization hole, was drilled to a depth of 880'. Drill hole C-1 penetrated the top of Precambrian bed rock at a depth of 630', and the CuOx intervals of ≥0.2% Cu are summarized in the following table. Drill hole C-1 is presently scheduled to be drilled to 2050'. Upon the completion of coring in C-1, the hole will be geophysically logged by the USGS and then abandoned by cementing the hole to the surface of the ground.

Summary of CuOx Intervals in C-1 above 1695'
(Excludes chalcocite; 0.2% Cu cut off grade)

From	To	Interval	Total Copper	Copper Mineral	Rock Type
1246'	1260'	14'	0.48%	Chry.	pЄgr
1290	1306	16	0.46	Chry.	pЄgr
1372	1422	50	0.50	Chry.	pЄgr
1504	1511	7	0.26	Chry.	pЄgr
1528	1547	19	0.38	Chry.	pЄgr
1607	1646	39	2.18	Atacam.	pЄgr
1673	1677	4	1.14	Atacam.	pЄgr

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

JDS

January 18, 1989

J.D. Sell

Quarterly Report
Fourth Quarter 1988

AUTHORIZED PROJECTS

Santa Cruz Project, EA-0075 and EA-0438, Pinal County, Arizona - Cu

During the fourth quarter 39.5 days were spent on the Santa Cruz Project (3.5 days to EA-0075 and 36 days to EA-0438). This time was used on briefings for Senator DeConcini and Red River Resources, meetings with the USBM and consultants, preparing to drill and drilling, project supervision, renovating office and storage facilities in Casa Grande, and core logging.

GENERAL EXPLORATION

Beaver and Sevier Counties, Utah - Au, Ag

Fifteen and a half days were spent on gold-silver exploration in the Milford-Marysvale area of Utah. Most of this time was spent staking the Yellow Jacket claims at Marysvale.

Tucson Office, Miscellaneous

Two days were spent on California and Arizona general exploration. A total of 8.5 days were charged to Tucson Office, Miscellaneous, and this included field trips to Nevada gold deposits and visits to Arizona leach operations with MIM visitors.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz

1-20-1989
C. Barter

Aquifer above SC-19 bdr.: 375 Minzen (= 20,000 millidarcies)

Based on preliminary analysis of pumping tests conducted by Montgomery & Associates in hydrogeologic characterization well HC-1, permeability of the leached capping at the SC-19 test site may range from about 3 to 20 gpd/ft2 (gallons per day per square foot of aquifer at 1:1 hydraulic gradient) or from about 160 to 1,100 millidarcys. Based on injection tests conducted in SC-19 and SC-46, permeability of the oxide copper mineralized zone at the SC-19 test site may be about to millidarcys. } field work completed by 1-16±-89

Inspection of geologic cross sections, prepared by Casa Grande Copper Company personnel and dated June 14, 1978, indicate that several hundred feet of indurated sediments exist in the area near exploration boreholes CG-27 and CG-94. Injection tests conducted during 1978 in borehole CG-90, located about 1,500 feet west northwest from borehole CG-27, are reported by Getty Oil Company. The range of permeabilities reported for intervals of borehole CG-90 are as follows:

DEPTH, FEET	ZONE	PERMEABILITY, MILLIDARCYS
1,670-1,807	Mineralized Zone	0.8
1,400-1,600	Leached Granite Capping	0.2
1,100-1,250	Indurated Conglomerate	4.4; 16.1
950-1,050	Lower Conglomerate	12.5; 41.2

Xerox copies for W.L.K. J.D.S.

JAN 20 1989

SW Exploration

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 547A
January 24, 1989
C-1 1438-1448 TO
C-1 1685-1695
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H. G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 5 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
8	C-1 1504-1511	.23
11	C-1 1536-1547	.27
18	C-1 1607-1617	.19
22	C-1 1250-1260	.51
23	C-1 1673-1677	1.12

cc: Mr. J. D. Sell
Mr. A. R. Raihl

ASARCO Incorp.
JAN 26 1989
SW Exploration

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK PHOENIX, Arizona U.S.A.

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 552A
January 24, 1989
C-1 1260 TO 2050
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 7 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
4	C-1 1290-1302	.48
5	C-1 1302-1306	.22
10	C-1 1804-1814	.57
14	C-1 1844-1854	.21
16	C-1 1860-1865	.82
23	C-1 1924-1933	.47
24	C-1 1933-1942	.34

cc: Mr. A. R. Raihl
Mr. J. D. Sell

ASARCO Incorporated
JAN 26 1989
SW Exploration

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA U. S. A.

2489

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 554
January 24, 1989
C-1 1695-1715 TO 1755-1764
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 6 Drill Core Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	C-1 1695-1715	1.51*
2	C-1 1715-1722	.04
3	C-1 1722-1735	.03
4	C-1 1735-1745	.02
5	C-1 1745-1755	.02
6	C-1 1755-1764	.03

*NOTE: nsCu analysis to follow as TAJ554-A.

cc: Mr. A. R. Raihl
Mr. J. D. Sell

ASARCO Incorporated
JAN 26 1989
SW Exploration

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
PARADISE VALLEY, Arizona, U.S.A.
1/25/89

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 554A
February 6, 1989
C-1 1695-1715 TO 1755-1764
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 1 Pulp Sample

ITEM	SAMPLE NUMBER	nsCu (%)
1	C-1 1695-1715	.52

cc: Asarco Incorporated
Attn.: Mr. A.R. Raihl
Mr. J.D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
FEB 8 1989
SW Exploration

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA

2/7/89

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JDS

REPORT OF ANALYSIS

JOB NO. TAJ 546A
February 7, 1989
SC-1 1212-1215 TO
SC-1 1637-1646
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 13 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
1	SC-1 1212-1215	.40
5	SC-1 1246-1250	.27
13	SC-1 1372-1382	.38
14	SC-1 1382-1392	.49
15	SC-1 1392-1402	.41
16	SC-1 1402-1412	.34
17	SC-1 1412-1422	.59
18	SC-1 1422-1430	.84
19	SC-1 1430-1438	1.34
20	SC-1 1528-1536	.44
21	SC-1 1617-1627	1.77
22	SC-1 1627-1637	4.25
23	SC-1 1637-1646	2.24

ASARCO Incorporated
FEB 8 1989
SW Exploration

cc: Asarco Incorporated
Attn.: Mr. James D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
ARIZONA U.S.A.

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JDS

REPORT OF ANALYSIS

JOB NO. TAJ 546A
February 7, 1989
C-1 1212-1215 TO
C-1 1637-1646
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
APR 24 1989
SW Exploration

Analysis of 13 Pulp Samples

ITEM	SAMPLE NUMBER		nsCu (%)
1	C-1	1212-1215	.40
5	C-1	1246-1250	.27
13	C-1	1372-1382	.38
14	C-1	1382-1392	.49
15	C-1	1392-1402	.41
16	C-1	1402-1412	.34
17	C-1	1412-1422	.59
18	C-1	1422-1430	.84
19	C-1	1430-1438	1.34
20	C-1	1528-1536	.44
21	C-1	1617-1627	1.77
22	C-1	1627-1637	4.25
23	C-1	1637-1646	2.24

cc: Mr. J. D. Sell
Mr. A. R. Raihl

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

ASARCO

Southwestern Exploration Division

February 17, 1989

R.L. Brown
New York Office

Monthly Report
H.G. Kreis
January 1989

During January drill hole C-1 was drilled from 1715' to its bottom at 2050', and drill hole HC-1 was drilled from 880' to its bottom at 1100'. The complete results of C-1 are summarized in the following table. Hydrologic testing of the granite bedrock above the top of the copper oxide mineralization (1246' depth) showed preliminary permeability values of 160 to 1,100 millidarcys.

SUMMARY OF CuOx INTERVALS IN C-1

(Excludes chalcocite; 0.2% Cu cutoff grade)

From	To	Interval	Total Copper	ns Cu*	Copper Mineral	Rock Type
1246'	1260'	14'	0.48%	0.44%	Chry.	pЄgr
1290	1306	16	0.46	0.42	Chry.	pЄgr
1372	1422	50	0.50	0.44	Chry.	pЄgr
1504	1511	7	0.26	0.23	Chry.	pЄgr
1528	1547	19	0.38	0.34	Chry.	pЄgr
1607	1646	39	2.18	2.11	Atacam.	pЄgr
1673	1677	4	1.14	1.12	Atacam.	pЄgr
1844	1854	10	0.24	0.21	Chry.	pЄgr
1924	1942	18	0.48	0.41	Chry.	pЄgr & Qmp

*"non sulfide" or acid soluble copper by Asarco's Ray Mine method.

Meetings were held with Freeport-McMoRan, the USBM, and our subcontractors to evaluate the results of C-1 and HC-1. In addition, consideration was given to moving the in situ leach test site to a location in our newly acquired soluble copper reserve, and it was decided to continue with the SC-19 in situ leach test site. An updated report on the SC-19 test site is being written to satisfy obligations with the USBM.

All of Hanna's pertinent files and maps on the Casa Grande West Deposit are now in Asarco's Tucson Office. Texaco is making arrangements to ship twenty boxes of similar information to Asarco's Tucson Office. Efforts are being made to locate computer tapes and other miscellaneous information for transfer to Asarco.

H. G. Kreis

HGK:mek

cc: WL Kurtz/ JD Sell
AR Raihl

ASARCO

Southwestern Exploration Division

March 1, 1989

Files

Sample Prep. and
Analytical Methods
Skyline Labs

The attached information describes the sample preparation methods and analytical methods presently being used on Santa Cruz samples at Skyline Labs.

Also attached are descriptions of the methods used on the "CG" samples submitted by Hanna-Getty.

H. G. Kreis

H. G. Kreis

HGK:mek
Atts.

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

H.G. Kreis

Feb. 28, 1989

SKYLINE LABS PROCEDURES

(Verbal from Jack Allen)

Sample Preparation* (Core):

- Crush entire sample to -½".
- With cone crusher reduce all sample to -10 to -20 mesh.
- Split out 250 grams with Jones splitter.
- Reduce the 250 gram, -10 mesh sample to -125 mesh with ring and puck mill.
- Take 0.5 gram for assay (less if over 5% Cu).

Analytical Method for Total Copper*:

- Nitric acid - hydrochloric acid - perchloric digestion.
- AA read out.

Analytical Method for Acid Soluble Copper:

- Using the Asarco Ray Mines method on Asarco Santa Cruz samples as of 1-1-1989.
- Prior to 1-1-1989 used method described in W.L. Lehmbeck's letter to H.G. Kreis dated 11-16-1981. The same method was used on the Hanna-Getty "CG" samples.

*Basically, the same methods were used on the Hanna-Getty "CG" samples.

ASARCO

Mineral Beneficiation Department

December 14, 1988

Mr. H. G. Kreis
Southwestern Exploration Department
TUCSON OFFICE

Method Used by Ray Unit for Assaying
for N.S. (Acid Soluble) Copper

Boil 1-gram sample with 50 ml of 10% sulfuric acid for 1 minute. Cool, filter, and wash residue on filter paper several times. Dilute filtrate to volume of 100 ml.

Determine copper content of filtrate either by AA or thiosulfate titration method, and calculate acid soluble copper content of sample.

T. D. Henderson Jr.

T. D. Henderson, Jr.

TDH:brw

cc: A. R. Raihl
DEC/File - Gen 3.01

ASARCO Incorporated

DEC 15 1988

SW Exploration

SKYLINE LABS, INC.
P.O. Box 50106 • 1700 West Grant Road
Tucson, Arizona 85703
(602) 622-4836

The Santa Cruz composite pulps of Skyline job number TAJ-128 (November 11, 1981) were run by this method. H.G.K., 11-16-81

November 16, 1981

Asarco Inc.
P. O. Box 5747
Tucson, Arizona 85703

Attn: Mr. H. G. Kreis

Dear Mr. Kreis:

NON SULFIDE COPPER

1. A 500 mg sample is weighed into a 250 ml beaker
2. Add 100 ml 5% H_2SO_4
3. Add 10 ml 6% H_2SO_3
4. Place in a Hot hot plate and bring to a rapid boil and boil for a timed 5 minutes.
5. Filter hot thru a 597 or comparable filter paper into a 200 ml flask.
6. Wash several times, cool and dilute to volume.
7. Run by Atomic Absorption analysis.

Sincerely,

SKYLINE LABS, INC.

William L. Lehmbeck
Manager

WLL/clp

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
P.O. Box 50106 • 1700 West Grant Road
Tucson, Arizona 85703
(602) 622-4836

RECEIVED
MAY 6 1977
COASTAL MINING

May 5, 1977

COASTAL MINING COMPANY
P. O. Box 1274
Casa Grande, Arizona 85222

Attention: Phil Nason

Dear Mr. Nason:

Following are our standard methods of analysis for Total Copper and Non-Sulfide Copper determinations.

STANDARD TOTAL COPPER METHOD

1. Weigh a 200mg sample into a 200ml volumetric flask.
2. Add 10ml Conc. HCl, 8ml Conc. HNO_3 and 4ml Conc $HClO_4$.
3. Digest over low heat until all NO_2 is gone. Then heat to heavy refluxing until volume is 2-3ml.
4. Cool, add 20ml H_2O and 10ml Conc HCl.
5. Heat to boiling to dissolve all soluble salts.
6. Cool, dilute to mark, mix, and read on A.A.S.

NON-SULFIDE COPPER METHOD

1. Weigh a 200mg sample into a 250ml beaker.
2. Add 10ml 5% H_2SO_4 and 10ml 6% H_2SO_3.
3. Bring to boil on a very hot plate, and boil for 5 minutes.
4. Filter thru #597 paper, into 200ml volumetric flask.
5. Wash filter paper twice with water, dilute to mark, mix, and read on A.A.S.

Sincerely,

William L. Lehmbeck
Manager

WLL/dap

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

Assays - Procedure

THE HANNA MINING COMPANY

RESEARCH CENTER
P. O. BOX 67
NASHWAUK, MINNESOTA 55769

(AREA CODE 218) 885-1951

Hanna Research Laboratory

Analytical Procedure

Acid Soluble Copper

1. Weigh 200 mg of -100 mesh sample into a 250 ml Erlenmeyer flask or beaker
2. Add 100 ml of 5% sulfuric acid (H_2SO_4) solution.
3. Add 10 ml of concentrated sulfurous acid (H_2SO_3).
4. Bring to boil and boil for 5 minutes.
5. Cool and transfer to a 200 ml volumetic flask.
6. Filter approximately 50 ml of sample through a Whatman 40 paper into a sample cup.
7. Analyze the filtered sample for copper by atomic absorption.
8. Report the results as acid soluble copper.

R. L. S.
6/21/79

CASA GRANDE COPPER CO.
RECEIVED
JUN 29 1979

CASA GRANDE SAMPLE PREPARATION

MINUS ½" CRUSHING AND SPLITTING:

1. Pass the entire sample through the jaw crusher by pouring from the bag.

2. Screen on the ½" shaker screen to remove the -½" material.

3. Transfer the screen oversize to a pouring pan and pass through the jaw crusher again.

4. Pour the recrushed material back on the screen and shake.

5. Recrush the oversize again and add directly to the -½" material without screening again - if and only if any remaining oversize material is less than 5% of the total sample weight and is visually very close to ½" in size. If in doubt, screen the sample and continue crushing the sample until it meets the above criteria.

6. Transfer the entire sample to the Gilson splitter set for 1½" chute openings.

7. Split the sample repeatedly in half (usually three times) until the analytical split is between 1100 and 2200 grams.

8. Under no circumstances shall the final split be less than 1100 grams. If the final split weight is over 2200 grams, split it in half again. The sample should never be split in any manner other than by splitting an entire sample or previous split in half.

9. Place the sample number tag along with the analytical sample in a "bread tin" for the -10 mesh grinding step below.

10. Bag all -½" material and label by CG number as -½" and return to the original cloth bag.

11. Clean the crusher, splitter, pans and seive shaker thoroughly with air before starting the next sample. Sweep the floor and keep it clean between samples.

MINUS 10-MESH GRINDING:

12. Screen the -½" analytical sample on the 10-mesh shaker screen to remove the -10 mesh material.

13. With the rolls set open 3/4 of a turn, pass the +10 mesh fraction through the roll crusher.

14. Rescreen the crushed material as before and recrush the oversize on the roll crusher with the rolls open 1/4 of a turn.

15. Repeat the screening of the crushed material and recrush the oversize fraction on the roll crusher with the rolls set to just touch each other.

16. Rescreen and hand grind the remaining oversize to pass the 10-mesh screen.

17. The entire sample must pass the 10-mesh screen.

18. Using the ¼" riffle splitter, split the entire -10 mesh sample repeatedly in half until a sample split of minimum 100 grams is obtained.

19. Weigh the final split to verify its weight. If less than 100 grams recombine and resplit the entire sample, stopping one split less than the previous time. If the split weight is over 200 grams, split it in half again.

20. Place the sample number tag and the analytical split in one of the small "bread tins" and set in the area designated for final sample pulverizing.

21. Bag the remaining -10 mesh material and label by CG number as -10 mesh. Place this bag in the appropriate original cloth sample bag.

22. Clean the area and all equipment thoroughly before going on to the next sample.

PULVERIZING THE ASSAY SAMPLE:

23. Place the entire -10 mesh analytical sample in the sample chamber to be pulverized on the impact pulverizer.

24. Pulverize for 2½ minutes.

25. Remove the chamber and carefully transfer by brushing the entire sample into a "bread tin" container.

26. A second sample may be running in the pulverizer in the second chamber during this step.

27. Pour the entire pulverized sample into the vibrating micro-splitter and split into two assay samples. Keep the hopper of the splitter full during the splitting.

28. The split weights should be approximately equal but this is not critical at this stage.

29. Place the two splits into sample assay envelopes and label by CG number.

30. Box one set of assay samples for shipment to the Research Lab for assay. File the other split in the Casa Grande sample filing system.

31. Thoroughly clean the chamber and splitter before proceeding to the next sample.

32. Load the chamber with the next sample and proceed as per Step 21.

CRITICAL STEPS:

1. The minimum -½" split weight of 1100 grams should not be lowered.

2. The minimum -10 mesh split weight of 100 grams should not be lowered.

3. No portion of the sample should ever be excluded from the sample preparation procedure except through proper splitting techniques. No portion of the sample such as screen oversize portion should ever be discarded.

4. Care should be taken to preserve the sample integrity by avoiding spillage or mechanical loss of the sample during the preparation steps. Such loss represents an improper splitting of the sample as discussed in #3 above.

5. This entire procedure has as dual purposes the preparation of the maximum quantity of coarse (-½") material for metallurgical testing while still allowing for a representative analytical fraction to be obtained. Both purposes are of high priority and the procedure must not be compromised to purposes other than these purposes without specific instructions to do so.

R. L. Swenson

R. L. Swenson
10/4/78

SS

THE HANNA MINING COMPANY
RESEARCH LABORATORY
P. O. BOX 67
NASHWAUK, MINNESOTA 55769
(AREA CODE 218) 885-1931

MEMORANDUM NO. M-78-24

January 31, 1978

RECEIVED
FEB 03 1978
CASA GRANDE COPPER CO.

TO: J. G. Stone

FROM: R. L. Swenson

SUBJECT: Project 673-267 Summary of Results of Sample Preparation Statistical Study of Casa Grande Ore

The study of sampling and sample preparation characteristics of Casa Grande Drill Core has been completed. A complete discussion of procedures used and results obtained will be presented in a subsequent memo. The purpose of this memo is twofold: to specify minimum split weights for each mesh size and to specify the sample preparation procedures to be used for the large diameter NC drill core.

Minimum Split Sizes

Attached is a graph showing the minimum weights to which a sample may be divided as a function of mesh size. Three of the four points were determined directly from the present study and should be considered briefly to understand the basis for the graph.

1) Minus 100 mesh point - This point was determined directly from the reproducibility of assays on minus 100 mesh samples. Samples as small as 50 milligrams were found to give results reproducible to within the limits of the analytical procedures used and, thus, all split weights down to 50 milligrams were judged to be acceptable, including "spot" sampling for assay purposes.

2) Minus 10 mesh point - This point represents the split weight below which the difference in assays between the two split halves exceeds the limits of reproducibility of the analytical procedure and above which any split variations are undetectable analytically. The minimum allowable split weight to be taken at minus 10 mesh is 450 grams.

3) Minus 1/2 inch point - The experimental results indicate that for split weights above 1100 grams there is only a small additional gain in splitting reproducibility regardless of increases in sample size. The splitting reproducibility for minus 1/2 inch splitting levels out to a value approximately three times the value of analytical reproducibility. Thus, it is concluded from

this study that, regardless of increases in split weight beyond 1100 grams, splitting at minus 1/2 inch size will never result in a representativeness of a split better than about ±3.5% of the amount of copper present in the sample. (This value represents ±0.05% copper in a 1.5% copper sample.)

At weights below 1100 grams the representativeness of a split deteriorates rapidly. Thus, the minimum allowable split weight to be taken at minus 1/2 inch is 1100 grams. (A full discussion of these results will be included in the test memo itself.)

4) Minus 35 mesh point - This additional point was determined emperically from consideration of the statistics generated for the minus 10 mesh point. The minimum allowable split weight at minus 35 mesh is 100 grams.

A splitting bias study was also carried out as a part of this study. No splitting bias was found in any of the splitting stages at either minus 1/2 inch, minus 10 mesh, minus 35 mesh or minus 100 mesh when splitting was procedurally correct and done in accord with the minimum weight guidelines established above. The only bias that was found occurred at split weights below 200 grams at minus 1/2 inch size. When splitting was done at these weights a splitting bias of 5% to 10% difference between the two splits was found in addition to a large standard deviation. This area needs to be looked at historically as, at one point, assay pulps were split at minus 1/2 inch size in the 100 to 150 gram range.

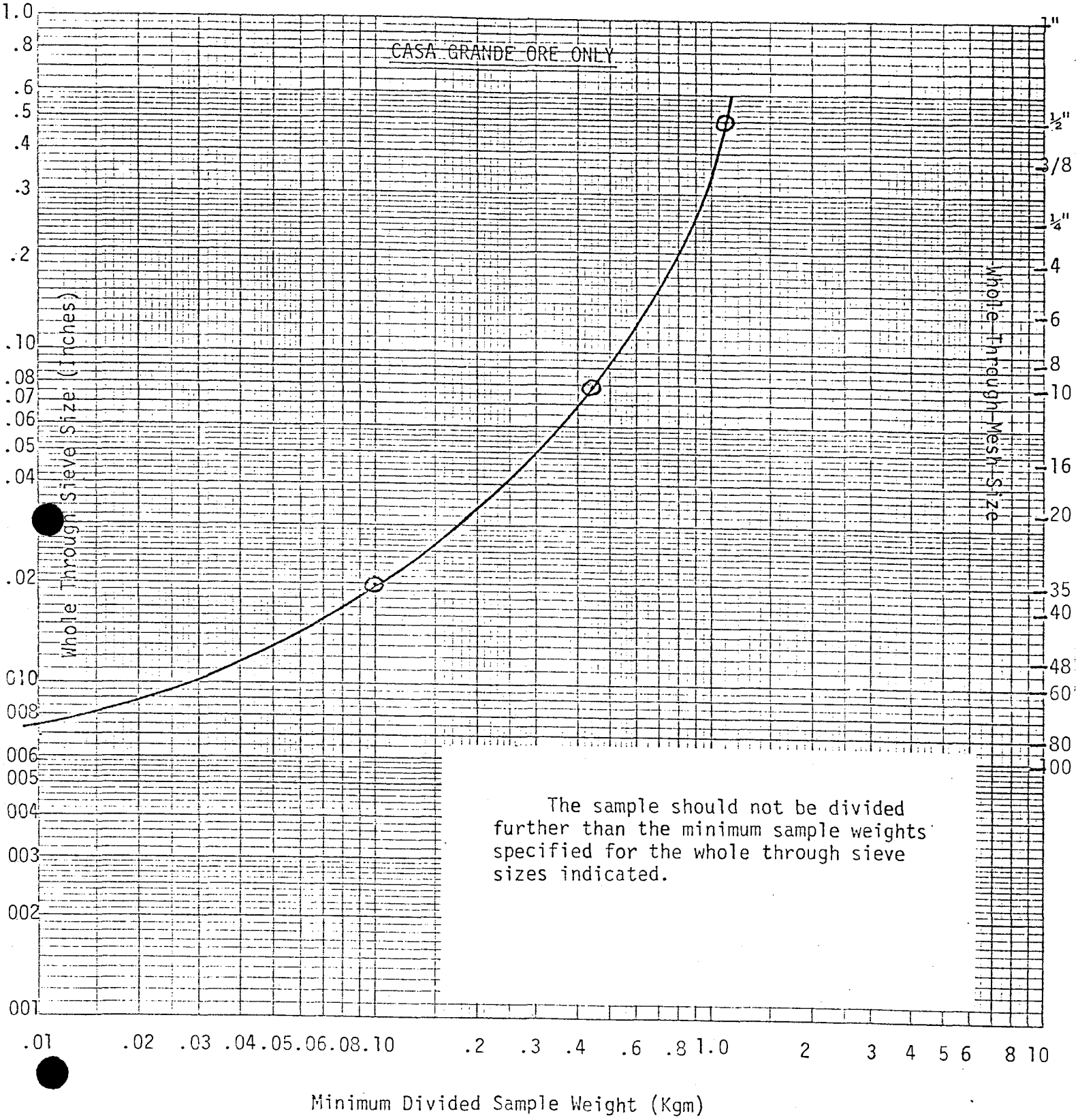
Sample Preparation Procedures for NC (large diameter) Drill Core

Attached is a flow chart outlining the sample preparation procedures recommended for use with the large diameter (NC) drill core.

The recommended procedures follow the minimum sample splitting specifications above as minimum guidelines. These minimum sample split weight guidelines should not be exceeded even if it requires modification of the sample preparation procedure to meet these guidelines.

Based on John Stone's estimate of 5 lbs of sample per foot of NC core (2.25 kgm/ft), following the recommended procedure will result in an eighth-split of 3/4 of the split core crushed to minus 1/2 inch size yielding approximately 0.21 kilograms of sample per foot of core. Thus, for intervals of 6 feet or more in length the eighth-split weight will be above 1200 gms and will meet the minimum specification. Intervals from 3 feet to 6 feet in length should only be quartered and intervals under 3 feet should only be halved.

Minimum Weight of Sample Split
For Various Particle Sizes



The following table summarizes the minimum starting sample weights which will allow splitting the sample the indicated number of times at minus 1/2 inch size. The guidelines of this table must be observed to maintain the minimum allowable split sizes at minus 1/2 inch.

Minus 1/2 Inch Splitting Specifications

Minus 1/2" Sample Weight (gms)	Smallest Split Fraction Allowable	Maximum Number of Half-Splits
50# 17,600 and over	1/16	4
*8,800 to 17,600	1/8	3
4,400 to 8,800	1/4	2
2,200 to 4,400	1/2	1
Under 2,200	Do not split sample	

*Most intervals should yield samples in this weight range

Description of Sample Prep Procedure for NC Core

The following procedure applies to core of 6 feet to 10 feet in length assuming normal core recovery. The procedure must be modified as per previous guidelines for shorter intervals or for low core recovery intervals.

1. Split drill core in half and split one of the halves in half again. Save one quarter-split and combine the remaining three-quarters for crushing.

2. Stage jaw crush the remaining core to minus 1/2 inch with screening between stages.

3. Split the sample in half using a riffle splitter with a minimum of 16 one-inch (1") chutes. (See specifications following).

4. Make an eighth-split by splitting one-half of the sample in half twice more.

5. The resulting eighth-split must weigh a minimum of 1100 grams. If not, the split must be recombined and a quarter-split taken. This split becomes the working sample for further crushing. Bag the reject minus 1/2 inch material for return.

6. Stage roll crush the minus 1/2 inch working sample to minus 10 mesh with screening between each stage.

7. Split this minus 10 mesh sample in half using a riffle splitter having a minimum of 24 one-quarter inch (1/4") chutes. (See specifications following).

8. One-half <u>may</u> be split again using the one-quarter inch riffle providing the resulting split weights are not less than 450 grams each. The minimum acceptable sample split for a minus 10 mesh sample is 450 grams.

9. This split becomes the working sample for further preparation. Bag the reject minus 10 mesh material for return. Label as minus 10 mesh.

10. Stage roll crush the minus 10 mesh working sample to minus 35 mesh with screening between each stage.

11. Using a microsplitter with 1/8 inch chutes split out an assay sample of minimum weight 100 grams. Bag and label as minus 35 mesh the reject material for return.

12. Pulverize the entire assay sample to pass a 100 mesh screen.

13. Split this assay sample in half and forward one-half to the Research Laboratory. Assay the remaining half as requested.

Sample Splitter Specifications

The following specifications apply to all riffle splitters used on Casa Grande ore.

1. The ore shall be "hopper" fed from a hopper directly above the riffles and discharged onto the riffles of the splitter perpendicular to the plane of the riffle top openings.

2. The delivery hopper shall deliver a smooth and uniform sample flow to the riffles.

3. The ends of the splitter shall be vertical to avoid "funneling" of the sample by the end pieces into the riffles. If the ends are not vertical the delivery hopper shall deliver the sample to the riffles directly onto the riffles without "funneling" at the ends.

4. The splitter shall have an equal number of delivery chutes to each side.

5. The riffle splitter, when properly used, shall deliver two split halves differing by no more than 5% of their average weight.

6. The splitter shall be in proper working order with uniform chute opening free from obstructions or irregularities which would tend to obstruct or otherwise destroy smooth sample flow through the riffle.

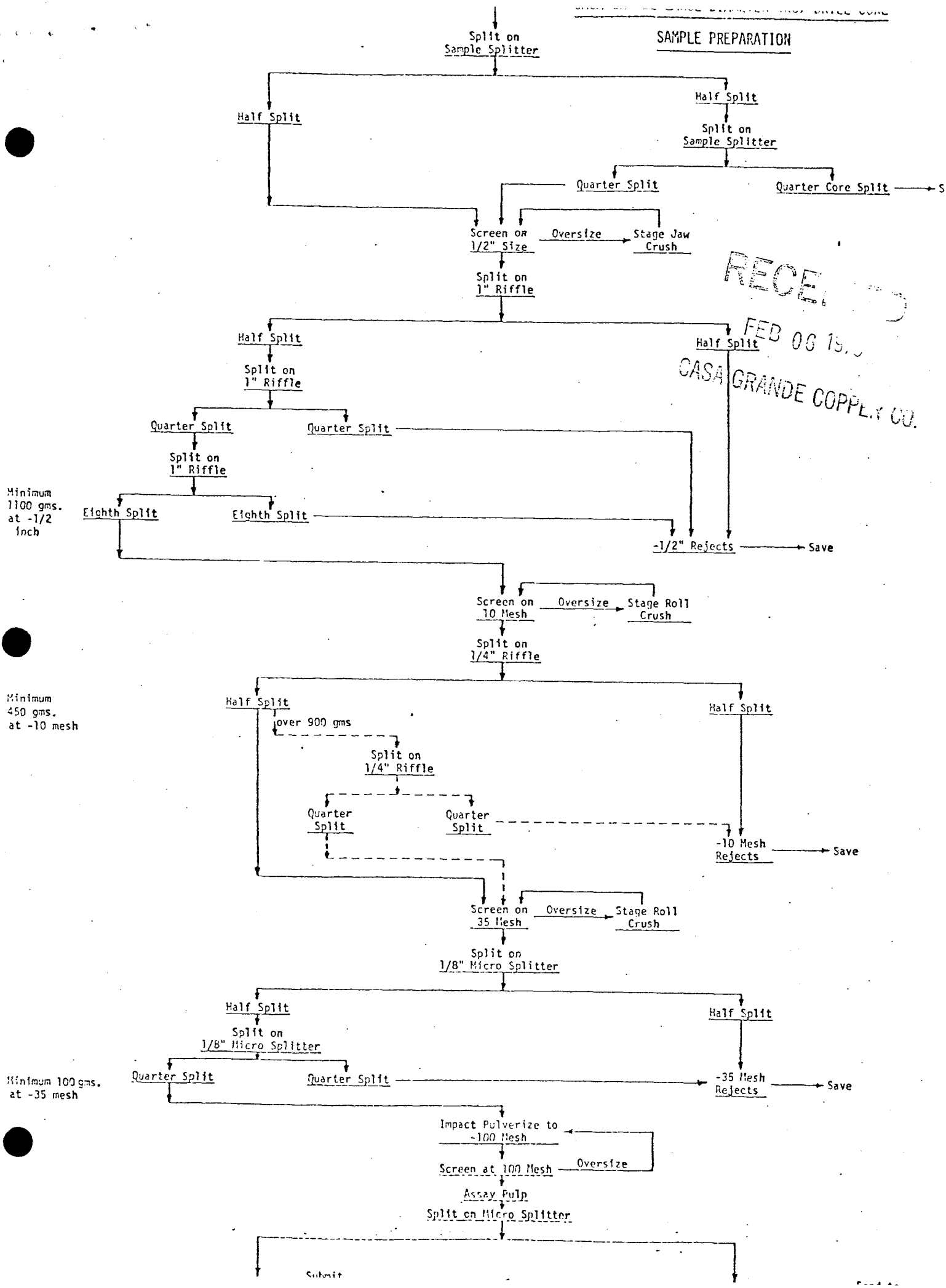
7. A vibrator may be used to assist smooth sample delivery and sample flow.

8. An adjustable riffle may be used providing it maintains uniform chute openings and meets the minimum specifications below for specific mesh sizes.

Sample Splitter Specifications for Various Mesh Sizes

Mesh Size	Chute Width	Minimum Number of Chutes
-1/2 inch	1 inch	16 (8 to each side)
-10 Mesh	1/4 inch	24 (12 to each side)
-35 Mesh	1/8 inch	16 (8 to each side)
-100 Mesh	1/8 inch	16 (8 to each side)

SAMPLE PREPARATION



RECEIVED
FEB 06 19..
CASA GRANDE COPPER CO.

W.L.K/J.D.S
FILE

ASARCO

Mining Department
A. R. Raihl

VIA TELEFAX
612-725-4526

March 9, 1989

Mr. Steve Swan
U.S. Bureau of Mines
5629 Minnehaha Avenue South
Minneapolis, MN 55417

Dear Mr. Swan:

Santa Cruz Project
Cooperative Agreement C0289001

Attached is a map, revision dated March 8, 1989, showing the collar locations of existing and proposed drill holes. The existing holes are SC-19, C-1, and HC-1. Core hole C-2 will be drilled at the location shown. The results obtained from C-2 will be evaluated by the USBM and the Santa Cruz Joint Venture prior to proceeding with the remaining drill holes. If results obtained from C-2 are satisfactory, T-1, T-2, T-3, and SM-1 will be drilled at the locations shown. Results from these wells will be evaluated in detail prior to proceeding with the drilling of the remaining holes. Undoubtedly, the location of the remaining holes will be changed from the locations shown.

Yours truly,

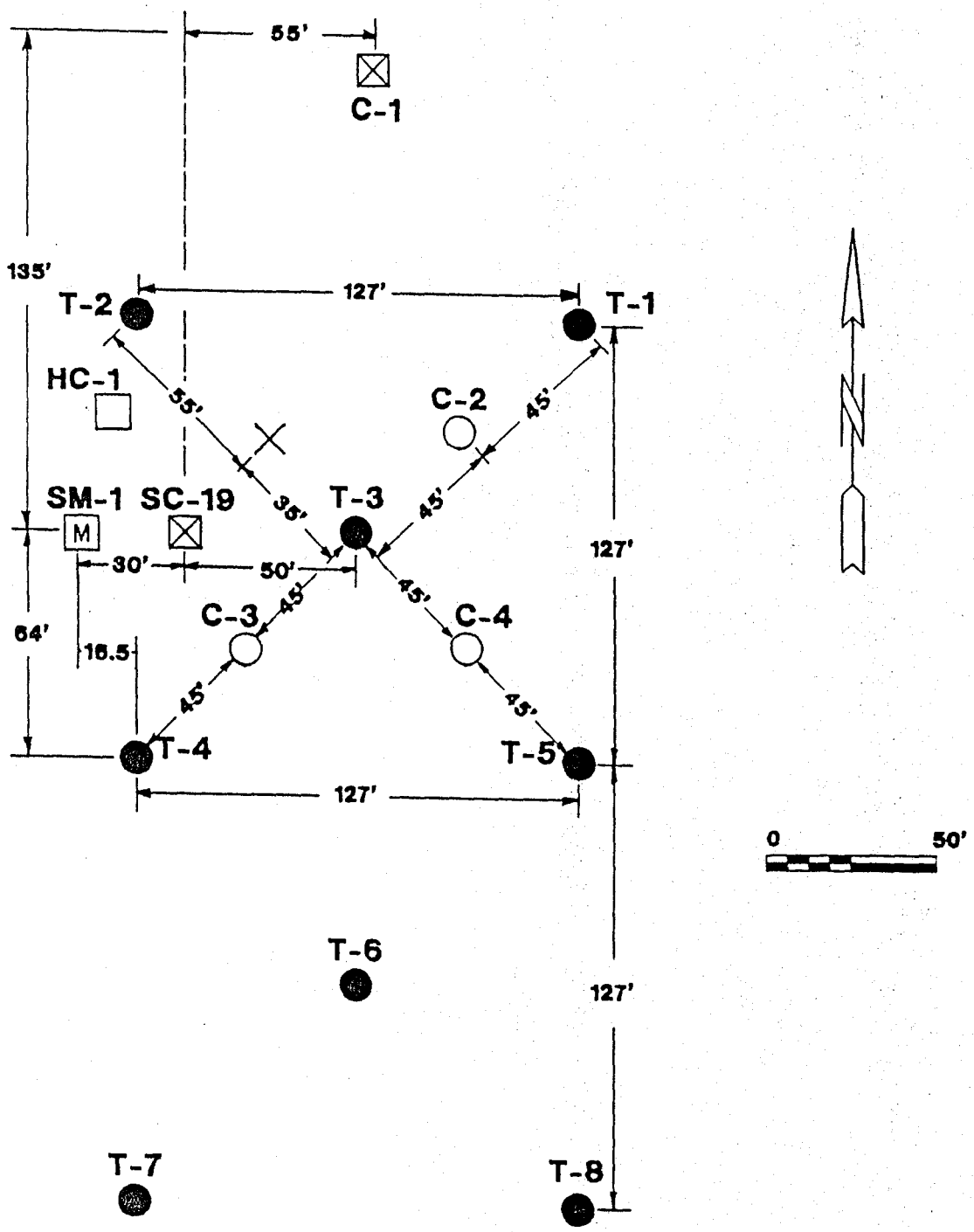
A. R. Raihl

ARR:brw
Attachment
cc: F. T. Graybeal w/att. (212-510-1978)
D. J. Askin " (303-236-0294)
G. Reinbold "
W. E. McCulloch "
C. F. Barter "
D. H. Davidson "
R. H. Huff "
~~H. G. Kreis "~~

ASARCO Incorp.
MAR 9 1989
SW Exploration

ASARCO Incorporated P.O. Box 5747 Tucson, AZ 85703-0747
1150 North 7th Avenue (602) 792-3010

SANTA CRUZ IN SITU TEST SITE



Test wells

Monitor well

Hydrologic test well

Future core hole

Existing core holes

Location of SC-19

ASARCO

Exploration Department
Southwestern United States Division

March 10, 1989

Mr. Bill Mounts
1129 E. Greenlee Place
Tucson, AZ 85719

Dear Bill:

Thanks for your advise and for the use of your negatives which are enclosed. We are looking at alternatives to the centrifuge and are running some lab tests to see how much copper ends up as very fine material.

Enclosed is a W-9 form that should be returned to Asarco with your consulting bill.

Sincerely yours,

Hank

Henry G. Kreis
Geologist

HGK:mek
Encs.

cc: W.L. Kurtz/J.D. Sell

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

J. Sell

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

MINING AND MINERAL RESOURCES RESEARCH INSTITUTE
OFFICE OF THE DIRECTOR
ROOM 103, GEOLOGY BUILDING

TELEPHONE: (602) 621-5392

March 14, 1989

MINING DEPT.

MAR 1 7 1989

TUCSON

Mr. Albert R. Raihl
ASARCO
Box 5747
Tucson, Arizona 85703

Dear Al:

Please find enclosed an announcement for a special seminar on Tuesday, March 22, 1989 which will focus on in-situ copper leaching. I hope you can find time to join us for this seminar.

Kind regards.

Sincerely,

Brent

J. Brent Hiskey

JBH:ooh

Encl

MAR 1 6 1989

SW Exploration

SPECIAL SEMINAR

Sponsored
by
Department of Mining and Geological Engineering
and
Arizona Mining and Mineral Resources Research Institute

Flood Drain Leach Cell Mining:
A Modified In-Situ Mining and Metallurgical System
for Copper Sulfides

by Bradley C. Paul, Ph.D. Candidate
Department of Mining Engineering
University of Utah

Flood Drain Leach Cell Mining was studied as a means of recovering copper from sulfide minerals in porphyry copper deposits too deep for conventional open pit mining. In Flood Drain Leach Cell Mining (FDLC), large underground cells are to be fragmented by an adaptation of Vertical Crater Retreat stopping and mass blasting. Cells prepared in this manner are to be flooded, drained, and artificially aerated to maintain high ore solution contact, and promote optimum bacterial conditions to enhance ferric sulfate leaching.

Non selective mass mining, and elimination of most ore handling, promises a mining cost per ton that is potentially lower than open pit mining. Solvent extraction and electrowinning should produce cathode quality copper at costs lower than concentrating, smelting, and refining. The key to making an economic mining system from this low cost combination is to accelerate a more complete recovery of copper. In this study, two new simulation models were created to aid in design of a mining and metallurgical system capable of achieving the needed recovery.

A new leaching simulation code, entitled D.L.S., give the rate of copper leaching from all major sulfides found in porphyry deposits. The D.L.S. code also provides information on net acid generation, iron salt precipitation, heat generation, and oxygen prediction of the completeness to which leaching will proceed. Heat generation and oxygen consumption provide design criteria for the ventilation system.

A new code, entitled "Air Module", simulated the flow of air through broken rock and predicts oxygen concentrations and temperatures at all points in the leach cell. The model also supplies air quantities and pressure heads needed for fan selection.

With these, and other computer models, it is possible to use commercially proven technologies in the design and costing of the proposed Flood Drain Leach Cell Mining method.

Date: Wednesday, March 22, 1989
Place: Mines 221
Time: 4:00 p.m.

ASARCO

Southwestern Exploration Division

April 3, 1989

R.L. Brown
New York

H.G. Kreis
Monthly Report
March 1989

All of March was used on the Santa Cruz Project. Work on the in situ leach test (EA-0438) included issuing an "Updated Evaluation of the SC-19 In Situ Leach Test Site" report, reviewing sampling methods, requesting screen tests on some C-1 rejects, giving a tour for people from the Arizona Department of Mines and Mineral Resources, giving quick tours of our facilities to J. Robinson and Bill Larson, initiating drilling of core hole C-2 and core logging, and preparing a field office. Work on the Santa Cruz Joint Venture consisted of continuing to acquire Hanna and Texaco data on the Casa Grande West Deposit; giving Steve Van Nort of Freeport-McMoRan a complete Santa Cruz tour; distributing certain materials stored in the Casa Grande storage facility to Hanna, Francisco Grande, and S. Van Nort (boxes of books, etc. given to Van Nort by Hanna); preparing an inventory of drilling muds acquired from Hanna-Texaco; meeting the manager of Desert Carmel (D.C. Properties); and renovating our core storage facilities in Casa Grande.

H. G. Kreis/mek

HGK:mek

H. G. Kreis

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

JDS

April 3, 1989

J. D. Sell

Quarterly Report
First Quarter 1989

Santa Cruz In Situ Project - EA-0438 - Copper

Forty-two days were spent on the Santa Cruz in situ leach test program. Most of this time was spent evaluating the results of drill hole C-1, reviewing alternative test site locations, writing a report on the SC-19 test site, reviewing sampling and drilling methods, and initiating drilling at site C-2.

Santa Cruz Project - EA-0075 - Copper

Twenty and one-half days were spent on the Asarco-Freeport-McMoRan joint venture. Most of this time was used on actvities associated with the acquisition of Hanna-Texaco's Casa Grande West deposit. This work included Hanna-Texaco data acquisition, construction of an updated land map, and renovation of storage and office facilities in Casa Grande.

Miscellaneous

Eight and one-half days were lost because of sickness.

H. G. Kreis/mek

JDS:mek

H. G. Kreis

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 575
April 11, 1989
C-2 1150 thru 1558

ASARCO INCORPORATED
Attn: Mr. Hank Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 46 Drill Core Samples

ITEM	SAMPLE NUMBER		TOTAL Cu (%)	
1	C-2 1150-1160		.02	
2	C-2 1160-1170		.04	
3	C-2 1170-1180		.12	
4	C-2 1180-1190		.09	
5	C-2 1190-1205		.08	
6	C-2 1205-1216	11	.11	1216
7	C-2 1216-1222	6	.35 *	
8	C-2 1222-1226	4	3.24 *	
9	C-2 1226-1234	8	.22 *	
10	C-2 1234-1238	4	.50 *	
11	C-2 1238-1247	9	.46 *	
12	C-2 1247-1257	10	.81 *	
13	C-2 1257-1267	10	.95 *	105.10 lb / 135' = 0.779 %
14	C-2 1267-1277	10	.79 *	
15	C-2 1277-1287	10	1.60 *	
16	C-2 1287-1297	10	.96 *	
17	C-2 1297-1307	10	.91 *	
18	C-2 1307-1317	10	.53 *	
19	C-2 1317-1327	10	.43 *	
20	C-2 1327-1337	10	.59 *	
21	C-2 1337-1347	10	.50 *	
22	C-2 1347-1351	4	.36 *	
23	C-2 1351-1361		.11	1351'
24	C-2 1361-1371		.13	
25	C-2 1371-1381		.08	

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
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Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	TOTAL Cu (%)
26	C-2 1381-1391	.09
27	C-2 1391-1400	.13
28	C-2 1400-1407	.68 *
29	C-2 1407-1417	.09
30	C-2 1417-1427	.07
31	C-2 1427-1439	.08
32	C-2 1439-1444	.34 *
33	C-2 1444-1449	1.60 *
34	C-2 1449-1459	.18
35	C-2 1459-1466	.06
36	C-2 1466-1472	.89 *
37	C-2 1472-1482	.05
38	C-2 1482-1492	.10
39	C-2 1492-1495	.10
40	C-2 1495-1500	.46 *
41	C-2 1500-1510	.05
42	C-2 1510-1518	.05
43	C-2 1518-1528	.03
44	C-2 1528-1538	.03
45	C-2 1538-1548	.02
46	C-2 1548-1558	.07

*NOTE: nsCu(%) analysis to follow as TAJ575-A.

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
Arizona U.S.A.
4/11/89

JDS

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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 576
April 11, 1989
C-2 1558 TO 1804

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 31 Drill Core Samples

ITEM	SAMPLE NUMBER		TOTAL Cu (%)	
1	C-2 1558-1568		.07	
2	C-2 1568-1573	ft	.10	1573'
3	C-2 1573-1584	11	1.52 *	
4	C-2 1584-1589	5	7.30 *	
5	C-2 1589-1595	6	1.74 *	
6	C-2 1595-1597	2	8.75 *	
7	C-2 1597-1604	7	3.20 *	
8	C-2 1604-1609	5	6.10 *	
9	C-2 1609-1613	4	4.10 *	
10	C-2 1613-1621	8	2.95 *	$\frac{405.62 \text{ ft\%}}{211'} = 1.92\%$
11	C-2 1621-1626	5	2.31 *	
12	C-2 1626-1633	7	.45 *	
13	C-2 1633-1642	9	3.50 *	
14	C-2 1642-1652	10	1.75 *	
15	C-2 1652-1660	8	4.80 *	
16	C-2 1660-1671	11	.18	
17	C-2 1671-1683	12	.07	
18	C-2 1683-1694	11	1.00 *	
19	C-2 1694-1705	11	.16	
20	C-2 1705-1715	10	.26 *	
21	C-2 1715-1725	10	.35 *	
22	C-2 1725-1733	8	1.62 *	
23	C-2 1733-1739	6	7.05 *	
24	C-2 1739-1747	8	3.15 *	
25	C-2 1747-1754	7	1.82 *	

SKYLINE LABS, INC.
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Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER		TOTAL Cu (%)	
26	C-2 1754-1764	10	.15	
27	C-2 1764-1770	6	.26 *	
28	C-2 1770-1776	6	1.40 *	
29	C-2 1776-1784	8	.39 *	1784'
30	C-2 1784-1794		.07	
31	C-2 1794-1804		.08	

*NOTE: nsCu(%) analysis to follow as TAJ576-A.

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA, U.S.A.

4/12/89

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 579
April 12, 1989
C-2 (1804 TO 1851)
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
APR 17 1989
SW Exploration

Analysis of 5 Drill Core Samples

ITEM	SAMPLE NUMBER	TOTAL Cu (%)
1	C-2 1804-1814	.08
2	C-2 1814-1824	.03
3	C-2 1824-1834	.03
4	C-2 1834-1844	.03
5	C-2 1844-1851	.06

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK DATE ISSUED ARIZONA U.S.A.
4/13/89

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 575A
April 18, 1989
C-2 1150 thru 1558

ASARCO INCORPORATED
Attn: Mr. Hank Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 21 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
7	C-2 1216-1222	.34
8	C-2 1222-1226	3.15
9	C-2 1226-1234	.20
10	C-2 1234-1238	.46
11	C-2 1238-1247	.42
12	C-2 1247-1257	.77
13	C-2 1257-1267	.88
14	C-2 1267-1277	.74
15	C-2 1277-1287	1.55
16	C-2 1287-1297	.91
17	C-2 1297-1307	.88
18	C-2 1307-1317	.51
19	C-2 1317-1327	.40
20	C-2 1327-1337	.56
21	C-2 1337-1347	.45

ASARCO Incorporated
APR 21 1989
SW Exploration

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

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Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 575A
April 18, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
22	C-2 1347-1351	.31
28	C-2 1400-1407	.61
32	C-2 1439-1444	.23
33	C-2 1444-1449	1.46
36	C-2 1466-1472	.53
40	C-2 1495-1500	.43

William L. Lehmbeck
Manager
4/18/89

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APR 21 1989
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Tucson, Arizona 85703
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REPORT OF ANALYSIS

JOB NO. TAJ 576A
April 18, 1989
C-2 1558 TO 1804

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 23 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
3	C-2 1573-1584	1.46
4	C-2 1584-1589	6.95
5	C-2 1589-1595	1.62
6	C-2 1595-1597	8.35
7	C-2 1597-1604	3.00
8	C-2 1604-1609	5.70
9	C-2 1609-1613	3.82
10	C-2 1613-1621	2.78
11	C-2 1621-1626	2.14
12	C-2 1626-1633	.43
13	C-2 1633-1642	3.20
14	C-2 1642-1652	1.54
15	C-2 1652-1660	4.35
18	C-2 1683-1694	.96
20	C-2 1705-1715	.21
21	C-2 1715-1725	.30
22	C-2 1725-1733	1.50
23	C-2 1733-1739	6.65
24	C-2 1739-1747	3.12
25	C-2 1747-1754	1.70

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Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 576A
April 18, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
27	C-2 1764-1770	.22
28	C-2 1770-1776	1.34
29	C-2 1776-1784	.34

cc: Asarco Incorporated
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703
Attn.: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 576A
April 18, 1989
C-2 1558 TO 1804

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 23 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
3	C-2 1573-1584	1.46
4	C-2 1584-1589	6.95
5	C-2 1589-1595	1.62
6	C-2 1595-1597	8.35
7	C-2 1597-1604	3.00
8	C-2 1604-1609	5.70
9	C-2 1609-1613	3.82
10	C-2 1613-1621	2.78
11	C-2 1621-1626	2.14
12	C-2 1626-1633	.43
13	C-2 1633-1642	3.20
14	C-2 1642-1652	1.54
15	C-2 1652-1660	4.35
18	C-2 1683-1694	.96
20	C-2 1705-1715	.21
21	C-2 1715-1725	.30
22	C-2 1725-1733	1.50
23	C-2 1733-1739	6.65
24	C-2 1739-1747	3.12
25	C-2 1747-1754	1.70

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(602) 622-4836

JOB NO. TAJ 576A
April 18, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
27	C-2 1764-1770	.22
28	C-2 1770-1776	1.34
29	C-2 1776-1784	.34

cc: Asarco Incorporated
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703
Attn.: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

ASARCO

Southwestern Exploration Division

April 19, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
April 1989

On the Santa Cruz in situ leach project, drilling on hole C-2 was started in late March and was completed in April. Drill hole C-2 intercepted CuOx intervals that correlated with similar intervals in SC-19, and the C-2 CuOx intervals are summarized in the following table.

Drill Hole C-2
Summary of CuOx Intercepts
(0.2% Total Cu cutoff grade at top and bottom of interval)

From	To	Interval	% Total Copper	Copper Mineralogy	Rock Type	Ft.-% Copper
1,216'	1,351'	135'	0.78	Ata & Chry	Granite	105
1,573'	1,660'	87'	3.17	Ata	Granite	276
1,660'	1,725'	65'	0.33	Ata & Chry	Granite	22
1,725'	1,754'	29'	3.21	Ata	Granite	93
1,754'	1,784'	30'	0.49	Ata & Chry	Granite	15
OR 1,573'	1,784'	211'	1.92	Ata & Chry	Granite	406

Work associated with drilling C-2 included: obtaining a contract for drilling water, preparing mud pits, supervising drilling, running drill hole deviation surveys, supervising sampling, logging geology, preparing rock structure-strength logs, supervising core splitting and assaying of core, and reporting results.

During the month the old sample preparation room in the Santa Cruz storage building was converted into a field office. Desks, tables and chairs were obtained on loan from the Sacation Mine. Arrangements are being made for a water supply and an evaporative cooler.

About a half dozen open pits on the recently acquired Hanna-Getty property presented a safety hazard and were filled in with dirt.

The drilling of test well T-1 will commence when Stewart Brothers has a suitable rig available. It may be two or three months before a rig is available.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

TDK/JDS

ASARCO

Mining Department

possible duplicate

April 20, 1989

Mr. A. R. Raihl
TUCSON OFFICE

Santa Cruz Project
C-2 Deviation Surveys

During the core drilling of C-2, there were problems obtaining reliable survey results. CBC Drilling Co. supplied an Eastman single shot survey tool obtained from Boyles Bros.' Navidrill company (all three of these companies are under the same ownership). Because of the following problems, excessive time delays were incurred:

1. The survey tool arrived on-site improperly assembled (camera and compass mounted upside down).

2. Weak batteries.

3. Bad film (coarse grained, "mud cracked" texture upon being developed).

4. Excessively worn fittings required jiggling the film canister to transfer film from the film canister to the camera. This allowed daylight to partially expose the film during the transfer of the film.

5. Although there were typed instructions with the survey tool, there was no instruction book that might have helped identify some of the above problems.

6. A replacement survey tool was delivered to the site to replace the original tool. The replacement survey tool did not work at all and had to be replaced.

7. A 0-20° inclination tool, when coupled with poor quality pictures, often gave questionable results which required more pictures to be taken. A 0-10° inclination tool was ordered, but it took several days to get one to the drill site.

RECEIVED
APR 20 1989
EXPLORATION DEPARTMENT

The total time for surveying amounted to 14 hours as follows:

Date	Hours
April 1	3.5
April 2	1.5
April 3	4.0
April 6	2.0
April 7	1.0
April 8	1.0
April 9	1.0
Total	14.0

Had the survey tools been in satisfactory working order, the total survey time would have been four hours or less.

H. G. Kreis

H. G. Kreis

HGK:brw

cc: WLK/JDS

ASARCO

Exploration Department
Southwestern United States Division

April 27, 1989

Ms. Valerie A. Gentile
M.A. Hanna Company
1301 E. Ninth St. #3600
Cleveland, Ohio 44114-1824

Dear Ms. Gentile:

We are shipping the Francisco Grande Resort data from our core shed in Casa Grande to you. The contents of the 29 boxes and the four large binders are being shipped in 28 boxes via UPS. A copy of the shipping invoice will be sent at a later date.

As you know, the remaining boxes of Francisco Grande Resort data are being stored in our core shed as a courtesy to the owners of the Francisco Grande Resort.

Sincerely yours,

Hank Kreis

Henry G. Kreis
Senior Geologist

HGK:mek

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

United States Department of the Interior

BUREAU OF MINES

TWIN CITIES RESEARCH CENTER
5629 MINNEHAHA AVENUE SOUTH
MINNEAPOLIS, MINNESOTA 55417
Telex: 362735 BOM TCRC UD

TAKE PRIDE IN AMERICA

May 9, 1989

Mr. Henry G. Kreis, Geologist
Southwestern Exploration Division
ASARCO, Inc.
P.O. Box 5747
Tucson, Arizona 85703

Dear Hank:

As you requested, enclosed is a list of reports, memorandums, geologic logs, etc., that John Stone allowed Sterling to copy from Casa Grande Copper Company files. I'm sorry that the trip I planned to search these files for oriented core and fracture mapping information had to be postponed. I would still like to schedule this at a later date, perhaps in conjunction with the drilling this summer at Santa Cruz.

If you have any questions on this information, please call me.

Sincerely,

Linda

LINDA J. DAHL, Geologist
In Situ Systems

Enclosures

cc: A. Raihl, ASARCO

copy: to WLK/JDS 5-15-89

ASARCO Incorporated
MAY 10 1989
SW Exploration

CASA GRANDE WEST REPORTS

"Hydrogeological Conditions and Water Control Requirements for CAP 20-52 Area." Preliminary Report, PR-A550-76-1, May 1976.

"Analysis of Aquifer Test Data and Preliminary Dewater Design (TW-1). Casa Grande West, Pinal County, Arizona. Interim Report. Harshbarger and Assoc., Inc., January 1978.

"Analyses of Core Samples From Casa Grande Well CG-109". Confidential Report 79-103, May 31, 1979.

"Preliminary Feasibility Report on In Situ Mining Methods. ASARCO's Santa Cruz Deposit, Pinal County, Arizona." Mountain States Research and Development, January 1980.

"Summary of Hydrologic Monitoring Program. Casa Grande West, Pinal County, AZ." Hargis & Montgomery, Inc., May 1980.

"In Situ Mining Feasibility Study--Casa Grande Copper Project" by Dravo Engineers and Constructors, Denver CO, December 1980.

"Summary of Hydrologic Monitoring Program, Casa Grande West, Pinal County, Arizona." Interim Report. Hargis & Montgomery, Inc., June 1981.

"Casa Grande Copper Company Ore Reserve Study for The Hanna Mining Company" by E. F. Evoy, Watts, Griffis & McQuat Limited, Consulting Geologists and Engineers, Toronto, Canada, April 1982.

"Summary of Hydrologic Monitoring Program, Casa Grande West, Pinal County, Arizona." Summary Report. Hargis & Montgomery, Inc., July 1983.

"Summary of Hydrologic Monitoring Program. Casa Grande West, Pinal County, Arizona." Summary Report. Hargis & Associates, Inc., November 1984.

"Summary of Hydrologic Conditions. Casa Grande West, Pinal County, AZ." Annual Report. Hargis & Montgomery, Inc., April 1986.

"Preliminary Analysis of Well TW-1 Step Discharge-Drawdown Test. Casa Grande West." Preliminary Memorandum Report PMR-A550-77-1, July 1977.

"Analysis of Aquifer Test TW-2 and Modified Dewater Design. Casa Grande West, Pinal County, Arizona." Harshbarger and Assoc., Inc. April 1978.

"Analysis of Long-Term Aquifer Test TW-3. Casa Grande West, Pinal County, Arizona." by P. Nason, Casa Grande Copper Co. Memorandum Report, May 1980.

"Analysis of Long-Term Aquifer Test TW-4. Casa Grande West, Pinal County, Arizona." by P. Nason, Casa Grande Copper Co. Memorandum Report, January 1981.

MISCELLANEOUS

Water Analysis, BC Laboratories, Submitted by Harsharger & Assoc., July 1978.

Memo to: F. H. Bunge, From: L. A. Mattson, Subj: Project 673 - Casa Grande Copper - Mineral Copper Distribution Procedure. Memo No. M-77-249. December 2, 1977.

Memo to: J. G. Stone, From: D. P. Martin, Subj: Project 673-281 Casa Grande - Clay Content of the High Grade Supergene Composite #79-88A and Primary Ore Composite #79-118. Memo No. M-79-259. November 27, 1979.

Memo to: J. B. Morrow, From: L. A. Mattson, Subj: Project 673 - Casa Grande, Chrysocolla. Memo No. M-79-102. May 25, 1979.

Memo to: D. D. Chilcote, From: P. W. Nason, Subj: Percent Atacamite in In Situ Copper Leach Reserve at Casa Grande West, November 7, 1980.

Memo to: M. L. Dicks, From: D. P. Martin, Subj: Project 673-267 - Casa Grande West - Summary of Pertinent Mineralogical Work, 1976 through 1980. Memo No. M-81-78. May 8, 1981.

Summary: Drill Hole CG-24.

Farm Operations and Water Usage, March 1978.

Drill Hole Location and Land Status Map.

Index Map of Well Locations mentioned in A T. Ethington Study.

Ltr to: Mr. Charles Dowd, Coastal Mining Co., From: Robin G. Weesner, Hargis & Assoc., Inc., Subj: Casa Grande West Monitoring, September 15, 1986.

Memo to: R. R. Smith, From: P. W. Nason, Subj: October 1983 Flood, March 8 1984.

Ltr to: Dave Hargis, From: John Stone, Subject: Agricultural pumping, July 31, 1979.

Memo to: J. G. Stone, From: C. A. Dowd, Subj: Information from Coldwell Banker on Peripheral Farms, April 5, 1979.

Ltr to: Ron DeWitt, Hargis & Montgomery, From: P. W. Nason, Subj: Summary of Pumpage Monitoring in the Casa Grande West Project Area, Oct. 24, 1983.

Ltr to: R. DeWitt, From: P. W. Nason, Subj: Summary of Pumpage Monitoring in the Casa Grande West Project Area, September 1, 1983.

Ltr to: R. DeWitt, From: P. W. Nason, Subj: Casa Grande West - Monthly Summary of Pumpage, July 29, 1983.

Memo to: J. G. Stone, From: C. A. Dowd, Hanna, Subj: Water Study by A. T. Ethington - Additional Possible Conclusions, September 27, 1977.

Ltr to: D. Hargis, From: R. T. Coxon, Casa Grande Copper Co., Subj: Water Level Recovery in CG-109B After Swabbing, October 118, 1979.

Memo to: D. D. Chilcote, From: T. M. Wolke, Subj: Project 673-235 - Report on the Results of the Column Leach Tests for Wedged Drill Hole 27A, June 2, 1978.

Memo to: D. D. Chilcote, From: T. M. Wolke, Subj: Project 673-235 - Report on Results for an Acid Ferric Sulfate Leach of Casa Grande Ore from Wedged Drill Hole 27A Using a Two-Foot Column Reactor, November 8, 1978.

CASA GRANDE WEST

Geologic Logs	Hole Surveys	Assay Summaries
CG-7		
CG-10		
CG-11	CG-11	CG-11
CG-13	CG-13	
CG-18	CG-18	
CG-18A		
CG-20	CG-20	
CG-21		
CG-22	CG-22	
CG-24		
CG-26		
CG-34	CG-34	
CG-36	CG-36	CG-36
CG-41		
CG-42	CG-42	CG-42
CG-63		
CG-74	CG-74	
CG-75	CG-75	CG-75
CG-76	CG-76A	
CG-77	CG-77	
CG-80	CG-80	CG-80
CG-81		CG-81
CG-82	CG-82	CG-82
CG-84	CG-84	CG-84 & 84A
CG-85	CG-85	
CG-88	CG-88	CG-88
CG-90	CG-90	CG-90
CG-91	CG-91	
CG-92	CG-92	CG-92
CG-93	CG-93	
CG-96A	CG-96A	CG-96A
	CG-97	CG-97
CG-100	CG-100	CG-100
CG-102		
CG-106		CG-106
CG-107	CG-107	
CG-109	CG-109	CG-109
CG-109A		CG-109A
CG-110	CG-110	

ASARCO

Exploration Department
Southwestern United States Division

May 12, 1989

Ms. Judy Moore
American Girl Mining Corp.
P.O. Box 879
Winterhaven, CA 92283

Dear Judy:

Thank you for giving Jim and Me a tour of the Madre-Padre Mine and the American Girl B vein. It was an informative and enjoyable tour, and we appreciate your hospitality on such short notice.

If we can be of any help to you in the future, please let us know.

Sincerely yours,

Hank Kreis

Henry G. Kreis
Senior Geologist

HGK:mek

cc: J.D. Sell

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

May 12, 1989

W.L. Kurtz

Metallurgical Samples
Hanna-Getty Deposit

There are 400 boxes (2' x 1' x 8") of metallurgical type samples from the Hanna-Getty deposit at Hanna's research center, Nashwauk, Minnesota. Now that Hanna has "discovered" these boxes, the people at the research center want to get rid of them to make more storage room.

In order to know what to do with the samples, an Asarco metallurgist will have to determine their value and make an appropriate recommendation.

H.G. Kreis

HGK:mek

H. G. Kreis

cc: J.D. Sell
A.R. Raihl

ASARCO

Exploration Department
Southwestern United States Division

May 12, 1989

Mr. Lou Matson
M.A. Hanna Co.
Research Center
P.O. Box 67
Nashwauk, Minn. 55769

Dear Lou:

Thank you for finding and sending the three boxes of metallurgical information on the Casa Grande West Deposit.

I will be in touch with you in the near future and will let you know what we want to do with the 400 boxes of samples.

Sincerely,

Henry G. Kreis

HGK:mek

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

May 16, 1989

Mr. Steve Axen
Ray V. Huff & Associates, Inc.
P.O. Box 1310
Golden, CO 80402

Santa Cruz Project

Dear Steve:

Attached is a list of drilling materials stored at our core storage building in Casa Grande. We are examining ways to reduce this inventory and would like to know what materials could be considered for use in drilling the next five test wells and the four monitor wells.

Sincerely,

Hank Kreis

Henry G. Kreis
Senior Geologist

HGK:mek
Att.: Mud Inventory

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

May 16, 1989

To: Files

From: H.G. Kreis

Mud Inventory
Santa Cruz Project

The following drilling materials remain in the Santa Cruz core storage buildings. These materials were acquired by Asarco-Freeport along with the Hanna-Getty deposit. Obviously spoiled materials and hazardous materials were disposed of in accordance with EPA standards, and they are not included in the inventory list.

Product	Weight/Vol. per Item	Approx. Number
Soda ash	100#	95
Sure Gel	50#	100
Caustic soda	50#	1
Lo Loss	50#	6
CC-16	50#	26
Q-Broxin	50#	5
Con Det	5 gal. can	54
Torq Trim	5 gal. can	5
WL-100L	50# can	1
EZ Spot	±20 gal. can	6
Microcrystal Graphite	50#	25
Cedar Fiber	40#	5
Marvel Mud Seal	40#	1
Dick's Mud Seal	40#	4
Quick Seal	40#	9
Walnut Flour	50#	6
Shell Flour (Glufil)	50#	8
Industrial corn flour	50#	4

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO SANTA CRUZ, Inc.
P.O. Box 5747
Tucson, ARizona 85703
(602) 792-3010

May 16, 1989

Operating Committee
Santa Cruz Joint Venture

Operating Committee
Alternate

Mr. H.G. Kreis is hereby appointed as an ASARCO Santa Cruz alternate on the Operating Committee. Other alternates are R.L. Brown, F.T. Graybeal and J.D. Sell.

W. L. Kurtz

WLK:mek

W. L. Kurtz

cc: D.L. Stevens - Freeport-McMoRan Gold Company
R.L. Brown/F.T. Graybeal - ASARCO Incorporated
H.G. Kreis - ASARCO Incorporated
A.R. Raihl - ASARCO Incorporated
J.D. Sell - ASARCO Incorporated

ASARCO

Southwestern Exploration Division

May 17, 1989

F.T. Graybeal
New York Office

USBM Request for
Hanna-Getty Data

As per our phone conversation this morning, the USBM will be given permission to copy the Hanna-Getty orientated core data. No other Hanna-Getty data will be given to them at this time.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Exploration Department
Southwestern United States Division

May 17, 1989

Mr. Steve Swan
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Dear Steve:

This morning Fred Graybeal passed along Asarco's present thoughts on releasing data from the recently acquired Casa Grande West Deposit. You will be pleased to know that all the information on the oriented core drilling of the Casa Grande West Deposit is available to the U.S.B.M. Asarco recognizes the contribution this data will make to evaluating fluid flow at the SC-19 test site.

As you may know, Asarco-Freeport acquired numerous file cabinets and boxes full of data on the Casa Grande West Deposit. It is going to be awhile before someone from Asarco goes through all the files in order to know exactly what is in them. Until that is done, consideration can not be given to freer access to the files.

As before Asarco, will certainly consider any requests for Casa Grande West Deposit information that will benefit the test work at the SC-19 test site, and I am confident that such requests will be granted.

If you have any thoughts or questions along these line, please let Al or me know.

Sincerely,

Henry G. Kreis
Senior Geologist

HGK:mek

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

May 19, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
May 1989

Plans are being made to start the drilling program for SM-1, T-3, and T-1 on June 5th. The drilling contractor is Stewart Brothers.

The Santa Cruz Joint Venture held an operating committee meeting on May 18. In attendance were A. Raihl, S. Van Nort, W. McCulloch, and H. Kreis.

The field office and core storage buildings on the Santa Cruz Project are now in good order. During the month, the water system for the buildings was equipped with a pressure pump and hooked up to a large storage tank. A cooler was installed on the room used for a field office. The north building was cleaned of mud and debris from the 1983 flood, and a number of drilling materials were rebagged. Bags of drilling materials that were spoiled or deemed hazardous waste were disposed of according to EPA regulations. In the south building a number of items were taken off shelves to make room for samples from the in situ leach drilling program.

New accounting procedures are being followed to keep track of the time spent by temporary help and to document expenditures with purchase orders.

A couple of days were spent giving J. Rasmussen a tour of the geology in the Yuma area.

H.G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

June 5, 1989

F.T. Graybeal
New York

Title to Water Rights,
Section B
Santa Cruz Project
Pinal County, Arizona

In summary of the phone conference you and I had with Al Raihl, the D.W.R.'s Pinal County A.M.A office has requested that wells T-4 and T-5 be permitted under our grandfathered water rights. As you can see on the attached certificate, the D.W.R.'s records show that S.C.J.V. water rights as being held by trust account number 1270 at Lawyer's Title of Arizona. In order for the D.W.R. to permit the S.C.J.V. under the grandfathered water rights, the D.W.R. needs legal proof of the S.C.J.V.'s ownership of the grandfathered water rights.

I discussed this situation with Bert Apker, and he called Lawyer's Title. Lawyer's Title told Bert they thought the trust was dissolved but needed time to check into the matter. Bert went on to say, there is no longer any need for the trust and everything should be taken out from under the trust.

Whatever the case, Bert will contact us as soon as he hears from Lawyer's Title.

H. G. Kreis/mek

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

Return to:
Lawyers Title OF ARIZONA
POST OFFICE BOX 7338
PHOENIX, ARIZONA 85011

Tr. 1270

1217-479

I

760933

Certificate Of Grandfathered Groundwater Right

COUNTY OF PINAL

STATE OF ARIZONA DEPARTMENT OF WATER RESOURCES

This is to certify that pursuant to the provisions of Title 45, Chapter 2, Arizona Revised Statutes

LAWYERS' TITLE OF ARIZONA AS TRUSTEE
UNDER TRUST NO. 1270
P.O. Box 5747
TUCSON, ARIZONA 85703

is granted
TYPE 1 NON-IRRIGATION GRANDFATHERED RIGHTS
in the

PINAL ACTIVE MANAGEMENT AREA

3,609 *acre-feet of groundwater annually from January 1 through December 31. The rights are appurtenant to* 1,203 *acres of land described as follows:*

SE¼ Sec 12 T6S R4E, and
W½; NE¼ Sec 13 T6S R4E, and
NE¼ Sec 23 T6S R4E, and
NW¼ Sec 24 T6S R4E, and
W½ Sec 18 T6S R5E GSRB&M
excluidng permanent roads, permanent drainage channels, and non-eligible areas as more fully described in the map attached hereto as Exhibit A and made a part hereof by reference.

503-31-[illegible] 032

NOTE: W½ & NE¼ SEC 13 (; is DWR conventional punctuation)

503-37-[illegible]

The use of groundwater under this right shall be for non-irrigation purposes in accordance with the laws of the State of Arizona and restrictions placed on use by the Director of the Department of Water Resources pursuant to Title 45, Chapter 2, Arizona Revised Statutes.

CERTIFICATE NO. 58-110104

is granted this 22nd day of December, 1983

ARIZONA DEPARTMENT OF WATER RESOURCES

Wesley E. Steiner
Director

The Department of Water Resources must be notified if the above named person(s) changes his address or conveys ownership of the land to another

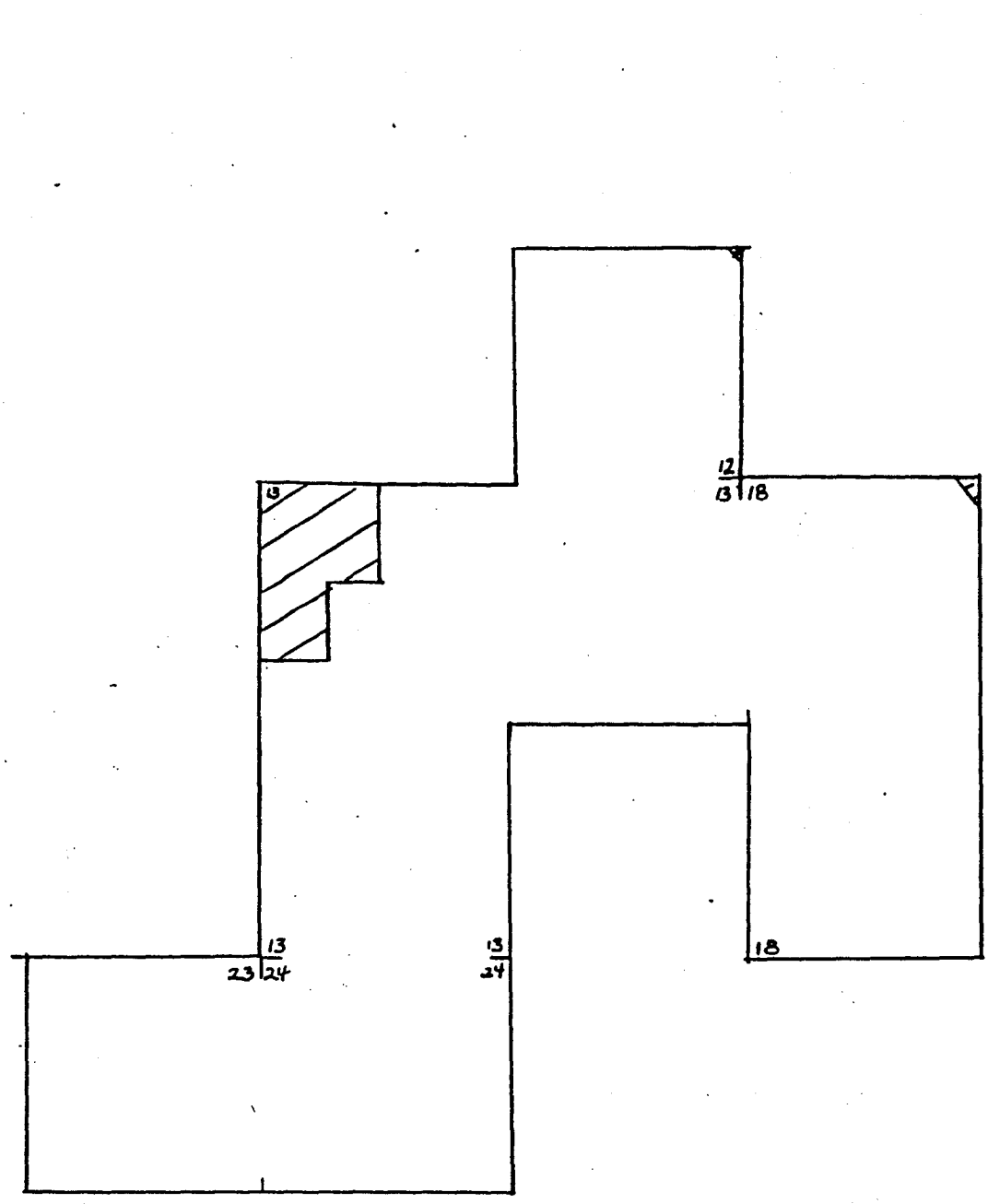
PAGE 1 OF 1 EXHIBIT A

AME Lawyers' Title of Arizon as Trustee
Under Trust No. 1270

CERTIFICATE NO. 58-110104

ec 12,13 23,24 T 6 S R 4 E Map Source 1979 ASCS Aerial Photo
ec 18 T 6 S R 5 E

Type 1 Acres Certified 1,203 Date 12 / 20 / 83 Scale 1:24,000



ASARCO

Southwestern Mining Department

June 13, 1989

Memo to: A. R. Raihl
H. G. Kreis
M. L. Beebe

From: G. H. Myers

RE: Purchase Orders - Asarco Santa Cruz, Inc.

The Asarco Santa Cruz, Inc. purchase orders are to be used for the In-Situ Leach Project only. Any and all purchases for any other of the Santa Cruz Joint Venture projects will be on Tucson Office purchase orders. In this way, everything to do with the Co-operative Agreement between the Joint Venture and the U. S. Bureau of Mines will remain segregated.

As these orders will include both purchases for Asarco, as part of our contribution, and for the U. S. Bureau of Mines, meaning Government ownership, are directly reimbursable, it has been determined that the issuer must designate ownership of the purchased equipment and/or supplies. To accommodate this, we will use the box marked "Plant Job No." in the upper left hand corner of the form. If for Asarco contribution, mark "Asarco"; if for Government ownership, mark "USBOM".

These orders will be maintained by the In-Situ Project accounting staff.

If there are any questions, please let me know.

G. H. Myers

GHM/kh

cc: WLKurtz

cc: J.D. Sell

RECEIVED
JUN 13 1989
EXPLORATION DEPARTMENT

ASARCO

Southwestern Exploration Division

JDS

June 14, 1989

H.G. Kreis

Santa Cruz In-Situ
Pinal County, AZ

Mr. R.L. Brown will be publishing the Exploration Quarterly Report and I would appreciate a summary from you on the quarter's activity by June 25.

James D. Sell

JDS:mek

James D. Sell

cc: W.L. Kurtz

JDS

ASARCO

Southwestern Exploration Division

June 23, 1989

J.D. Sell

Quarterly Report
Second Quarter 1989
H.G. Kreis

Santa Cruz In Situ Project - EA-0438 - Copper

Sixty two and one half days were spent on drilling C-2, SM-1 and T-3. In the Third Quarter, T-3 and transient testing in T-3 will be completed. Following the completion of T-3, well T-1 will be drilled and completed. If funding permits, the drilling of T-2 will follow the completion of T-1.

Santa Cruz Project - EA-0075 - Copper

Four and one half days were spent on the Santa Cruz Project. This work included a joint venture meeting with Freeport-McMoRan, maintaining our storage-office facility, and matters pertaining to the Hanna-Getty acquisition.

General Exploration - Au

A two and one half day tour of gold mineralization and structure in the Yuma area was taken to show the geology to a new temporary employee.

H. G. Kreis

HGK:mek

H. G. Kreis

JDS

ASARCO

Southwestern Exploration Division

June 27, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
June 1989

During the month of June drill hole SM-1, the ground-water monitor well, was started and completed; and drill hole T-3, the injection well, was started and drilled to a depth of 220'. Drill hole SM-1 was bottomed at 650' and cased to 640' with perforated casing. SM-1 was completed with the installation of a water pump.

Water tanks, pumps, and a generator for the initial permeability testing of the "T" wells have been installed, and the plumbing and electrical work will be completed shortly. An ocean container for storage and a rented trailer office are also on site.

The two water wells used by the Francisco Grande in Section 19, T6S, R5E, were surveyed. Also surveyed were easements for phone and water lines to the core storage and field office building in Section 19.

Lawyers Title Trust No. 1270 which holds a substantial amount of Santa Cruz Joint Venture Land is being dissolved, and the land held in trust will be transferred to the direct ownership of the Santa Cruz Joint Venture.

In late May, I attended an AIME in situ mining conference held at Casper, Wyoming. The conference included a trip to the in situ uranium mining operation at Highland, about 50 miles NE of Casper. It was obvious that in situ mining of uranium is commercially viable and apparently profitable even at today's low uranium prices. At least two operating in situ uranium mines are substantially expanding their well fields. The mining industry appears to have a good working relationship with the regulatory agencies, the Wyoming D.E.Q. and the U.S. Nuclear Regulatory Commission. Applications for permits to develop new properties do <u>not</u> require an Environmental Impact Statement. An Environmental Assessment is all that is needed. However, most (all?) applications require a commitment to restore the ground water to certain acceptable standards, and pilot plant operations usually include restoration to demonstrate the operator's ability to return the ground water to acceptable standards.

In Wyoming, applications for in situ operating permits include detailed descriptions of the in situ mining techniques. All this information is available to the public, and the information is frequently duplicated by competitors and others who want to stay abreast of the latest developments in in situ mining.

In July the drilling of hole T-3 will be completed along with transient testing and other various activities. Following the completion of T-3, the drilling of T-1 will be initiated.

During the month numerous trips were made to Casa Grande, one trip was made to Phoenix, and one trip was made to Florence.

H.G. Kreis/mek

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

LHGK - SDS → fil

New York, N.Y., July 18, 1989

RECEIVED
JUL 24 1989
EXPLORATION DEPARTMENT

To: R. L. Brown

Santa Cruz In Situ Talk

The Technical Program Committee of the AMC has requested a Santa Cruz Joint Venture-USBM paper on the in situ field test for the AMC annual meeting September 17-20, 1989 in San Francisco (see attached letter). The abstract of the paper is attached. Content would be essentially a progress report.

F. T. Graybeal

F. T. Graybeal

FTG:mc
Att.

cc: R. J. Muth (w/att.)
E. A. Romagnoli "
W. K. Murray "
W. L. Kurtz/J. D. Sell "
A. R. Raihl "
W. E. McCulloch-Freeport "

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

July 6, 1989

Mr. Frederick T. Graybeal
Chief Geologist--Exploration
ASARCO, Inc.
180 Maiden Lane
New York, New York 10038

Dear Mr. Graybeal:

During the formulation of the program for the upcoming Mining Convention in San Francisco, September 17-20, 1989, the American Mining Congress' Technical Program Committee determined that a presentation on the Bureau of Mines-ASARCO cooperative project on in situ leaching of copper in Arizona would be appropriate. This letter is to determine ASARCO's interest in this opportunity and your willingness to perhaps co-author a paper with a Bureau representative. Bill Larson, of the Twin Cities Research Center, would be the likely Bureau participant.

A slot on the Monday afternoon, September 18, 1989, session on "Operating Innovations" has been tentatively scheduled for the presentation. I have agreed to Chair that session.

Please let me know at your earliest convenience of your interest in presenting this paper. You can reach me in Washington at (202) 634-1251, should you wish to discuss the matter.

Sincerely,

Philip G. Meikle
Chief, Division of Health,
Safety and Mining Technology

IN SITU COPPER MINING AT THE SANTA CRUZ DEPOSIT, CASA GRANDE, AZ: A COOPERATIVE RESEARCH PROJECT BETWEEN THE SANTA CRUZ JOINT VENTURE AND THE UNITED STATES BUREAU OF MINES

By Frederick T. Graybeal[1] and William C. Larson[2]

ABSTRACT

The U.S. Bureau of Mines has started a production-scale, in situ mining field research project in cooperation with the Santa Cruz Joint Venture, which is 50 percent-owned by ASARCO Santa Cruz Inc., a subsidiary of ASARCO Incorporated and 50 percent by Freeport Copper Co., a subsidiary of Freeport-McMoran Gold Co. This research is being conducted at the Santa Cruz Project, located 7 miles west of Casa Grande, Arizona. Santa Cruz is a large oxidized porphyry copper deposit, concealed beneath post-mineral alluvium at depths of 1,500-3,000 ft. The research objective is to evaluate in situ mining as a method for extracting copper from a previously unmined copper oxide deposit. Funding is provided through a cost-sharing program with the Bureau of Mines contributing 75 percent and the Santa Cruz Joint Venture 25 percent over the life of the project.

Important project milestones reached to date include site selection, well field orientation, and demonstration that adequate amounts of water can be injected into the mineralized zone at pressures below the threshold for hydraulic fracturing. Current work will characterize the hydrologic regime and gather flow data from communication tests to support an application for an environmental permit to inject a dilute acid solution. Future steps will involve completion of a 5-spot well pattern, construction of a small solvent extraction-electrowinning plant, 12-18 month operation of the well field, and final technical and economic evaluation. The field activities are scheduled for a 4-year life subject to permitting and funding. Total project costs, including data evaluation, are presently estimated at $20.8 million. All data gathered from the project will be published by the Bureau of Mines.

---

[1]Chief Geologist, ASARCO
[2]Research Supervisor, Twin Cities Research Center, Bureau of Mines, Minneapolis, MN.

ASARCO

Exploration Department
Southwestern United States Division

July 19, 1989

Mr. Maurice Mordka
1800 N. Grady
Tucson, Arizona 85715

Dear Mr. Mordka:

On behalf of Mr. Graybeal and myself, I want to thank you for submitting your Montgomery Road property to Asarco.

At this time, Asarco is only acquiring drilled out copper deposits and is not doing any drilling or other forms of copper exploration. If Asarco does get back into copper exploration, we will review your property once again at that time.

Thanks again.

Sincerely,

Hank Kreis

HGK:mek

Henry G. Kreis
Senior Geologist

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Western USA

July 19, 1989

Al Raihl
Tucson Office

Purchase Orders
Santa Cruz Project

I do not need to see all those numerous purchase orders you are churning out. By copy of this memo I am asking Mr. Kreis to inform me of any he feels are not necessary, or are not within the "correct" price range.

W. L. Kurtz

WLK:mek

W. L. Kurtz

cc: R.L. Brown/F.T. Graybeal
H.G. Kreis
J.D. Sell

7/21/89

Field Notes on
T-3 Injection Tests
(open hole; washed out
drill mud with clear
water)

T-3 1200' (bot. of casing) to 1330:
2 gpm w/ 400 psi surface pressure; 880 psi bottom hole pressure

T-3 1666 - 1790
2 gpm w/ 250-300 psi surface pressure

T-3 1525 - 1790
5-7 gpm w/ 450-500 psi surface pressure
2-3 gpm w/ 300 psi " "

cpy: W.L.K. / J.D.S.

ASARCO

Southwestern Exploration Division

July 24, 1989

J.D. Sell

Gold in CG-31
Santa Cruz Project
Pinal County, AZ

In 1980 Hanna-Getty discovered that an old drill hole, CG-31, intercepted 10' at 9.91 oz. per ton gold from 2430 to 2440'. The gold occurs in a 6" thick zone of brecciated altered granite having substantial chrysocolla mineralization (S. Van Nort, 7-16-1980, memo to J.T. Cumberlidge).

Additional assaying of composite pulps for Au-Ag mineralization found no other significant Au or Ag mineralization. Thus, it was concluded the intercept was a small, isolated occurrence.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

July 24, 1989

W.L. Kurtz

Water Wells
Santa Cruz Project
Pinal County, Arizona

The five water wells that were at one time optioned to Asarco-Freeport by NAAC were acquired in the December 1988 purchase of land from Simmons. Since that time Bert Apker has transferred the DWR registrations on those five wells to Asarco-Freeport. The registrations on two of the five wells were transferred March 24, 1989, and the registrations on the other three wells were transferred on or immediately prior to July 14, 1989.

The registration on water well No. 55-609660 was also transferred into Asarco-Freeport's name on or immediately prior to July 14, 1989.

Mr. Bert Apker will clarify Asarco-Freeport's ownership of water well No. 55-609655 with the DWR and have its registration transferred into Asarco-Freeport's name.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: J.D. Sell
W.D. Gay
A.R. Raihl
C. Barter

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 596A
July 24, 1989
T-3 (1080 TO 1790)

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
JUL 27 1989
SW Exploration

Analysis of 40 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
6	T-3 1180-1200	1.10
7	T-3 1200-1220	.27
10	T-3 1240-1250	.19
11	T-3 1250-1260	.18
12	T-3 1260-1270	.34
13	T-3 1270-1280	.44
14	T-3 1280-1290	.56
15	T-3 1290-1300	.58
16	T-3 1300-1310	1.05
17	T-3 1310-1320	.95
18	T-3 1320-1330	.71
19	T-3 1330-1340	.33
20	T-3 1340-1350	.22
21	T-3 1350-1360	.39
23	T-3 1370-1380	.18
27	T-3 1410-1420	.07
37	T-3 1510-1520	.17
42	T-3 1560-1570	.56
43	T-3 1570-1580	.15
44	T-3 1580-1590	1.61
45	T-3 1590-1600	1.62
46	T-3 1600-1610	.36
47	T-3 1610-1620	.22
48	T-3 1620-1630	1.38
49	T-3 1630-1640	2.24

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 596A
July 24, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
50	T-3 1640-1650	.84
51	T-3 1650-1660	1.74
52	T-3 1660-1670	1.15
53	T-3 1670-1680	.66
54	T-3 1680-1690	.67
55	T-3 1690-1700	.87
56	T-3 1700-1710	.37
57	T-3 1710-1720	.29
58	T-3 1720-1730	1.02
59	T-3 1730-1740	2.56
60	T-3 1740-1750	1.74
61	T-3 1750-1760	2.01
62	T-3 1760-1770	.80
63	T-3 1770-1780	1.85
64	T-3 1780-1790	.44

JUL 27 1989
SW Exploration

cc: Mr. J. D. Sell
Mr. A. R. Raihl

JD S

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 597
July 25, 1989
T-3 (1790 TO 1870)
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 8 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-3 1790-1800	.27 *
2	T-3 1800-1810	.13
3	T-3 1810-1820	.08
4	T-3 1820-1830	.12
5	T-3 1830-1840	.08
6	T-3 1840-1850	.05
7	T-3 1850-1860	.05
8	T-3 1860-1870	.36 *

*NOTE: Further analysis pending.

ASARCO Incorporated
JUL 28 1989
SW Exploration

cc: Mr. J. D. Sell
Mr. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
REGISTERED
ARIZONA U.S.A.

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 597A
July 27, 1989
T-3 (1790 TO 1870)
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 2 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
1	T-3 1790-1800	.24
8	T-3 1860-1870	.24

cc: Mr. J. D. Sell
Mr. R. Raihl

ASARCO Incorporate
JUL 31 1989
SW Exploration

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
ARIZONA

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

H G Kreis

	SC #0438	SC #0075	Gen Exp.
JAN	20½ days	3½ days	
Feb *	9	14	
MAR	6	12	
APR	24	3	
MAY	16	3½	2½
JUNE	—	—	—
JULY	27	—	—

H G Kreis

1989

JANUARY	Santa Cruz #0438 in situ	20 1/2	days
	" " #0075	3 1/2	"
FEBRUARY	Santa Cruz #0075	112	hours
	" " #0438	76	"
MARCH	Santa Cruz #0075	12	days
	" " #0438	6	"
APRIL	Santa Cruz #0438	24	days
	" " #0075	3	days
MAY	Santa Cruz #0438	128 hrs.	16 days
	" " #0075	28 hrs.	3 1/2 "
	Gen. Expl.	20 hrs.	2 1/2 "
JUNE	NO INFO		
JULY	Santa Cruz #0438	27 days.	

ASARCO

Mining Department
Tucson, Arizona

RECEIVED
AUG 1 1989
EXPLORATION DEPARTMENT

August 1, 1989

Mr. R. L. Brown, V.P.
Exploration Department
NEW YORK OFFICE

Santa Cruz Project
In Situ Leach Program

As you will observe from the attached letter, Mr. Kurtz gave Mr. Kreis certain instructions on the Santa Cruz In Situ Copper Mining Research Project which place Hank in an untenable, "no win" situation. If Hank does not follow the instructions, he may be given a poor performance evaluation in the Exploration Department; if he does follow the instructions, he will be in direct confrontation with me. I believe this problem requires some clarification.

While Mr. Kreis is working on the Santa Cruz In Situ Copper Mining Research Project, he reports to me; therefore, all instructions to him must come through me or, in my absence, through Mr. Graybeal. This does not apply to Santa Cruz Project activities outside of the in situ leach program. When Mr. Kreis is not required on the in situ project, he can resume his normal duties within the Exploration Department with the normal chain of command.

I believe that Mr. Kreis will be totally committed to the in situ leach project until at least the middle of 1990. He will have little, if any, free time to accomplish even minor additional tasks including looking after the Santa Cruz land situation. Presently, I am having difficulties giving Hank 3 or 4 days off a month, let alone the normal weekends and holidays; those will have to be made up later in the year, including his vacation.

I trust the above clarifies the situation and will help avoid placing Hank in a difficult position.

A. R. Raihl

ARR:brw

Attachment

cc: F. T. Graybeal w/att.
W. L. Kurtz "
J. D. Sell "
H. G. Kreis "
R. J. Kupsch "

ASARCO

Exploration Department
Western USA

July 19, 1989

Al Raihl
Tucson Office

MINING DEPT
JUL 20 1989
TUCSON

Purchase Orders
Santa Cruz Project

I do not need to see all those numerous purchase orders you are churning out. By copy of this memo I am asking Mr. Kreis to inform me of any he feels are not necessary, or are not within the "correct" price range.

W. L. Kurtz

WLK:mek

W. L. Kurtz

cc: R.L. Brown/F.T. Graybeal
H.G. Kreis
J.D. Sell

ch Pat Maley — Litter + ~~Medical~~ Trauma Kit

intercall

Call Mark

ASARCO

Southwestern Exploration Division

August 9, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
July 1989

During the month of July, drill hole T-3 was drilled from 220' to a total depth of 1873' where it was cased with fiberglass casing and cemented to the surface of the ground. Before the hole was fiberglass cased, the upper and lower copper oxide intercepts were subjected to pressure transient tests.

Drill hole T-3 intercepted 200' at 0.53% Cu from 1180' to 1380' and 240' at 1.14% Cu from 1560' to 1800'. The copper mineralization from 1180' to 1380' consisted of chrysocolla and atacamite in Precambrian granite, and the copper mineralization from 1560' to 1800' was atacamite with minor chrysocolla in Precambrian granite.

The drilling of hole T-1 commenced in mid July, and it was drilled to 1800' by the end of July. Copper oxide mineralization, chrysocolla and atacamite, was intercepted from 1240' to 1380' and from 1410' to 1460'. The high grade atacamite zone typically found between depths of 1550' and 1800' was absent in T-1. All the T-1 samples are at the assayor, and the results will be out in a few days.

Pressure transient tests were run in the open hole of T-1 from 1225' to 1391' and from 1507' to 1800'. A fluid flow profile (spinner logging tool) of the open hole from 1225' to 1800' is scheduled for early August. A TV camera will be run following the fluid flow profile.

Drill hole T-2 will be started immediately following the completion of T-1.

My activities during July are described in the attached July Monthly Report to A.R. Raihl.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz/J.D. Sell (w/o att.)
A.R. Raihl (w/o att.)

ASARCO

Southwestern Exploration Division

August 9, 1989

A.R. Raihl

Monthly Report
July 1989

During the month of July I looked after the completion of drill hole T-3, and the drilling of T-1 which will be completed in the month of August. Various activities included fishing for casing, abandoning air drilling below 1200', casing and cementing to surface, geophysical logging, directional surveys, caliper logs, pressure injection tests, collecting samples for assay, collecting metallurgical samples for the USBM, and jet drilling cement out of the fiberglass casing in T-3.

Other activities included running brunton-tape surveys of drill hole collars and underground electric wires, delivering samples to the assayor, looking after the test site and warehouse facilities, and making regular examinations of the geology of the rotary cuttings. Plans were made and a hand sampler was prepared to check the quality of the mud sampling equipment, and this will be done in drill hole T-2.

Tours of the drill core and test site were given to R.L. Brown, S. Anzalone, E. Romagnoli, T. Scartaccini, and R. Kupsch.

Several trips were made by me from Tucson to Casa Grande and one trip was made to Haliburton's office in Duncan, Oklahoma.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz/J.D. Sell

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 600
August 9, 1989
T-1 1000-1020 TO
T-1 1790-1800
PAGE 1 OF 3

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
AUG 11 1989
SW Exploration

Analysis of 68 Drill Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-1 1000-1020	<.01
2	T-1 1020-1040	<.01
3	T-1 1040-1060	<.01
4	T-1 1060-1080	.01
5	T-1 1080-1100	.01
6	T-1 1100-1120	.02
7	T-1 1120-1140	.02
8	T-1 1140-1160	.02
9	T-1 1160-1180	.03
10	T-1 1180-1200	.10
11	T-1 1200-1220	.15
12	T-1 1220-1230	.07
13	T-1 1230-1240	.06
14	T-1 1240-1250	.44
15	T-1 1250-1260	.65
16	T-1 1260-1270	.20
17	T-1 1270-1280	.25
18	T-1 1280-1290	.99
19	T-1 1290-1300	.60
20	T-1 1300-1310	.50
21	T-1 1310-1320	.60
22	T-1 1320-1330	.43
23	T-1 1330-1340	.26
24	T-1 1340-1350	.15
25	T-1 1350-1360 *	.00

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	Cu (%)
26	T-1 1360-1370	.36
27	T-1 1370-1380	.23
28	T-1 1380-1390	.18
29	T-1 1390-1400	.20
30	T-1 1400-1410	.16
31	T-1 1410-1420	.15
32	T-1 1420-1430	.73
33	T-1 1430-1440	.90
34	T-1 1440-1450	.83
35	T-1 1450-1460	.95
36	T-1 1460-1470	.26
37	T-1 1470-1480	.10
38	T-1 1480-1490	.24
39	T-1 1490-1500	.27
40	T-1 1500-1510	.09
41	T-1 1510-1520	.08
42	T-1 1520-1530	.07
43	T-1 1530-1540	.11
44	T-1 1540-1550	.06
45	T-1 1550-1560	.07
46	T-1 1560-1570	.35
47	T-1 1570-1580	.95
48	T-1 1580-1590	.33
49	T-1 1590-1600	.53
50	T-1 1600-1610	.14

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	Cu (%)
51	T-1 1610-1620	.10
52	T-1 1620-1630	.10
53	T-1 1630-1640	.07
54	T-1 1640-1650	.09
55	T-1 1650-1660	.05
56	T-1 1660-1670	.07
57	T-1 1670-1680	.06
58	T-1 1680-1690	.05
59	T-1 1690-1700	.06
60	T-1 1700-1710	.05
61	T-1 1710-1720	.07
62	T-1 1720-1730	.07
63	T-1 1730-1740	.08
64	T-1 1740-1750	.10
65	T-1 1750-1760	.20
66	T-1 1760-1770	.09
67	T-1 1770-1780	.08
68	T-1 1780-1790	.16
69	T-1 1790-1800	.05

*NOTE: Sample not received.

NOTE: ncCu analysis pending.

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA

8/9/89

ASARCO

Southwestern Exploration Division

August 9, 1989

FILES

Metallurgical Samples
Santa Cruz Deposit
Pinal County, Arizona

On July 24th 20,000# of metallurgical samples on 16 pallets arrived from Hanna Mining Co. in Nashwauk, Minn. All of this material is stored in the Sacaton mill building. Hanna will be reimbursed for the cost of packaging and shipping.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: R.L. Brown/F.T. Graybeal
W.L. Kurtz/J.D. Sell
A.R. Raihl
D.E. Crowell

JDS

ASARCO SANTA CRUZ INC.
P. O. Box 5747
Tucson, Arizona 85703
(602) 792-3010

August 9, 1989

FREEPORT-McMORAN GOLD CO.
P. O. Box 41330
Reno, Nevada 89504

Attention: G. R. Reinbold

SANTA CRUZ PROJECT

In accordance with the Santa Cruz Joint Venture dated July 1, 1977, we charge you as follows for July 1989:

Our E.A. No. 0075 - The Lands		
General Administrative Charges	$ 50.00	
Salaries	1,813.50	
Field Services & Supplies	571.51	
Employee Overhead	562.00	
Professional Services	4,833.63	7,830.64
Our E. A. No. 0087 -Peripheral Lands		
General Administrative Charges	50.00	
Legal Fees	142.08	192.08
Rent Income - Talla Lease	(10,500.00)	(10,500.00)
		(2,477.28)
1/2 to Freeport -McMoran		(1,238.64)
Balance brought forward		(37,257.66)
In Situ Leach Project July charges		20,280.98
Balance		$(18,215.32)

cc: Controller/Att: EJFranko
JDSell
PJorgensen - Freeport-McMoran
File

ASARCO Incorporated
AUG 11 1989
SW Exploration

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 601
August 11, 1989
T-1 (1800 TO 1360)
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
AUG 14 1989
SW Exploration

Analysis of 9 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-1 1800-1810	.26
2	T-1 1810-1820	.13
3	T-1 1820-1830	.37
4	T-1 1830-1840	.18
5	T-1 1840-1850	.13
6	T-1 1850-1860	.18
7	T-1 1860-1870	.31
8	T-1 1340-1350	.15
9	T-1 1350-1360	.20

cc: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
ARIZONA U.S.A.

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 600A
August 17, 1989
T-1 1000-1020 TO
T-1 1790-1800
PAGE 1 OF 2

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO INC.
AUG 17 1989
SW Exploration

Analysis of 25 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
14	T-1 1240-1250	.38
15	T-1 1250-1260	.64
16	T-1 1260-1270	.18
17	T-1 1270-1280	.22
18	T-1 1280-1290	.96
19	T-1 1290-1300	.56
20	T-1 1300-1310	.47
21	T-1 1310-1320	.55
22	T-1 1320-1330	.39
23	T-1 1330-1340	.23
26	T-1 1360-1370	.32
27	T-1 1370-1380	.19
29	T-1 1390-1400	.16
32	T-1 1420-1430	.69
33	T-1 1430-1440	.83
34	T-1 1440-1450	.73
35	T-1 1450-1460	.76
36	T-1 1460-1470	.20
38	T-1 1480-1490	.15
39	T-1 1490-1500	.15

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 600A
August 17, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
46	T-1 1560-1570	.20
47	T-1 1570-1580	.22
48	T-1 1580-1590	.18
49	T-1 1590-1600	.24
65	T-1 1750-1760	.16

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9427
CHARLES E.
THOMPSON
DATE SIGNED
Arizona U. S. A.

Charles E. Thompson 8/22/89

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 601A
August 17, 1989
T-1 (1800 TO 1360)
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

AUG 17 1989
SW Exploration

Analysis of 4 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
1	T-1 1800-1810	.20
3	T-1 1820-1830	.22
7	T-1 1860-1870	.29
9	T-1 1350-1360	.18

cc: Mr. J. D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9427
CHARLES E.
THOMPSON
DATE SIGNED
Arizona U. S. A.

Charles E. Thompson 8/17/89

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 603
August 22, 1989
T-2 (1000 TO 1640)

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

AUG 2 4 1989

Analysis of 53 Rotary Drill Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-2 1000-1020	.02
2	T-2 1020-1040	.02
3	T-2 1040-1060	.02
4	T-2 1060-1080	.04
5	T-2 1080-1100	.03
6	T-2 1100-1120	.03
7	T-2 1120-1140	.02
8	T-2 1140-1160	.03
9	T-2 1160-1180	.03
10	T-2 1180-1200	.03
11	T-2 1200-1220	.07
12	T-2 1220-1230	.15
13	T-2 1230-1240	.38 *
14	T-2 1240-1250	.28 *
15	T-2 1250-1260	.34 *
16	T-2 1260-1270	.46 *
17	T-2 1270-1280	.85 *
18	T-2 1280-1290	.34 *
19	T-2 1290-1300	.49 *
20	T-2 1300-1310	.25 *

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	Cu (%)
21	T-2 1310-1320	.40 *
22	T-2 1320-1330	.80 *
23	T-2 1330-1340	.36 *
24	T-2 1340-1350	.42 *
25	T-2 1350-1360	.30 *
26	T-2 1360-1370	.36 *
27	T-2 1370-1380	.54 *
28	T-2 1380-1390	.42 *
29	T-2 1390-1400	.52 *
30	T-2 1400-1410	.54 *
31	T-2 1410-1420	.24 *
32	T-2 1420-1430	.13
33	T-2 1430-1440	.81 *
34	T-2 1440-1450	1.47 *
35	T-2 1450-1460	.80 *
36	T-2 1460-1470	.38 *
37	T-2 1470-1480	.16
38	T-2 1480-1490	.16
39	T-2 1490-1500	.11
40	T-2 1500-1510	.09
41	T-2 1510-1520	.08
42	T-2 1520-1530	.09
43	T-2 1530-1540	.12
44	T-2 1540-1550	.11
45	T-2 1550-1560	.12

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 603
August 22, 1989

ITEM	SAMPLE NUMBER	Cu (%)
46	T-2 1560-1570	.17
47	T-2 1570-1580	.14
48	T-2 1580-1590	.11
49	T-2 1590-1600	.14
50	T-2 1600-1610	.15
51	T-2 1610-1620	.18
52	T-2 1620-1630	.32 *
53	T-2 1630-1640	.26 *

*NOTE: nsCu(%) analysis pending.

cc: Mr. A. R. Raihl
Mr. J. D. Sell

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
DATE SIGNED
Arizona U.S.A.

William L. Lehmbeck
Manager

ASARCO

Southwestern Exploration Division

September 7, 1989

A.R. Raihl

Monthly Report
August 1989

During the month of August I looked after the completion of T-1 and T-2. Various activities included a TV camera in T-1, a mini hydrofracture test and spot core in T-2, check samples of sampling equipment, the collection of bulk samples, pressure injection tests, fluid flow tests, various geophysical logs, and casing and cementing procedures.

Other activities included slight modifications of the solution injection-recovery plant, collecting samples for the USGS (gas studies), rerouting of telephone lines, the preparation of a plan map and cross sections, and temporarily shutting down all field activities.

Visitors included R. Schmidt and two others from the USBM, S. Swan, P. Robinson, S. Van Nort, Clark Arnold, and a number of subcontractors.

Several trips between Tucson and Casa Grande were made by me. The last week of August was spent on vacation.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell

JDS

ASARCO SANTA CRUZ INC.
P. O. Box 5747
Tucson, Arizona 85703
(602) 792-3010

September 8, 1989

FREEPORT-McMORAN GOLD CO.
P. O. Box 41330
Reno, Nevada 89504

Attention: G. R. Reinbold

SANTA CRUZ PROJECT

In accordance with the Santa Cruz Joint Venture dated July 1, 1977, we charge you as follows for August 1989:

Our E.A. No. 0075 - The Lands		
General Administrative Charges	$ 50.00	
Field Services & Supplies	370.70	
		420.70
Our E. A. No. 0087 -Peripheral Lands		
General Administrative Charges	50.00	
Legal Fees	400.29	
		450.29
		870.99

1/2 to Freeport -McMoran	435.49
Balance brought forward	(18,215.32)
In Situ Leach Project August charges	17,972.53
Balance due	$ 192.70

cc: Controller/Att: EJFranko
JDSell
PJorgensen - Freeport-McMoran
File

ARCO Incorp
SEP 15 1989
SW Exploration

ASARCO

Southwestern Exploration Division

September 11, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
August 1989

During August drill hole T-1 was drilled from 1800' to 1870' T.D., the bottom of the hole. Following the completion of T-1, drill hole T-2 was drilled, and it was bottomed at 1870' T.D. Following the completion of T-2, the drill rig was released; and all field activities were suspended. There will be no field activity during September while all the data acquired to date is being evaluated.

The significant copper oxide intercepts in T-1, T-2, and T-3 are summarized in the following table.

	Upper Chry.>Atacam. Zone				Lower Atacamite Zone			
Hole	From	To	Int.	% Cu	From	To	Int.	% Cu
T-1	1240'	1460'	220'	0.45	Not present			
T-2	1230'	1470'	240'	0.50	1670'	1750'	80'	2.90
					or 1670'	1780'	110'	2.27
T-3	1180'	1360'	180'	0.56	1560'	1790'	230'	1.17

Drill holes T-4 and T-5 are expected to be drilled later in the year.

My activities during August are described in the attached August monthly report to A.R. Raihl.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz (w/o att.)
J.D. Sell (w/o att.)
A.R. Raihl (w/o att.)

Sept 18, 1989 JRS

IN SITU COPPER MINING AT THE SANTA CRUZ DEPOSIT, CASA GRANDE, AZ: A COOPERATIVE RESEARCH PROJECT BETWEEN THE SANTA CRUZ JOINT VENTURE AND THE UNITED STATES BUREAU OF MINES

By Frederick T. Graybeal[1] and William C. Larson[2]

ABSTRACT

The U.S. Bureau of Mines has started a production-scale, in situ mining field research project in cooperation with the Santa Cruz Joint Venture, which is 50 percent-owned by ASARCO Santa Cruz, Inc., a subsidiary of ASARCO Incorporated and 50 percent by Freeport Copper Co., a subsidiary of Freeport-McMoran Gold Co. This research is being conducted at the Santa Cruz Project, located 7 miles west of Casa Grande, Arizona. Santa Cruz is a large oxidized porphyry copper deposit, concealed beneath post-mineral alluvium at depths of 1,500-3,000 ft. The research objective is to evaluate in situ mining as a method for extracting copper from a previously unmined copper oxide deposit. Funding is provided through a cost-sharing program with the Bureau of Mines contributing 75 percent and the Santa Cruz Joint Venture 25 percent over the life of the project.

Important project milestones reached to date include site selection, well field orientation, and demonstration that significant amounts of water can be injected into the mineralized zone at pressures below the threshold for hydraulic fracturing. Current work will characterize the hydrologic regime and gather flow data from communication tests to support an application for an environmental permit to inject a dilute acid solution. Future steps will involve completion of a 5-spot well pattern, construction of a small solvent extraction-electrowinning plant, 12-18 month operation of the well field, and final technical and economic evaluation. The research activities are scheduled for a 5-year life subject to permitting and funding. All data gathered from the project will be published by the Bureau of Mines.

[1]Chief Geologist, ASARCO Incorporated, New York, NY
[2]Research Supervisor, Twin Cities Research Center, Bureau of Mines, Minneapolis, MN

INTRODUCTION

Santa Cruz is a typical porphyry copper deposit located 7 miles west of Casa Grande, Arizona as shown on Figure 1. The project site is owned by the Santa Cruz Joint Venture (SCJV) which is 50 percent controlled by ASARCO Santa Cruz, Inc., a wholly-owned subsidiary of ASARCO Incorporated and 50 percent by Freeport Copper Co., a wholly-owned subsidiary of Freeport-McMoRan Gold Co.

Mineralization was first discovered in the Santa Cruz area by ASARCO in 1964. Drilling was terminated in 1965 when it appeared that a preexisting chalcocite blanket had been destroyed by erosion and oxidation. Property was re-acquired in 1974 by the SCJV and by 1981 a large zone of oxidized copper mineralization had been located. In 1988 the deposit was selected by the U.S. Bureau of Mines as the site of a field research test for in situ copper mining. Also in 1988 the SCJV purchased the adjacent Casa Grande West mineralization from a Texaco-Hanna joint venture. This mineralization is not part of the in situ mining field test, although it and the original Santa Cruz zone are part of a single continuous zone of copper mineralization.

GEOLOGY OF THE SANTA CRUZ COPPER DEPOSIT

The Santa Cruz porphyry copper deposit is entirely concealed beneath 600-3,000 ft. of post-mineral unconsolidated alluvial cover, also termed basin-fill deposits, and as a result all information has been derived from diamond drill core. Host rocks for the mineralization are Precambrian granite (80%) and various intrusive Laramide quartz monzonite and granodiorite porphyries (20%) which cut the granite as dikes and irregular masses.

Structure in the oxide copper zone is characterized by numerous faults and strong fracturing. Detailed logging of unsplit diamond drill core indicates an average fracture density of 5 broken fractures per foot of core. Structural interpretations suggest an originally immense porphyry copper system, including the Sacaton mine which is located 5 miles to the northeast, was broken into isolated blocks by landslide or gravity faulting with some blocks moving laterally over distances of several miles from their original position. Later block faulting with vertical offsets of several thousand feet and tilting of 10-30 degrees further complicate the picture.

Hypogene alteration and mineralization are typical of Arizona porphyry copper deposits in that chalcopyrite associated with orthoclase-biotite alteration grades outward into pyrite associated with quartz-sericite alteration.

Alteration of plagioclase ~~to~~ or orthoclase ~~or~~ to sericite alteration is 30-100% complete throughout the deposit. Exposure of the hypogene mineralization to weathering developed an enrichment blanket beneath 100-700 ft. of leached capping in which chalcocite replaced preexisting pyrite and chalcopyrite. Continued oxidation of a portion of the chalcocite blanket in the absence of sufficient acid-generating sulfide to dissolve the copper formed what is now considered to be the largest known oxide copper zone associated with a porphyry copper deposit in the world. Within this zone 35% of the copper is contained in chrysocolla [$CuSiO_3$ $2H_2O$], 45% in atacamite [$Cu_2(OH)_3Cl$], and 20% in remnant zones of chalcocite and cuprite.

Chrysocolla occurs along fractures where it may form veins to 1/2 inch thick and includes copper-rich material formed by adsorbtion of copper on clays, particularly altered plagioclase phenocrysts. Atacamite occurs as a stockwork-like web of thin veins in which grades often exceed 3% Cu over 10 ft. intervals. Oxide mineralization is normally dominated by either chrysocolla or atacamite; it is rare for similar amounts of both minerals to be present in the same zone.

A review of drill data from the northern portion of the deposit indicated the presence of roughly 800 million tons of oxide mineralization averaging 0.43% Cu with an internal higher grade zone containing 89 million tons averaging 0.78% Cu all at depths exceeding 1,500 ft. At foreseeable copper prices it was clear that mineralization in this area was too deep for open pit mining and too low grade for underground mining. However, several characteristics including:

1) pervasive oxidation of the deposit and abundance of atacamite, a highly soluble copper chloride mineral

2) pervasive and strong fracturing of the deposit in which all copper oxide minerals now occur at an average distance of 2 inches from a broken fracture,

3) unusually thick columns of the oxide mineralization,

4) relatively non-reactive (to sulfuric acid) mineralogy of the host rocks,

5) saturation of the deposit with no previous mining activity, and

6) separation of the deposit from near-surface basin-fill deposits aquifers beneath 50-1,000 ft. of indurated volcanic rocks and conglomerate and an additional 100-700 ft. of leached capping

indicated the deposit might respond to in situ mining.

IN SITU MINING

In situ mining involves pumping a dilute acid solution down wells, injecting the solution into an ore zone where copper is dissolved, and pumping the solution up adjacent recovery wells to the surface where copper is recovered in a solvent extraction/electrowinning (SXEW) plant (Fig. 2). Potential advantages of in situ as compared to conventional mining are that capital costs of an in situ plant are significantly lower per unit of metal produced and there are no pits, dumps, or tailings. In situ mining, where metal is selectively dissolved, is different from solution mining where wholesale dissolution of the rock occurs. True in situ mining takes advantage of the natural permeability and undisturbed rock fracture patterns in an ore body to control the direction of fluid flow. This differs from leaching of the collapsed rubble above block cave mines which, although often referred to as in situ, is a modified heap leach process.

The possibility of in situ mining of copper has been under consideration for several decades. Particularly notable field research tests were conducted in the 1970's by Kennecott on copper sulfides at the Safford deposit and in the 1980's by Occidental on copper oxides at the Van Dyke deposit and Noranda Lakeshore on copper oxides from underground mine workings at the Lakeshore mine (now owned by Cyprus) all in Arizona. Termination of the Safford and Van Dyke tests had been due largely to non-technical reasons and majority of the research results were never made public. Testing by Cyprus is continuing and has been restarted at Van Dyke.

In situ mining of copper from undisturbed deposits has not been attempted on a commercial scale, although some field work has been done which indicates the process is technically feasible. Commercial development of the technology is limited by a lack of reliable operating cost data on which financial outcome studies would be based.

Technology currently used for true in situ mining of uranium is not easily transferred because of major differences in the geologic characteristics of porphyry copper and sandstone-hosted uranium deposits.

Outcome estimates suggest that operating costs of roughly $0.40/lb. Cu recovered might be achieved in an in situ mine using the following assumptions:

average well depth - 2,136 ft.
average leach interval - 345 ft.
50 percent recovery of copper ore averaging 0.72% Cu
160 ft. well spacing for 26 5-spot patterns
3 year well life, 15 year mine life
40 gallon/min. well flow rate
10 gm/liter copper solution loading
3.5 lb. H_2SO_4 consumption/lb. Cu recovered

A mine of this size would produce 23,600 tons of electrowon copper per year. The major unproven assumptions are copper recovery, well flow rate, and solution loading.

THE COOPERATIVE AGREEMENT

There are 15-20 large oxidized copper deposits in the western United States which might respond to in situ mining, all of which were known prior to 1980. In addition, the Bureau of Mines had compiled an extensive bibliography of in situ literature including their in-house research (In Situ., 1986, v.10, n.3, p.277-311). However, low copper prices, high levels of debt, and ongoing cost-cutting at existing operations in the copper industry over most of this decade left no funds for discretionary research on new mining techniques. Although modest in-house field and feasibility studies on in situ mining had been conducted by Asarco since 1970, the need for production scale data was clear. Discussions of the frontier nature of an in situ field research test designed to benefit the entire copper industry had sufficient appeal to generate rapid response and strong support from the Bureau of Mines and from within the Arizona congressional delegation.

The current research initiative was made possible by federal appropriations won through the leadership of Senator Dennis DeConcini (D-Arizona). Initial funding for fiscal year 1987 supported a modest field test program to measure rock permeability in exploration holes, laboratory leach tests at the Bureau of Mines Twin Cities Research

Center on ore samples from several copper deposits, and pro forma design feasibilities of various in situ mining configurations all of which were compiled in a Draft Generic In Situ Copper Mine Design Manual (Contract No. J0267001) published in April 1988 by the Bureau. The combined information was then used to select the Santa Cruz copper deposit as the most suitable of available candidates for a production-scale field research test of in situ mining. Among the principal technical criteria in the selection were absence of mining and saturation of the deposit.

In September 1988 a cooperative cost-sharing agreement to begin the field test was signed by the Bureau of Mines and the Santa Cruz Joint Venture. Under the agreement 75 percent of the cost is contributed by the Bureau of Mines and 25 percent by the Santa Cruz Joint Venture over the life of the project. ASARCO Santa Cruz, Inc. is manager of the SCJV and is also prime contractor to the Bureau for the field test. The research objective is to evaluate in situ mining as a method for extracting copper from a previously un-mined copper deposit with emphasis on permitting and operating costs derived from production-scale well field equipment and a pilot scale surface plant. Research activities are scheduled for a 5-year life subject to permitting and funding. All data gathered from the field test will be published by the Bureau of Mines. A recent review of Bureau research is contained in U.S. Bureau of Mines Information Circular 9216.

THE FIELD TEST

The field test has been scheduled and budgeted into 5 annual phases as shown on Table 1. The schedules shown on Table 1 are approximate as experience to date indicates it is difficult to coordinate federal fiscal year budgets which start October 1 and which cannot be accurately predicted in advance, with industry budgets which generally follow the calendar year and can vary with metal prices, with contractor availability, with the Arizona Department of Environmental Quality permitting process for in situ mining which has not yet been established, or with presently unknown gaps in the in situ learning curve which give the technical flow of project activity a speed of its own.

The current field test design has followed the Draft Generic In Situ Test Design Manual with modifications to accommodate site-specific characteristics of the Santa Cruz deposit and to minimize expenditures. The site chosen for the test is located at the collar of exploration hole SC-19 (see Fig. 3), which cut a 1297 ft. intersection of 0.62% Cu starting at a depth of 1193 ft. including an internal 150 ft. of 2.98% Cu starting at 1620 ft. The mineralization is zoned with chrysocolla dominant in the upper portion of the intersection and atacamite dominant in the lower portion. This hole was largely in Precambrian granite which visually appears more fractured and might be more permeable than the intrusive porphyries. The granite also contains less plagiolase feldspar than the porphyries, thus, reducing the likelihood that troublesome Na and Ca salts might form. The possibility that the porphyry is present as swarms of tabular dikes which might act as permeability barriers or short circuits was also considered.

Orientation of the well site was based on indirect data with the primary emphasis being to avoid siting of an injection-to-recovery well flow net on a single high-permeability channel which would serve to short circuit flow through a small volume of rock. It was known that Laramide-age mineralized fractures in Arizona show a peak concentration at N75° E $\pm$ 20°. Oriented core from hole C-1 (Fig. 3) show that principal joint sets strike N66°E and N20°E with a lesser set containing oxide copper minerals striking N16°W. Further, the overall trend of the zone of the mineralization in this area was N10-20°E. The orientation of the site was therefore established with the injection- recovery well bearing at N45°E roughly bisecting the two known or assumed principle directional controls on mineralization.

The well pattern is shown on Figure 3. The injection well (T-3) is at the center of the 5-spot pattern surrounded by 4 recovery wells; all are planned to bottom about 1,850 ft. depth. Diamond drill holes SC-19 and C-2 will be used both to determine grade in the injection-recovery flow net and for post-leach coring to study mineralogical changes, assuming the project gets that far. HC-1 is a hydrologic characterization hole. SM-1 is a groundwater quality monitoring hole; three other monitor holes will also be drilled, 1 east of and 2 west of the double connected 5-spot site.

Each test well has 29 feet of steel conductor casing set at the surface, inside of which is an intermediate steel casing set into bedrock at about 1200 ft. and cemented with cement resistant to dilute sulfuric acid solutions. The hole is then rotary drilled, using a polymer-based mud to reduce permeability damage, through the upper chrysocolla mineralization followed by a water injection and pressure transient test, then continued through the lower atacamite zone followed by another injection test. Cuttings from bedrock are assayed. The hole is then cased with fiberglass reinforced plastic casing and cemented to the surface with the acid resistant cement. Various geophysical logs are run before and after casing to obtain information on rock characteristics and cement bonding and the first logs are still being analyzed. To date holes T-1, 2 and 3 have been drilled, subjected to injection tests, and cased. The bottoms of all wells are within one horizontal foot of the collar.

Initial results of the injection tests completed this August have been encouraging. Flow rates of 13 gallons/minute normalized to a vertical interval of 250 ft. were achieved in the atacamite zone at pressure gradients of less than 0.75 psi/ft. which is believed to be a minimum threshold for hydrofracturing. Results to date suggest that permeability may increase with pressure below the hydrofracture threshold and that flow rates in the atacamite zone are about one-half of rates observed in the chrysocolla zone. During injection tests in T-1 and T-2 water levels in both SC-19 and C-2 rose in an inverse proportion to distance to the test well, indicating that there are no serious short circuits in either flow net. There was no response in SM-1. At this moment field activities have been stopped for one month to allow time to interpret data.

Results appear to justify continuation of the project which will involve perforating the fiberglass casing in the atacamite zone and running an interference test in the 3 test wells. These data will be used to complete the 5-spot pattern with modifications if necessary. It now appears likely that short-radius (8-10 ft.) borehole stimulation will be required. Once the single 5-spot pattern has been completed a saline solution tracer test will be run to evaluate flow between the injection and recovery wells over an extended period of time, possibly several months. The tracer test will be monitored to insure there is no communication between the 5-spot well system and the overlying basin-fill deposits aquifer. If the tracer test demonstrates that adequate flow can be established and that

flow direction can be controlled to the extent there is no hydrologic connection between the ore zone and the aquifer, an application will be prepared and submitted to the Arizona Department of Environmental Quality for a permit to inject a dilute acid leach solution. If the permit is granted, and subject to funding, the project will continue as outlined on Table 1 with the construction of a pilot-scale SXEW plant capable of treating up to 50 gallons/minute and operation of the well pattern to recover copper. Electrowon copper will be owned by the SCJV.

Other ongoing project activities include meetings with local citizen and industry groups in Casa Grande, Arizona on technical and environmental subjects, core leach research by the Bureau of Mines at the Twin Cities Research Center, and support for federal funding initiatives.

PRINCIPAL OBJECTIVES

The 2 principal objectives of the project are 1) to demonstrate that an in situ research test can be operated in an environmentally acceptable manner so it can be permitted in Arizona, and 2) to operate an in situ well pattern long enough to develop information on operating costs.

The SCJV will assume the role as permittee for application and approval of environmental permits. All test wells fall in the Class V designation under current U.S. Environmental Protection Agency regulations because of the experimental nature of the project. Wells will be constructed to meet the more rigorous Class III specifications established for production wells in commercial operations. The most comprehensive permitting requirements for the research test will involve an Aquifer Protection Permit which is issued by the Arizona Department of Environmental Quality. The SCJV will not apply for this permit until it can be demonstrated that there will be no substantial impact on the basin-fill deposits aquifer.

Isolation of the test zone from the overlying basin-fill sediments aquifer has always been a principal consideration in the test. Because of the close spacing of the holes relative to the depth of the copper mineralization, various block diagrams and cross sections have distorted scales to present all information legibly. This distortion, although noted on the diagrams, gives the false appearance to some that the copper zones were close to the aquifer. Figure 4 is introduced here to provide a true

scale perspective of the test site. Figure 4 shows clearly that the distance from the injection well (T-3) to the recovery wells (T-2 and 5) in both copper zones is a small fraction of the distance from the injection zone to the overlying aquifer. This close spacing of wells in addition to information that injected fluids in settings such as this move horizontally and planned installation of a pump in the recovery well which will induce a flow of water toward the recovery well all suggest that a lack of communication between the copper zones and the aquifer can be demonstrated and maintained.

The permitting approach will involve certain important considerations including 1) the copper deposit has limited capacity to yield water due to permeability which is several orders of magnitude less than the overlying basin-fill deposits, and 2) point of compliance will be the monitor wells which will monitor groundwater quality at the base of the basin-fill deposits aquifer and down gradient from the test site. This will be the first attempt to obtain an Aquifer Protection Permit for a true in situ copper mining research project in Arizona. All data gathering and permitting costs are part of the Cooperative Agreement.

Operating costs are the primary unknown in an in situ copper mining feasibility study. Costs to drill, log and complete wells, and to build and operate pumps and SXEW plants are well known. However, the total operating cost per pound of copper recovered from an in situ mine is unknown. Among the important components of the operating cost are rock permeability (gallons per minute pumped in to the rock), communication between holes, sweep efficiency (how much of the leach block is leached), solution loading, percent recovery of copper, and extent to which the leaching process alters the rock permeability during the leach cycle. It is likely these factors will vary from hole to hole and the extent of that variation must also be known.

CONCLUSIONS

It must be remembered that this is a research project and there is no guarantee it will succeed. Even if the test has a successful conclusion in situ mines are unlikely to produce significant amounts of refined copper until well into the 21st century. In situ does have potential for significant metal production at low capital investment and low operating cost along with substantially reduced impact

on the environment. The latter will become an increasingly important consideration as the growing need for minerals confronts a rising public concern about the environmental impacts of resource extraction. In situ mining is not without environmental impact, but the physical and chemical procedures proposed to mine oxide copper are very similar to the natural process which leached and transported copper in the Santa Cruz deposit some 30 million years ago and the technology, therefore, may come to be seen as quite compatible with the environment. If in situ mining ultimately becomes a viable alternative to conventional mining of buried deposits, exploration for deposits now considered too deep or otherwise unattractive will be justified.

ACKNOWLEDGEMENT

We acknowledge particular commitment to the project by Steve Swan, Jon Ahlness, Linda Dahl, and Dan Millenacker of the Twin Cities Research Center, U.S. Bureau of Mines, Al Raihl and Hank Kreis of ASARCO Incorporated, Charlie Barter of Errol L. Montgomery and Associates, Inc. and Don Davidson of SAIC who all offered constructive reviews of this paper.

Presented Sept. 18, 1989 at the
American Mining Congress Convention
in San Francisco

TABLE 1. Schedule of Activities - Santa Cruz In Situ Test

Phase 1.	Geologic and hydrogeologic characterization holes Three test wells, open hole injection tests; one monitor well
Phase 2.	Two additional test wells to complete 5-spot Cased hole injection, transient, interference tests Three groundwater monitor wells Tracer test Apply for Aquifer Protection Permit
Phase 3.	Obtain permits Construct SXEW plant Plug exploration holes Purchase field equipment
Phase 4.	Operate well pattern
Phase 5.	Decommission site Interpret and publish data.

SANTA CRUZ IN-SITU COPPER MINING PROJECT

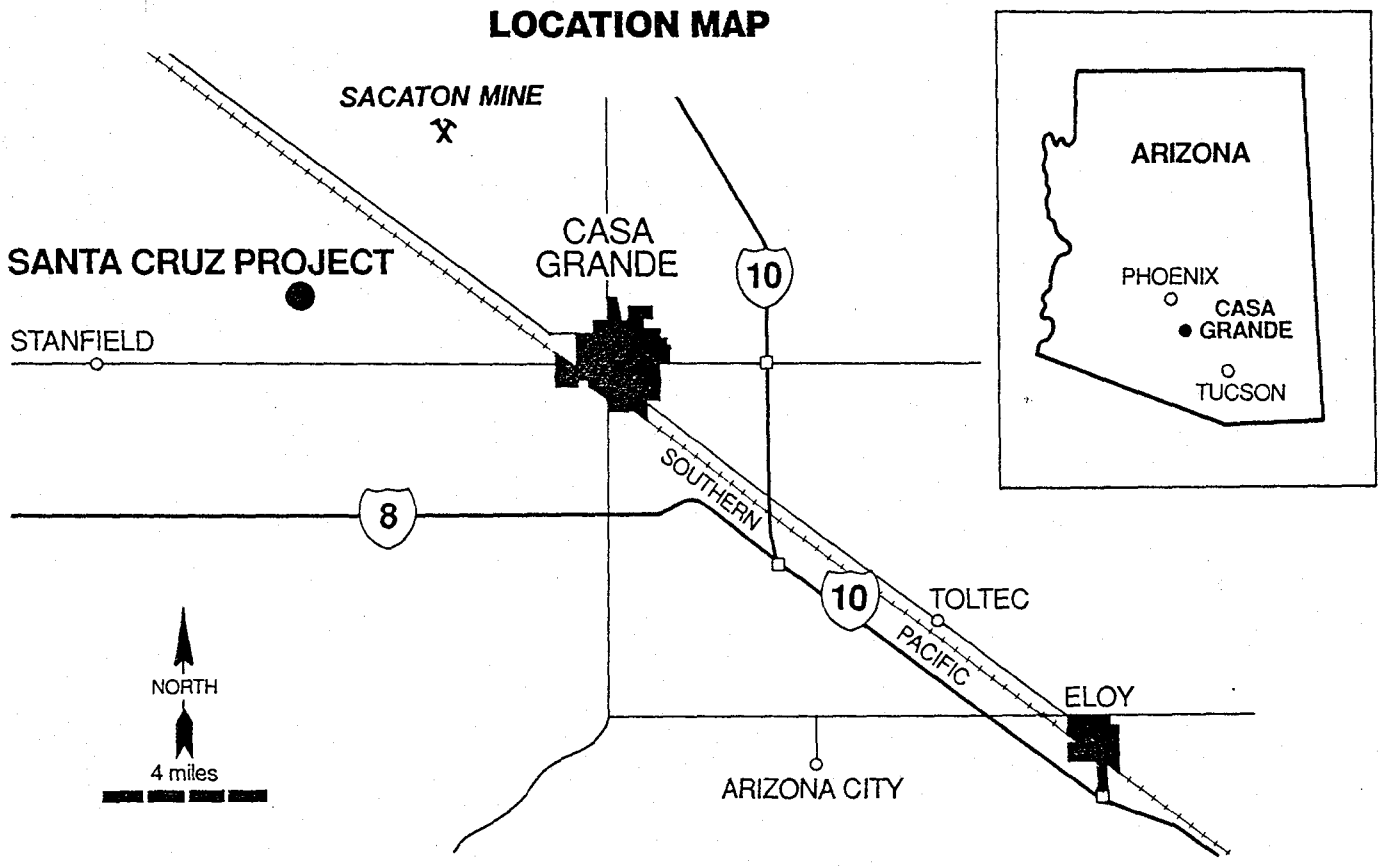


FIGURE 1

IN-SITU MINING OPERATION

Description of process:

① Dilute acid solution is pumped down an injection well to the copper deposit.

② Solution is injected into the copper deposit where copper is dissolved and solution is drawn to a recovery well.

③ Solution is pumped from deposit to the surface.

④ Copper is removed from solution in a surface plant and solution is circulated back to the injection well.

Blue arrows show direction of movement of solution.

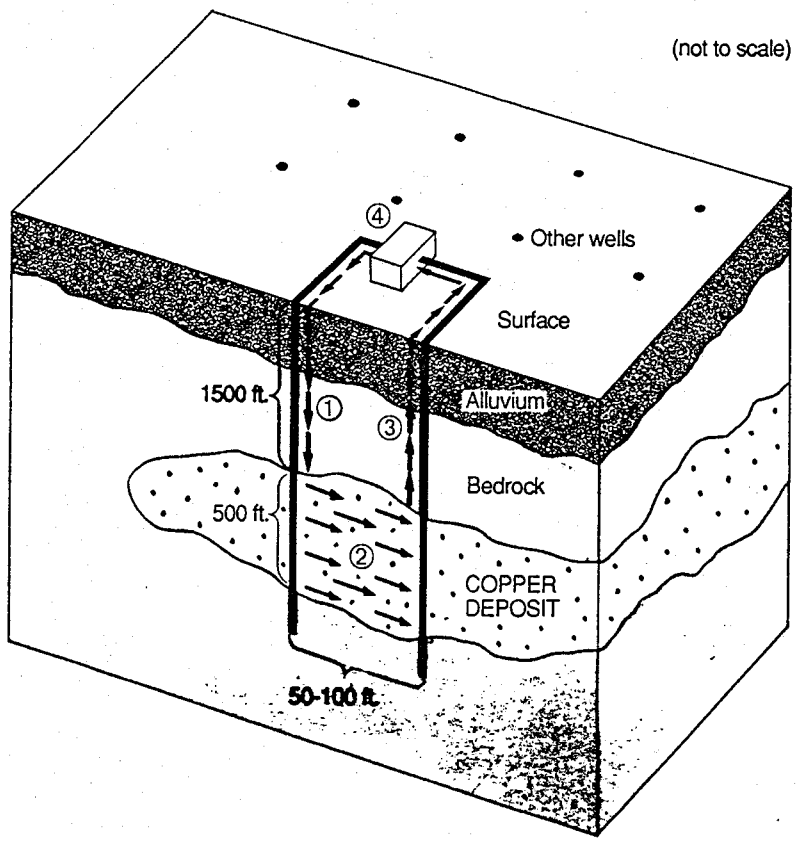


FIGURE 2

SANTA CRUZ IN SITU TEST SITE

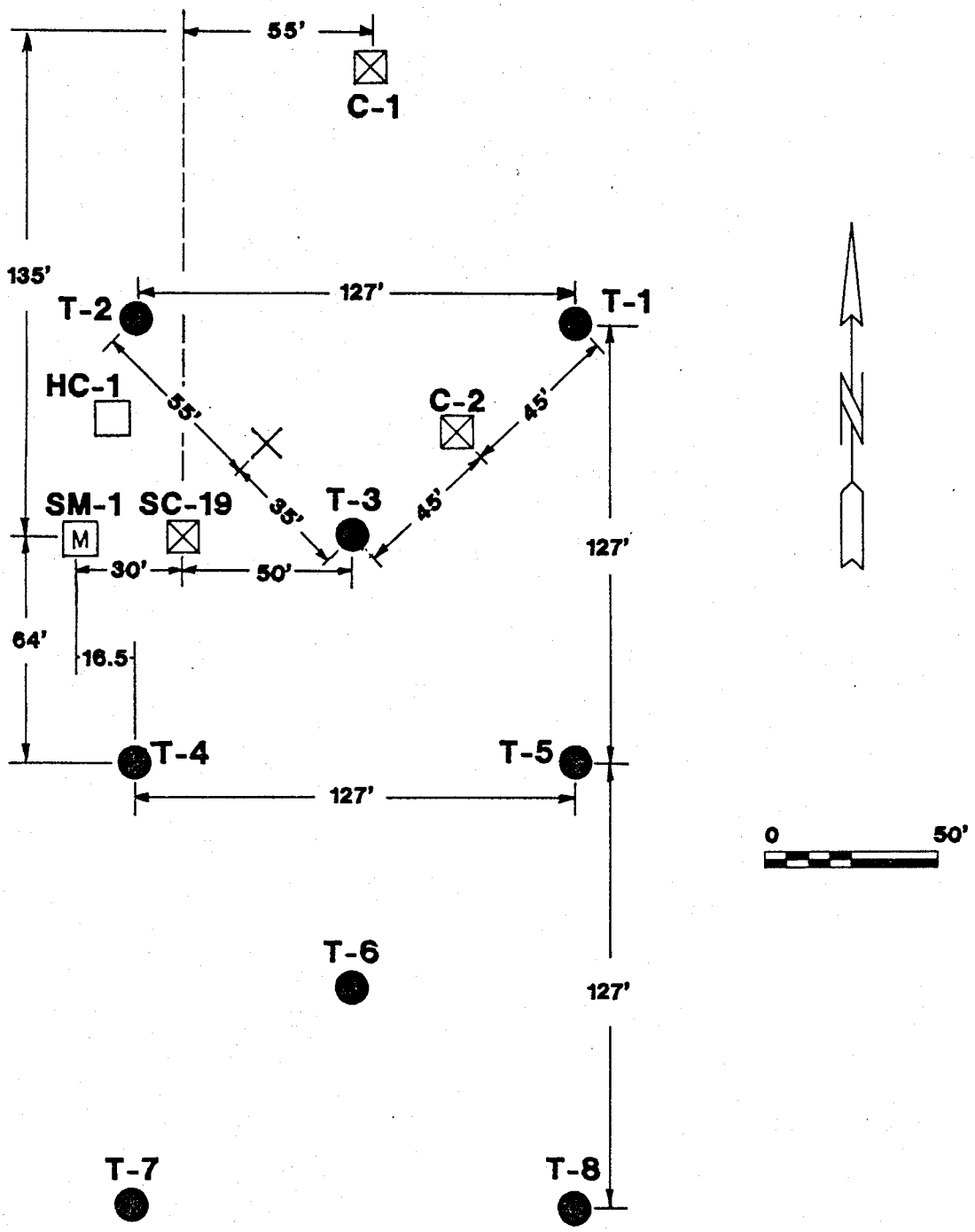
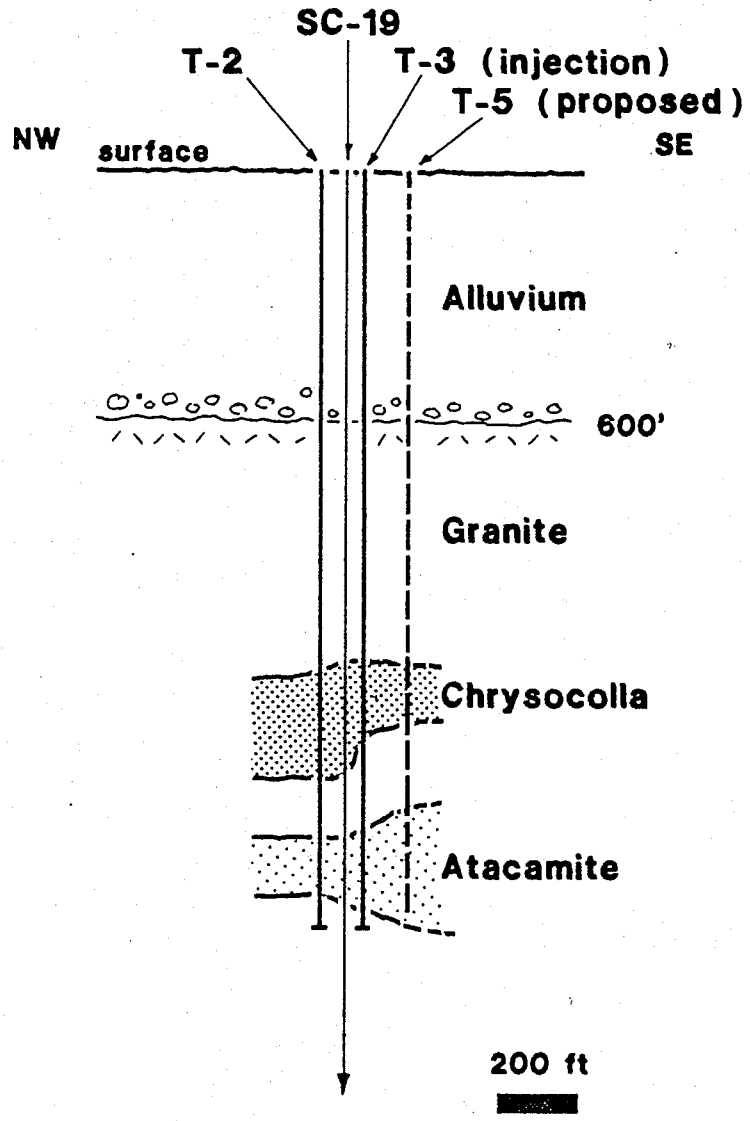


FIGURE 3

- Test wells
- M Monitor well
- Hydrologic test well
- Existing core holes
- Location of SC-19 atacamite at 1700' depth



TRUE SCALE CROSS SECTION
SANTA CRUZ IN SITU TEST SITE
(looking N 45° E)

FIGURE 4

9108

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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 606A
September 19, 1989
T-2 1760-1770 TO
T-2 1860-1870
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. Henry G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 2 Pulp Samples

SEP 21 1989

ITEM	SAMPLE NUMBER	nsCu (%)
1	T-2 1760-1770	.45
2	T-2 1770-1780	.44

cc: Asarco Incorporated
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703
Attn.: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
Arizona U.S.A.
9/20/89

ASARCO Southwestern Exploration Division

JDS

October 6, 1989

J.D. Sell

Quarterly Report
Third Quarter 1989
H.G. Kreis

Santa Cruz In Situ Project - EA-0438 - Copper

Sixty five days were spent on drilling and doing test work in T-1, T-2, T-3, and SM-2. During the fourth quarter T-4, T-5, SM-3, and SM-4 will be drilled.

Santa Cruz Project - EA-0075 - Copper

One and one-half days were spent on Santa Cruz land, etc.

Miscellaneous

Five days of vacation were taken.

H. G. Kreis

HGK:mek

H. G. Kreis

ASARCO

Southwestern Exploration Division

October 6, 1989

A.R. Raihl

Monthly Report
September 1989

In September, my activities included issuing copies of the geologic logs for T-1, T-2, and T-3; preparing a geology and drill report on C-2; evaluating the sampling procedure used during mud rotary drilling; designing and fabricating new sampling equipment; choosing an interval to perforate in T-1; supplying geologic information to SAIC to help them interpret the geophysical logs; compiling drill hole deviation information; helping to solve water source problems and paying for water used; locating drill sites in the field; resolving surveying problems; and overseeing the drilling of SM-2.

Visitors to the site included about forty members of the Arizona Hydrological Society.

Several trips between Tucson and Casa Grande were made by me.

H.G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

October 6, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
September 1989

Drilling on the Santa Cruz Project was resumed in late September with the collaring of SM-2, a monitor well. SM-2 was bottomed at 650', and perforated casing was installed.

In October monitor wells SM-3 and SM-4 will be drilled and cased. Upon their completion, recovery wells T-4 and T-5 will be drilled and cased.

In mid October the fiber glass casing in T-1 will be perforated in order to collect a ground water sample from the elevation of the high grade atacamite.

Talks on the geology and hydrology of the in situ site and, also, a tour to the site were given to the Arizona Hydrologic Society by C. Barter and H. Kreis.

My activities during September are described in the attached September monthly report to A.R. Raihl.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz (w/o att.)
J.D. Sell (w/o att.)
A.R. Raihl (w/o att.)

11-1-1989

TO: W.L.K / J.D.S.

FROM: H.G. KREIS

TOTAL OF 3 PAGES, INCLUDING THIS PAGE

To: F. T. GRAYBEAL, NYO

FROM: H. G. KREIS, SANTA CRUZ FIELD OFFICE

Nov. 1, 1989

Fred,

Here the results of T-4. The thicknesses and grades on the attached figure are all visual estimates.

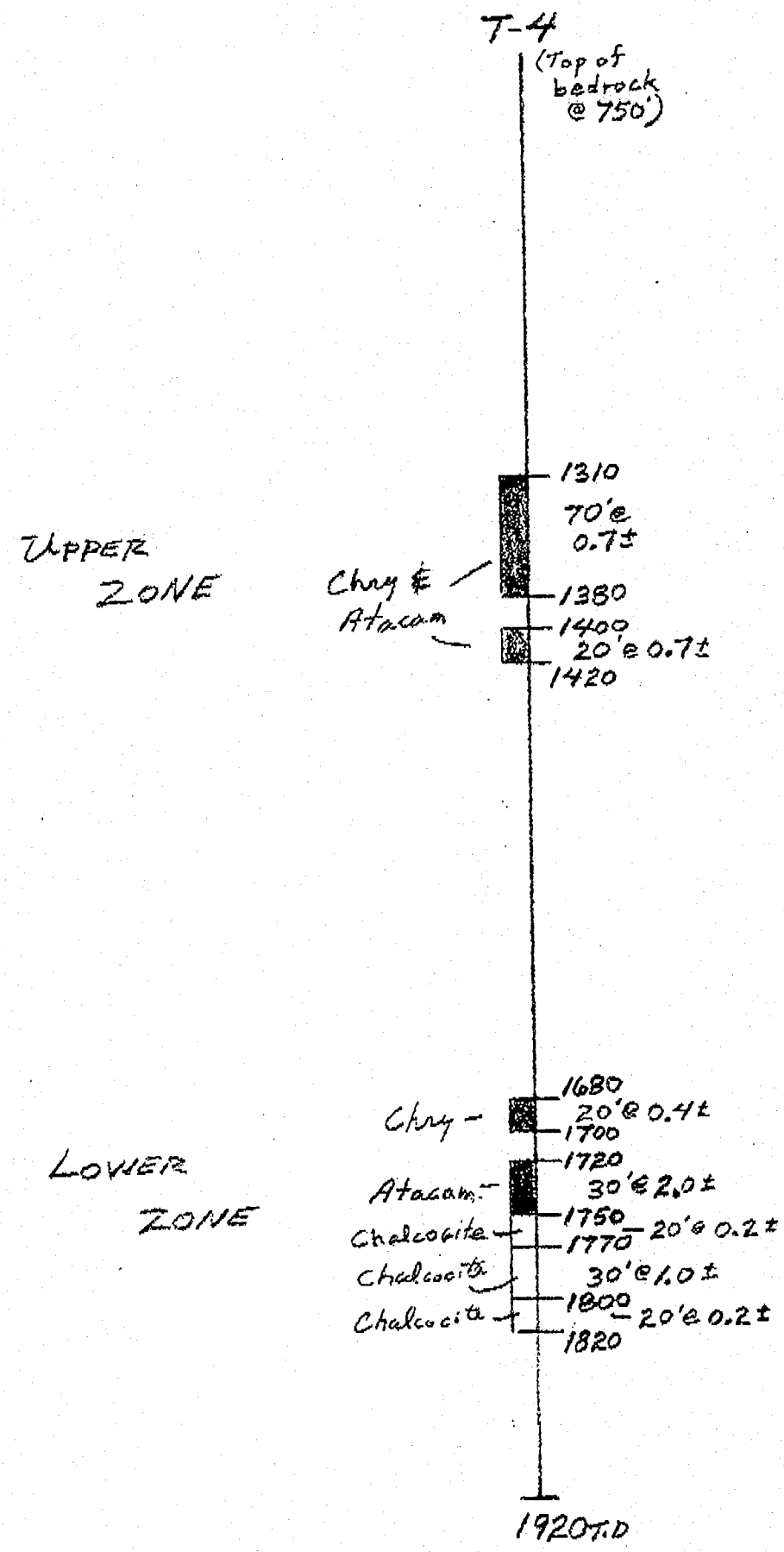
If you have any questions call me at 602-836-6249.

Drill hole T-5 will be started Nov. 3 or 4th and will finish about Nov. 21st.

Hank

Copy: W.L.K / J.D.S

To: F.T.G.
From: HGK



ESTIMATED
COPPER INTERCEPTS
T-4
H.G.K. 11-1-89
1" = 100'

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Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 613
November 8, 1989
T-4 1210-1220
TO T-4 1790-1800

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporated
NOV 9 1989
SW Exploration

Analysis of 59 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Weight (lbs)	Cu (%)
1	T-4 1210-1220		.06
2	T-4 1220-1230		.06
3	T-4 1230-1240		.09
4	T-4 1240-1250		.12
5	T-4 1250-1260		.17
6	T-4 1260-1270		.36
7	T-4 1270-1280		.27
8	T-4 1280-1290		.19
9	T-4 1290-1300		.22
10	T-4 1300-1310		.39
11	T-4 1310-1320		.57
12	T-4 1320-1330		.72
13	T-4 1330-1340		.79
14	T-4 1340-1350		1.80
15	T-4 1350-1360		.97
16	T-4 1360-1370		.81
17	T-4 1370-1380		.43
18	T-4 1380-1390		.31
19	T-4 1390-1400		.17
20	T-4 1400-1410		.37
21	T-4 1410-1420		1.65
22	T-4 1420-1430		2.08
23	T-4 1430-1440		.42
24	T-4 1440-1450		.24
25	T-4 1450-1460		.19

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Tucson, Arizona 85703
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ITEM	SAMPLE NUMBER	Weight (lbs)	Cu (%)
26	T-4 1460-1470		.16
27	T-4 1470-1480		.15
28	T-4 1480-1490		.12
29	T-4 1490-1500		.13
30	T-4 1500-1510		.15
31	T-4 1510-1520		.11
32	T-4 1520-1530		.11
33	T-4 1530-1540		.09
34	T-4 1540-1550		.13
35	T-4 1550-1560		.11
36	T-4 1560-1570		.33
37	T-4 1570-1580		.13
38	T-4 1580-1590		.13
39	T-4 1590-1600		.13
40	T-4 1600-1610		.14
41	T-4 1610-1620		.15
42	T-4 1620-1630		.13
43	T-4 1630-1640		.12
44	T-4 1640-1650		.15
45	T-4 1650-1660		.11
46	T-4 1660-1670		.11
47	T-4 1670-1680		.38
48	T-4 1680-1690		.44
49	T-4 1690-1700		.21
50	T-4 1700-1710	44.	.45

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1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 613
November 8, 1989

ITEM	SAMPLE NUMBER	Weight (lbs)	Cu (%)
51	T-4 1710-1720	40.	.63
52	T-4 1720-1730	37.	2.41
53	T-4 1730-1740	36.	6.45
54	T-4 1740-1750	17.	1.47
55	T-4 1750-1760	54.	.72
56	T-4 1760-1770	36.	1.60
57	T-4 1770-1780	36.	.73
58	T-4 1780-1790	41.	1.27
59	T-4 1790-1800	32.	1.29

cc: Mr. J.D. Sell

cc: Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK

William L. Lehmbeck
Manager

9108

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 616
November 14, 1989
T-4 1330-1340 S.W. TO
T-4 1910-1920
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO Incorporate
NOV 16 1989
SW Exploration

Analysis of 16 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)	Weight (lbs)
1	T-4 1330-1340 S.W.	.78	54.
2	T-4 1340-1350 S.W.	2.08	41.
3	T-4 1360-1370 S.W.	.79	60.
4	T-4 1730-1740 S.W.	6.40	55.
5	T-4 1800-1810	.68	
6	T-4 1810-1820	.32	
7	T-4 1820-1830	.16	
8	T-4 1830-1840	.13	
9	T-4 1840-1850	.11	
10	T-4 1850-1860	.17	
11	T-4 1860-1870	.21	
12	T-4 1870-1880	.30	
13	T-4 1880-1890	.13	
14	T-4 1890-1900	.14	
15	T-4 1900-1910	.11	
16	T-4 1910-1920	.10	

NOTE: nsCU values to follow as TAJ616-A.

cc: Mr. J.D. Sell

cc: Mr. A.R. Raihl

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK
11/14/89

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 613A
November 20, 1989
T-4 1210-1220
TO T-4 1790-1800

ASARCO Incorporate

NOV 2 2 1989

SW Exploration

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 31 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
6	T-4 1260-1270	.32
7	T-4 1270-1280	.23
9	T-4 1290-1300	.19
10	T-4 1300-1310	.36
11	T-4 1310-1320	.56
12	T-4 1320-1330	.70
13	T-4 1330-1340	.74
14	T-4 1340-1350	1.71
15	T-4 1350-1360	.93
16	T-4 1360-1370	.74
17	T-4 1370-1380	.40
18	T-4 1380-1390	.27
20	T-4 1400-1410	.33
21	T-4 1410-1420	1.21
22	T-4 1420-1430	1.31
23	T-4 1430-1440	.30
24	T-4 1440-1450	.15
36	T-4 1560-1570	.18
47	T-4 1670-1680	.31
48	T-4 1680-1690	.37
49	T-4 1690-1700	.15
50	T-4 1700-1710	.40
51	T-4 1710-1720	.58
52	T-4 1720-1730	2.30
53	T-4 1730-1740	6.00

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 613A
November 20, 1989

ITEM	SAMPLE NUMBER	nsCu (%)
54	T-4 1740-1750	1.32
55	T-4 1750-1760	.66
56	T-4 1760-1770	.76
57	T-4 1770-1780	.36
58	T-4 1780-1790	.34
59	T-4 1790-1800	.58

cc: Mr. J.D. Sell
Mr. A. R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA, U.S.A.

11/20/89

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

JDS

ASARCO

Mining Department
A. R. Raihl

ASARCO Inc
NOV 21 1989
SW Exploration

VIA TELEFAX
504-582-1639

November 20, 1989

Mr. Walter E. McCulloch
Freeport Mining Company
P. O. Box 61520
New Orleans, LA 70161

Dear Mr. McCulloch:

Santa Cruz Project Review and
SCJV Operating Committee Meeting

It is proposed that the Santa Cruz Joint Venture hold a review of the Santa Cruz In Situ Copper Mining Research Project (Project) on Thursday, November 30, 1989, beginning at 8:30 a.m. in the offices of ASARCO Incorporated located at 1150 N. 7th Avenue, Tucson, Arizona, followed by a quarterly operating committee meeting.

Presently there are only two items that Asarco will place on the agenda of the Operating Committee meeting.

1. For long-term public information purposes, a 10- to 15-minute video production of the Project is planned. The estimated cost of this video is $30,000, and the USBM will not allow this cost to be part of the Joint Venture cost share. It will, therefore, be proposed that the Joint Venture totally fund this production.

2. An attempt is being made to conduct a tour of the in situ leach site and provide a descriptive program for a group of Congressional aides and Casa Grande opinion makers some time in early January 1990 (presently thought to be between January 8 and 10). It is hoped that Senator DeConcini, other Senators and Congressmen, and T. S. Ary may be available to attend.

   The cost of the program will be considered a part of the USBM/SCJV cost share agreement; however, the cost of the reception will not be. It will therefore be proposed that the SCJV totally fund the cost of the reception and other costs not allowed under the cost share agreement. Based on an attendance of 50 people, with the reception limited to finger foods and an open bar, the estimated cost is $2,000. Other costs are unknown at this time.

ASARCO Incorporated P.O. Box 5747 Tucson, AZ 85703-0747
1150 North 7th Avenue (602) 792-3010
TELEX: WU 666413 FACSIMILE: (602) 792-3934

It is assumed that the time required for the Operating Committee meeting will be minimal; therefore, it is scheduled to begin after the discussions of the Project have been completed.

I believe that it is time to have a rather detailed discussion of the Project and, therefore, will have the various consultants speak about their areas of expertise and be available for questions. A tentative agenda is attached for your reference.

If you or anyone receiving a copy of this letter have any suggestions or recommendations, please let me know. Also, please advise me as to the Freeport personnel who will be attending the meeting.

Yours truly,

A. R. Raihl

ARR:brw

Attachment

cc:	R. J. Hickson	w/att.	Via Telefax	(504-582-1639)
	S. D. Van Nort	"		
	G. Reinbold	"	Via Telefax	(702-826-7902)
	T. C. Osborne	"	" "	(212-510-1855)
	R. J. Kupsch	"	" "	
	R. L. Brown	"	" "	
	F. T. Graybeal	"	" "	
	W. L. Kurtz	"		
	J. D. Sell	"		
	H. G. Kreis	"		
	S. A. Anzalone	"		
	T. E. Scartaccini	"		

SANTA CRUZ IN SITU COPPER MINING RESEARCH PROJECT
SCJV REVIEW - NOVEMBER 30, 1989

A G E N D A

TIME	SPEAKER	COMPANY	POSITION	REMARKS
		MORNING SESSION - ALL CONSULTANTS PRESENT		
8:30-8:45	A. Raihl	Asarco	Project Manager	Introduction - Generalized description of what has been accomplished and what is planned for the near future.
8:45-9:15	G. Barker	SAIC	Drilling Engineer	Description of test well drilling methods including drilling, logging, casing, and cementing. Also description of planned cased hole perforation and the acid completion program.
9:15-9:45	H. Kreis	Asarco	Field Manager and Project Geologist	Description of in situ leach site geology and his interpretation. Possible Project problems due to geology.
9:45-10:15	C. Barter	ELM&A	Project Hydrogeologist (Lead role in obtaining permits.)	Permits required, data base, Aquifer Protection Permit. Permit scheduled, problems, etc.
10:15-10:30	Break			
10:30-10:45	A. Raihl	Asarco	Project Manager	Open hole injection test results. Production rate of well T-1 obtaining water sample.
10:45-11:15	P. Robinson	P. Robinson	Public Information Consultant	Methodology being used to keep the public informed on the Project both in the past and in the future including meetings, brochures, video, receptions, etc. USBM NEPA program, public meeting, and EA.
11:15-12:00	Round Table Discussion and Questions			
12:00-1:00	Lunch			
		AFTERNOON SESSION - ONLY ASARCO AND FREEPORT PRESENT		
1:00-2:00	A. Raihl	Asarco	Project Manager	1. Comparison between original program and present program. 2. Comparison between original estimated costs and actual costs. 3. Estimated program schedule. 4. Phase 3 of program.
2:00-3:00	Questions and Answers			
3:00-3:30	SCJV Operating Committee Meeting			

9168

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 616A
November 24, 1989
T-4 1330-1340 S.W. TO
T-4 1910-1920
PAGE 1 OF 1

ASARCO Incorporated
NOV 27 1989
SW Exploration

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 8 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
1	T-4 1330-1340 S.W.	.69
2	T-4 1340-1350 S.W.	1.85
3	T-4 1360-1370 S.W.	.67
4	T-4 1730-1740 S.W.	5.90
5	T-4 1800-1810	.41
6	T-4 1810-1820	.21
11	T-4 1860-1870	.13
12	T-4 1870-1880	.18

cc: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
STATE OF
ARIZONA U.S.A.

11/25/89

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Incorporated
NOV 30 1989
SW Exploration

REPORT OF ANALYSIS

JOB NO. TAJ 630
November 28, 1989
T-5 1150-1800
PAGE 1 OF 3

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 64 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-5 1150-1160	.02
2	T-5 1160-1170	.04
3	T-5 1170-1180	.07
4	T-5 1180-1190	.08
5	T-5 1190-1200	.19
6	T-5 1200-1210 **	.00
7	T-5 1210-1220	.04
8	T-5 1220-1230	.26
9	T-5 1230-1240	.50
10	T-5 1240-1250	.13
11	T-5 1250-1260 *	.50
12	T-5 1260-1270	.46
13	T-5 1270-1280	.41
14	T-5 1280-1290	.25
15	T-5 1290-1300	.41
16	T-5 1300-1310	.20
17	T-5 1310-1320	.18
18	T-5 1320-1330	.77
19	T-5 1330-1340	.81
20	T-5 1340-1350	1.90
21	T-5 1350-1360	.45
22	T-5 1360-1370	.66
23	T-5 1370-1380	.75
24	T-5 1380-1390	.33
25	T-5 1390-1400	.24

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 630
November 28, 1989

ITEM	SAMPLE NUMBER	Cu (%)
26	T-5 1400-1410	.18
27	T-5 1410-1420	.19
28	T-5 1420-1430	.18
29	T-5 1430-1440	.19
30	T-5 1440-1450	.11
31	T-5 1450-1460	.08
32	T-5 1460-1470	.05
33	T-5 1470-1480	.04
34	T-5 1480-1490	.58
35	T-5 1490-1500	.09
36	T-5 1500-1510	.30
37	T-5 1510-1520	.27
38	T-5 1520-1530	.08
39	T-5 1530-1540	.06
40	T-5 1540-1550	.29
41	T-5 1550-1560	.85
42	T-5 1560-1570	.54
43	T-5 1570-1580	.30
44	T-5 1580-1590	.15
45	T-5 1590-1600	.10
46	T-5 1600-1610	.08
47	T-5 1610-1620	.06
48	T-5 1620-1630	.06
49	T-5 1630-1640	.06
50	T-5 1640-1650	.09

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ITEM	SAMPLE NUMBER	Cu (%)
51	T-5 1650-1660	.05
52	T-5 1660-1670	.65
53	T-5 1670-1680	.12
54	T-5 1680-1690	.16
55	T-5 1690-1700	.07
56	T-5 1700-1710	.23
57	T-5 1710-1720	.32
58	T-5 1720-1730	.17
59	T-5 1730-1740	.27
60	T-5 1740-1750	.30
61	T-5 1750-1760	.17
62	T-5 1760-1770	.12
63	T-5 1770-1780	.08
64	T-5 1780-1790	.09
65	T-5 1790-1800	.47

*NOTE: Item 11 Sample No. 1250-1260
Sample bag marked 1252-1260.

**NOTE: Item No 6 Sample No. T-5 1200-1210
was not received.

cc: Mr. J.D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Mr. A.R. Raihl
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK

9105

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 631
November 29, 1989
T-5 1800-1870
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

DEC 1 1989
SW Exploration

Analysis of 7 Rotary Cutting Samples

ITEM	SAMPLE NUMBER	Cu (%)
1	T-5 1800-1810	.49
2	T-5 1810-1820	.27
3	T-5 1820-1830	.08
4	T-5 1830-1840	.09
5	T-5 1840-1850	.15
6	T-5 1850-1860	.06
7	T-5 1860-1870	.57

NOTE: Results to follow as TAJ631-A.

cc: ASARCO INCORPORATED
Attn: Mr. J.D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

ASARCO INCORPORATED
Attn: Mr. A.R. Raihl
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REGISTERED ASSAYER
CERTIFICATE NO. 9425
WILLIAM L. LEHMBECK
ARIZONA U.S.A.

ASARCO

Southwestern Exploration Division

December 1, 1989

A.R. Raihl

Perforating
Test Wells
In Situ Test Site

As requested, a two hundred foot thick, horizontal interval in the lower copper oxide zone has been chosen for perforating. The interval to be perforated in T-1, T-2, T-3, T-4, and T-5 is from 1570' to 1770'. Test Well T-1 has already been perforated from 1620' to 1770', so the interval from 1570' to 1620' remains to be perforated.

The attached north-south, east looking cross sections show the thickness and grades of atacamite mineralization with minor chrysocolla. The chalcocite mineralization in T-1, T-4, and T-5 is shown with a "CC" notation to distinguish the chalcocite from the copper oxide mineralization.

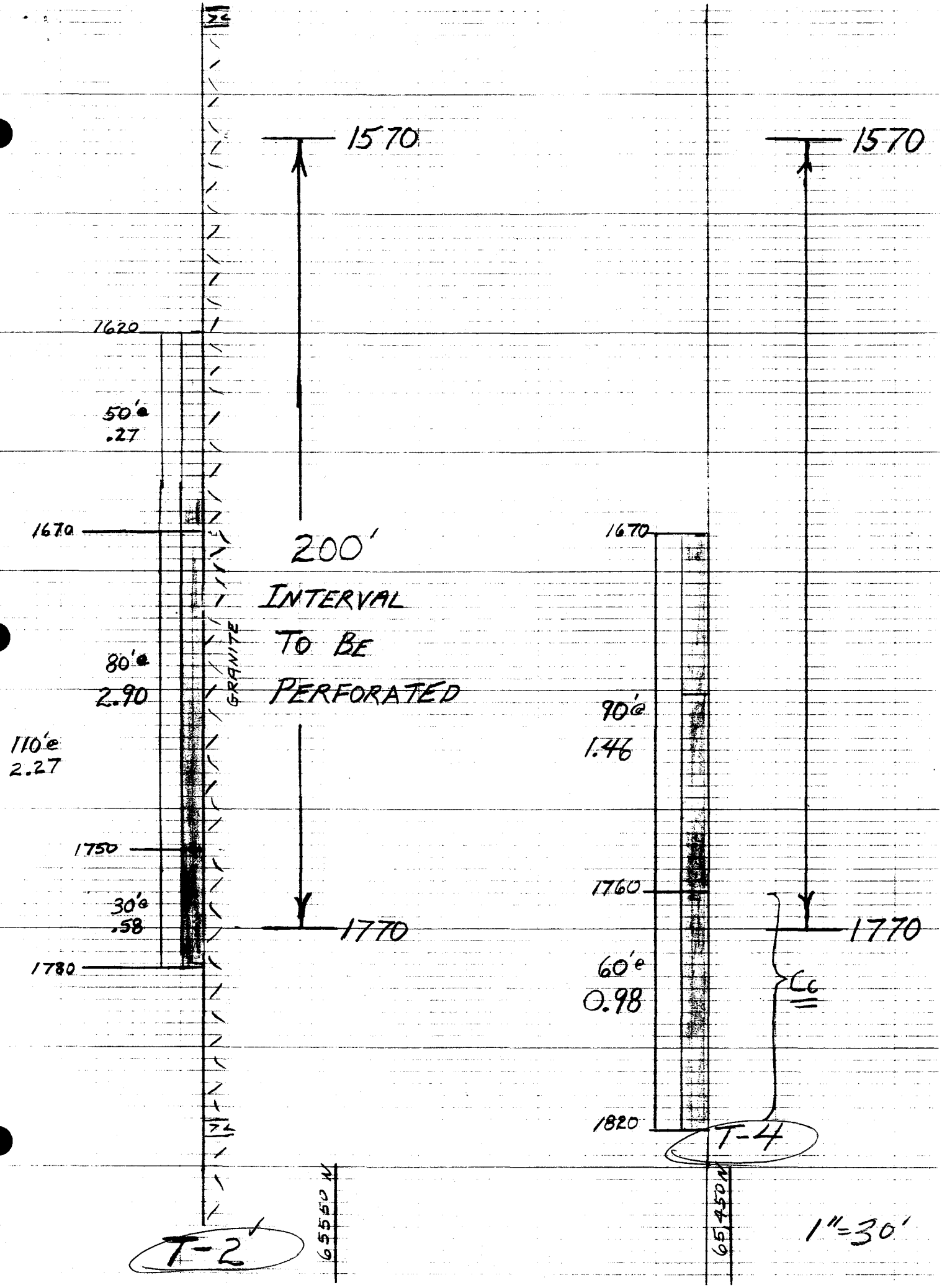
The two hundred foot perforated interval was located to optimize leaching of the higher grade portions of the atacamite mineralization.

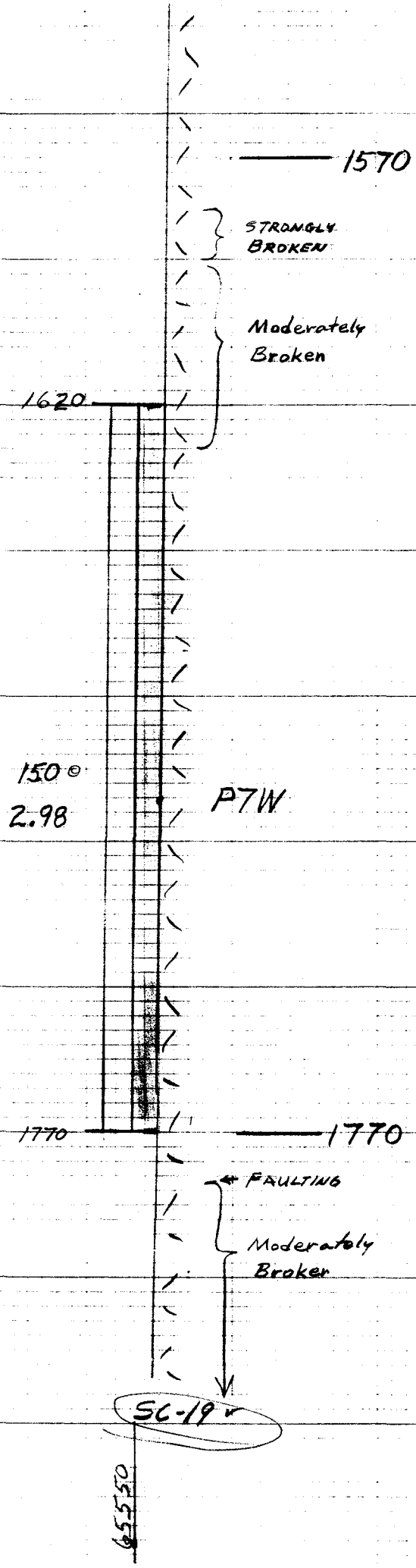
H.G. Kreis

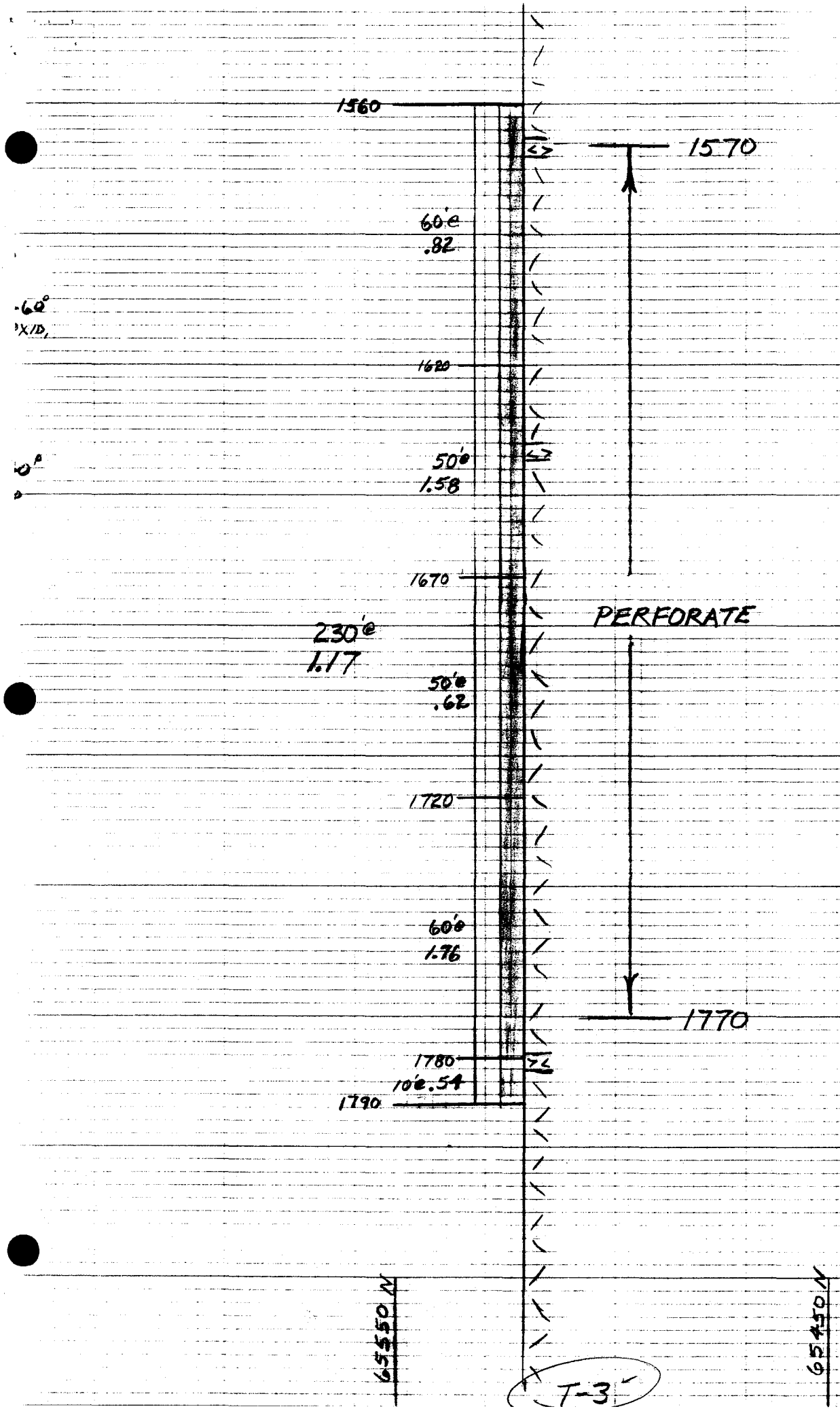
H.G. Kreis

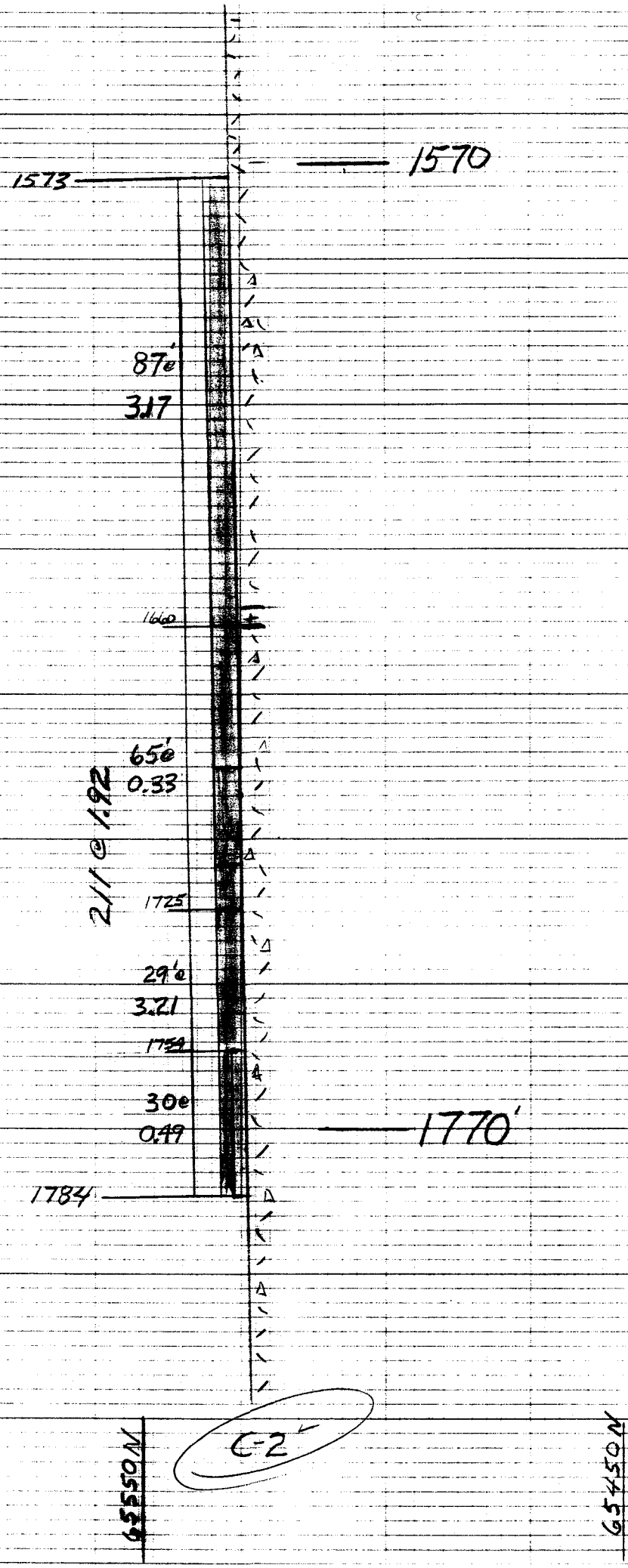
HGK:mek
atts.

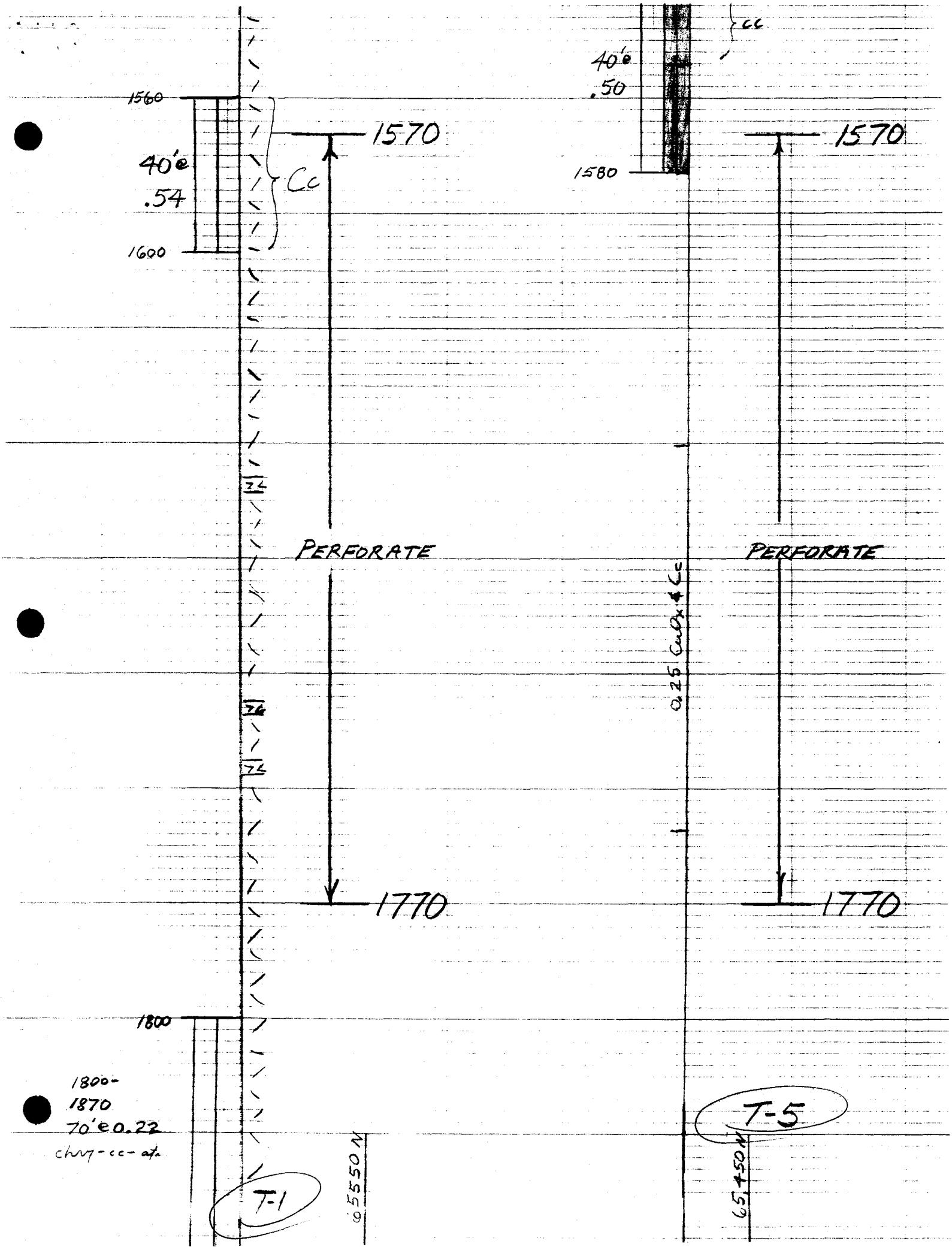
cc: R.L. Brown/F.T. Graybeal
W.L. Kurtz/J.D. Sell


1570
1620
50'@
.27
1670
200'
INTERVAL
TO BE
PERFORATED
GRANITE
80'@
2.90
110'@
2.27
1750
30'@
.58
1770
1780
T-2
65550 N
1570
1670
90'@
1.46
1760
1770
60'@
0.98
Cc
1820
T-4
65450 N
1"=30'


1570
STRONGLY BROKEN
Moderately Broken
1620
150 ©
2.98
P7W
1770
1770
FAULTING
Moderately Broken
SC-19
65550
65450


1560
1570
60'@
.82
1620
50'@
1.58
1670
PERFORATE
230'@
1.17
50'@
.62
1720
60'@
1.76
1770
1780
10'@.54
1790
65550 N
65450 N
T-3


1570
1573
87e
3.17
1660
65e
0.33
2/1 @ 1.92
1725
29e
3.21
1754
30e
0.49
1770'
1784
C-2
655 50N
654 50N


1560
40'@
.54
1600
1570
Cc
PERFORATE
1770
1800
1800-
1870
70'@0.22
chrg-cc-at.
T-1
65550N
40'@
.50
1580
cc
1570
PERFORATE
0.26 CuOx + Cc
1770
T-5
65450N

Santa Cruz
AR Zonat

FROM: W. L. KURTZ

TO: Walt McCullough
Freeport

The attached gives notice that Simmons will purchase the lands along Highway 84. According to agreement they have 15 days to complete the transaction. Burt Apker, our attorney, has been notified.

Bill Kurtz

cc: JDSell,
HGKovis

SIMMONS

THE SIMMONS COMPANY
3200 EAST CAMELBACK
PHOENIX, ARIZONA 85018
(602) 224-7555

HAND DELIVERED

RECEIVED
DEC 1 1989
EXPLORATION DEPARTMENT

December 1, 1989

Mr. Richard Brown
Vice President
ASARCO, Incorporated
180 Maiden Lane
New York, New York 10038

Re: Exercise of Option

Dear Mr. Brown:

Pursuant to paragraph 4 of that certain Option to Purchase and First Right of Refusal Agreement by and between Simmons DevCor, Inc. and Santa Cruz Joint Venture, dated December 23, 1988, we are hereby providing you written notice of our election to exercise the option to purchase the "Exhibit B Property".

Very truly yours,

Jerry D. Simmons
President

sll

c.c. Bill Kurtz

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Incorporated
DEC 8 1989
SW Exploration

REPORT OF ANALYSIS

JOB NO. TAJ 631A
December 6, 1989
T-5 1800-1870
PAGE 1 OF 1

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 3 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
1	T-5 1800-1810	.13
2	T-5 1810-1820	.10
7	T-5 1860-1870	.15

cc: Asarco Incorporated
Attn: Mr. J.D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Asarco Incorporated
Attn: Mr. A.R. Raihl
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK ARIZONA U.S.A.

ASARCO SANTA CRUZ INC.
P. O. BOX 5747
Tucson, Arizona 85703
(602) 792-3010

December 07, 1989

FREEPORT-McMORAN GOLD CO.
P. O. Box 41330
Reno, Nevada 89504

Attention: G. R. Reinbold

SANTA CRUZ PROJECT

In accordance with the Santa Cruz Joint Venture dated July 1, 1977, we charge you as follows for November 1989:

Our E.A. No. 0075 - The Lands		
General Administrative Charges	$ 50.00	
Field Services & Supplies	420.20	
Salaries	806.00	
Employee Overhead	250.00	
Recording Fee	18.00	
Professional Services	230.00	1,774.20
Our E.A. No. 0087 - Peripheral Lands		
General Administrative Charges	50.00	50.00
		1,824.20

1/2 to Freeport-McMoran	912.10
Balance brought forward	127,221.20
Payment received from Freeport-McMoran	(127,221.20)
In Situ Leach Project November charges	19,869.03
Balance Due	20,781.13

cc: Controller/Attn: EJFranko
JDSell
PJorgensen - Freeport-McMoran
File

ASARCO Incorporated
DEC 19 1989
SW Exploration

ASARCO

Southwestern Exploration Division

December 8, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
November 1989

Drilling on the Santa Cruz Project was completed in late November with the completion of T-4 and T-5. The drilling contractor, Stewart Brothers, has removed all its drilling equipment from the test site.

In late November CBC Drilling Co. moved a core rig to the test site area, and CBC is in the process of abandoning five old core holes.

All the samples from the test wells, T-1 to T-5, have been assayed, and the attached rough draft cross sections show the results of the assaying.

My activities during November are described in the attached November monthly report to A.R. Raihl.

H.G. Kreis

H.G. Kreis

HGK:mek
Atts.

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

December 8, 1989

A.R. Raihl

Monthly Report
November 1989

In November, project activities included completing drill holes T-4 and T-5; taking bulk samples for metallurgical work, assay checks, and screen tests; completing all assay work; shipping the T-2, 4" core to the USBM; pumping well T-1 for a water sample from the test site horizon; moving Stewart Brothers Drilling Co. equipment and equipment belonging to other contractors off the test site; moving a CBC Drilling Co. core rig on site for old core hole abandonment; various geophysical and cement bond logs; extensive site clean up; assisting a videotape crew and a professional photographer; attending a well rehabilitation symposium; and giving a presentation on the T-1 to T-5 results to representatives of Freeport-McMoRan Gold Co. and the USBM.

Tours were given to J. Hardigan, Arizona State Legislature; Joe Murray, President of Freeport-McMoRan Gold Co.; two representatives of the ADEQ; and Bev Coulter, Mt. Isa Mines.

Several trips between Tucson and Casa Grande were made by me.

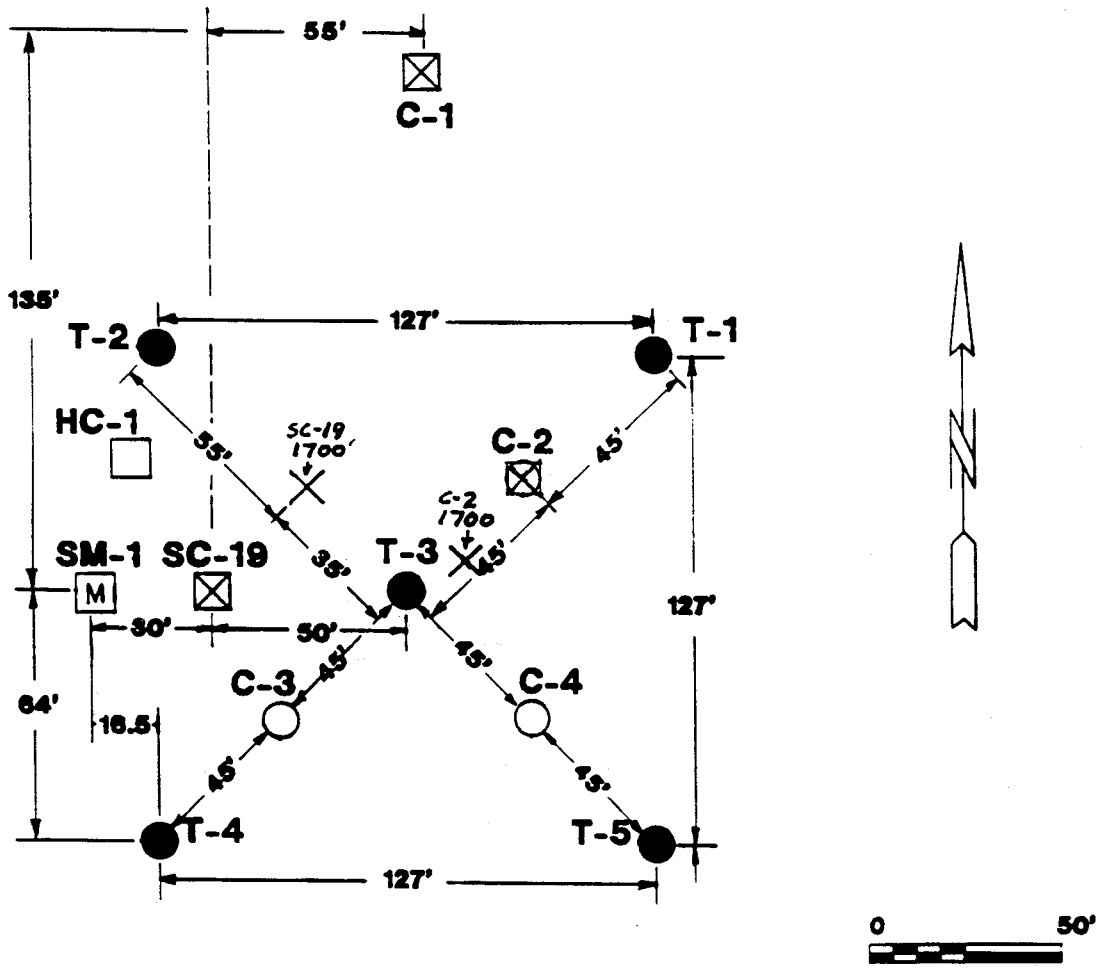
H. G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell

SANTA CRUZ IN SITU TEST SITE



● Test wells

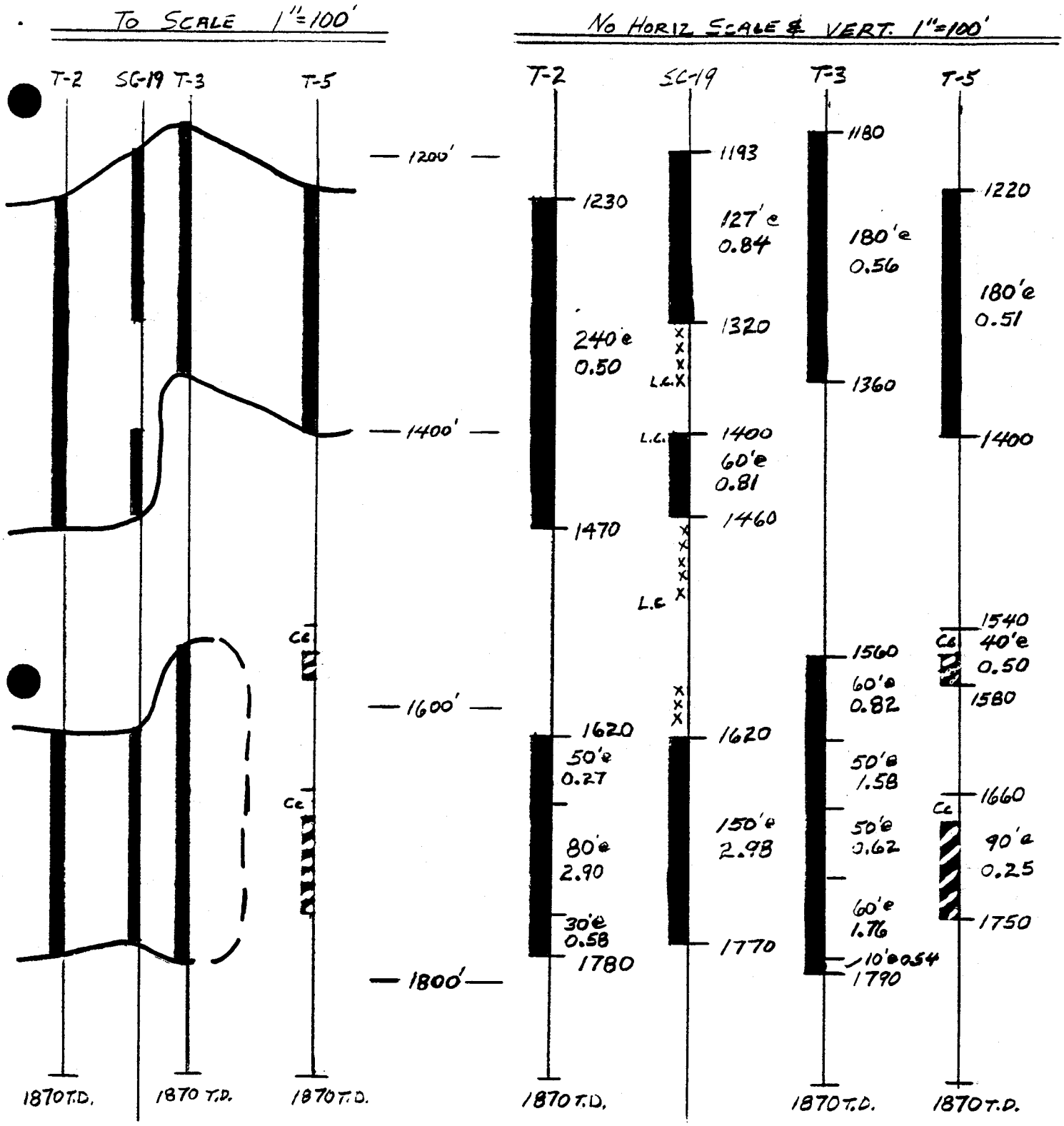
M Monitor well

□ Hydrologic test well

○ Future core hole

⊠ Existing core holes

× Location of SC-19 AND C-2 atacamite at 1700' depth



EXPLANATION

× × Fault-fracture zones in core holes

L.C. Lost circulation in core holes

Cc Chalcocite

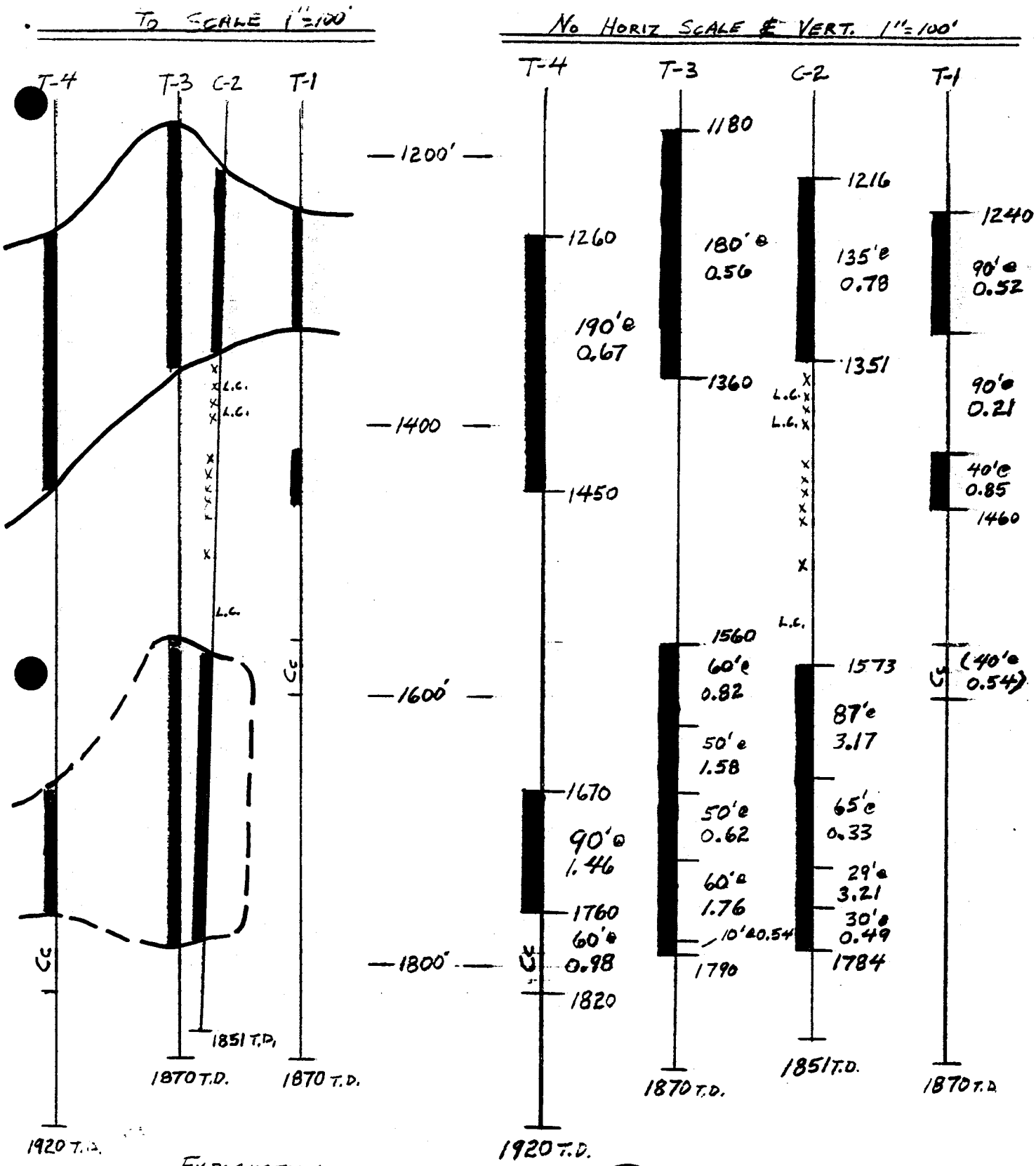
CuOx intercept

PRELIMINARY ROUGH DRAFT

SANTA CRUZ PROJ.

T-2 TO T-5 SECTION

H. G. K. 11-28-'89



EXPLANATION

* Fault-fracture zones in core holes

L.C. Lost circulation in core holes

Cc Chalcocite

CuOx intercept

PRELIMINARY ROUGH DRAFT

SANTA CRUZ PROJ.

T-4 TO T-1 SECTION

H.G.K. 11-28-'89

ASARCO

Mining Department
Tucson, Arizona

VIA TELEFAX
212-510-1978

DEC 1 2 1989

SW Exploration

December 11, 1989

Mr. R. L. Brown, V.P.
Exploration Department
NEW YORK OFFICE

Santa Cruz Joint Venture Operating Committee
Meeting of November 30, 1989

Attached is a draft copy of the minutes of the Santa Cruz Joint Venture (SCJV) Operating Committee meeting held November 30, 1989. Please review and make comments and recommendations and/or give your approval as soon as possible so they can be sent to Freeport for their approval. As you know, Freeport-McMoRan Inc. may in the near future be selling their interest in Freeport-McMoRan Gold Company and thus Freeport Copper Company and its interests in the SCJV.

The costs associated with the video and the reception were discussed previously with you, R. Kupsch, R. Muth, and D. Noyes. Approval had been given; therefore, H. Kreis and I had the authority to approve these expenditures at the SCJV meeting. Upon the recommendation of the Tucson Office accounting staff, I will submit an Application for Supplemental Exploration Appropriation form EA0075 in the amount of $20,000 to cover ASARCO Santa Cruz, Inc.'s share of the cost of the video, the reception, and other public relations costs not allowed under the USBM/SCJV cost share agreement.

Mr. R. deJ. Osborne's comments concerning the assembled field shots for the proposed video which was shown at the 1989 Exploration Department meeting held recently in Denver were passed on to me and are duly noted. A format for the video along with a script will be developed in the near future. This will be distributed for approval prior to producing a draft video. The draft video will be distributed for approval prior to producing the final version.

A. R. Raihl

ARR:brw
Attachment
cc: R. J. Kupsch w/att.
F. T. Graybeal "
R. J. Muth "
G. H. Myers "
W. L. Kurtz "
J. D. Sell "
H. G. Kreis "

DRAFT

SANTA CRUZ JOINT VENTURE
OPERATING COMMITTEE MEETING

A Santa Cruz Joint Venture Operating Committee meeting was convened on Thursday, November 30, 1989, at 3:00 p.m. at the ASARCO Incorporated offices located at 1150 N. 7th Avenue, Tucson, Arizona 85705. Present at the meeting were the following, constituting a quorum:

ASARCO Santa Cruz, Inc.	Freeport Copper Company
A. R. Raihl, Tucson, AZ	S. D. Van Nort, Tucson, AZ
H. G. Kreis, Tucson, AZ	W. E. McCulloch, Jr., New Orleans, LA

Mr. McCulloch and Mr. H. G. Kreis, Alternate Members, had full voting rights in the absence of Mr. R. J. Hickson and Mr. W. L. Kurtz, respectively. Mr. Raihl chaired the meeting.

It was noted by Mr. Raihl that minutes of all previous meetings had been approved as complete and correct.

Old Business

No old business was brought to the attention of the Committee.

New Business

It was proposed to the Committee that up to $30,000 be spent to produce a video for the purpose of explaining the Santa Cruz In Situ Copper Mining Research Project (Project) and the efforts being taken to protect the environment, especially the overlying aquifer. The video would be aimed toward the general lay audience in the Casa Grande and Arizona areas; however, it would also be useful in explaining the Project to a greater audience. It was emphasized that the video production costs would <u>not</u> be considered as part of the USBM/Santa Cruz Joint Venture cost share program. This proposal was unanimously approved by the Committee.

A field tour of the Project site followed by a briefing and reception is being planned for members of Congress, Congressional staff, and local Arizona and Casa Grande dignitaries to be held January 5, 1990. It was explained that the field tour and briefing costs were legitimate USBM/SCJV cost share expenditures; however, the costs associated with the reception were not. It was therefore proposed that the SCJV fund separate from the cost share program up to $4,000 to cover the costs of the reception and other associated costs not allowed under the cost share agreement. This proposal was unanimously approved by the Committee.

No other new business was proposed to the Committee.

Closing

Upon motion duly made and seconded, the meeting was adjourned at 3:10 p.m.

Submitted by: A. R. Raihl

Minutes approved as complete and correct:

A. R. Raihl

S. D. Van Nort

H. G. Kreis

W. E. McCulloch, Jr.

JDS

ASARCO

Southwestern Exploration Division

December 21, 1989

J.D. Sell

Quarterly Report
Fourth Quarter 1989
H.G. Kreis

Santa Cruz In Situ Project - EA-0438 - Copper

During the quarter 54 days were spent on drilling and testing in T-4 and T-5, the completion of SM-3 and SM-4, and numerous other project activities. In the first quarter of 1990 perforating the "T" well casings will be completed and water injection-recovery tests will be made.

Santa Cruz Project - EA-0075 - Copper

Two days were expended on Santa Cruz land situations and the agricultural lease.

Miscellaneous

Six days were spent in conjunction with the Exploration Department meeting in Denver. Six days of vacation were taken.

H.G. Kreis

HGK:mek

H.G. Kreis

ASARCO

Southwestern Exploration Division

December 21, 1989

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
December 1989

Old diamond drill holes C-2, SC-19, and SC-36 have been abandoned using casing perforating techniques where necessary and cementing. Drill holes SC-49, SC-35, and HC-1 will be abandoned in January. A core rig from CBC Drilling Co. is being used for this work.

A Stewart Brothers drill rig is back on site to pull and install pumps in T-1 and T-2. Schlumberger was used to perforate the casing in T-2 from 1570' to 1770'.

Volatile organic compounds were found in the ground water of T-1; and, in a test, a 500 gallon water sample from T-1 is being treated to evaporate volatile organic compounds from the water. The volatiles are thought to have been caused by the perforating techniques.

Senator DeConcini and others will visit the test site on January 5th.

A presentation on the Santa Cruz in situ leach program was given to Asarco's Exploration Department and officers from the New York Office.

Since Simmons has notified Asarco that Simmons DevCor, Inc. will exercise its option to purchase the "Exhibit B Property," no agricultural leases for 1990 will be granted.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

December 21, 1989

A.R. Raihl

Monthly Report
December 1989

In December, project activities included the abandonment of C-2, SC-19, and SC-36; CBL and CTE logging; perforating casing in T-2 from 1570' to 1770'; taking a 500 gallon water sample from T-1 for treatment; setting up equipment to treat the T-1 water by evaporating volatile organic compounds; pulling the pump from T-1 and steam cleaning the pump and pipe; preparing for DeConcini and others to visit on January 5th; and giving a presentation on the Santa Cruz in situ leach program to Asarco's Exploration Department and officers from the New York Office.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell

LAW OFFICES OF
APKER, APKER, HAGGARD & KURTZ, P.C.
A PROFESSIONAL CORPORATION
PARK ONE
2111 EAST HIGHLAND AVENUE, SUITE 230
PHOENIX, ARIZONA 85016
AREA CODE 602 TELEPHONE 381-0085

BURTON M. APKER*
JERRY L. HAGGARD**
DAVID B. APKER***
GERRIE APKER KURTZ
JOHN R. FITZPATRICK

*ALSO ADMITTED IN WISCONSIN
**ALSO ADMITTED IN DISTRICT OF COLUMBIA AND KANSAS
***ALSO ADMITTED IN COLORADO

MAILING ADDRESS
P. O. BOX 10280
PHOENIX, ARIZONA 85064-0280

TELECOPIER
(602) 956-3457

December 29, 1989

direct line:
(602) 381-0084

Mr. R. L. Brown, Jr.
Vice President
Exploration Department
ASARCO Incorporated
180 Maiden Lane
New York, New York 10038

Dear Mr. Brown:

Here is a copy of a letter we received today from H. Mason Coggin, PE & LS.

Yours very truly,

Burton M. Apker

BMA:ms

Enclosure

cc w/enc: Mr. W. L. Kurtz ✓

cc: J.D. Sell
W.D. Gay
1/2/90

RECEIVED
JAN 2 1990
EXPLORATION DEPARTMENT

Recd 12/29/89 Burg

H. Mason Coggin PE & LS

Mining Engineering and Land Surveying

317 East Griswold Phoenix, AZ 85020

Pho. 602 944-3763 Fax 602 678-1822

December 27, 1989

Burton Apker, Aty. 602 956 3457
Apker, Apker, Haggard & Kurtz, P. C.
Park One 2111 E. Highland, # 201
Phoenix, AZ 85016

Dear Mr. Apker:

My sister, Daphne (Coggin) Morrison, has been handling the estate of Ida Mae Coggin my mother. This estate includes the mineral rights to a parcel of land near Casa Grande, AZ. The surface was sold to Hanna Mining some years ago and the mineral rights were leased to Hanna for $100 per year with a 2.5% NSR on any production.

Hanna's successor, Santa Cruz Joint Venture, who I understand is your client, may wish to complete the purchase of these mineral rights for cash. I have talked with my brother and sister; they have agreed with me to offer these mineral rights to your client at this time.

The price we have discussed is $60,000.

If your client has any interest in acquiring these mineral rights please call.

Sincerely,

H. Mason Coggin, PE & LS

RECEIVED
JAN 2 1990
EXPLORATION DEPARTMENT

JDS

ASARCO

Exploration Department
Southwestern United States Division

James D. Sell
Manager

January 16, 1990

Mr. Tauno Laine
1406 Longview Drive
Fullerton, CA 92631

Dear Mr. Laine:

Your letter of January 12, 1990 arrived today. Thank you for the offer of Las Vegas and the grand tour; however, I'll be taking along one of the field geologists and together he and I may spend more time in the area, although your part of the tour might be only a day.

I'm looking forward for the time slot to see all there is to see.

Sincerely,

James D. Sell

James D. Sell

JDS:mek

cc: W.L. Kurtz
J.D. Rasmussen

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

Tauno Laine
1406 Longview Drive
Fullerton, CA 92631
Tel. 714 871 1923

January 12, 1990

JAN 1 6 1990

SW Exploration

Mr.J. d. Sell, Manager
Asarco Exploration
P. O. Box 5747
Tuscon. Az 95703-0747

Dear Mr. Sell:

During our telephone conversation yesterday you gave me a ray of hope when you mentioned that you could possibly to make a trip to my property to get acquainted with its features.

That is exatly what I have hoped. In my opinion the features in the Doublin Hills are so unique that a geologist visiting it is trying to fit it to known and typical features around the country and misses its values. These "hidden features" are the reason it has taken so long, 27 years, to finally realize it. One needs, using your term, a "mental picture" about it to penetrate into its comlexities. Some twelve geologists have visited it and only Kennecott's Mr. Steven D. Craig was able to understand the nature of the property and was very enthusiastic about it, but unfortunately Kennecott Company is interest about gold only.

Please, let me invite you to this trip. You can fly to Las Vegas and you do not need to drive from Tuscon. I'll pick you up at the airport and we will spend a day at the property, and I will take you back to Las Vegas. This could be done on the week days or on the weekends. Now it is an excellent time to visit Las Vegas. There is no big crowd now. Please, let me know, and I'll arrange the hotel.

Very truly yours

Tauno Laine

Tauno Laine

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Incorporated
JAN 22 1990
SW Exploration

REPORT OF ANALYSIS

JOB NO. TAJ 630A
January 19, 1990
T-5 1150-1800

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 29 Pulp Samples

ITEM	SAMPLE NUMBER	nsCu (%)
8	T-5 1220-1230	.23
9	T-5 1230-1240	.47
11	T-5 1250-1260	.46
12	T-5 1260-1270	.44
13	T-5 1270-1280	.39
14	T-5 1280-1290	.20
15	T-5 1290-1300	.37
16	T-5 1300-1310	.17
18	T-5 1320-1330	.73
19	T-5 1330-1340	.78
20	T-5 1340-1350	1.80
21	T-5 1350-1360	.42
22	T-5 1360-1370	.61
23	T-5 1370-1380	.69
24	T-5 1380-1390	.30
25	T-5 1390-1400	.21
34	T-5 1480-1490	.40
36	T-5 1500-1510	.23
37	T-5 1510-1520	.19
40	T-5 1540-1550	.12
41	T-5 1550-1560	.16
42	T-5 1560-1570	.45
43	T-5 1570-1580	.26
52	T-5 1660-1670	.33
56	T-5 1700-1710	.18

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

AMAX Incorporated

JAN 22 1990

SW Exploration

JOB NO. TAJ 630A
January 19, 1990

ITEM	SAMPLE NUMBER	nsCu (%)
57	T-5 1710-1720	.26
59	T-5 1730-1740	.22
60	T-5 1740-1750	.25
65	T-5 1790-1800	.19

cc: Mr. J.D. Sell
Mr. A.R. Raihl

REGISTERED ASSAYER
CERTIFICATE NO.
9425
WILLIAM L.
LEHMBECK
ARIZONA
1/19/90

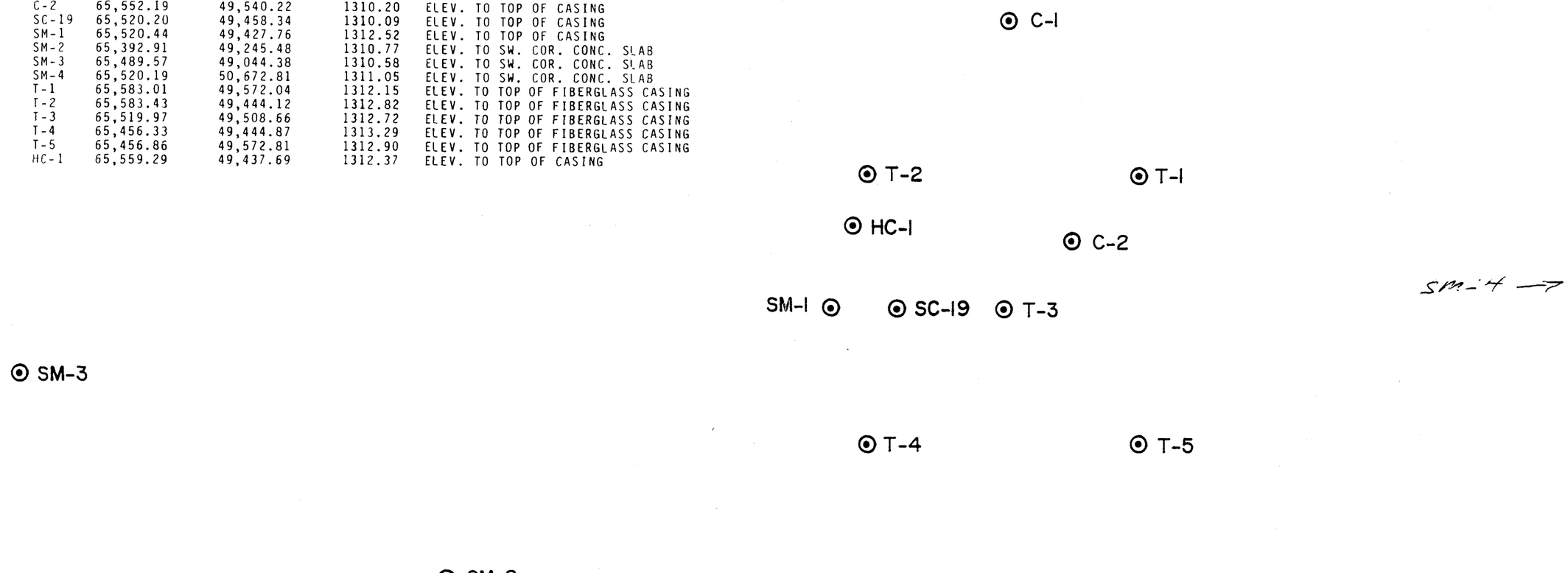
~~WEK~~/J.D.S.

CONTROL POINTS

	NORTH. COORD.	EAST COORD.	ELEV.
W-43	61,217.61	51,341.63	1324.63
X-43	61,201.16	56,506.21	1328.92
TC-9	63,989.49	51,351.00	1317.93

DRILL HOLES

	NORTH COORD.	EAST COORD.	ELEV.	COMMENT
C-1	65,656.14	49,509.96	1309.79	ELEV. TO TOP OF CASING
C-2	65,552.19	49,540.22	1310.20	ELEV. TO TOP OF CASING
SC-19	65,520.20	49,458.34	1310.09	ELEV. TO TOP OF CASING
SM-1	65,520.44	49,427.76	1312.52	ELEV. TO TOP OF CASING
SM-2	65,392.91	49,245.48	1310.77	ELEV. TO SW. COR. CONC. SLAB
SM-3	65,489.57	49,044.38	1310.58	ELEV. TO SW. COR. CONC. SLAB
SM-4	65,520.19	50,672.81	1311.05	ELEV. TO SW. COR. CONC. SLAB
T-1	65,583.01	49,572.04	1312.15	ELEV. TO TOP OF FIBERGLASS CASING
T-2	65,583.43	49,444.12	1312.82	ELEV. TO TOP OF FIBERGLASS CASING
T-3	65,519.97	49,508.66	1312.72	ELEV. TO TOP OF FIBERGLASS CASING
T-4	65,456.33	49,444.87	1313.29	ELEV. TO TOP OF FIBERGLASS CASING
T-5	65,456.86	49,572.81	1312.90	ELEV. TO TOP OF FIBERGLASS CASING
HC-1	65,559.29	49,437.69	1312.37	ELEV. TO TOP OF CASING



Center Sec 13
63,927.70
48,766.03

Note
Xerox reproduction of part of Stitzer's original survey map.

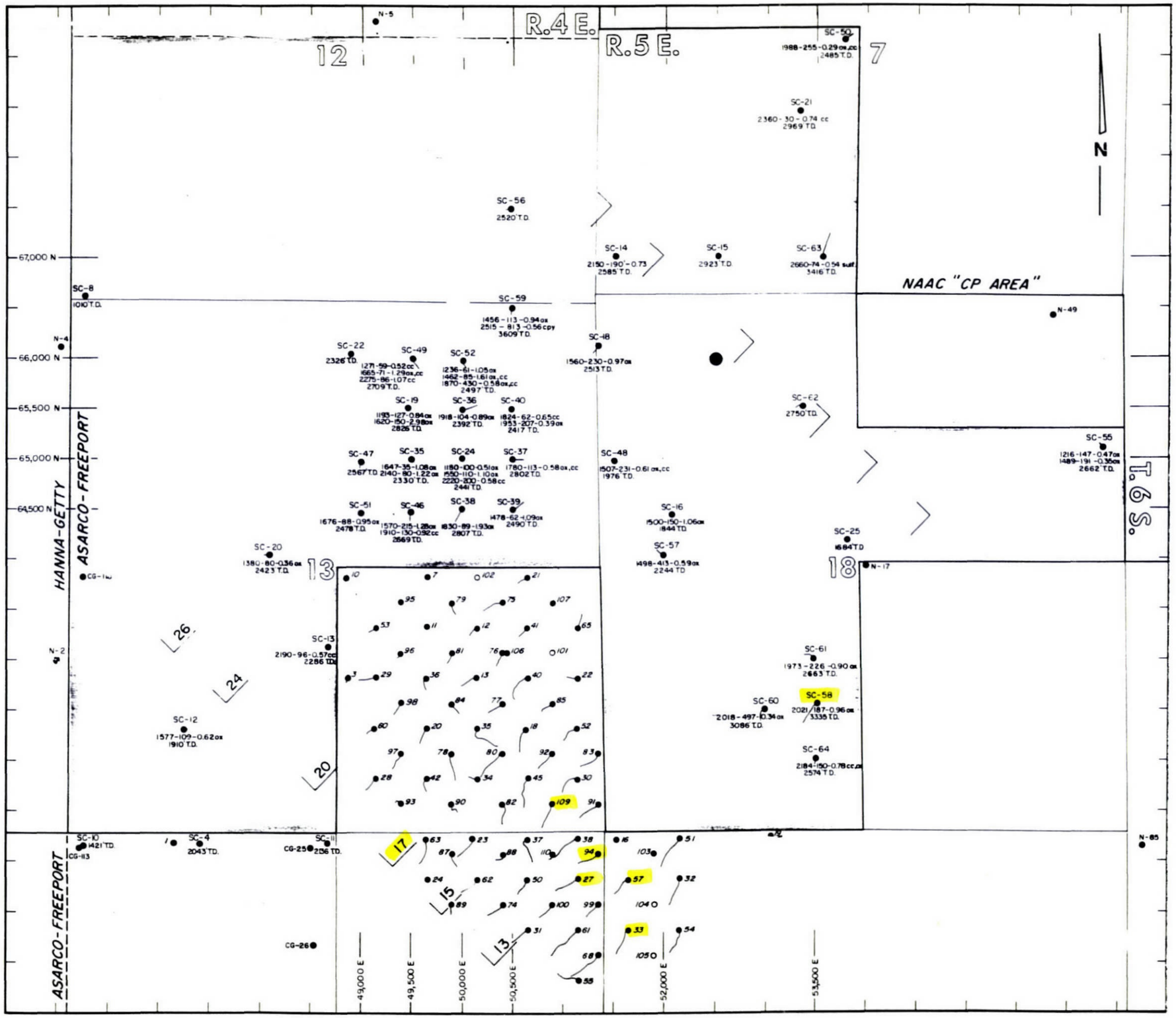
SELECTED DRILL HOLE LOCATIONS
OF THE SANTA CRUZ TEST SITE
WITHIN THE NE - 1/4 OF SECTION 13,
T 6 S, R 5 E, PINAL COUNTY, ARIZONA.

FOR : ASARCO INCORPORATED.

BY: S & S SURVEYS, INC. 1665 E. 18th ST. #204

TUCSON, AZ 85719 (602) 624-6466

SCALE: 1" = 50' JOB# 89-07-01 JANUARY 1990



EXPLANATION

DRILL HOLES

○ Top hole completed (not cored)

● Completed drill hole showing deviation and higher grade copper intercepts of ASARCO-Freeport. The selection of these intercepts did not consider continuity or any other criteria. See accompanying cross sections and plan maps for a complete listing of copper intercepts.

1560 — 230 — 0.97 ox
depth (ft) — length (ft) — %Cu — mineral
ox - oxide
cc - chalcocite

MINERAL OWNERSHIP:

- ASARCO - Freeport
- NAAC "CP AREA"
- Hanna-Getty

CROSS SECTION:

North-south and east-west cross sections have coordinate designations.

24 Location of oblique cross section

Figure 1

SANTA CRUZ PROJECT
PINAL COUNTY, ARIZONA

THE LANDS AREA

H.G.K. ASARCO Incorporated Jan. 1982

0 1000' 2000'

mn 5311 dam 1/82

ASARCO

Southwestern Exploration Division

January 22, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
January 1990

In January my work included having all the 1989 drill holes surveyed, working on three reports, laying out lines for installing buried electric cable, negotiating for contractors rates at local Casa Grande stores, issuing purchase orders for 1990, compiling data from 1989 work on the test site, providing geologic and technical support for field operations, reviewed video tapes of perforations in T-1 and T-2, making arrangements for a Sacaton air compressor to be repaired and loaned to the Santa Cruz Project, visiting the test site on a regular basis, and attending meetings with SAIC and Montgomery and Associates.

Several trips were made to Casa Grande.

H.G. Kreis

HGK:mek

H. G. Kreis

cc: W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

January 22, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
January 1990

With the completion of abandonment work on SC-49 and SC-35 in January, a total of five core holes have been abandoned. It was decided not to abandon HC-1 at this time. The CBC drill rig was released.

A "48 hour" pump test was run in SM-1 to evaluate the hydrology of the aquifer. Monitoring of water levels in nearby wells was done for several days afterward to evaluate the drawdown and recovery from pumping SM-1.

Water from both T-1 and T-2 is being treated to remove volatile organic compounds that are thought to have been caused by perforating techniques.

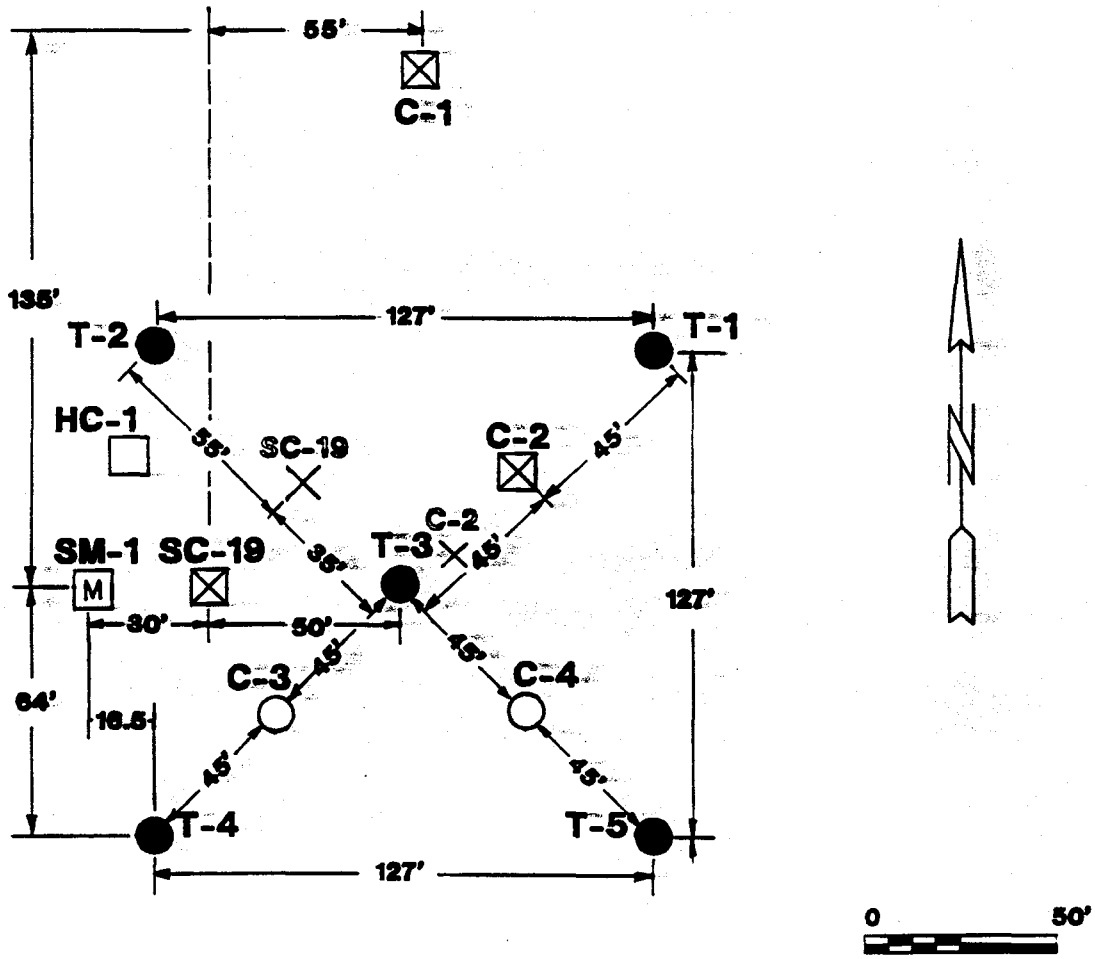
H. G. Kreis

H. G. Kreis

HGK:mek
Atts.

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

SANTA CRUZ IN SITU TEST SITE



● Test wells

[M] Monitor well

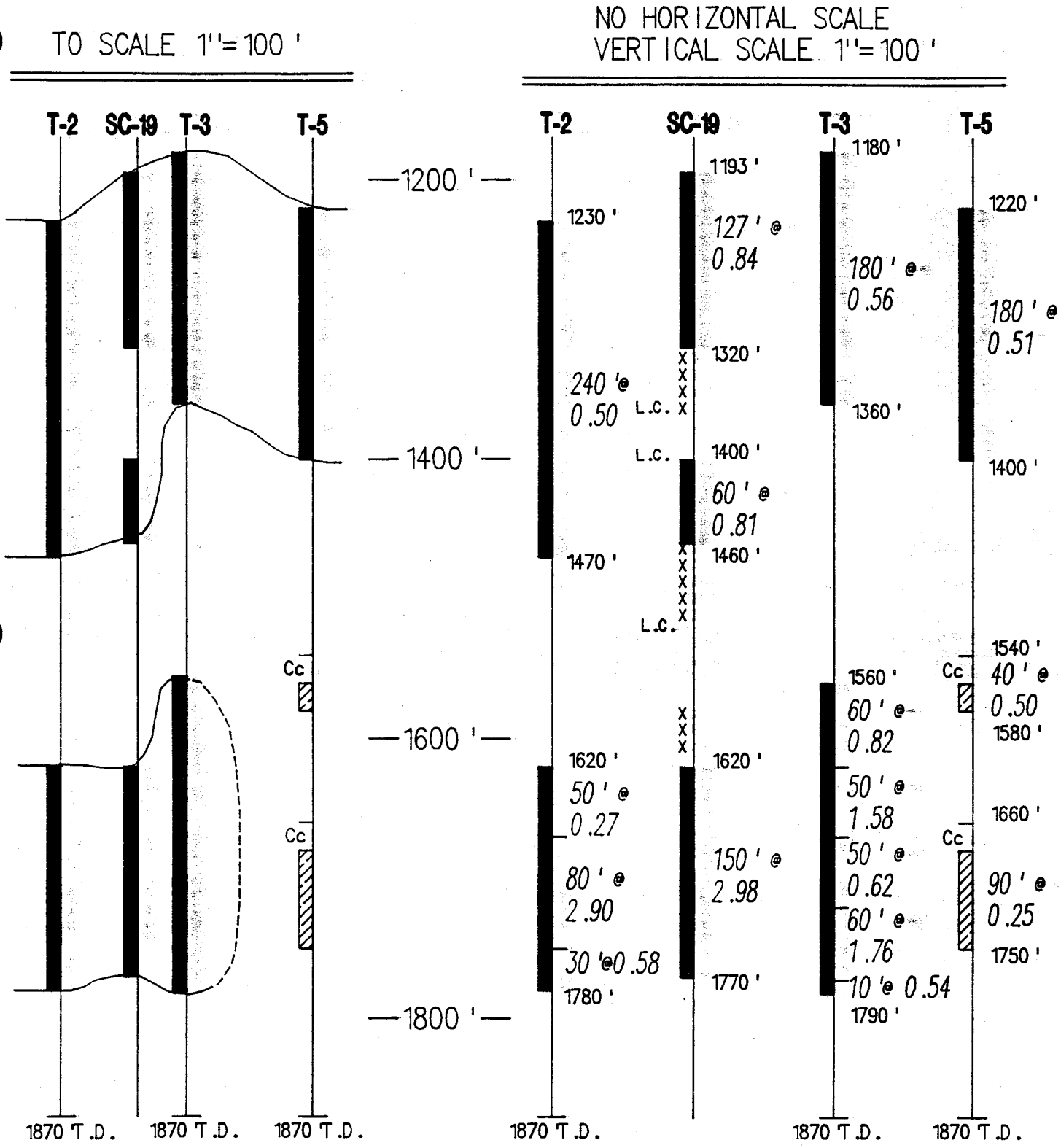
□ Hydrologic test well

○ Future core hole

⊠ Existing core holes

× Location of SC-19 and C-2 atacamite at 1700' depth

mn6676 ARR/dam tuc 3-8-89



EXPLANATION

X X FAULT-FRACTURE ZONES IN CORE HOLES

L.C. LOST CIRCULATION IN CORE HOLE

Cc CHALCOCITE

CuOx INTERCEPT

ASARCO Incorporated

SANTA CRUZ PROJECT

T-2 TO T-5 SECTION

PINAL COUNTY, ARIZONA

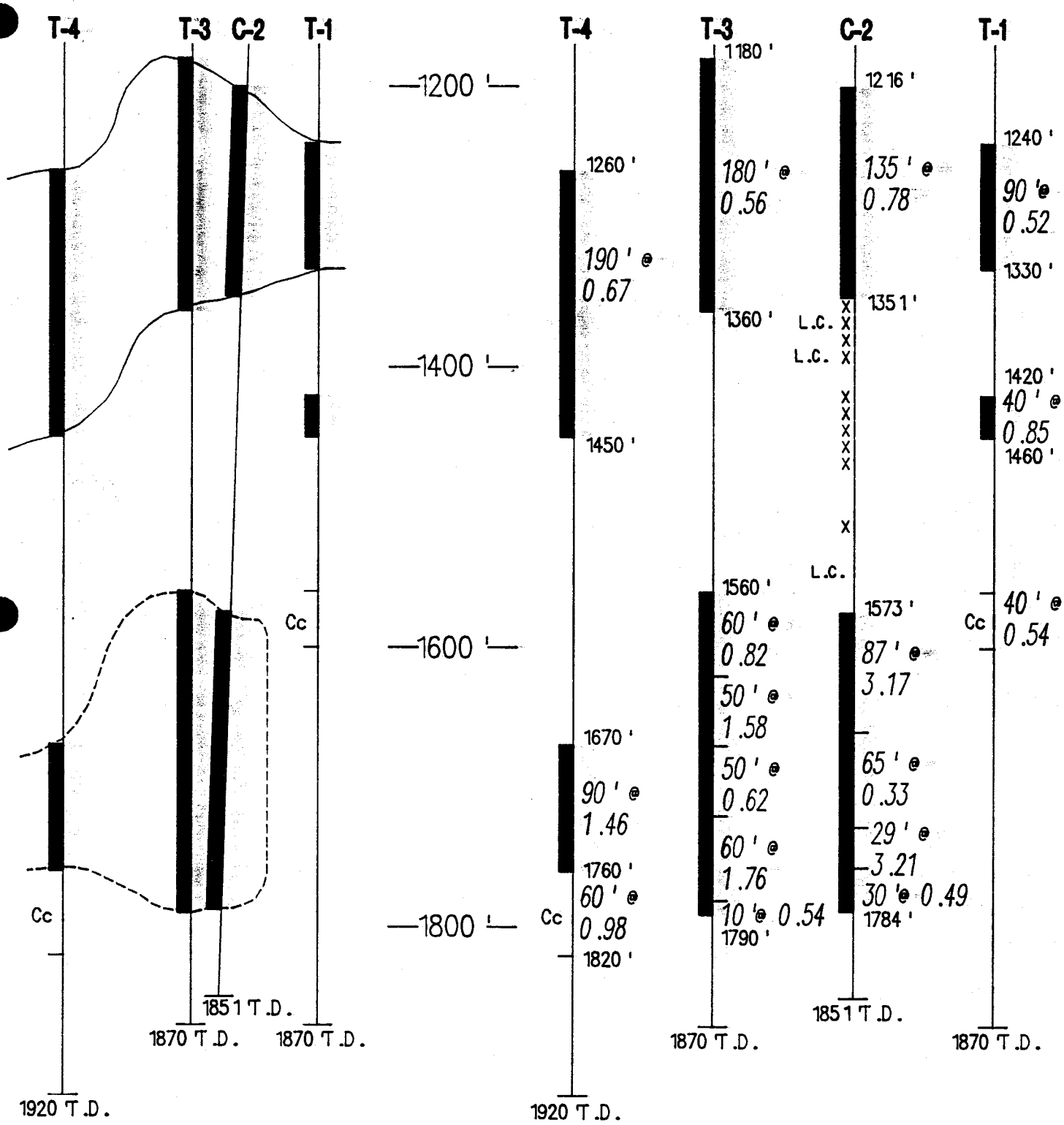
H.G.K. 11-28-89

MN 6819 HGK/DAM TUC 12-22-89

FILE SC-T2-T5.DWG

TO SCALE 1"=100'

NO HORIZONTAL SCALE
VERTICAL SCALE 1"=100'



EXPLANATION

X X FAULT-FRACTURE ZONES IN CORE HOLES

L.C. LOST CIRCULATION IN CORE HOLES

Cc CHALCOCITE

CuOx INTERCEPT

ASARCO Incorporated

SANTA CRUZ PROJECT

T-4 TO T-1 SECTION

PINAL COUNTY, ARIZONA

H.G.K. 11-28-89

MN 6820 HGK/DAM TUC 12-22-89
FILE SC-T4-T1.DWG

JDS

Media Plan for Santa Cruz In Situ Mining Research Project
January 29, 1990

The purpose of this plan is to coordinate a response to possible media interest in the contamination of the two test wells at the Santa Cruz research site; make sure that the positive aspects of the Joint Venture story are included in a first story; and to ensure that the many participants in the project are operating on the same assumptions.

Action trigger It is assumed that no action is necessary or will be taken unless a request for information is received from the media. The event poses no threat to nearby wells.

Likely scenarios Information about the event is most likely to come from ADEQ, in which case initial calls would probably be directed to Errol Montgomery and Associates, or from workers at the site, in which case initial calls would probably be directed to ASARCO in Tucson.

Immediate response We have a positive story to tell about this event, and we want to be sure that it gets told if media coverage occurs. See critical message below. It is important that the positive facts are communicated quickly and are included in the first story. Later stories usually receive less prominent coverage. If a story is going to break, we want our story told.

Person receiving the initial call should refer the reporter to the designated spokespersons. However, the first call is likely to be from a reporter who is working on a deadline. If the reporter is unable to reach anyone else, it is very important that the critical message is given to the reporter prior to deadline. The person receiving the first call should take responsibility for making sure that the reporter gets an appropriate response from the project, including (1) checking with the reporter to determine deadlines, (2) providing names and phone numbers (3) notifying other project members (4) calling the reporter back prior to deadline if necessary to make sure that our positive message was delivered.

Critical Message These points need to be made whether or not they are elicited by a reporter's questions. We want them appear near the beginning of the story if possible. See attached statement for details on issues.

* The contaminants cannot reach local wells because of the geology of the site and the well construction. See explanation in statement.

* The contamination was reported promptly and all laws have been complied with.

* A cleanup plan has been approved by Arizona Department of Environmental Quality and is being successfully implemented.

JAN 30 1990

SW Exploration

* Contamination occurred as the result of two unforeseen, isolated events. It is not an ongoing situation and every precaution is being taken to prevent another occurrence.

Spokespersons Initial calls should be directed to Bill Larson at the Twin Cities Research Center, or if he is not available to Tom Scartaccini in Tucson, or to Errol Montgomery.

William C. Larson, Manager Advanced Mining Division, United States Bureau of Mines
(612) 725-4690

Tom Scartaccini, General Manager, Southwest Mining Department, ASARCO (602) 792-3010

Errol L. Montgomery, Errol L.Montgomery and Associates, Inc
(602) 881-4912 (Also Charles Barter)

Standby statement The attached statement is not a press release. It is designed to:

1. Organize the relevant facts in a single document for use by project personnel. It could serve as an emergency briefing paper.

2. Provide language and approach for project personnel who may be called upon to explain the situation.

3. Provide a basis for preparation of a press release should one be needed.

4. Serve as a handout for interested people, such as owners of nearby wells should press coverage generate concern.

5. Be updated periodically to include water test information as cleanup progresses and other information as appropriate.

Followup plan Key project people should meet and discuss need for further action, if any, depending on the nature of the coverage and the situation, after publication of story.

Priscilla Robinson
January 29, 1990

P.R. copies to: Larson
Magner
Noyes
Scartaccini
Maley
Barter
Barber

HK → F.T.G & R.L.B 1-30-90
W.L.K & J.D.S. "

Standby Statement for Santa Cruz In Situ Sampling

To be used in Accordance with Media Plan

January 29, 1990

The Santa Cruz Joint Venture is constructing a series of five wells as the first step in a U. S. Bureau of Mines mining research project and has reported minute amounts of volatile organic compounds in well water in two of the wells. The contaminants, measured in parts per billion, appear to have been introduced into the wells during perforation of the well casing. The Arizona Department of Environmental Quality has been advised and is closely monitoring the situation. A cleanup plan has been approved by the Arizona Department of Environmental Quality and is being implemented. The Santa Cruz Joint Venture is investigating possible sources of the contamination. There is virtually no possibility that these contaminants could reach local wells because of the methods used in well construction and the geology at the research site. The wells are located about seven miles west of Casa Grande.

Change to "organics" (R.L.B. 1-29-90)

The contamination will not reach local water wells because the contamination zone is separated from the aquifer that supplies local wells by nearly 1000 feet of granite with very low permeability. The aquifer that supplies local wells is the uppermost formation in the geologic sequence. It is composed of

unconsolidated basin-fill and is approximately 650 feet thick at the test site. The perforation of the well and apparent resulting contamination occurred in the underlying granite formation between 1570 and 1770 feet below the land surface. Consultants for the project have estimated that water in the granite formation moves at approximately 1 foot per year.

Additionally, the total volume of the contaminants is very small and is contained within the well casing and near the well casing below the 1570 foot level. A test sample from a monitor well located at the site revealed no trace of the contaminants in the basin-fill deposits aquifer.

The purpose of this Bureau of Mines/private sector experimental research project is to test the feasibility of "in situ" (in place) mining of deeply buried copper deposits. If it is demonstrated to be feasible, in situ mining will allow recovery of copper from deep underground with minimum disturbance of the land surface and the rock in the ore body.

The field test is a step-by-step implementation of a design manual prepared by the Bureau of Mines. The research program is designed to investigate and utilize the best available technology and to test the applicability of this technology for use in in situ copper mining.

The first step in the field test was construction of five deep wells into the ore body to a depth of 1880 feet. The five wells were drilled, cased with blank fiberglass reinforced plastic pipe and sealed from the aquifer with acid resistant cement. The final step in the construction of the wells was perforation of a 200 foot section of casing near the bottom of the well to allow injection into the ore body and recovery of fluids.

The technique used for the perforation of wells is well-known technology used successfully for many years in the petroleum industry. Small, shaped explosive charges are detonated inside the well casing, creating circular openings in the casing and the cement seal between the rock wall of the borehole and the well casing. These openings, through which fluids can be injected and recovered, are about 1 inch in diameter and about 1 foot apart.

Following the perforation of the first well, water samples were taken and minute amounts of styrene, benzene, ethylbenzene, toluene, methylethyl ketone, vinyl chloride and acetone were detected. Early indications were that the contaminants were from materials used to perforate the well. After consultation with the Arizona Department of Environmental Quality, the perforation procedure was modified and permission was given to perform the perforations in a second well. While the results were different, minute amounts of the same contaminants were again found in the residues within the fully cased wells.

A plan to clean up the contaminated water has been presented to and accepted by Arizona Department of Environmental Quality for treatment of the test wells and for treatment of water pumped from the wells. This plan is currently being implemented. The plan includes removal of the contaminants from the two test wells, containment of water pumped from test wells, and removal of the contaminants from the contained water. Testing indicates that the removal of contaminants from the contained water is successful and permission has been given by the Arizona Department of Environmental Quality to use the water for dust control. Update

Demonstrated in lab. work

Scientists and chemical laboratories are investigating ~~whether~~ the contaminants ~~are~~ from the explosives, the ~~well~~ casing, the ~~material covering the~~ electric ~~cable~~ used to ~~detonate~~ the ~~explosives~~, or the ~~material that~~ holds the ~~explosives~~ in place. Perforation of the remaining three wells will not be conducted until the source of contamination is fully understood and the necessary modifications in the process have been made and approved.

Following construction of the well field, the next step in the research project is injection of an inert tracer solution to permit study of the movement of fluids through the ore body. Injection of leaching solutions cannot take place until after hydrologic studies are complete and environmental permits have been issued, estimated to take at least another year.

ASARCO

Southwestern Exploration Division

February 21, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
February 1990

The water from test well T-1 no longer contains volatile organic compounds. The water from test well T-2 shows substantial decreases in volatile organic compounds.

The extent of my involvement in the in situ leach portion of the Santa Cruz Project is described in the attached monthly report to Mr. Raihl. A substantial amount of my time in February was charged to the Santa Cruz Joint Venture (EA-0075). My S.C.J.V. work included:

(1) preparing an up-to-date land status map,
(2) determining future land needs (tailings, subsidence limits, and ore potential)
(3) acquiring from CBC Drilling all the old Joy Drilling shift reports for Santa Cruz South,
(4) identifying old exploration drill holes in Santa Cruz South that would be favorable for injection test work (favorable geology and free of drill casing),
(5) developing alternative plans for future storage of all the Santa Cruz Project core, etc., and
(6) providing Freeport with geologic information.

I visited Cyprus Casa Grande (Lakeshore) with Jim Paschis of In Situ Leach Inc.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

February 21, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
February 1990

In February my work on the in situ portion of the Santa Cruz Project consisted of filling in for you while you were in Africa for a little more than two weeks. Most of the activities during that time consisted of treating water with volatile organic compounds; the standby statement; and the aquifer protection permit.

Slides for talks were given to Mr. Millenacker, Mr. Swan, Mr. Graybeal, and Mr. Van Nort.

Mr. Jim Paschis of In Situ Leach Inc. was given a tour of the test site.

Ms. Dahl and I met with Dan White to discuss his past structural work on the Santa Cruz Project.

Mr. P. Nelson of the USGS updated Ms. Dahl and me on the status of his geophysical work.

During the month, I made weekly visits to the test site.

H. G. Kreis

Henry G. Kreis

HGK:mek

cc: W.L. Kurtz
J.D. Sell

JDS

ASARCO

Southwestern Exploration Division

March 6, 1990

F.T. Graybeal

Injection Tests
Santa Cruz South
Pinal County, Arizona

As requested by you, drill holes of the Santa Cruz South deposit have been reviewed to find copper oxide intercepts that are suitable for water injection permeability tests. The drill holes most suitable to this test work have been identified, and they are summarized in Table 1, starting with the most suitable hole and ending with the least suitable hole. Details on drill hole conditions and geology are in the attached appendix.

Table 1. Suitable CuOx Intercepts

Hole*	Remarks
CG-57	NX hole with good CuOx. Two separations in the rotary drill hole casing did not cause problems during coring but could be a potential problem for a packer.
SC-58	NX hole with good CuOx. This hole is not in the Santa Cruz South deposit, but in the Southeast reserve. However, it is geologically representative of the Santa Cruz South deposit.
CG-94	Excellent CuOx intercept but it is cased off. This is the best suited hole if cement abandonment and coring a wedged out hole is to be considered.
CG-27A	NX hole with good CuOx, but CG-27 and an apparent lost wedge out drill hole are in close proximity and will cloud the validity of encouraging test results.
CG-109C	NX hole with good CuOx, but three other holes (CG-109, -109A, and -109B) are in close proximity. These close drill holes will cloud the validity of encouraging test results.
CG-33	BX hole with good CuOx, but it is poorly situated on the very outer edge of the deposit.

* For drill hole locations see Figure 1.

There is no hole with a thick, representative copper oxide intercept that is free of casing in the copper oxide interval, free of nearby wedged out holes, free of separated casing, free of cement plugs, and free of perforated casing. One has to look to SC-58 to find such a hole, and that is why it was included in Table 1.

Of all the Santa Cruz South copper oxide intercepts, the one in CG-57 offers the best opportunity for doing meaningful permeability injection test work. The rotary drill hole casing in CG-57 could be a problem because it is separated in two places, 57' and about 1795'. Nonetheless, the opportunity for a meaningful test outweighs the possibility of problems.

Drill holes CG-27A and CG-109C are both wedge out NX core holes with good copper oxide intercepts. These wedge out core holes were drilled along the side of preexisting core holes. Consequently, injected water could "short circuit" to the neighboring drill holes, and this fact would cloud the validity of encouraging results. There is no way to cement the neighboring drill holes because the access is blocked by a wedge.

If one is willing to go to the cost of cementing off an existing cased hole (as best one can realizing the annulus between the wall of the hole and the casing will not get cemented) and drill a new wedge out core hole, CG-94 is the best candidate. Drill hole CG-94 has an excellent copper oxide intercept (copper mineralogy, thickness, grade, and continuity), and it is representative of the thicker portion of the Santa Cruz South deposit.

In searching for a suitable copper oxide intercept for testing, a large number of copper oxide intercepts were eliminated because of being cased off. Over 40,000' of casing was left in the drill holes below the cased off rotary drill holes. Some copper oxide intercepts were eliminated because of long intervals of cement plugs (present in six holes), and because of extensive perforated intervals in the casing of the rotary drill hole (present in eleven drill holes). Other copper oxide intercepts were eliminated on the basis of copper mineralogy, thickness (<200'), and not being representative. If a relatively thin copper oxide intercept is deemed to be suitable for test work, the holes northwest of Cross Section No. 17 can be researched.

H.G. Kreis

H.G. Kreis

HGK:mek
Atts.

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

APPENDIX

SUMMARY OF DRILL HOLE DATA

CG-33 — BX size hole with good intercept of 280' at atacamite and chrysocolla in granite. Strong faults at top and bottom of CuOx intercept. Hole is located on outer edge of reserve and, thus, is not in a representative location. CG-33's small hole size and fringe location are negative factors.

CG-99 — CuOx interval is cased off. Too much chalcocite mixed with atacamite to be considered representative of CuOx mineralization.

CG-57 — NX hole in CuOx interval. The 3" surface casing is separated at 57' and at 1795', but the separated casing caused no significant drilling problems. Good intercept of CuOx mineralization: 2210'-2420', 210' at 2.0% Cu as chrysocolla in granite; 2420'-2670', 250' at 0.7% Cu as atacamite in granite; 2670'-2760', 90' interval of leached capping in a strong fault zone; and 2760'-2920', 160' at 1.3% as atacamite and minor chrysocolla in granite. Good hole for injection test as long as packer can pass through the separated casing.

CG-100 — CuOx interval is cased off. Thin, 150' thick, CuOx interval capped by fault and overlying conglomerate.

CG-27A — NX hole in CuOx interval. CG-27 has 3" I.D. steel casing from surface to 1920'. CG-27A is a wedge out hole with the wedge set between 1912' and 1922'. Drill reports are incomplete and suggest a possible abandoned (lost) wedge out hole from 1920' to 2142'. The adjoining, original CG-27 core hole is open from 1920' to 2100', cased from 2100' to 2510', and open from 2510' to 3906' T.D. CG-27A has good CuOx mineralization: 1930' to 2160', 230' at 2.0% Cu as atacamite and chrysocolla in porphyry; 2160'-2360', 200' at 1.4% Cu as atacamite in granite; 2360' to 2600', 240' at 1.2% Cu as atacamite and chalcocite in granite. CG-27A has good geology, but the close proximity of CG-27 and the possible lost wedge out hole may interfere with injection tests in CG-27A.

CG-94 — CuOx intercept is cased off; otherwise, an excellent, 600' thick copper intercept for injection tests. Worth considering cement abandonment of CG-94 and wedging out an NC core hole. From 2220' to 2820' is 600' at 1.0% Cu as atacamite in granite with minor porphyry.

APPENDIX

SUMMARY OF DRILL HOLE DATA, Continued

CG-16	500' Thick CuOx intercept contains three, steeply dipping, strong fault zones. In addition the CG-16 CuOx intercept is interpreted to be less than 100' from the steeply dipping Eastern Fault and less than 100' from conglomerate in the hanging wall of the Eastern Fault. The abundance of faults in and near CG-16 and the presence of conglomerate within 100' are representative of the geology along the Eastern Fault, but not the rest of the CuOx mineralization. Consequently, CG-16 is only worth injection testing if one wants to evaluate the permeability along the Eastern fault zone.
CG-50	The 200' CuOx intercept is cased off.
CG-110	The 300' of CuOx mineralization is cased off.
CG-38	Excellent 600' thick CuOx intercept, but the CuOx intercept is cased off and the surface casing is perforated from 500' to 1620'.
CG-91	CuOx intercept is cased off. The CuOx intercept is in the Eastern fault zone and is not of interest for injection test work.
CG-88	CuOx intercept is cased off and the geology is not particularly favorable.
CG-37	Unfavorable CuOx thickness and continuity.
CG-109, -109A, -109B, -109C	Drill hole CG-109 was cored from 1986' to 3609' T.D. Three wedge out holes were drilled: CG-109A, 2067'-2379'; CG-109B, 2015'-2561'; and CG-109C, 2004'-2619'. CG-109C is an NX size hole with no casing. Casing is present in the cored hole of CG-109, 1995'-3215'; and in CG-109A, 2051'-2379'. The CuOx mineralization in CG-109 (and CG-109C) is: 2080'-2320', 240' at 1.9% Cu as atacamite in granite; and 2370'-2600', 230' at 0.8% Cu as atacamite, chrysocolla, and chalcocite in granite. The geology of CG-109C is favorable but the proximity of neighboring core holes to CG-109C is considered not favorable for injection test work.
CG-87	Unfavorable geology.
CG-23	Unfavorable geology.
CG-82	Unfavorable geology.

APPENDIX

SUMMARY OF DRILL HOLE DATA, Continued

CG-45	CuOx intercept is cased off.
CG-90	The 4" casing in the rotary hole has been extensively perforated and four plugs may have been left in the hole between perforated intervals. Hanna-Getty ran injection tests in the CuOx, the leached capping, and the conglomerate. This hole is not suitable for injection test work at this time.
SC-58	NX hole in CuOx. 1904' is bottom of 3½" I.D. casing in rotary drill hole. Excellent CuOx intercept: 2021'-2208', 187' at 0.96% Cu as atacamite and chrysocolla in granite; and 2208'-2614', 406' at 0.51% Cu in granite.

SANTA CRUZ COMMUNICATION TESTS

J.D.S.

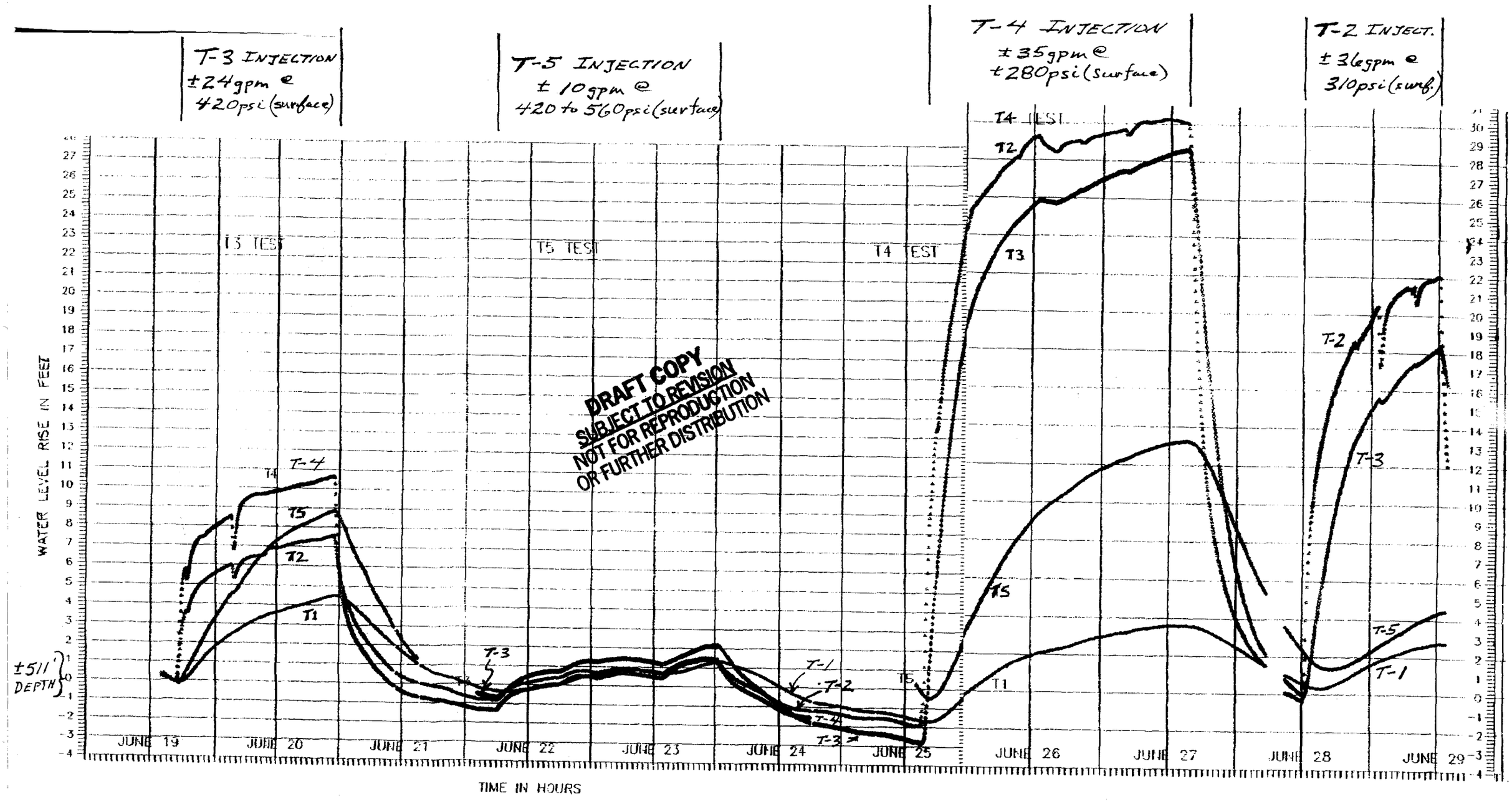


FIGURE WATER LEVEL HYDROGRAPH OF TEST WELLS DURING INTERFERENCE TESTING

JDS

ASARCO

Southwestern Exploration Division

March 22, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
March 1990

Test wells T-3, T-4, and T-5 were perforated, and the water is being treated to remove volatile organic compounds. All the test wells have been perforated, and all of the test wells are expected to be free of volatile organic compounds before the end of April.

During the month the following memos/items were issued: a memo on suitable drill holes for possible injection test work on Santa Cruz South, a land status map, a future land use map, a memo on SCJV storage facilities, and a memo on SCJV unpatented mining claims. Preparations are being made for the Asarco Board of Directors to visit the Santa Cruz in situ project.

I attended an AIME short course on in situ leaching.

My work in the in situ test in March is described in the attached monthly report to A.R. Raihl.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz/J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

March 22, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
March 1990

In March my work on the in situ portion of the Santa Cruz Project consisted mostly of compiling information and preparing maps and sections for the Phase I and II report. In addition there were discussions on interpreting the geophysical logs, and there was other miscellaneous project work.

Mr. Neil Williams, Chief Geologist for Mount Isa Mines, was given a tour of the test site.

March 16 and 17 were spent at the test site.

H. G. Kreis

HGK:mek

Henry G. Kreis

cc: W.L. Kurtz
J.D. Sell

JDS

ASARCO

Southwestern Exploration Division

March 22, 1990

J.D. Sell

Quarterly Report
First Quarter 1990
H.G. Kreis

Santa Cruz In Situ Project - EA-0438 - Copper

In the first quarter 34 days of time were spent on activities of the in situ leach program.

Santa Cruz Project - EA-0075 - Copper

A total of 27 days were expended on Santa Cruz land, storage facilities, land use plans, possible injection test work, and other miscellaneous work.

Miscellaneous

Four days of vacation time were taken.

H.G. Kreis

HGK:mek

H. G. Kreis

Plans (3 of 5 well cleaned of contamination
Pressure injection hole test
Plans for acid-injection
Test communication with well.

option of moving core etc.

ASARCO

Exploration Department
Southwestern United States Division

March 23, 1990

Dorothy
Arizona Tent, Table & Chair Rentals
2034 W. Fillmore
Phoenix, Arizona 85009

Dear Dorothy:

Enclosed is a check for $534.41 made payable to Arizona Tent, Table & Chair Rental.

Also enclosed is a map showing where the tent will be erected.

Sincerely,

H. G. Kreis

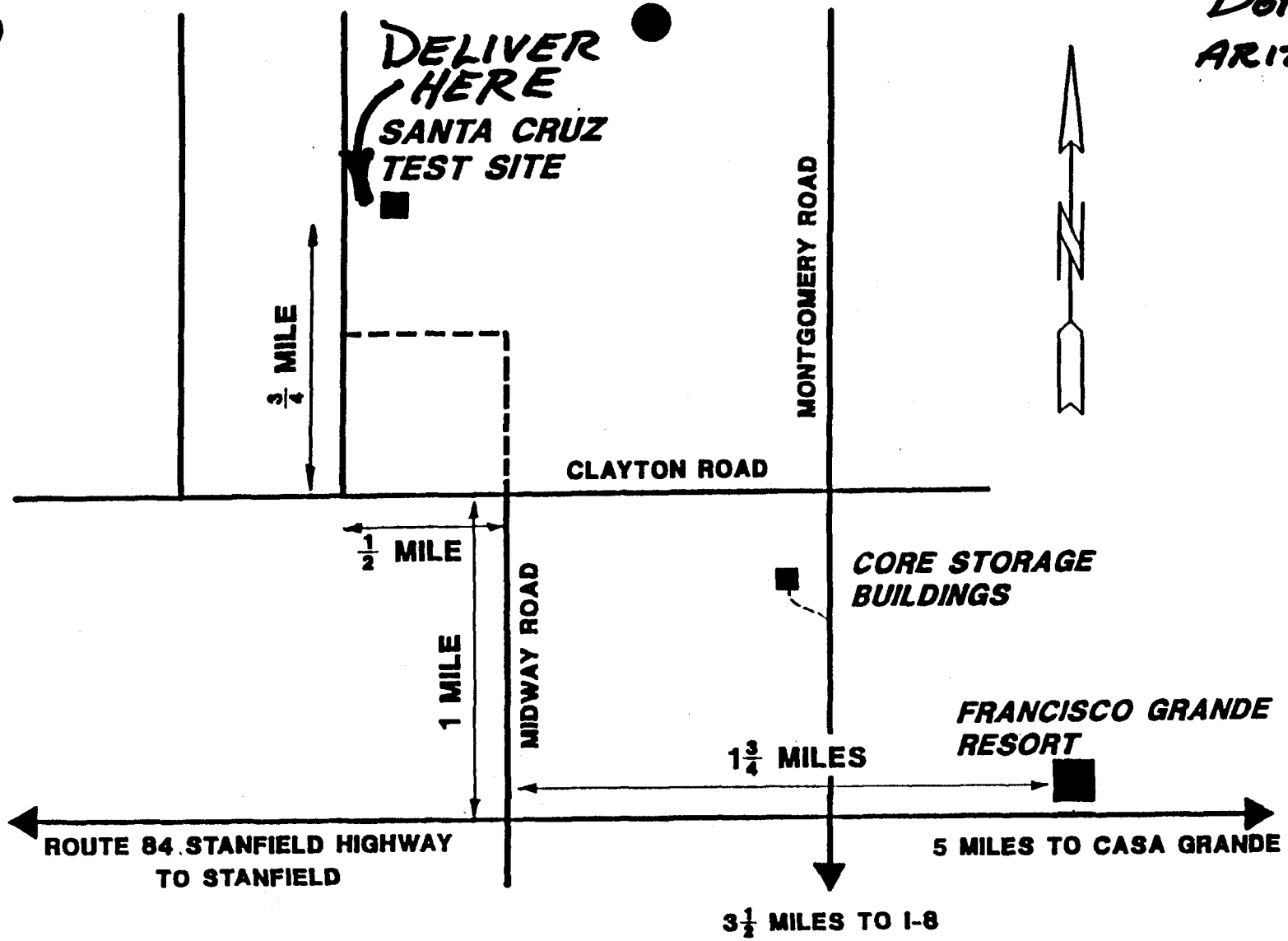
Henry G. Kreis
Site Manager
Santa Cruz Project

HGK:mek
Encs.

cc: J.D. Sell
C.L. Snow

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

DOROTHY
ARIZ TENT



PURCHASE ORDER: T-47-0

Tucson 792-3010
Casa Grande 836-6249

ASARCO INC.
P.O. Box 5747
Tucson, Az
85703

SANTA CRUZ
TEST SITE LOCATION
PINAL CO., ARIZONA

DECEMBER 1988

0 1/2 MILE

mn6646 HGK/dam tuc 11-88

arizona tent, table & chair rentals

Mar, 21, 1990

ASARCO, Inc.
P.O. Box 5747
Tucson, Az. 85703

Phone 792-3010
FAX 792-3934

Attn: Hank Kreis

30 x 40 canopy	$396.00
70' sidewall	35.00
36 - gray Samsonite chairs	18.00
1 - 6' table	5.00
	$454.00
Tax	30.41
Del.	50.00
Total	$534.41

Canopy to be set up in Casa Grand on April 10th and taken down April 12th.

Must be paid in full by April 6th.

Thank you for calling Arizona Tent, Table & Chair Rental.

Dorothy
Dorothy

Received the map, thanks!
P.O. T-47-0
Mining General 2910 (As per ARR.)
H. G. Krei

2034 W. Fillmore / Phoenix, AZ 85009 / (602) 252-8368 (602) 252-TENT

ASARCO

Southwestern Exploration Division

April 23, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
April 1990

The treatment of water to remove volatile organic compounds in T-3 and T-5 continues. Test wells T-1, T-2, and T-4 are free of volatile organic compounds. As soon as T-3 and T-5 are clean, the wells will be cleaned with acid and subjected to water injection tests.

During the month preparations were made for the Asarco Board of Directors visit to the in situ test site. The visit was made on April 11th.

Arrangements are being made for a local contractor to do the assessment work on the Santa Cruz unpatented mining claims.

Early in April I attended the Nevada Geological Society's gold sympsoium in Reno.

My April work on the in situ leach test is described in the attached monthly report to A.R. Raihl.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

April 23, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
April 1990

In April my work on the in situ portion of the Santa Cruz Project consisted of preparing an ore reserve for the test site and preparing the geological section of the Phase I and II report.

Contractual and field arrangements are being made with Zonge Engineering for the CSAMT survey on the test site. Mr. Pat Talla has given his permission to use one of his leased agricultural fields for the transmitter site.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell

JDS

ASARCO

Southwestern Exploration Division

May 1, 1990

H.G. Kreis

Welcome Back
Review - New Ideas
Porphyry Copper - Pediment

As you gain more open time from the In Situ work, Mr. R.L. Brown suggested that you might like to stay in the porphyry copper mode.

Place, as Priority One, a new report through a study of all previous reports, drill hole sniffs, alteration-geology trends, etc. which you can find for integrating into a new porphyry copper pediment program.

By mid-summer Mr. Carl Windels, Asarco's Manager of Geophysics and Exploration Technology, will be in a position to discuss with SWED how we might integrate geophysics into a pediment program.

Several target areas come to mind, but I'm sure you can come up with many others:

a. Park - Salyer

b. Two areas east of Florence Highway, one of which you drilled. Reinterpretation now possible?

Such targets should include both high-grade, superenriched zones, and oxide copper zones, which will lower the unit cost of production.

James D. Sell

JDS:mek

James D. Sell

cc: R.L. Brown/F.T. Graybeal
W.L. Kurtz

ASARCO

Exploration Department
Southwestern United States Division

May 21, 1990

Department of Water Resources
15 South 15th Avenue
Phoenix, Arizona 85007

Santa Cruz JV
Notices of Intention to
Drill Exploration Wells

Gentlemen:

Enclosed are three (3) "Notice of Intention to Drill Exploration Well" forms for three wells. Asarco's check of $30.00 for the filing fees is also enclosed.

Sincerely yours,

Henry G. Kreis/mek

Henry G. Kreis
Field Manager

HGK:mek
Encs. (3 in duplicate)
(check)

cc: J.D. Sell
W.L. Kurtz

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

EXPLORATION WELL(S)

FILING FEE $10.00

DEPARTMENT OF WATER RESOURCES (DWR)
NOTICE OF INTENTION TO DRILL
EXPLORATION WELL(S)

EXPLORATION WELL(S)

Section 45-596, Arizona Revised Statutes and Rule R12-15-817 provide: Prior to drilling one or more exploration wells, the well owner, lessee or exploration firm shall file a Notice of Intention to Drill on a form provided by the Department.

WELL/LAND LOCATION

1. Township 6S N/S
   Range 4E E/W
   Section 12

In the case of a single well, list 10-acre subdivision

SW ¼, SW ¼, NE ¼

2. County Pinal

3. Applicant:
   ASARCO Incorporated
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

4. Henry G. Kreis
   NAME OF CONTACT PERSON
   Phone 792-3010

5. Owner of well:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

6. Purpose of well(s) drilled pursuant to this Notice:
   Mineral Exploration X
   Geotechnical ____
   Cathodic Protection ____
   Grounding ____

7. Number of wells 1
   (See Condition 3 on reverse)

8. Owner of land:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

9. DESCRIPTION OF WELL:
   Diameter 5 inches
   Depth Approx. 190 feet
   Type of casing None
   (If none, so state)

10. Construction will start:
    June 11 1990
    Month Day Year

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

File No. ____
Filed ____ By ____
Input ____ By ____
Duplicate Mailed ____ By ____
Registration ____
AMA/INA ____
W/S ____ S/B ____

11. Drilling firm:
    Cissell Drilling
    Name
    P.O. Box 1048
    Address
    Casa Grande, AZ 85222
    City State Zip
    317
    DWR License Number

12. Period well will remain in use None months.

13. Proposed method of abandonment of well(s) after project is completed:
    Back fill with rotary cuttings immediately after drilling.

14. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area of hazardous materials? Yes ___ No X

If yes, a request for a variance must accompany this application pursuant to R12-15-820.

GENERAL INSTRUCTIONS

1. Fill out this form in duplicate and mail to Department of Water Resources, 15 South 15th Ave. Phoenix, Arizona 85007
2. Proper filing fee of $10.00 must accompany Notice.

I state that this Notice is filed in compliance with Rule R12-15-809 and is complete and correct to the best of my knowledge and belief and that I understand the conditions set forth on the reverse side of this form.

DATE May 21, 1990

James D. Sell
Signature of Applicant

DWR 55-40-10/88 (Revised)

EXPLORATION WELL(S)

FILING FEE $10.00

DEPARTMENT OF WATER RESOURCES (DWR)
NOTICE OF INTENTION TO DRILL
EXPLORATION WELL(S)

EXPLORATION WELL(S)

Section 45-596, Arizona Revised Statutes and Rule R12-15-817 provide: Prior to drilling one or more exploration wells, the well owner, lessee or exploration firm shall file a Notice of Intention to Drill on a form provided by the Department.

WELL/LAND LOCATION

1. Township 6S M/S
   Range 4E E/W
   Section 23

In the case of a single well, list 10-acre subdivision

NE ¼, NE ¼, NW ¼

2. County Pinal

3. Applicant:
   ASARCO Incorporated
   Name
   P.O. Box 5747
   Address
   Tucson AZ 85703
   City State Zip

4. Henry G. Kreis
   NAME OF CONTACT PERSON
   Phone 792-3010

5. Owner of well:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

6. Purpose of well(s) drilled pursuant to this Notice:
   Mineral Exploration X
   Geotechnical
   Cathodic Protection
   Grounding

7. Number of wells 1
   (See Condition 3 on reverse)

8. Owner of land:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

9. DESCRIPTION OF WELL:
   Diameter 5 inches
   Deepen an old hole 130'
   Depth approx. 600 feet total

   Type of casing 20' steel
   (If none, so state)

10. Construction will start:
    June 11 1990
    Month Day Year

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

File No.
Filed By
Input By
Duplicate Mailed By
Registration
AMA/INA
W/S S/B

11. Drilling firm:
    Cissell Drilling
    Name
    P.O. Box 1048
    Address
    Casa Grande, AZ 85222
    City State Zip
    317
    DWR License Number

12. Period well will remain in use ? months.

13. Proposed method of abandonment of well(s) after project is completed:
    Weld cap on steel casing leaving hole open for reentry next year.

14. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area of hazardous materials? Yes__ No X
    If yes, a request for a variance must accompany this application pursuant to R12-15-820.

GENERAL INSTRUCTIONS

1. Fill out this form in duplicate and mail to Department of Water Resources, 15 South 15th Ave. Phoenix, Arizona 85007
2. Proper filing fee of $10.00 must accompany Notice.

I state that this Notice is filed in compliance with Rule R12-15-809 and is complete and correct to the best of my knowledge and belief and that I understand the conditions set forth on the reverse side of this form.

DATE May 21, 1990

James D. Scott
Signature of Applicant

DWR 55-40-10/88 (Revised)

EXPLORATION WELL(S)

FILING FEE $10.00

DEPARTMENT OF WATER RESOURCES (DWR)
NOTICE OF INTENTION TO DRILL
EXPLORATION WELL(S)

EXPLORATION WELL(S)

Section 45-596, Arizona Revised Statutes and Rule R12-15-817 provide: Prior to drilling one or more exploration wells, the well owner, lessee or exploration firm shall file a Notice of Intention to Drill on a form provided by the Department.

WELL/LAND LOCATION

1. Township 6S N/S
   Range 4E E/W
   Section 24

In the case of a single well, list 10-acre subdivision

NW ¼, NW ¼, NW ¼

2. County Pinal

3. Applicant:
   ASARCO Incorporated
   Name
   P.O. Box 5747
   Address
   Tucson, AZ 85703
   City State Zip

4. Henry G. Kreis
   NAME OF CONTACT PERSON
   Phone 792-3010

5. Owner of well:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson AZ 85703
   City State Zip

6. Purpose of well(s) drilled pursuant to this Notice:
   Mineral Exploration X
   Geotechnical ___
   Cathodic Protection ___
   Grounding ___

7. Number of wells 1
   (See Condition 3 on reverse)

8. Owner of land:
   Santa Cruz JV
   Name
   P.O. Box 5747
   Address
   Tucson AZ 85703
   City State Zip

9. DESCRIPTION OF WELL:
   Diameter 5 inches
   Depth Approx. 190 feet
   Type of casing None
   (If none, so state)

10. Construction will start:
    June 11 1990
    Month Day Year

11. Drilling firm:
    Cissell Drilling
    Name
    P.O. Box 1048
    Address
    Casa Grande, AZ 85222
    City State Zip
    317
    DWR License Number

12. Period well will remain in use None months.

13. Proposed method of abandonment of well(s) after project is completed:
    Back fill with rotary cuttings immediately after drilling.

DO NOT WRITE IN THIS SPACE
OFFICE RECORD

File No. ___
Filed ___ By ___
Input ___ By ___
Duplicate Mailed ___ By ___
Registration ___
AMA/INA ___
W/S ___ S/B ___

14. Is the proposed wellsite within 100 feet of a septic tank system, sewage disposal area, landfill, hazardous waste facility or storage area of hazardous materials? Yes ___ No X
    If yes, a request for a variance must accompany this application pursuant to R12-15-820.

GENERAL INSTRUCTIONS

1. Fill out this form in duplicate and mail to Department of Water Resources, 15 South 15th Ave. Phoenix, Arizona 85007
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I state that this Notice is filed in compliance with Rule R12-15-809 and is complete and correct to the best of my knowledge and belief and that I understand the conditions set forth on the reverse side of this form.

DATE May 21, 1990

James D. Self
Signature of Applicant

DWR 55-40-10/88 (Revised)

ASARCO

Southwestern Exploration Division

June 5, 1990

A.R. Raihl

Break In
Santa Cruz
Test Site

A break in occurred at the Santa Cruz test site between 7:00 PM (possibly as early as 5:00 PM) June 1st and June 2nd 6:00 AM. Padlocks and chains were cut with a bolt cutter. Deputy Dill from the Pinal County Sheriff's Stanfield office arrived at the site at about 7:30 AM. Deputy Dill photographed the tire tracks and at least one footprint left by the suspect(s). One footprint was that of a very small adult or child.

The following items are known to have been stolen:

Owner	Item	Value
SCJV-USBM	Box of tools	$1,000
" "	Generator*	1,200
Layne Western	Tools	2,500

*Winpower, Model GP3000R, Serial No. 61050-13

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
Accounting

ASARCO

Southwestern Exploration Division

June 6, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
May 1990

During May I worked on preparing a Santa Cruz EA-0075 budget and a work proposal for in situ test work on Santa Cruz South. This was done in preparation for the S.C.J.V. meeting on May 31st. Mr. Dave Deci, a Freeport-McMoRan mining engineer, spent a day reviewing and obtaining Santa Cruz South data from the Hanna-Getty files.

Test wells T-1, -2, -3, -4, and -5 were acidized to clean out the perforations and fractures near the well bore. After acidizing, acid water was removed from each well by the use of swabs and Moyno pumps. The copper bearing acid water was hauled in lined tanker trucks to the heap leach dumps at Ray Mines. Sediment that had accumulated in the bottoms of the test wells was bailed out.

A number of failures were experienced with the fiberglass casing. A torque problem associated with the running of the Moyno pumps caused threads on the fiberglass tubing to strip off in some cases; and, in other cases, the fiberglass tubing unscrewed. The reason for the torque problem has not been identified for certain. In one hole, the fiberglass tubing locked together and had to be sawed apart to get it out of the hole. This problem was solved with the use of teflon tape in addition to the teflon pipe dope that was being used.

Fishing equipment was purchased to use for fishing fiberglass tubing and sucker rods.

A controlled source audio frequency magnetotellurics survey (CSAMT) was run over the test site, and the results will be presented at a meeting in the Tucson Office on June 13th.

A land survey was made of the buried electrical system and other components of the test site. A water well site was located on the east side of Section 13, and the well will be drilled next month.

Plans are being made to run a telephone line to the test site and the plant site.

My May work on the in situ leach test is described in the attached monthly report to A.R. Raihl.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz, J.D. Sell, A.R. Raihl

ASARCO

Southwestern Exploration Division

June 6, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
May 1990

During May my work on the in situ portion of the Santa Cruz Project included the following:

- overseeing acidization of the test wells
- trouble shooting the perforation problem in T-3
- overseeing acid removal from the wells by bailing and the use of Moyno pumps
- collecting 55 gallon drums of copper bearing acid solution for the USBM
- overseeing the collection of regularly taken samples of recovered acid solution.
- compiling records on the amount of acid solution recovered from each well
- making daily arrangements for shipping recovered acid solution to Ray Mines
- watching for corrosion caused by the acid
- making arrangements for the CSAMT survey and the follow up CSAMT survey work
- making arrangements for a land survey of the buried electrical system, etc.
- locating the water well site and making arrangements for electrical power to the site
- photographing various site activities
- having 4" core cut and polished
- making daily progress reports to USBM are copies in the ASARCO file?
- having prints made of photographs taken from helicopter
- seeing that any diesel spills and any acid solution spills were cleaned up
- making arrangements for telephone service to the test site
- giving tours to S. Anzalone and to P. Tilman
- attending the ADEQ meeting in Mobile, Arizona concerning the hazardous waste disposal site
- attending a Denver meeting on down-hole geophysical information from the test site.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
R.L. Brown

ASARCO

Southwestern Exploration Division

June 6, 1990

F.T. Graybeal

Polished Core
Santa Cruz

Enclosed for the Asarco Board of Directors' meeting room is a cut and polished piece of 4" diameter core. It was taken from T-2 at a depth of 1706'.

The end of the core was not cut and polished the way I had requested. It looks alright the way it is, particularly if the core is mounted at a slant.

If this core meets your satisfaction the way it is, I would suggest having it mounted on a wood base at a trophy shop.

H. G. Kreis

H. G. Kreis

HGK:mek
Enc.

cc: W.L. Kurtz
J.D. Sell

J DS

ASARCO

Southwestern Exploration Division

June 13, 1990

A.R. Raihl

Zonge Engineering
CSAMT Survey
Santa Cruz Project

On June 13th Zonge Engineering gave a presentation on the results of their CSAMT survey on the Santa Cruz Test Site. The survey was conducted prior to the injection of acid into the casing perforations. Present at the meeting were Norm Carlson (Zonge Eng.), Scott McInnis (Zonge Eng.), Steve Wilds (Zonge Eng.), Carl Windels, Steve Swan Charlie Barter, Errol Montgomery, you and I. Copies of their report, "Phase I Report" dated June 13, 1990, were made available to everyone. Mr. Windels, Mr. Montgomery, and I kept copies of the report, and Mr. Swan will receive his copy from you.

Zonge Engineering concluded the following from the CSAMT results:

- The CSAMT resistivity values are reproducible with an error of less than 5%.
- The steel casing of the test wells and the other cultural features had no significant effect on the survey results.
- Interpretations of the resistivity values correlate well with the geology as it is known from the drill hole results.
- A CSAMT survey probably will detect the acid-copper bearing solution during leaching, and it may detect the brine solution during the tracer test. There is some question as to whether or not the brine will be detected.

Between now and the tracer test, the following work will be done:

- Zonge Engineering and Carl Windels will review the resistivity contrast caused by the brine tracer to determine the likelihood of detecting the tracer solution.
- Zonge Engineering and Carl Windels will determine if the HCl left in the test site horizon is enough to suggest a need for a CSAMT prior to the tracer test.

- Zonge Engineering and Carl Windels will review the resistivity contrast caused by the sulfuric acid leach solution.

- Sometime in late July Zonge Engineering, Carl Windels, Don Davidson, and I will review all the information obtained to date. We will check to see if we are all still in agreement with Mr. Davidson's recommendations of March 19th as to when to run the CSAMT survey during the brine tracer test.

- We will check with Phil Nelson (USGS) to see if some of his work can be interfaced with the CSAMT survey work.

H. G. Kreis

HGK;mek

H. G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
C.O. Windels

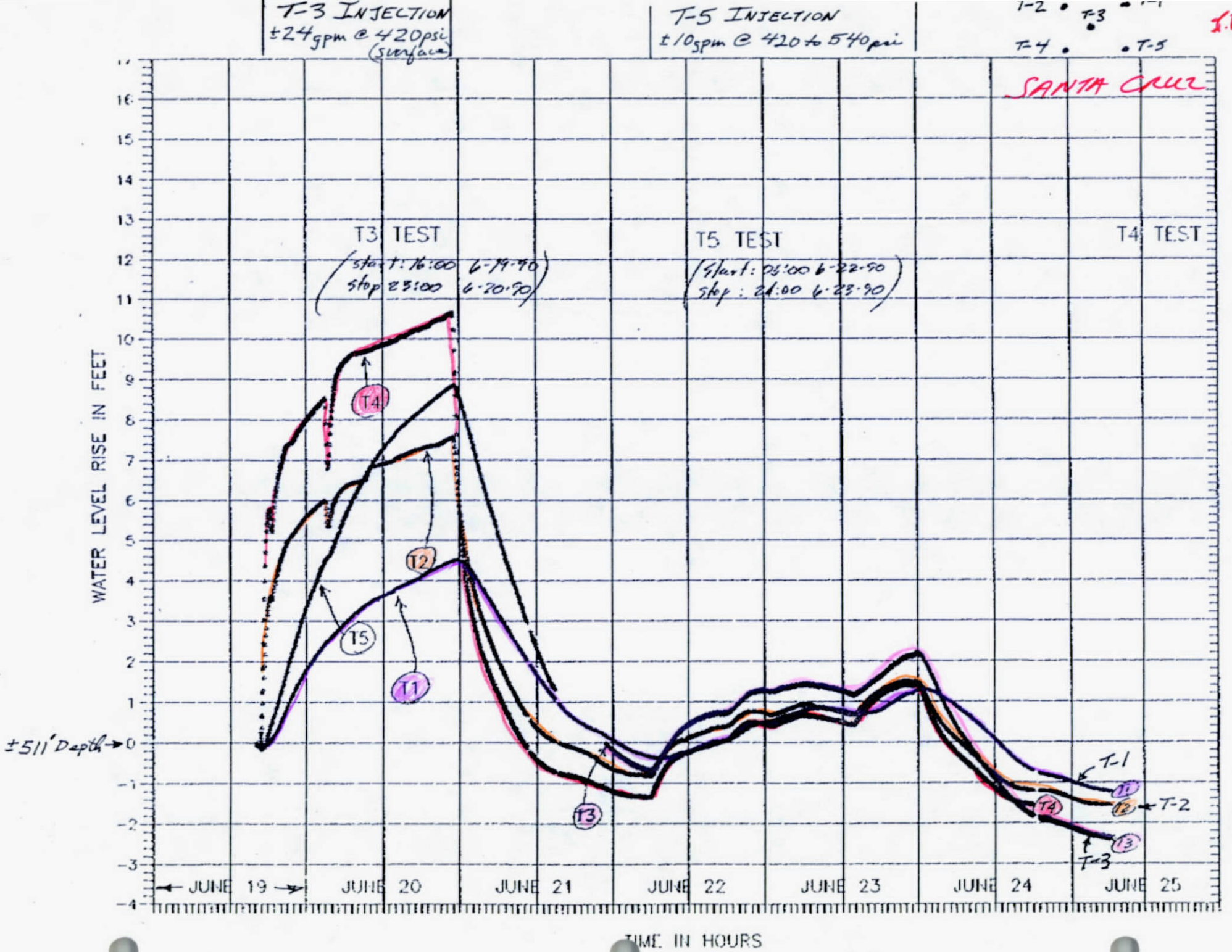


FIGURE . WATER LEVEL HYDROGRAPH FOR TEST WELLS DURING INTERFERENCE TESTING

TOTAL P.02

ASARCO

Southwestern Exploration Division

June 29, 1990

A.R. Raihl

Attempted Core Shed
Break In
Santa Cruz Project

On the night of June 22nd or 23rd (possibly June 24th), there was an attempt to break into the south core storage building. The following was found:

- The west door on the north side of the building was pried partially open.
- Several 22 gauge shots were fired at the power meter breaking off the cover but not turning off the power.
- Several shots were fired at the outside night light but did not hit the bulb so it stayed lit.
- Several shots were fired into the west side of the building.
- Tire tracks and a couple of footprints were found on the west side of the building.
- There were no footprints or other evidence suggesting the party(ies) had any interest in the other two buildings.

Officer Ron Harrison of the Pinal County Sheriff's Department investigated the above on June 26th when the attempted break in was first noticed.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

July 3, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
June 1990

During June, drilling assessment work for the unpatented mining claims was completed, and appropriate forms were filed with the Arizona DWR.

Following the clean-up of acidic copper solution from the wells, fresh water was pumped into the formation. This pushed back any remaining acidic solution so logging tools could be run down the holes.

Pressure injection/pressure fall off tests were run in each of the test wells. In each well, this was followed by the running of a flow profile log using a full bore spinner tool. The results of the full bore flow profile were checked in several holes with the use of a diverter spinner tool flow profile.

Communication tests were run for four of the five test wells (T-2, T-3, T-4, and T-5). This test consisted of injecting water under pressure in one well and measuring the water level rise in each of the other four wells.

The results of the above test work are being evaluated by Mr. Davidson.

In general Mr. Davidson interprets the results to date as being encouraging.

The drilling of a water well on the west side of Section 13 was started at the end of the month, and it will be completed before the middle of July.

My work on the in situ leach test is described in the attached monthly report to A.R. Raihl.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz (w/o att.)
J.D. Sell (" ")
A.R. Raihl (" ")

JDS

ASARCO

Southwestern Exploration Division

July 3, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
June 1990

During June my work on the in situ portion of the Santa Cruz Project included the following:

- overseeing the last of the acid removal from the test wells and the shipments of acidic copper solution to Ray Mines
- overseeing the injection of well water to push back any acidic water in each of the test wells
- overseeing pressure injection/pressure fall off tests
- overseeing fluid flow profile logging
- overseeing communication test work
- overseeing the installation of buried conduit for wires to the pressure transducers
- overseeing the cleaning of the Baker tanks
- completing field work for the telephone line
- making arrangements for surveying services
- reporting on the break-in at the test site and an attempted break-in at the core shed
- purchasing replacement tools and equipment
- making arrangements for another water source
- making arrangements for Bean pump repairs
- collecting and shipping 50 to 60 core samples for the USBM-USGS porosity work
- collecting and shipping pulps of sulfide mineralization to the USBM for heavy metal analysis
- shipping bottles of acidic copper solution to the USBM
- making arrangements for electrical power to SM-2 and SM-3
- keeping track of site activities and keeping the USBM up-to-date
- arranging and attending a meeting on Zong Engineering's CSAMT survey results

- arranging for a meeting to bring C. Windels up-to-date on the USGS work being done on the down-the-hole Schlumberger logs
- attending a briefing for D. Kramer of the Casa Grande Dispatch
- attending two briefings for local environmental and city government people
- giving tours to: Al Johnson (Michigan Tech), Phil Goode (Mt. Isa Mines), Ed Van Eckout and Carry Burns (both from Los Alamos Labs) and Paige Whitaker and Jim Magner.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: R.L. Brown
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

JDS

July 3, 1990

J.D. Sell

Quarterly Report
Second Quarter 1990
H.G. Kreis

Santa Cruz In Situ Project - EA-0438 - Copper

During the quarter 59 days of work were spent on field activities of the in situ leach test. These activities included acidizing the perforations in all the test wells, removing the resulting acidic copper solution and shipping it to Ray Mines, injecting fresh water, pressure injection/ pressure fall off tests, fluid flow profiles, and communication tests.

The results to date are encouraging, and the salt tracer test is expected to begin in the latter part of the third quarter.

Santa Cruz Project - EA-0075 - Copper

Five days were spent on Santa Cruz Joint Venture matters. This work included preparing information for the 1990 budget, attending the SCJV meeting with Freeport, and getting the assessment work done.

General Exploration

Nine days were charged to general exploration. This included all my time associated with Asarco's Board of Directors visit to the Santa Cruz test site, and my attendance at the NGS gold symposium in Reno.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz

ASARCO

Southwestern Exploration Division

August 3, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
July 1990

During July my work on the in situ portion of the Santa Cruz Project included the following:

- filling in for you while you were on vacation
- overseeing field activities involving the pumping of groundwater from our test wells, monitoring water level changes, and various pump problems
- giving a briefing to the Pinal County Supervisor, the Casa Grande City manager, and others
- giving an interview to the Casa Grande Dispatch
- attending the USBM's public meeting in Casa Grande and the debriefing which followed the meeting
- giving tours to USBM visitors and to a representative of the Minnesota Department of Mines and Mineral Resources
- making arrangements for a CSAMT geophysical survey meeting in Tucson in early August
- shipping 55 gallon drums of HCl-Cu solution to the USBM's Salt Lake City SX-EW laboratory
- arranging and attending a geophysical meeting in Denver with the USGS, Asarco, SAIC, and Schlumberger
- duplicating and distributing T.V. videotapes of T-1 to T-5
- overseeing the drilling and completion of water well PW-1
- overseeing the installation of electric lines to monitor wells SM-2 and SM-3
- shipping samples of organic materials from clogged pumps to Asarco Environmental Services.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: R.L. Brown
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

August 3, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
July 1990

During July pumps were installed in each of the four recovery test wells, and groundwater is being pumped out of each of them. The work is being done to develop a reliable pumping system and to gather information on the amount of groundwater that can be produced from each of the recovery wells. Changes in the level of the water in the injection well, T-3, are being monitored as the pumping progresses.

The drilling of the water well, PW-1, has been completed. Although a pumping test has yet to be performed, the initial air lift development of the well suggests the well will produce enough water for all our needs.

Plastic pipe is being installed from the test site to the water well and to the evaporation pond.

During the month I attended and reported on the USBM's in situ sulfide leach proposal meeting in Tucson. Along with Mr. Raihl, Mr. McCulloch, and Mr. Hickson, I visited Ferret's Crow Butte Uranium in situ leach mine in Nebraska and Power Resources' Highland Uranium in situ leach mine in Wyoming.

My work on the in situ leach test is described in the attached monthly report to A.R. Raihl.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz (w/o att.)
J.D. Sell (w/o att.)
A.R. Raihl (w/o att.)

JDS

SAIC COPY

Science Applications International Corporation
An Employee-Owned Company

September 10, 1990

(024) 1-279-05-543
Y89-ZS-436

Asarco, Inc.
180 Maiden Lane
New York, NY 10038
Attn: Fred Graybeal, Chief Geologist

RE: Agreement of 11/16/88
Exp. Date: 11/15/90

Value: $20,000.00

INVOICE #2

Costs incurred through August 17, 1990:

LABOR	CURRENT HOURS	CUMULATIVE HOURS	RATE/HR.	CURRENT	CUMULATIVE
D. Davidson	11.00 hrs	28.00 hrs	@$100.00 /hr	$1,100.00	$2,800.00
F. Zafran	13.00 hrs	13.00 hrs	@ 80.76 /hr	1,049.88	1,049.88
C. Manikas	0.00 hrs	0.00 hrs	@ 60.00 /hr	0.00	0.00
Clerical	0.00 hrs	3.50 hrs	@ 30.00 /hr	0.00	105.00
Total:	24.00 hrs	44.50 hrs		$2,149.88	$3,954.88

OTHER DIRECT COSTS		
Communication & Reproduction	$0.00	$302.04
Travel	34.00	857.80
Computer	0.00	1.50
Subtotal ODC's	$34.00	$1,161.34
Plus 25% of Total ODC's	8.50	290.34
Total ODC's	$42.50	$1,451.68
Total Costs Claimed	$2,192.38	$5,406.56

TOTAL AMOUNT DUE THIS INVOICE: **Total Amount Due** $2,192.38

PLEASE REMIT PAYMENT TO:

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION
c/o First National Bank of Maryland
Account No. 401-9197-2
P. O. Box 64115
Baltimore, MD 21264

No-Per ACR
AUTHORIZATION # ~~0438~~
Chg. 0075-12

REFER QUESTIONS TO: (615) 481-2126, Robin Lomax

P.O. Box 2501, 800 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830 (615) 482-9031 FAX (615) 482-6828
Other SAIC Offices Albuquerque, Boston, Colorado Springs, Dayton, Huntsville, Las Vegas, Los Angeles, McLean, Orlando, Palo Alto, San Diego, Seattle, and Tucson

JDS

ASARCO

Southwestern Exploration Division

September 24, 1990

J.D. Sell

H.G. Kreis
Quarterly Report
September 1990

Santa Cruz In Situ Leach Project, EA-0438, Copper

A total of 32 days were spent on activities associated with the test site, writing for the Phase I and II report, giving tours, and providing assistance to geophysical work.

Santa Cruz Project, EA-0075, Copper

Eleven and one-half days were expended on attending the USBM public hearing, working on land and environmental concerns, attending the SCJV meeting in New Orleans, and touring uranium in situ leach mines in Wyoming and Nebraska.

General Exploration, Copper

Five and one-half days were spent on the USBM's sulfide in situ leach proposal, and attending the AMC Convention in New Orleans.

Miscellaneous

Fifteen days of vacation were taken.

H. G. Kreis/mek

HGK:mek

H. G. Kreis

cc: W.L. Kurtz

ASARCO

Southwestern Exploration Division

October 2, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
September 1990

During September my work on the in situ portion of the Santa Cruz Project included the following:

- writing sections of the Phase I and II Report that pertain to geology, copper reserves, test site selection, plant site selection, and core hole results.

- writing a report describing the sampling program used during the drilling of the five test wells.

- giving presentations and tours to Jim Murphy, Jim Lukasko, and Dan Dyskinger, all from the USBM Reno office; Louis Coppa and Barbara White from the USBM Washington Office; and Jim Brown of Mt. Isa Mines.

- submitting C-2 samples to Skyline Labs for whole rock analysis to aid USGS and Schlumberger interpretations of geophysical logs.

- collecting and shipping core samples from SC-19 and C-2 to the USBM and USGS for porosity measurements.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: R.L. Brown
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

October 2, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
September 1990

Santa Cruz Joint Venture

On September 27th the Operating Committee of the S.C.J.V. held a meeting at Freeport-McMoRan's corporate headquarters in New Orleans. During the course of the meeting a formal presentation on the Santa Cruz Project and the Santa Cruz In Situ Mining Research Project was given to five people from Freeport-McMoRan, including Milt Ward and George Mealey.

The availability of land about the S.C.J.V. holdings has prompted some land reviews. All the land held by Texaco and jointly by Hanna and Texaco is available. The land held by Simmons may be available, and Bert Apker will make an inquiry at an appropriate time later this year. These lands will be reviewed with consideration given to buffer zones and ore potential.

The cost of capping and cement sealing the upper twenty feet of the old exploration drill holes on the Santa Cruz Project is being looked into. The State of Arizona requires these wells to be sealed to prevent surface water from flowing directly into the underlying aquifer.

My work on the in situ leach test is described in the attached monthly report to A.R. Raihl.

General Exploration

On September 28th representatives of Asarco, Cyprus, Magma, Phelps Dodge, and Placer Dome met in Phoenix to discuss the USBM's in situ sulfide leach proposal to the D.O.E. The main industry concerns at this time are (1) forming an industry association of some type and (2) developing a program with the USBM that will lead to commercial development with a minimum of research. Industry representatives will meet on October 18th at Asarco's Tucson Office.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: W.L. Kurtz (w/o att.)
J.D. Sell (w/o att.)
A.R. Raihl (w/o att.)

ASARCO Southwestern Exploration Division JDS

October 4, 1990

F.T. Graybeal

Industry Meeting
Sulfide In Situ Leach

Industry participants in the USBM's sulfide in situ leach proposal met on September 28th at Phelps Dodge's Phoenix office. The participating companies at this meeting were: Magma, Asarco, Phelps Dodge, Cyprus, and Placer Dome (list of employees who attended is attached). No other companies, interested parties, or USBM people were at the meeting except for Dave Ridinger of the Arizona Mining Association. Freeport-McMoRan has officially dropped out of participating in this proposal; however, they would reconsider participating if Asarco wants the Santa Cruz Joint Venture to participate.

Forming an Association

Although there was no significant discussion, all those at the meeting seemed to agree that the participating companies should form an association. One of Magma's representatives, Ms. Sharon Young, Manager of Metallurgical Services, presented the attached Magma proposal to form an association called "Copper Industry Participants Research Association" (CIPRA). Everyone took a copy of the proposed CIPRA agreement for review by their management. The proposed CIPRA agreement appears reasonably comprehensive, workable and worthy of review by Asarco management.

Managing an Association

The association that industry forms will need some form of management. In fact it would be most helpful to have strong leadership at this time while the participating companies are forming an association. For, at the same time, they are working to make changes that are needed in the USBM's Phase I proposal. Most importantly, at least in my mind, industry needs to negotiate with the USBM the degree to which industry will participate in managing the overall sulfide in situ leach program, and I'll say more about this in the following section.

There are two types of management that have been suggested at our meetings. One type is to contract management with an individual or a consulting company, but this type of management wasn't given much consideration. The other type is to elect one of the participating companies to do the managing. The suggestion of this type of management prompted a question or two.

I asked in the July 12th meeting if any of the companies might be interested in managing the association. M. Young replied that Magma would definitely be interested, and she reaffirmed this in the September 28th meeting. No other company has expressed an interest in managing the association. Dave Ridinger has served to coordinate the meeting dates and has served as the go-between between industry and the USBM.

The company that is eventually chosen to manage the association will have some degree of competitive advantage in having its deposit chosen for a field test. The degree of the competitive advantage is undeterminable at this time. It will depend substantially on the amount of responsibility that industry will have over the USBM program. This has yet to be determined. Nonetheless, it is a thought worth keeping in mind as things progress.

Contributions-in-Kind

As you know from previous correspondence, industry can contribute "in kind" for its 30% of the total cost of the USBM proposed budget. There is a lot of work that will have to be done to find mutually acceptable in kind contributions and establish their value. There are a few items that have come forward at this time.

Properties: Magma is definitely willing to contribute either Kalamazoo or Copper Creek, and Cyprus is considering the contribution of one of its copper deposits. No other deposits were mentioned. The selection of a deposit for a test site is not a pressing matter at this time. It will eventually generate a lot off discussion, particularly when it comes to determining its in kind value.

Leaching Data: The in kind contribution of proprietary chalcopyrite leach data and in situ leach data is a major item that is starting to be addressed. The big ticket contribution will be Phelps Dodge's contribution of the Kennecott chalcopyrite in situ leach data from Safford. Because of its value, which has yet to be determined, it will have a substantial impact on industry's 30% contribution. More importantly, it has the potential of forming the foundation of the USBM's research program, and it could substantially reduce the time it

takes to develop a lixiviant and start a field test.

Phelps Dodge has come forward with the Kennecott data in a generous and open fashion. Mr. Bob Johnson, Director of Research and Business Development for Phelps Dodge, said that Phelps Dodge is willing to contribute the data (as payment in kind) realizing the whole program could be cancelled at any time. Phelps Dodge would, of course, withhold any environmentally sensitive data. Phelps Dodge realizes the Kennecott data will never be used by Phelps Dodge unless it is with a program like the USBM-DOE has to offer.

The USBM is planning to send one of its people to look over Phelps Dodge's Kennecott data which is at Morenci. This effort will help in establishing an in kind value for the data.

Cyprus, like Phelps Dodge, is willing to contribute its Cymet and CLEAR chloride leach data. However, its technical value to the USBM proposal remains to be determined.

Cyprus may also want to contribute its in situ data from Cyprus Casa Grande (Lakeshore). Undoubtedly, this data will be of value to the USBM program.

Management Services: Magma is willing to contribute its management services as an in kind contribution. As previously mentioned, there have been no other volunteers.

Core Samples: Apparently everyone is willing to contribute in kind, core samples of chalcopyrite mineralization. It was suggested that the value be set at $100 per foot.

USBM Proposal Program

The accompanying USBM report, "Detailed Task Breakdown and Cost Estimate, Phase I," gives a detailed description of Phase I. The general activities and costs for Phase I through VI are summarized in the attached table.

The general industry reaction to the USBM'S Phase I proposal was that it is not acceptable in its present form. Consequently, a substantial part of the next meeting (October 18th) will be devoted to revising Phase I and going back to the USBM with a revised Phase I. Industry wants less "make work for the USBM," more emphasis on Task II (lixiviant) by moving it up front, and less emphasis on Task I (geology). Industry also wants more funding for the University of Arizona and the Copper Research Center, and a substantial amount of the

funding for the work done at the University should come out of the DOE's 70% cost share.

The USBM wants a letter of commitment from industry in the near future and a joint USBM-industry meeting near the end of October.

Work in Progress

During the September 28th meeting, it was decided that each company should work on the following items in preparation for the October 18th meeting: (1) rework the unacceptable portions of the USBM Phase I report, (2) decide if the proposed CIPRA association is acceptable, (3) describe and, if possible, place a value on in kind contributions, and (4) determine how industry will participate in the management of the overall program (i.e., can we do more than being advisors to the USBM on the expenditures of the 70% DOE contributions).

Comments

The USBM sulfide in situ leach proposal, with 70% government funding and 30% industry funding, can be of benefit to Asarco and the mining industry. Benefits include developing a lixiviant for chalcopyrite, identifying corrosion resistant materials, and furthering the development of in situ leaching.

The probability of generating benefits to Asarco will be increased if: (1) industry is strongly involved with the management of the program, (2) Phelps Dodge contributes the KCC Safford data, and (3) the development of a lixiviant for chalcopyrite heap leaching is included in the USBM's proposal, and (4) the USBM's proposed program can be dovetailed into other copper mining research projects, such as the Santa Cruz in situ leach project, the EPRI-Asarco-Magma research project, and those being conducted by the UofA Copper Mining Research Center. — what's this

The two most pressing concerns at the time are: (1) establishing leadership and management of the industry association and (2) establishing industry's role in the overall management of the USBM proposed program. In regard to the first concern, only Magma has volunteered to manage industry's association, and Magma is a good candidate for the job. The second concern has been addressed by the USBM. The USBM has proposed that industry establish an industry advisory committee to "review technical progress and to resolve any potential problems." I would like to see industry taking more responsibility for the program.

Industry Meeting
Sulfide In Situ Leach

October 4, 1990

The USBM is pushing for a letter of commitment from industry to complete its proposal to DOE. If industry wants more responsibility in the management of the USBM's program, it would be best to negotiate for it now, before industry signs a letter of commitment.

H.G. Kreis

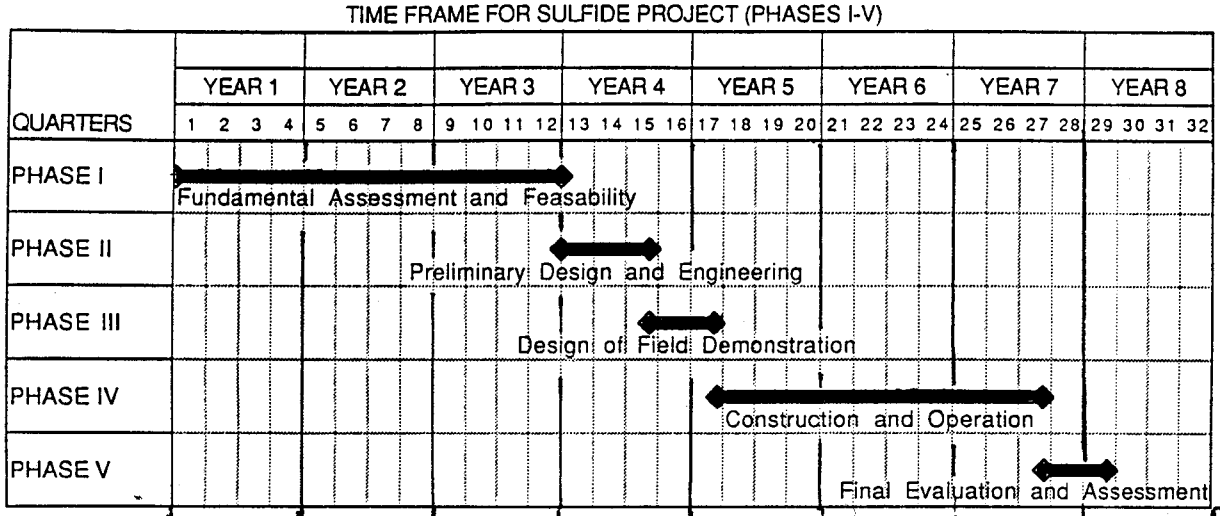
HGK:mek
Attachment & Accompaniment

H.G. Kreis

cc: W.L. Kurtz (w/o accompaniments)
J.D. Sell (w/o accompaniments)

Accompaniment:
D. Ridinger letter of Oct. 2, 1990, Industry In Situ Meeting
Proposed CIPRA Agreement
USBM Detailed Phase I Proposal
UofA Fracture Flow Proposal
UofA Imaging Proposal

TIME FRAME FOR SULFIDE PROJECT (PHASES I-V)



	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	TOTAL
70% DOE	$1,800K	$1,980K	$2,160K	$7,900K	$8,000K	$5,500K	$5,070K	$1,930K	$34,340K
30% INDUSTRY	770K	850K	920K	3,400K	3,400K	2,400K	2,170K	830K	14,740K
TOTAL	$2,570K	$2,830K	$3,080K	$11,300K	$11,400K	$7,900K	$7,240K	$2,760K	$49,080K

H.G.K
10-5-1990

PHASE I PROJECT EXPENSE SUMMARY

YEAR 1	TASK I GEOLOGY	TASK II LIXIVIANT	TASK III HYROLOGY	TASK IV METAL RECOVERY	TASK V ECONOMIC EVALUATION	TASK VI ENVIRONMENT	TOTAL FOR YEAR
Personnel/Center Overhead	$484,981.00	$769,777.00	$202,646.00	$0.00	$0.00	$57,690.00	$1,515,094.00
Equipment & Supplies	$525,000.00	$142,000.00	$0.00	$0.00	$0.00	$17,000.00	$684,000.00
Travel	$65,000.00	$31,600.00	$10,800.00	$0.00	$0.00	$0.00	$107,400.00
University of Arizona	$0.00	$119,500.00	$0.00	$0.00	$0.00	$0.00	$119,500.00
Subtotal	$1,074,981.00	$1,062,877.00	$213,446.00	$0.00	$0.00	$74,690.00	$2,425,994.00
YEAR 2							
Personnel/Center Overhead	$817,967.00	$957,077.00	$168,224.00	$186,146.00	$19,615.00	$79,997.00	$2,229,026.00
Equipment & Supplies	$110,000.00	$85,000.00	$124,000.00	$15,000.00	$0.00	$40,000.00	$374,000.00
Travel	$72,000.00	$18,200.00	$16,000.00	$4,800.00	$0.00	$10,500.00	$121,500.00
University of Arizona	$0.00	$106,500.00	$0.00	$0.00	$0.00	$0.00	$106,500.00
Subtotal	$999,967.00	$1,166,777.00	$308,224.00	$205,946.00	$19,615.00	$130,497.00	$2,831,026.00
YEAR 3							
Personnel	$753,970.00	$826,698.00	$455,982.00	$173,839.00	$12,692.00	$251,528.00	$2,474,709.00
Equipment & Supplies	$80,000.00	$85,000.00	$32,400.00	$10,000.00	$0.00	$35,000.00	$242,400.00
Travel	$66,000.00	$19,600.00	$8,000.00	$4,200.00	$1,400.00	$22,300.00	$121,500.00
University of Arizona	$0.00	$90,524.00	$0.00	$0.00	$0.00	$0.00	$90,524.00
Contract	$0.00	$0.00	$0.00	$0.00	$150,000.00	$0.00	$150,000.00
Subtotal	$899,970.00	$1,021,822.00	$496,382.00	$188,039.00	$164,092.00	$308,828.00	$3,079,133.00
TOTAL COST	$2,974,918.00	$3,251,476.00	$1,018,052.00	$393,985.00	$183,707.00	$514,015.00	$8,336,153.00
Bureau of Mines Washington Office Administrative Overhead (6%)*	$178,495.00	$176,097.00	$61,083.00	$23,639.00	$11,022.00	$30,841.00	$481,177.00
PHASE I GRAND TOTAL	$3,153,413.00	$3,427,573.00	$1,079,135.00	$417,624.00	$194,729.00	$544,856.00	$8,817,330.00

* 6% BuMines Funds Only

USBM
9-28-1990

Industry Meeting
Sulfide In Situ Leach

October 4, 1990

PARTICIPANTS AT THE SEPTEMBER 28th MEETING
AT PHELPS DODGE'S OFFICE IN PHOENIX

Sharon Young	Magma
Chris Burt	Magma
Bob Johnson	Phelps Dodge
Hank Kreis	Asarco
Ron Kellner	Cyprus
Jerry Dobson	Cyprus
Kermit Behnke	Cyprus
Noel Kirshenbaum	Placer Dome
Dave Ridinger	Arizona Mining Association

JDS

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 682
October 9, 1990

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

OCT 1 0 1990

Analysis of 14 Composite Samples

ITEM	SAMPLE NUMBER	SiO2 (%)	Al2O3 (%)	MgO (%)	CaO (%)
1	COMP C-2 1205-1247	74.6	13.1	.26	.07
2	COMP C-2 1247-1351	76.3	12.3	.23	.10
3	COMP C-2 1351-1400	74.6	12.8	.18	.11
4	COMP C-2 1400-1439	73.0	13.8	.20	.10
5	COMP C-2 1439-1449	53.9	17.0	1.50	.48
6	COMP C-2 1449-1500	75.0	12.0	.22	.09
7	COMP C-2 1500-1573	76.1	12.1	.21	.05
8	COMP C-2 1573-1621	72.9	12.1	.30	.04
9	COMP C-2 1621-1660	75.1	12.1	.38	.06
10	COMP C-2 1660-1683	75.6	12.5	.22	.05
11	COMP C-2 1683-1694	74.0	12.9	.26	.05
12	COMP C-2 1694-1754	75.4	12.0	.16	.06
13	COMP C-2 1754-1794	78.0	12.0	.23	.05
14	COMP C-2 1794-1851	75.5	12.5	.15	.05

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1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NO. TAJ 682
October 9, 1990

ITEM	SAMPLE NUMBER	Na2O (%)	K2O (%)	MnO (%)	Fe2O3 (%)
1	COMP C-2 1205-1247	.32	5.7	.01	2.0
2	COMP C-2 1247-1351	.38	5.6	.01	1.5
3	COMP C-2 1351-1400	.37	5.8	.01	2.5
4	COMP C-2 1400-1439	.42	6.6	.01	2.2
5	COMP C-2 1439-1449	.15	3.5	.05	10.1
6	COMP C-2 1449-1500	.20	4.0	.02	4.5
7	COMP C-2 1500-1573	.26	4.9	.01	2.9
8	COMP C-2 1573-1621	.22	4.8	.01	2.5
9	COMP C-2 1621-1660	.32	5.5	.01	2.5
10	COMP C-2 1660-1683	.28	5.3	.01	3.1
11	COMP C-2 1683-1694	.18	4.5	.01	3.7
12	COMP C-2 1694-1754	.32	5.4	.01	2.1
13	COMP C-2 1754-1794	.20	4.2	.01	2.3
14	COMP C-2 1794-1851	.32	5.5	.01	2.1

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Tucson, Arizona 85703
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JOB NO. TAJ 682
October 9, 1990

ITEM	SAMPLE NUMBER	Cl (%)	CO2 (%)	L.O.I. (%)
1	COMP C-2 1205-1247	.15	<.05	1.6
2	COMP C-2 1247-1351	.10	<.05	2.1
3	COMP C-2 1351-1400	.05	<.05	2.4
4	COMP C-2 1400-1439	.05	<.05	1.9
5	COMP C-2 1439-1449	.05	<.05	7.2
6	COMP C-2 1449-1500	.05	.05	3.2
7	COMP C-2 1500-1573	.05	.10	1.9
8	COMP C-2 1573-1621	1.20	.20	4.0
9	COMP C-2 1621-1660	.65	<.05	2.6
10	COMP C-2 1660-1683	<.05	.20	1.6
11	COMP C-2 1683-1694	.25	.20	2.5
12	COMP C-2 1694-1754	.55	<.05	2.3
13	COMP C-2 1754-1794	.05	<.05	1.9
14	COMP C-2 1794-1851	.05	<.05	1.4

cc: Asarco Incorporated
Attn.: Mr. James D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, Arizona 85703

10/9/90

ASARCO

Southwestern Exploration Division

October 10, 1990

A.R. Raihl

C-2 Whole Rock
Analytical Results
Santa Cruz Project

Attached are the analytical results that were run on composite pulps from core hole C-2. These analytical results will be used to help in the interpretation of Schlumberger's geochemical logs.

By copy of this letter, the analytical results are being sent to the USBM, USGS, SAIC, and Schlumberger.

H. G. Kreis

H. G. Kreis

HGK:mek
Att.

cc: F.T. Graybeal
W.L. Kurtz/J.D. Sell
S. Swan, USBM
P. Nelson, USGS
D. Davidson, SAIC
D. Johnston, Schlumberger

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REPORT OF ANALYSIS

JOB NO. TAJ 682
October 9, 1990

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

OCT 1 0 1990
SW Exploration

Analysis of 14 Composite Samples

ITEM	SAMPLE NUMBER	SiO2 (%)	Al2O3 (%)	MgO (%)	CaO (%)
1	COMP C-2 1205-1247	74.6	13.1	.26	.07
2	COMP C-2 1247-1351	76.3	12.3	.23	.10
3	COMP C-2 1351-1400	74.6	12.8	.18	.11
4	COMP C-2 1400-1439	73.0	13.8	.20	.10
5	COMP C-2 1439-1449	53.9	17.0	1.50	.48
6	COMP C-2 1449-1500	75.0	12.0	.22	.09
7	COMP C-2 1500-1573	76.1	12.1	.21	.05
8	COMP C-2 1573-1621	72.9	12.1	.30	.04
9	COMP C-2 1621-1660	75.1	12.1	.38	.06
10	COMP C-2 1660-1683	75.6	12.5	.22	.05
11	COMP C-2 1683-1694	74.0	12.9	.26	.05
12	COMP C-2 1694-1754	75.4	12.0	.16	.06
13	COMP C-2 1754-1794	78.0	12.0	.23	.05
14	COMP C-2 1794-1851	75.5	12.5	.15	.05

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ITEM	SAMPLE NUMBER	Na2O (%)	K2O (%)	MnO (%)	Fe2O3 (%)
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8	COMP C-2 1573-1621	.22	4.8	.01	2.5
9	COMP C-2 1621-1660	.32	5.5	.01	2.5
10	COMP C-2 1660-1683	.28	5.3	.01	3.1
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12	COMP C-2 1694-1754	.32	5.4	.01	2.1
13	COMP C-2 1754-1794	.20	4.2	.01	2.3
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13	COMP C-2 1754-1794	.05	<.05	1.9
14	COMP C-2 1794-1851	.05	<.05	1.4

cc: Asarco Incorporated
Attn.: Mr. James D. Sell
Southwestern Exploration
P.O. Box 5747
Tucson, Arizona 85703

William L. Lehmbeck
Manager
10/9/90

ASARCO

Exploration Department
Southwestern United States Division

FAX

October 10, 1990

Mr. Dave Ridinger
Arizona Mining Association
2702 N. third Street #2015
Phoenix, AZ 85004

Dear Dave:

In preparing for the October 18th industry meeting, I prepared a possible agenda. I am sending this possible agenda to you for distribution since it may help someone else in preparing for the meeting. If those at the meeting would like to use it for an agenda, it is available for that purpose.

The enclosed directory was prepared to help expedite the business that is before the industry group. A Xerox copy of the addresses from your distribution list would help to round out the directory.

If there is anything else I can do to prepare for the October 18th meeting, please let me know.

Sincerely yours,

Hank Kreis

HGK:mek

Hank Kreis

bl.cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

October 10, 1990

POSSIBLE AGENDA FOR OCTOBER 18th MEETING

I. Introduction
   A. New representatives
   B. Planned absences
      1. D. Ridinger
      2. Placer Dome, N. Kirshenbaum
   C. Directory
   D. Possible agenda
      1. Use it?
      2. Revise it?
      3. Additions?
   E. Review last meeting?
   F. B. Larson of USBM available via conference call

II. Happenings since last meeting
   A. Ridinger's letter with USBM reply
   B. Anything else?

III. Industry association
   A. CIPRA agreement
      1. Comments and discussion
      2. Acceptable?
      3. Arrangements to formalize agreement (if acceptable)
      4. USBM review?
   B. Interim management?
   C. Company representatives
   D. Solicit additional companies?

IV. Payments in kind
   A. List of contributions
      1. Proposed
      2. Potential
      3. Solicitations
   B. Usefulness of contributions
   C. Determining value
   D. Acceptability
      1. To industry participants
      2. To USBM
      3. To DOE
   E. Timing
      1. When needed technically
      2. When to donate (budget)
   F. Effect on proposed USBM budget
      1. Carry forward aspects
   G. Effect on USBM proposed work
   H. USBM
      1. Discussion
      2. Individually or collectively present to USBM
      3. Industry representative?

POSSIBLE AGENDA FOR OCTOBER 18th MEETING

V. USBM Phase I proposal
   A. Comments and discussion
   B. Secondary objectives
   C. Industry's Phase I proposal
   D. Industry representative

VI. Letter of commitment
   A. Preliminary draft

VII. Concurrent research
   A. Identify
   B. Coordinate efforts?
   C. Industry representative

VII. University of Arizona
   A. Express support
   B. Types of work we need
   C. Industry representative

IX. Next industry meeting
   A. Time and place
   B. Tentative future meetings

X. Next USBM industry meeting

SULFIDE IN SITU LEACH DIRECTORY

		Office Phone	FAX Number
Arizona Min. Assoc.	Dave Ridinger	602-266-4416	602-266-4418
Asarco	Fred Graybeal	212-510-1871	212-510-1978
	Hank Kreis	601-792-3010	602-792-3934
Cyprus	Kermit Behnke	602-623-1539	602-631-2480
	Jerry Dobson	602-628-4027	602-625-2628
	Ron Kelner	602-628-4088	602-625-2628
Magma	Chris Burt	602-385-8537	602-385-8599
	Sharon Young	602-385-3135	602-385-3464
Phelps Dodge	Bob Johnson	602-865-4521 (#415)	602-865-3916
Placer Dome	Noel Kirshenbaum	415-986-0740	415-397-0747
USBM	Bill Larson	612-725-4690	612-725-4526
U. of Arizona	Brent Hiskey	602-621-6037	
	Ben Sternberg	602-621-2439	

JDS

ASARCO

Dr. Stu Sinfield

Exploration Department
Southwestern United States Division

VIA TELEFAX
602-266-4418

October 22, 1990

Mr. Dave Ridinger
Arizona Mining Association
2702 N. Third Street, #2015
Phoenix, AZ 85004

Dear Dave:

On October 18, 1990, industry representatives met at Asarco's Tucson Office. Those in attendance were Sharon Young, Chris Burt, Jerry Dobson, Fred Graybeal, and the undersigned. As we had agreed prior to the meeting, I filled in for you in your absence.

The following topics were proposed and accepted by those present:

Next Meeting

The next meeting is scheduled for November 9, 1990; however, efforts will be made to schedule the meeting at an earlier date, preferably a Friday. The meeting, on whichever date, will be held at 9:00 a.m. at Asarco's Tucson Office. The date is contingent on everyone getting their payments in kind in order, so check with me for details.

Needed at Next Meeting

All those companies that are planning to submit payments in kind should be prepared to do so by the next meeting. Each company will have a typed list describing the item(s) submitted as payment in kind, the benefits that the item will have for the program, and a dollar value. Each submitted list will have the approval of the submitting company's management.

CIPRA

The CIPRA agreement was found to be acceptable to all those present, and an additional clause to the agreement will be made. Sharon Young will write and add a clause to allow the participating companies to vote on who can join CIPRA in the future and under what conditions they will be allowed to join. The CIPRA agreement now needs approval by each participating company's management so the CIPRA agreement can be put into effect.

Management of USBM Program

During the meeting we all talked with Bill Larson via telephone. Bill requested greater participation by industry in the management of the USBM program. He felt industry's advisory position was not enough input.

It so happened that we had a rough draft of the attached proposed management structure already on the table. It is open for comments, etc. This proposal will be kept confidential within industry until decided otherwise.

Industry's 30% Funding

Industry will provide a minimum cash contribution to the program on an annual basis. The minimum amount of cash to be contributed each year was set at 20% of industry's minimum level of annual funding; i.e. 20% of the 30% industry funding in the USBM proposal. The cash would be contributed in equal amounts by each of the participating companies. With five participating companies, the amount of cash per company is $50,000 in the first year.

Industry proposes that large in kind payments will be "bankable". This means the excess portion of any payment in a year will be applied to satisfy the following years' obligation. This will allow excessively large payments in kind to be made in the first year with the excess value (credit) being applied to following years. This bankable value applies to both CIPRA accounting and to the satisfaction of DOE's accounting. The DOE's acceptance of bankable in king payments has yet to be explored.

There was some discussion as to determining the value of in kind payments. It was suggested that, at least in part, the value could be determined by the cost of the work that the payment in kind would cause to be deleted from the USBM's Phase I proposal.

University of Arizona

Industry is not planning to use the services of the University of Arizona during the first year. The University needs to be told that industry will consider funding University proposals during the sulfide in situ leach project, but not during the first year.

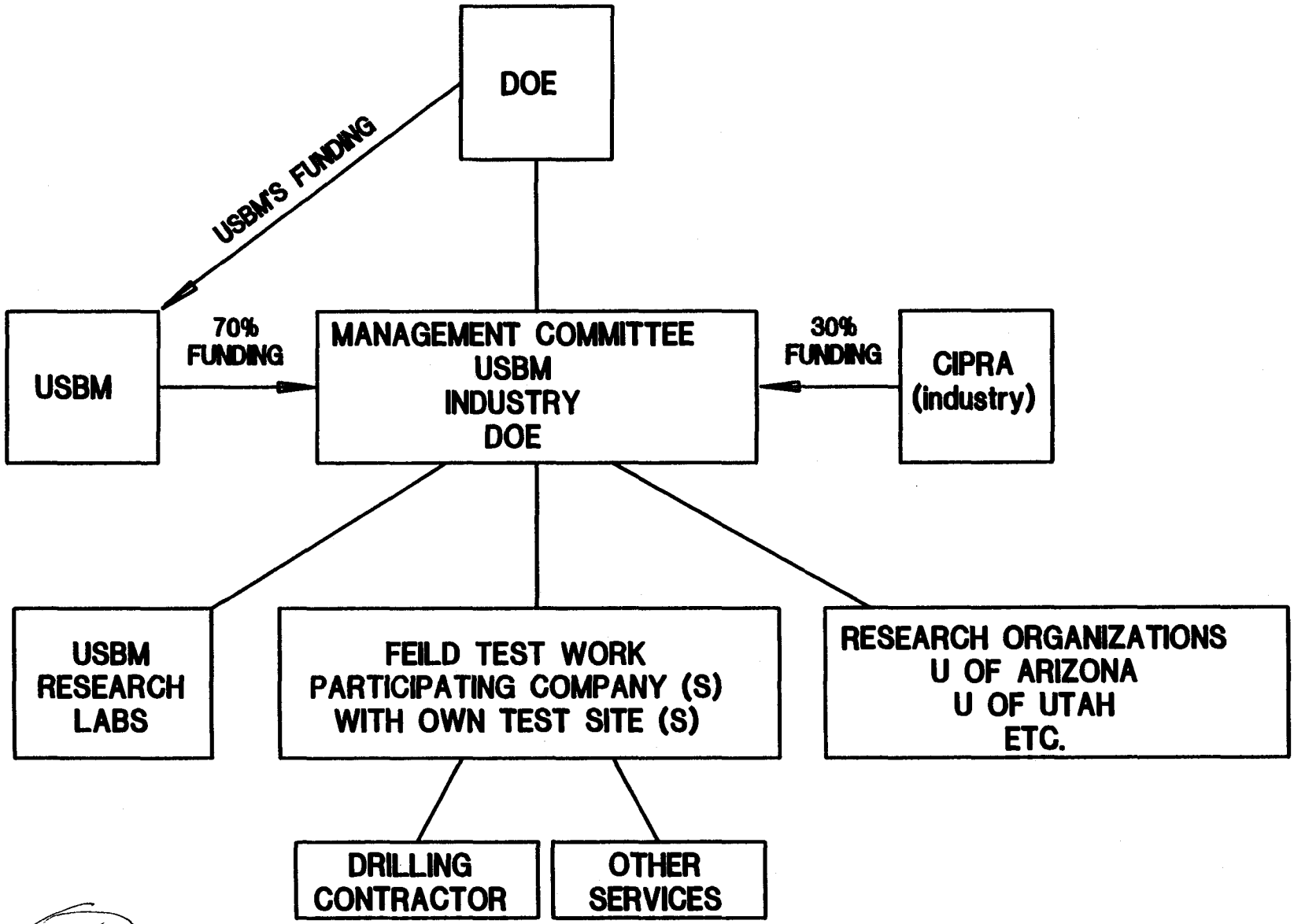
Yours truly,

Henry G. Kreis

Henry G. Kreis

HGK:brw
Attachment
bc: F. T. Graybeal w/att.
W. L. Kurtz "
J. D. Sell "

PROPOSED MANAGEMENT STRUCTURE *



NOTE → * (FOR INDUSTRY'S CONSIDERATION ONLY AT THIS TIME, 10-18-90)

mn SC90 1008 HGK/DAM TUC 10-18-90

JDS

ASARCO

Mining Department
Tucson, Arizona

October 25, 1990

OCT 2 6 1990

Mr. A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Phase I and II Technical Report

Attached are copies of the text I wrote for the Phase I and II, In Situ Copper Mining Research Project report (two hard copies, one floppy disk). The topics covered are: geology of the Santa Cruz Copper Deposit, test site selection, SX/EW plant site selection, test site geology, test site copper reserves, and the results of the core holes C-1 and C-2. Each section is arranged in the following order: (1) text, (2) tables, and (3) figures.

The Appendix lists the inclusion of the C-1 and C-2 geology reports. These reports have not been included with any of the copies I am issuing as all parties concerned already have copies of them.

If there is anything else that needs to be done, please let me know.

H. G. Kreis

H. G. Kreis

HGK:brw
Attachments
cc: R. L. Brown w/att.
F. T. Graybeal w/o att.
W. L. Kurtz " "
J. D. Sell " "

ASARCO

Mining Department
Tucson, Arizona

October 26, 1990

ASARCO Incorporated

OCT 31 1990

SW Exploration

Mr. A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Sampling and Assay Procedures

Attached are three copies of "Sampling and Assaying Procedure for Test Wells T-1, T-2, T-3, T-4, and T-5". The report describes the sampling equipment, the sampling procedure, the assayer's sample preparation procedure, and the assay procedure. All of the sampling equipment and the various procedures used were found to have been adequate for our purposes.

H. G. Kreis

H. G. Kreis

HGK:brw
Attachments

cc:	R. L. Brown	w/att.
	F. T. Graybeal	w/o att.
	W. L. Kurtz	" "
	J. D. Sell	" "

See file for description, plans, photos, data entry.

ASARCO

Southwestern Exploration Division

November 16, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
October 1990

During October my work on the in situ portion of the Santa Cruz Project included the following:

- completing the writing of my portion of the Phase I and II report and distributing the final report.

- completing the writing of "Sampling and Assaying Procedure for Test Wells T-1, T-2, T-3, T-4, and T-5" and distributing the final report.

- Providing data for Montgomery and Associates.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

November 19, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
October 1990

Santa Cruz Joint Venture

During October proposals were made to acquire land from Simmons DevCor, Texaco, and Hanna-Texaco. The total amount held by each entity is: Simmons DevCor, 523 acres; Texaco, 1088 acres; and Hanna-Texaco, 3630 acres.

My work on the in situ leach test is described in a memo to Mr. Raihl, and you are designated to receive a copy of this memo.

General Exploration

A substantial part of October was spent working on the USBM-industry sulfide in situ leach program. This work involved preparing for and leading industry meetings, preparing a management structure that took industry out of an advisory position and put it on equal footing with the USBM, working on payments in kind, reviewing the USBM's detailed Phase I proposal, making recommendations for changes in the USBM Phase I proposal, and writing reports on the outcome of industry meeting.

H. G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

JDS

ASARCO

Southwestern Exploration Division

November 19, 1990

F.T. Graybeal

Industry Meeting
Sulfide In Situ Leach

On November 9th Industry met at Asarco's Tucson Office to discuss the USBM's sulfide in place leach proposal. Present were Sharon Young (Magma), Chris Burt (Magma), Kevin Purdy (Chief Metallurgist at Cyprus and sitting in for Jerry Dobson), and the undersigned for Asarco. At times during the meeting the group talked with Bill Larson via phone.

Industry Association

The industry group that wants to join together under the CIPRA agreement presently consists of Magma, Cyprus, and Asarco. Both Placer Dome and Phelps Dodge have dropped out. Placer Dome joined the industry group while the company was in the process of acquiring a property that was a candidate for sulfide in situ leaching. Placer's acquisition attempt fell through, so Placer dropped the idea of in situ leaching research.

Phelps Dodge dropped out without giving a reason for its decision. Dave Ridinger will call Bob Johnson to find out why Phelps Dodge dropped out and to see if there is any way to get Phelps Dodge back in the industry group. The loss of Phelps Dodge's participation and the lack of Phelps Dodge's Kennecott sulfide in situ leach data will have a substantial impact on the sulfide in situ leach program. Both the funding of the program and the amount of lixiviant research will be affected as will be discussed later in this memo.

All three companies remaining in the industry group have reviewed the CIPRA agreement and have found it to be acceptable. As you have requested, an early drop out clause has been added (see enclosed rough draft). This clause will allow a company to drop out any time before an agreement is signed with the DOE. A company that drops out at such time will not incur any financial responsibility for the first year's funding. The CIPRA agreement is being made ready for final review and signing by the participating companies.

Asarco has yet to decide exactly how it will participate in the CIPRA agreement. As proposed in your November 9th letter to me, Asarco's participation might be through the SCJV. This proposal, and the

remainder of the contents in your letter, were made known to those at the November 9th industry meeting. The only response was from Sharon Young. She expressed concern about the idea of two companies getting into the program for the price of one company. After hearing Asarco's thoughts on the matter, she said that, if this is the only way to keep Asarco in the group, we may have to live with this arrangement. It will probably take another meeting or two before the proposal is resolved, and this will delay the signing of the CIPRA agreement.

Management Structure

As you know, at the last industry meeting Asarco proposed a joint USBM-industry management structure for the USBM-industry sulfide in situ leach program. This proposal was designed to take industry out of the USBM's proposed advisory role and put industry in a joint management position. Before this proposal could be approved by industry and presented to the USBM, a copy of the proposed management structure was accidently sent by the Arizona Mining Association to the USBM. After seeing the proposal, Bill Larson, Dave Askin, and at least two of the USBM people in Washington approved of the joint, USBM-industry management structure. Industry participants have also approved of the joint, USBM-industry management structure. The most recent version of the management structure is enclosed. A copy of the most recent version has yet to be sent to the USBM.

Industry Funding

All of the participating companies have agreed to pay $50,000 in cash for the first year of the program. Bill Larson was so enthusiastic about this development that he will have the USBM contribute $50,000 in cash. The DOE will not match, 70%-30%, the USBM contribution, because it is government money and not money from a non-government source. The bottom line for cash funding of the first year of the program looks like this:

30% Industry	$150,000
70% DOE	350,000
USBM	50,000
Total Cash	$550,000

This amount will be increased by industry payments in kind and, more importantly, by the amount of DOE matching funding (70% DOE - 30% industry). Industry and the USBM had expected Phelps Dodge's payment in kind, the old KCC data, to be a large financial contribution causing the DOE to contribute substantially more cash funding to achieve the 70%-30% match. Since this payment in kind was lost with Phelps Dodge's withdrawal from the program, industry will have to rely on the in kind

contributions of Cyprus, Magma, and Asarco. A description of each company's payment in kind list is enclosed. Magma's list is complete. Cyprus plans to add the Cyprus Casa Grande deposit or the Twin Buttes deposit to its list. Your letter to me constitutes Asarco's list.

The value of these payments in kind has yet to be determined. Industry plans to meet or talk with the USBM and DOE more extensively to identify the exact criteria used to determine payments in kind and to learn about precedents set in past DOE programs.

USBM Phase I Proposal

Industry did not work on revising the USBM Phase I Proposal at the November 9th meeting. Industry will return to this work as soon as the level of funding can be reasonably estimated. As previously discussed, the level of funding depends largely on the size of payments in kind.

Next Meeting

The next meeting is planned to start at 9 AM on December 6th at Asarco's Tucson Office. The USBM has been invited, and Bill Larson and Tom Philips will attend. Attempts are being made to have someone from the DOE attend or be available via conference call.

Conclusion

Industry has cleared two hurdles -- forming an association (CIPRA) and establishing joint, USBM-Industry management of the program. As soon as realistic estimates can be placed on payments in kind, the work on the USBM Phase I proposal will be restarted. In the meantime, Dave Ridinger will check with Phelps Dodge to see if there is any circumstance under which Phelps Dodge would rejoin the industry group.

H.G. Kreis

H.G. Kreis

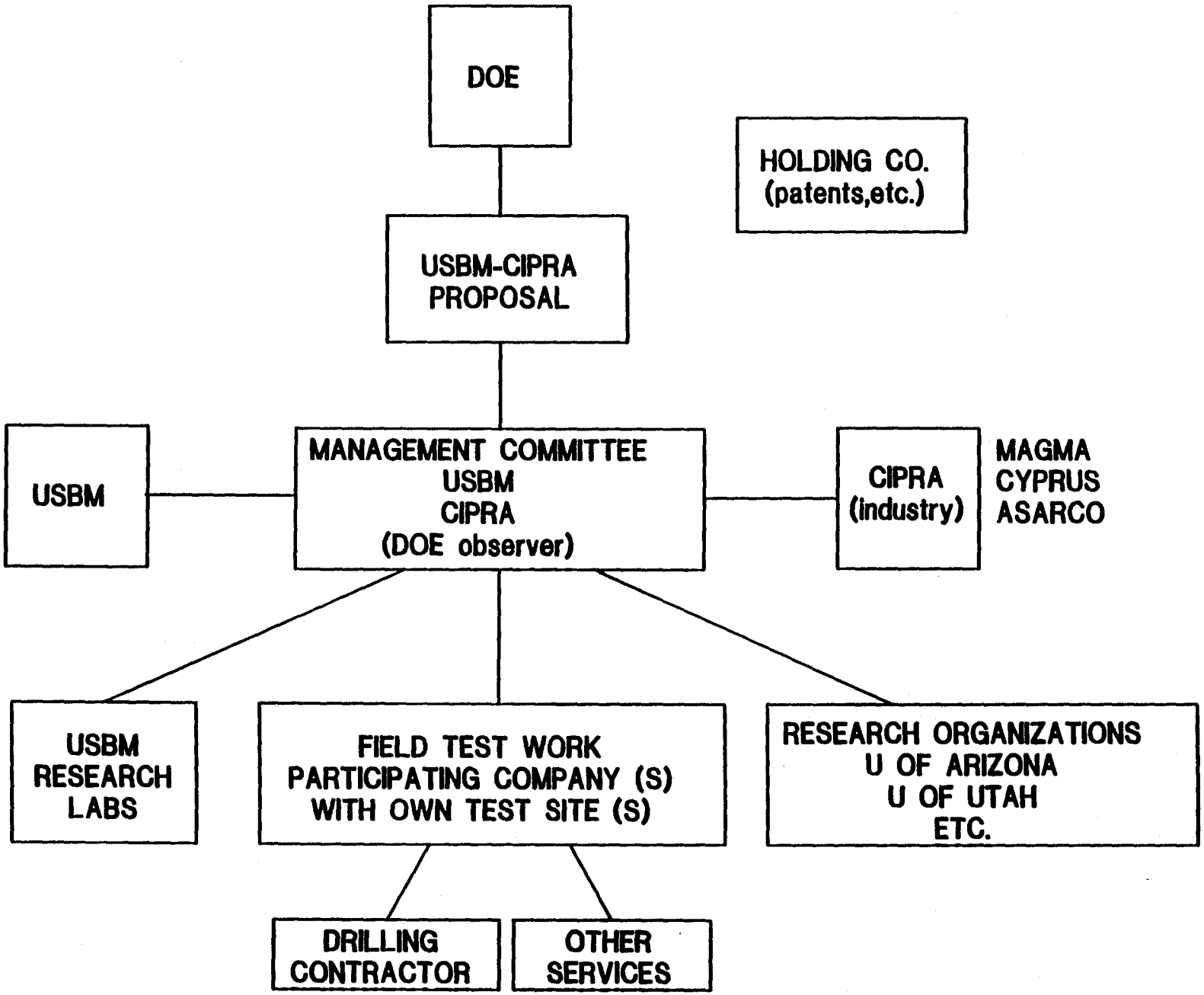
HGK:mek
Enclosures: (hand delivered 11/14/90 with rough draft of text)
- Proposed Management Structure H.G. Kreis
- Management payment in kind
- Cyprus payment in kind
- Asarco payment in kind (Graybeal letter)
- DOE management plan
- CIPRA agreement

Industry Meeting
Sulfide In Situ Leach

November 19, 1990

cc: W.L. Kurtz (w/encs.)
J.D. Sell (w/encs.)
A.R. Raihl (w/encs.)

PROPOSED MANAGEMENT STRUCTURE
AS OF NOVEMBER 9, 1990



M A G M A C O P P E R C O M P A N Y

INTER-OFFICE CORRESPONDENCE

September 27, 1990

To: Chris Burt

From: Terry Ackerman

Subject: Preliminary "In-Kind" Service List with Estimated Values

Per our conversation the following estimated "In Kind" values associated with information Magma has pertaining to Sulfide copper resources, (Lower Kalamazoo geologic resource and the Copper Creek geologic resource) have been prepared. These estimated values do not reflect "Project to Date" costs but only project costs associated with the components or work. No property purchase or carrying costs are included.

General

Regional Hydrology	(to date)	$ 160,000
Groundwater Baseline Data	(to date)	105,000
Project Management	(annual)	100,000

Kalamazoo (260 million ton resource)

Deposit Characterization	(to date)	6,200,000
Surface churn drilling		
Underground diamond drilling		
Core logging and Assaying		
Metallurgical testing		
Production method evaluations		
Mining method evaluations		
Geologic Characterization	(to date)	150,000

" Preliminary "In-Kind" Service List with Estimated Values"

Drill Core

Very little core remaining

new core $/ft (drill,logging & assaying) $ 50 /ft

Bulk sampling available

Prototype system in an actual sulfide environment

Copper Creek (100 million ton resource)

Deposit Characterization (to date) 2,200,000

Surface churn drilling

Underground diamond drilling

Core logging and Assaying

Metallurgical testing

Production method evaluations

Mining method evaluations

Geologic Characterization (to date) 10,000

Drill Core

Extensive half-core available

Cyprus Sierrita Corporation

Post Office Box 527
Green Valley, Arizona 85622-0527
Telephone (602) 791-2950

11/9/90

INDUSTRY IN SITU PROJECT

1. Cyprus participation in the project has received tentative verbal approval by upper management. The extent of cash contribution should be limited to approximately $50K.

2. The draft CIPRA agreement has been examined by Cyprus' legal department and no problems were noted.

3. Cyprus' contribution in kind has been partially defined for the initial stage of the project as follows:

	Item	Benefits	$ Value
Noranda + Cyprus Data	1. 5-Volume report of in situ leach studies at Casa Grande	Geologic and geophysical characterization, leaching studies, injection and recovery techniques, drilling.	250 K (Original cost >$5M)
	2. Twin Buttes sulfide drill core.	Test samples for lab work.	25 K per hole
	3. Casa Grande drill core (not yet located).	Test samples for lab work.	25 K per hole
	4. Literature and reports on CYMET process and Duval chloride heap leach tests.	Actual test results for guidance; data on which to build.	? (Files not yet located).
H.K. Note	5. Twin Buttes or Cyprus Casa Grande	Test site	?

CYPRUS

ASARCO

FAX to
Mary Cavanagh
Tucson Office

Exploration Department
Frederick T. Graybeal
Chief Geologist

Nov[redacted]

Mr. H.G. Kreis
Field Manager
Santa Cruz In Situ Copper Mining Resea
Asarco Incorporated
Tucson Office

CIPRA-US
Sulfi

Dear Mr. Kreis:

ASARCO Incorporated is prepared to participate in the proposed industry in situ copper sulfide mining research group to be called CIPRA. This participation is contingent on:

1.) An acceptable agreement describing CIPRA being prepared and

2.) An acceptable research proposal being designed including but not limited to budgets, schedules, research design, and treatment of in kind contributions.

The CIPRA draft agreement distributed on October 18, 1990 was acceptable except that:

1.) A clause was to be added to describe conditions under which members might join CIPRA during the project, and

2.) A clause needs to be added to allow any member to drop out prior to a research budget, schedule, and program design being fully accepted by CIPRA, USBM, and DOE without incurring any of the annual basis research costs described in Section 4.1 of the CIPRA draft.

Asarco's participation in CIPRA might be through the Santa Cruz Joint Venture (SCJV). Asarco holds a 50% interest in the SCJV through Asarco Santa Cruz Inc. a wholly-owned subsidiary of Asarco and Freeport McMoRan Inc. holds the other 50% interest through their wholly-owned subsidiary Freeport Copper Co.

Asarco is prepared to propose a site as candidate for the field test. The candidate site is a chalcopyrite zone lying at depths of 2,700-3,500 ft. This site would benefit the project because it contains disseminated and vein chalcopyrite mineralization in altered granitic rocks typical of porphyry copper deposits in Arizona and therefore the generic value of the research data would be high. This site has excellent access and the mineral rights are owned in fee. Expenditures on this zone have been roughly $1.2 million which would be our estimate of the in kind value accruable under the proposed in situ sulfide research project.

Nothing implied by or stated in this letter is to be construed as formal acceptance of the draft CIPRA agreement or participation by Asarco in any research proposal discussed at previous meetings on this subject. Participation in this project by Asarco is contingent on drafting of an acceptable agreement for CIPRA, on the banking of in kind contributions, and the design, budgeting, and scheduling of an acceptable research program.

Very truly yours,

F.T. Graybeal

F.T. Graybeal

FTG:lj

Rec'ed from
WSBon 11-9-1990

STEEL AND ALUMINUM ENERGY CONSERVATION AND TECHNOLOGY COMPETITIVENESS ACT OF 1988

MANAGEMENT PLAN

INTRODUCTION

The Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988 was signed by President Reagan on November 17, 1988. This Act, Public Law 100-680 (see Appendix A), hereinafter referred to as the "Act", has the following purposes:

(1) to "increase the energy efficiency and enhance the competitiveness of American steel, aluminum, and copper industries...," and

(2) to continue steel research and development efforts begun under the Department of Energy (DOE) program known as the Steel Initiative.

The Act directs the Secretary of Energy to "reestablish an industrial energy conservation and competitive technology program to conduct scientific research and development of steel and aluminum technologies to carry out the purposes of this Act." This Management Plan provides a framework for program implementation. The intent of Congress, as indicated in the legislation and committee reports, as well as DOE policies and operating practices, have been considered in developing this Plan.

Prior to signing of the Act, steel research and development activities conducted in response to the Steel Initiative had been managed in accordance with the Management Plan published by DOE on April 1, 1987. This revised Management Plan was written using the previous Plan as a point of departure. Its provisions apply to all proposals received by DOE after November 17, 1988, for research and development work directed toward the purposes of the Act. It is not necessary to refer to the Plan of April 1, 1987, for any current requirements. This revised Management Plan does not include a research agenda. The Research Plan required by this Act will be published separately by DOE.

PROGRAM MANAGEMENT

The purpose of this section is to generally define the roles and responsibilities of the organizations involved in implementing the Act -- including the Federal Government, the National Laboratories, industry, and universities. Other objectives are to provide information on non-Federal cost sharing and to identify organizational and administrative procedures involved in the conduct of this program.

Within the Department of Energy, the responsibility for management of this program is assigned to the Director, Office of Industrial Programs (OIP), a program office within

Conservation and Renewable Energy. OIP has identified roles and responsibilities for several parties as outlined below.

1. DOE/HQ Office of Industrial Programs

- Overall program management and direction, including development of multi-year plans with sufficient rationale to support agency budget documents;
- Coordination of research and development programs with other elements within DOE and other Federal agencies;
- Analyses, overviews, and recommendations to the Office Director, Deputy Assistant Secretary, and Assistant Secretary regarding program requirements, issues resolution, and management;
- Coordination with the domestic steel, aluminum, copper, and other metals industries, and other entities outside DOE, to obtain recommendations and viewpoints on program implementation;
- Receipt and processing of solicited and unsolicited proposals for formal review from sources other than DOE National Laboratories;
- Preparation of an annual report on the status of research and development activities at the end of each fiscal year;
- Identification and acquisition of assistance from other DOE organizational elements as appropriate;
- Decisions on funding of research and development projects;
- Evaluation of technology transfer efforts;
- Initiation of documentation required to obligate appropriated funds; and
- Development and updating of the Research Plan.

2. DOE Idaho Operations Office

The Idaho Operations Office (ID) of DOE is the primary field office providing assistance in executing projects approved for funding under this Act by the Office of Industrial Programs. ID is responsible for:

- Solicitation, receipt, and coordination of the evaluation of Field Work Proposals (FWPs) from DOE National Laboratories, consistent with guidance and direction from DOE headquarters;

- Implementation and monitoring of research projects after receipt of funding documentation from DOE Headquarters, consistent with applicable laws, Federal regulations, and DOE policies; this includes formal approval of FWPs and negotiation of financial assistance instruments as appropriate;

- Obligation of DOE funds appropriated in support of this Act in response to decisions of DOE headquarters;

- Tracking and technical reviews of progress on research and development projects;

- Providing recommendations on program modifications;

- Administration of agreements entered into with National Laboratories and other entities conducting research;

- Execution of Memoranda of Understanding with other cognizant DOE Field Offices as necessary;

- Modification of project agreements as required; and

- Contractual and administrative arrangements with EG&G Idaho, Inc. (EG&G) for technical support of research activities supported by this program.

3. EG&G Idaho, Inc.

EG&G Idaho, Inc., a management and operating contractor for the Department of Energy at the Idaho National Engineering Laboratory (INEL), will provide technical and administrative support to ID. EG&G will provide the following types of services:

- Proposal reviews, other than proposals submitted by INEL;

- Recommendations on project modifications, based on ongoing technical monitoring of R&D in progress;

- Periodic oral and written documentation on the status, issues, and problems associated with research activities; and

- Assistance with the transfer of research results.

These functions will not be performed by EG&G for proposal and/or project activities involving the INEL. In such cases, OIP will engage the support of other qualified organizations.

4. Private Industry

Involvement of private industry is an essential element of the program authorized by the Act. Research and development supported under this program must include substantial cost sharing participation by domestic companies that are potential users of the resulting technology. Participation by suppliers of equipment is encouraged. According to the Act, the term "domestic company" means a company "which is substantially involved in the United States domestic production, processing, or use of steel, aluminum, copper, or other metals and has a substantial percentage of its operations located within the United States."

Private industry is expected to take a leadership position in the development of research proposals. Industry leadership may be manifested either by organizing and conducting specific projects within industrial facilities, or by participating in research and development projects conducted by other research organizations. After a decision is made to fund a specific project, the prime contractor will be responsible for:

- Conducting the research in a professional, purposeful manner;
- Awarding subcontracts as appropriate;
- Providing technical materials required for processing patent applications resulting from its research;
- Management of efforts necessary to achieve project objectives identified in the proposed Statement of Work or otherwise as agreed upon between DOE and the proposer; and
- Periodic research and progress reports to DOE.

5. DOE National Laboratories

The National Laboratories are recognized as a source of broad, generalized technical expertise which is available to support research and development efforts directed toward the goals of the Act. National Laboratories are encouraged to prepare and submit FWPs directed toward areas of opportunity identified by the Research Plan. FWPs are subject to the same requirements and criteria as all other proposals submitted in response to this program. Research and development funded in response to an FWP need not be conducted entirely at the National Laboratory facilities, depending on the nature of the work. DOE encourages the use of existing facilities, whether in industry, at National Laboratories, or elsewhere, to minimize the time and expense associated with construction of new facilities.

6. Universities

The Act's legislative history notes the important contributions which have been made by the nation's universities. For each research activity, the contractor will determine supporting research, if any, which could best be performed at a university. Universities located in the United States may also submit proposals directly for consideration by DOE.

7. Other Entities

Other Federal agencies, state agencies, research institutes, not-for-profit organizations, industry associations, and professional societies may also submit research proposals for work consistent with the purposes of the Act, and may cost share and be participants in research projects. The research agenda developed by DOE will be coordinated with research and development activities of the National Institute of Standards and Technology and other Federal agencies.

DOE National Laboratories, universities, and other entities which serve in the capacity of a lead laboratory or prime contractor will have the same responsibilities as those identified in the section above on "Private Industry."

PROJECT REQUIREMENTS

1. Cost Sharing

The Act requires that for research and development proposals received after November 17, 1988, "the non-Federal financial share shall equal at least 30 percent of the total cost of any project." Cash, personnel, equipment, and facilities contributed by industry may be included in cost sharing. Existing facilities, equipment, supplies, personnel, and other property may be included in the non-Federal cost share of a project only when they are directly relevant to the project, that is, those required to accomplish the objectives of the project. The value of all non-cash cost sharing will be determined by DOE prior to project funding approval, in accordance with guidance in the DOE Assistance Regulations.

Research projects may consist of a single phase or contain several proposed phases. A definitive description of all proposed work in one or more phases with accompanying estimated costs must be given. Cost sharing must accompany each phase. Additional participants may join a project at any time with the approval of the current participants.

Entities that cost share in research conducted in accordance with the Act will become *participants*, eligible for the following benefits relative to those activities in which they elect to cost share:

- Immediate and continuing access to research results,
- The opportunity to receive a royalty-free license to resulting technologies, and
- A share of the royalties received from non-participating companies.

2. Proposal Preparation Considerations

Projects must have the potential to make a significant impact on the energy efficiency and competitiveness of the steel, aluminum, copper, or other metals industries. Proposals for projects to be funded by the program must address the following requirements.

1. The proposed research and development is consistent with the purposes of the Act;

2. The initial phase of a proposed effort may be laboratory, bench-scale, or pilot-scale research; the final phase will ordinarily be pilot-scale research;

3. A critical review of existing and emerging technologies, patents, on-going research, and practices, on a world-wide basis, that are and/or could be competitive with the proposed new technology. The hurdles that must be overcome to ensure commercial viability must be identified;

4. (a) An initial economic evaluation indicating the potential for a significant reduction in manufacturing costs and/or a significant improvement in product value due to an improvement in product characteristics, and (b) an estimate of the economic benefit to the domestic metals industry;

5. An estimate of the potential energy savings attributable to the implementation of the technology expected to result from the R&D;

6. A Statement of Work for achieving the stated project objective, including project schedule, work breakdown structure, spending plan, milestones, and decision points;

7. Identification and qualifications of the principal research personnel and equipment involved in the effort;

8. Non-Federal cost sharing commitment. There is a legislative requirement that non-Federal cost sharing must equal at least 30 percent of the total cost of any project;

9. An estimate of the total R&D costs required to reach the stage of technology development at which Federal funding will no longer be required; and

10. A plan for commercialization, including timing, given successful accomplishment of R&D objectives.

DOE will publish changes to these requirements as appropriate in the *Federal Register* and *Commerce Business Daily*.

3. Proposal Review and Evaluation

Procedures for proposal review and evaluation will depend on whether the submission responds to a formal solicitation or is unsolicited. An unsolicited proposal is an independently originated written request developed by an offeror for DOE support of an innovative or unique project, which is submitted without a written solicitation issued by DOE. Unsolicited proposals submitted for funding under the Act will be handled according to the procedures described in the DOE publication "Guide for the Submission of Unsolicited Proposals." The proposed research and development work will be reviewed by DOE personnel and, if deemed appropriate, will be referred for detailed evaluation. The principal elements that will be considered in evaluating a proposal are:

1. Overall scientific, technical and/or socioeconomic merit of the proposed activity;

2. The scientific and technical competence of the proposer and supporting institution(s) and the adequacy of necessary facilities;

3. The relevance of the proposed research project to the purposes of the Act; and

4. The appropriateness of proposed costs, including cost sharing.

Details of the review and evaluation procedure for solicited proposals will be given in the formal solicitation notice.

PROTECTION OF INTELLECTUAL PROPERTY

The knowledge resulting from research and development efforts conducted under this Act shall be developed for the benefit of the domestic companies which provide financial resources to the program. It is DOE's intention to immediately transfer title to all resulting intellectual property to a holding company selected by the project's participants.

For each project, an entity or holding company will be created or designated by the project's participants for the purpose of holding patents and licensing technology. Title to all patents resulting from research authorized by the Act will be available to the holding company as a result of the Statement of Analysis and Determination of Exceptional Circumstances for DOE Funding Agreements Relating to the U. S. Department of Energy Steel Initiative issued on June 3, 1987, and the provisions of an advance waiver of the Government's U.S. and Foreign Patent Rights. This method of handling intellectual property is intended to serve the dual purposes of facilitating technology transfer to the market place and providing benefits to project participants.

DOE expects every effort to be made by the holding companies to secure patent protection for the technology developed for each project. Prior to filing for patent coverage, information concerning inventions developed under this program will be held in confidence among DOE and the project participants, and will not be subject to dissemination under the requirements of the Freedom of Information Act (FOIA) to the extent authorized by 35 U.S.C. 205. After patents have been issued, dissemination of this information will not be restricted.

Information supplied on a confidential or privileged basis by one or more participants, including trade secrets and commercial and financial information as defined under section 552(b)(4) of title 5, United States Code, will be protected. Requests made for such information will be forwarded to the provider(s) of such information for review.

need to know who this may.

Data and other technical information generated during the conduct of research funded by this Act which are not included in the previous categories, and which would be a trade secret or commercial or financial information and privileged or confidential under the meaning of section 552(b)(4) of title 5 of the United States Code if obtained from a domestic company, will generally be made available to the public unless one or more participants and DOE determine that the information should be withheld from dissemination for the benefit of the participants; such information will not be disseminated for five years (P.L. 100-680, section 4(b)(4)). Information released by any participant or other source to any non-participant may cause that information to be publicly available. Periodic research reports furnished to DOE in fulfillment of contractual requirements will be readily available to the public, with no restriction on distribution. Likewise, technical papers presented in the public domain will have unrestricted availability.

Participants in a project and the United States Government will receive a fully-paid-up, royalty-free license from the holding company to all patents generated by the project. Participants will not have the right to sub-license except as necessary for the sale of products or equipment. Holding companies must make available nonexclusive licenses on reasonable terms and conditions to practice technology developed under this Act to all responsible domestic companies that do not participate in a project. Royalties and other fees obtained through the sale and/or licensing of intellectual property will be distributed among the participants, the holding company, research organizations, and inventors, and the Federal Government, according to the agreements among these parties.

11-9-90

RESEARCH PROGRAM: IN-SITU LEACH MINING OF COPPER SULFIDES

1. CONTRACTING PARTIES

The agreement to participate in a joint research program to be defined below is made between a group of Companies including:

-Magma Copper Company, San Manuel, Arizona

-

-

-

-

to be called the COPPER INDUSTRY PARTICIPANTS RESEARCH ASSOCIATION (hereafter called CIPRA).

2. SUBJECT MATTER OF AGREEMENT

The Companies each own/operate copper mines and already have considerable knowledge and experience in the field of in-situ mining and leaching of copper ores. However the Companies wish to deepen their knowledge in this field. The group therefore jointly wishes to enter into a research program with the US Bureau of Mines in order to conduct research in the IN-SITU LEACH MINING OF COPPER SULFIDES, as further detailed in the attached proposal of the U.S. Bureau of Mines which is incorporated herein by this reference.

FOR THIS PURPOSE, the parties agree as follows:

2.1. The parties shall mutually agree upon:

2.1.1 the general aims of the joint research programs,

2.1.2 detailed aims of research programs part or wholly funded by industry participation,

2.1.3 terms and conditions of industry participation,

2.1.4 extent of individual CIPRA member contributions (monies and in-kind contributions)

2.1.5 acceptability and value of industry in-kind contributions, and

2.1.6 management of industry participation.

The mutually agreed upon decisions shall be recorded in minutes which shall be signed by all parties hereto.

2.2 The parties shall meet at least once a year in order to discuss and make decisions concerning the following. Each member shall be entitled to one voting representative and one vote. All matters submitted shall be decided by mutual agreement, or if not possible, by majority vote, of all representatives present.

2.2.1 the progress of the research program, analysis of progress reports, discussion of available results,

2.2.2 extension, limitation, and ending of research programs,

2.2.3 alterations to other decisions made under 2.l

2.2.4 compilation of incurred CIPRA costs,

2.2.5 preparation of an annual budget,

2.2.6 use and exploitation of results, confidentiality, and

2.2.7 patents and licenses.

3. The costs of the program are to be born 70% by the Federal Government Department of Energy and 30% by industry participants. Any contributions of monies or services by industry participants who are not CIPRA members shall be credited as part of the 30% industry participation and shall reduce the amount of CIPRA participation. Non-CIPRA participants may attend CIPRA meetings and receive research results to the extent determined by CIPRA.

The cost of the CIPRA participation shall be apportioned amongst the parties named in Section 1 in equal proportions and shall be paid in either monies or in-kind services as per the parties mutual agreement under Section 2 hereof. Each party shall keep a record of its own costs related to matters set out in Section 2. Any company wishing to join CIPRA subsequent to the execution of this agreement by the parties named in Section 1 may do so upon approval by CIPRA and by meeting contribution requirements as determined by CIPRA.

Parties commissioning special investigations on their own shall be solely responsible for the costs of such investigations. Any decision for the allocation of such costs toward participation shall be jointly agreed upon by all parties.

4. PERIOD OF PROJECT

(A) INSERT DRAFT TEXT FROM LAST PAGE

4.1 ~~This agreement shall be in effect for Phase 1 of the program as proposed by the US Bureau of Mines which shall last approximately three years.~~ Each party shall be entitled to withdraw from participation by notice in writing at the end of any contract year. The withdrawing party shall bear its proportion of the costs incurred up until that date. A withdrawing party shall be entitled to receive details of all research results obtained before that date. The agreement may be renewed for additional Phases by notice in writing of those parties that wish to continue with the program.

5. MANAGEMENT OF INDUSTRY PARTICIPATION

5.1 Industry participation shall be managed by a group in which all CIPRA members are represented. The group shall select, designate, and direct an individual participant or contract with an individual not in CIPRA to manage the industry participation. The costs of such management shall be included within the industry participants cost of the program. If such management is provided by a CIPRA member it will be allowable as in-kind contributions under Section 2 hereof. Such management shall include:

5.1.1 interaction with USBM,

5.1.2 accounting of CIPRA costs,

5.1.3 receipt & disbursement of CIPRA funds,

5.1.4 awarding & supervision of contracts or agreements made by CIPRA and/or USBM, and

5.1.5 disseminate or distribute through any media or communication, information pertaining to the industry participation.

6. USE OF RESEARCH DATA AND RESULTS

All of the CIPRA members shall to the extent permitted by the USBM and the U.S. Department of Energy be entitled to make use of the results of the research program in their own mines or those of their wholly-owned subsidiaries.
The ownership of inventions arising fron the exchange of information between the parties shall be the property of the parties to the agreement at the time of discovery.

IN WITNESS thereof, the parties have executed this agreement to be effective as of _____.

MAGMA COPPER COMPANY

TITLE _____

(9) This agreement shall be in effect through Phase 1 of the program proposed by the US Bureau of Mines which shall last approximately three years. Each party shall be entitled to withdraw from participation by notice in writing at any time prior to final commitment by CIPRA to DOE to initiate the program. Such withdrawal shall be without penalty or costs other than those incurred by the party at the time of withdrawal. Furthermore, each party - - -

ASARCO

Southwestern Exploration Division

December 5, 1990

FILE NOTE

USFS Visit
Santa Cruz Project

On November 26th a presentation and tour of the Santa Cruz In Situ Copper Mining Research Project was given most of the following U.S. Forest Service people:

Robin Strathy; geologist, Arizona Zone Office, Phoenix Mineral Examiner
John Gutierrez; mining engineer, Arizona Zone Office, Phoenix
Julie Curtiss; geologist, Tonto Nat. Forest, Phoenix
Milada Pajaczkowski; geotechnical engineer, Tonto NF, Phoenix
Roger Marion; regional geologist, Albuquerque
Tom Collins; geologist, New Mexico Zone, Albuquerque
Pete Peters; mining engineer, New Mexico Zone, Albuquerque
Ed Vukelich; geologist, Albuquerque
Tina Garcia-Brito; land law examiner, Albuquerque
Kathyrn Devenport; geologist, Coronado Nat. Forest, Tucson

H.G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
A.R. Raihl
W.L. Kurtz
J.D. Sell
W.E. McCulloch - Freeport
S. Swan - USBM

ASARCO

Southwestern Exploration Division

December 10, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
November 1990

During the month of November my work on the in situ portion of the Santa Cruz Project included the following:

- photographing all the physical plant facilities and representative pieces of equipment at the test site;
- preparing and delivering a presentation at the Minneapolis USBM meeting on Nov. 14th;
- purchasing and setting up a T.V. and VCR to show the Santa Cruz in situ leach video tape in Casa Grande; and
- giving presentations and tours to the U.S. Forest Service, the Sierra Club, the publisher and reporter from the Casa Grande Dispatch, and the Mayor of Casa Grande.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: R.L. Brown
F.T. Graybeal
W.T. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

December 10, 1990

R.L. Brown
New York Office

H.G. Kreis
Monthly Report
November 1990

GENERAL EXPLORATION

Work on the USBM-industry sulfide in situ leach proposal continued during November. On November 8th industry participants in the proposal met at Asarco's Tucson Office. Most of the work during the month centered on identifying satisfactory payments in kind, preparing a CIPRA agreement, and examining possible business arrangements with the USBM and DOE. Plans were made to talk to the DOE and have an industry-USBM meeting in Asarco's Tucson Office on December 6th.

A tour of the in situ leach test site was given to senior managers of the Polish mining company KGHM.

Santa Cruz Joint Venture

A small amount of time was spent on budgetary and land matters.

My work on the in situ leach test is described in my memo to Mr. Raihl, and you are designated to receive a copy of this memo.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

JDS

ASARCO

Southwestern Exploration Division

December 10, 1990

H.G. Kreis

EM Geophysics
San Xavier Mine
Pima County, AZ

I comment on your December 10, 1990 memo to C.O. Windels, on the above subject.

1. Did the UofA, USBM secure a brine injection permit?

2. What did they do to monitor the change in the plume within the water table, and for how long?

3. Is the proposed Santa Cruz brine solution more or less than the 23 grams/liter NaCl used at San Xavier?

4. What is the USBM-Zonge throught on interpreting such data at 516 feet versus your ±2000 feet at Santa Cruz?

5. Apparently the surface receiver array was much more successful in delineating the brine outline/changes than were the sub-surface receivers. Will both types of receiver be tested at Santa Cruz?

JDS:mek

James D. Sell

cc: C.O. Windels
W.L. Kurtz

ASARCO

Southwestern Exploration Division

December 10, 1990

C.O. Windels
Denver Office

EM Geophysics
San Xavier Mine
Pima County, AZ

Daryl Tweeton, A USBM Research Physicist, passed along the enclosed San Xavier geophysical test work. The test work includes CSAMT survey work before and after the injection of a salt solution into the ground at the San Xavier Mine.

We are interested in knowing what you think about the test results at the San Xavier Mine, and how it relates to our CSAMT and TEM test work at the Santa Cruz in situ test site. The TEM survey, incidentally, was recently added to our geophysical program at relatively little cost.

Daryl Tweeton said he would be glad to answer any questions you might have, and he is willing to furnish additional detailed information if needed by you. His telephone number is 612-725-4670 in Minneapolis, Minnesota.

H. G. Kreis

H.G. Kreis

HGK:mek
Encs.

cc: F.T. Graybeal (w/Tweeton text only)
A.R. Raihl (" " " ")
W.L. Kurtz (" " " ")
J.D. Sell (" " " ")

Rec. 11-15-90
from D. Tweeton,
Research Physicist
USBM

Daryl R. Tweeton
RESEARCH PHYSICIST

U.S. BUREAU OF MINES
5629 MINNEHAHA AVE. SOUTH
MINNEAPOLIS, MINNESOTA 55417
PHONE: 612 - 725-~~3408~~ 4670 725-4500

PRELIMINARY RESULTS OF EM TESTS AT SAN XAVIER MINE

Prepared for Santa Cruz Joint Venture
by Daryl Tweeton, Nov 14, 1990

SUMMARY: Tests of electromagnetic methods were conducted in cooperation with the University of Arizona and Sandia National Laboratories at the San Xavier mine near Tucson. The tests were conducted to compare the effectiveness of six geophysical methods in locating a brine solution simulating in situ leach solution or a high-conductivity plume of contamination. The Bureau of Mines tested surface-to-surface controlled source audio-magnetotellurics (CSAMT), surface-to-surface time-domain electromagnetic induction (TEM), and surface-to-borehole TEM. In surface-to-borehole tests, the transmitter was on the surface and the receiver was in the borehole. Sandia tested surface-to-borehole and crosshole modified CSAMT. The University of Arizona tested a surface-to-surface frequency-domain electromagnetic induction method for measuring the magnetic field ellipticity. These methods had been selected as most promising for detecting high-conductivity solutions in rock having relatively high conductivity, such as metallic ore deposits.

The methods were tested by conducting surveys before and during brine solution injection. The comparison of variations of CSAMT and TEM involved all components of the magnetic and electric fields in both surface and borehole configurations before and during brine injection. Comparing geophysical surveys taken before and during injection allows the effects of geology to be separated from those of the injected solution. A total of 110 cubic meters (29,000 gallons) of solution containing 23 grams per liter NaCl was injected.

Surface-to-borehole CSAMT measurements showed the location of fractures carrying the solution. Surface-to-surface TEM indicated the presence of the leach solution at the water table, about 160 m below surface. The apparent resistivity in a narrow zone at and below the water table under the injection well decreased from 90 ohm-m before injection to 50 ohm-m during injection. The lateral resolution was very good, apparently limited by the 10 m station spacing. Such positive results with a surface-to-surface method is very promising. Preliminary results indicate that all of the methods detected the brine solution. The results will be analyzed more fully to compare the effectiveness of the methods.

The description that follows provides more details on the Bureau of Mines tests of TEM and CSAMT. Please feel free to call me at (612) 725-4670 if you want to discuss the test further.

Daryl Tweeton

DESCRIPTION OF CSAMT AND TEM EXPERIMENTS

Site and borehole description

The test site was the San Xavier experimental mine, operated by the University of Arizona at Tucson. It is about 20 miles south of Tucson. Figure 1 is topographic map of the site on which the geophysical survey lines and the TEM transmitter loop have been drawn. The primary survey line was A, and some data was collected along line B. Line C was not used in these experiments. The survey lines were 10 meters apart, and the survey station spacing along the lines was also 10 meters.

A plan view of the boreholes used in these experiments and the nearby station locations are shown in figure 2. Brine was injected in holes H4 and H15. H14 was the primary monitoring well for environmental monitoring and surface-to-borehole geophysical surveys. The depth of the holes in figure 2 is the drilled depth. The effective depth was less for some holes because of sediment. The depth of H4 was 420 ft (128 m). The depth of H15 to sediment was about 430 ft (131 m), and the depth to sediment in H14 was about 523 ft (159 m). The water table was at 516 ft (157 m), so the injection and borehole survey locations were above the water table. Tests with downhole CSAMT showed that water flowed from H4 to H14 in a large fracture at 393 ft (120 m). The drift at 150 ft is much shallower than our region of interest.

The rock had a resistivity of 50 to 100 ohm-m above the water table before injection of brine, so it was quite conductive.

Experimental method

CSAMT and TEM surveys were conducted before injecting brine, while injecting brine in hole H14, and while injecting brine in both H4 and H15. The brine contained 23 g NaCl per liter of water. The water was municipal water from Tucson, trucked to the site. The brine had a conductivity of 35 mho/cm (corrected to 25 deg C), which provided a strong contrast with the rock. Brine was injected in hole H4 during the one-well injection at about 8 gpm, and in H4 and H15 at 4 to 5 gpm in each borehole during the two-well injection. A total of 29,000 gallons was injected, 18,000 during the one-well test and 11,000 during the two-well test. The one-well injection was longer because more borehole measurements were conducted during the one-well test than the two-well test.

For surface-to-surface CSAMT, the configuration of the transmitter and receiver is shown in figure 3. All three components of the magnetic field and two components of the electric field were measured to examine whether components that are not usually measured provided useful data. The 450 m transmitter dipole was 1.8 km south-southeast of the injection wells, perpendicular to the survey lines. The Ey field and the Hx receiver coil were parallel to the survey line, from the transmitter to the receiver. The usual practice in CSAMT is to measure Ex and Hy, but Ey and Hx were also measured because they could, in principle, help to show channeling of current by the high conductivity brine. The frequencies transmitted were 64 to 8192 Hz.

For surface-to-surface TEM, the configuration of the transmitter and receiver are shown in figure 4. All three components of the magnetic field were measured. The Hx receiver coil was parallel to the survey line. The location of the transmitter loop, 200 m on each side, is shown in figure 1. All TEM data were collected with this one fixed transmitter loop.

For surface-to-borehole TEM, the downhole receiver measured all three components of the magnetic field. The effective areas of the receiver coils were much smaller for the downhole probe than for the surface probe. The effective area of each surface receiver coil was 10,000 sq m. The area of the downhole coils was 130 sq m for the x and y components and 400 sq m for the z component. Thus the downhole probe was much less sensitive to a given field than the surface probe, negating to some extent its advantage in being closer to the region of interest.

The data for all tests were collected on a Zonge GDP-16 receiver.

Results

The data and calculated resistivities are in the many plots from Zonge Engineering. As of November 14, 1990, the reported data are not quite complete. The remainder is expected shortly. In several of the Zonge figures, station numbers are given as, for example, 81 instead of 80. The corresponding station really is 80, but it was necessary to supply distinct labels for Ex/Hy and Ey/Hx data for the computer data processing.

Perhaps the clearest indication of the effect of the high conductivity brine is shown in the TEM surveys along line B. Data were collected at only a few stations along line B because the major fault pattern was expected to cause solution injected above the water table to move southwest, toward line A. However, data were collected along line B because unknown local conditions in the highly fractured rock could cause flow in any direction.

Examining the colored TEM plots for line B shows a high resistivity region near the injection boreholes at and below the water table changing to a low resistivity region during brine injection, with good lateral resolution. Along line A, the shortening of the blue high resistivity region could be attributed to the brine, but the interpretation is more ambiguous than along line B.

For both lines, the microV/ampere induction shown in the window magnitudes for TEM has a large change in the Hx component under the injection boreholes. The Hy component is ambiguous, and the Hz component shows little change with injection.

In general, the calculated resistivity decreased with injection in the surface-to-borehole TEM tests. The apparent increase in resistivity at short times and large depths in H14 has not been explained, but may be due to experimental problems with the probe damaged by brine dripping on it deep in this borehole. Determining the resolution of this method will require further analysis.

The static corrected CSAMT results as a function of Bostick calculated depth along line A are shown in colored plots. Corresponding plots for line B are not yet available. The A line results for Ey/Hx seem more consistent than the Ex/Hy results with an indication of the brine location. In the Ey/Hx results, the low resistivity region below station 80 that develops with injection is consistent with the expected location of the brine.

I will keep you informed as we receive any additional results from Zonge that may be of interest to you.

See attached memo 12-26-90

JDS / W.L.K / File

ASARCO

Southwestern Exploration Division

December 10, 1990

H.G. Kreis

EM Geophysics
San Xavier Mine
Pima County, AZ

I comment on your December 10, 1990 memo to C.O. Windels, on the above subject.

1. Did the UofA, USBM secure a brine injection permit? The U of A was granted a permit by ADEQ.

2. What did they do to monitor the change in the plume within the water table, and for how long? The U of A was required to do some -- see attached

3. Is the proposed Santa Cruz brine solution more or less than the 23 grams/liter NaCl used at San Xavier? Much less -- 3 gpl

4. What is the USBM-Zonge throught on interpreting such data at 516 feet versus your ±2000 feet at Santa Cruz? At best a 50-50 chance of seeing NaCl at 1700'.

5. Apparently the surface receiver array was much more successful in delineating the brine outline/changes than were the sub-surface receivers. Will both types of receiver be tested at Santa Cruz? Only the surface

James D. Sell

JDS:mek

James D. Sell

cc: C.O. Windels
W.L. Kurtz

ASARCO

Southwestern Exploration Division

December 27, 1990

F.T. Graybeal

CIPRA Agreement
Sulfide In Situ Leaching

The writing of the CIPRA agreement has been completed, and the modifications you suggested have been included. The original copy of this agreement and three Xerox copies are enclosed.

H.G. Kreis

H.G. Kreis

HGK:mek
encs.

cc: W.L. Kurtz (encs.)
J.D. Sell (encs.)
A.R. Raihl (encs.)

RESEARCH PROGRAM: IN-SITU LEACH MINING OF COPPER SULFIDES

1. CONTRACTING PARTIES

The agreement to participate in a joint research program to be defined below is made between a group of Companies including:

-ASARCO, Inc.

-Cyprus Minerals Corporation

-Magma Copper Company

-

-

to be called the COPPER INDUSTRY PARTICIPANTS RESEARCH ASSOCIATION (hereafter called CIPRA).

2. SUBJECT MATTER OF AGREEMENT

The Companies each own/operate copper mines and already have considerable knowledge and experience in the field of in-situ mining and leaching of copper ores. However the Companies wish to deepen their knowledge in this field. The group therefore jointly wishes to enter into a research program with the US Bureau of Mines in order to conduct research in the IN-SITU LEACH MINING OF COPPER SULFIDES.

FOR THIS PURPOSE, the parties agree as follows:

2.1. The parties shall mutually agree upon:

2.1.1 the general aims of the joint research programs,

2.1.2 detailed aims of research programs part or wholly funded by industry participation,

2.1.3 terms and conditions of industry participation,

2.1.4 extent of individual CIPRA member contributions (monies and in-kind contributions)

2.1.5 acceptability and value of industry in-kind contributions, and

2.1.6 management of industry participation.

The mutually agreed upon decisions shall be recorded in minutes which shall be signed by all parties hereto.

2.2 The parties shall meet at least once a year in order to discuss and make decisions concerning the following. Each member shall be entitled to one voting representative and one vote. All matters submitted shall be decided by mutual agreement, or if not possible, by majority vote, of all representatives present. Such matters will include but not be limited to:

2.2.1 the progress of the research program, analysis of progress reports, discussion of available results,

2.2.2 extension, limitation, and ending of research programs,

2.2.3 alterations to other decisions made under 2.l

2.2.4 compilation of incurred CIPRA costs,

2.2.5 preparation of an annual budget,

2.2.6 use and exploitation of results, confidentiality, and

2.2.7 patents and licenses.

3. The costs of the program are to be born 70% by the Federal Government Department of Energy and 30% by industry participants. Any contributions of monies or services by industry participants who are not CIPRA members shall be credited as part of the 30% industry participation and shall reduce the amount of CIPRA participation. Non-CIPRA participants may attend CIPRA meetings and receive research results to the extent determined by CIPRA.

The cost of the CIPRA participation shall be apportioned amongst the parties named in Section 1 and shall be paid in either monies or in-kind services as per the parties mutual agreement under Section 2 hereof. Each party shall keep a record of its own costs related to matters set out in Section 2. Any company wishing to join CIPRA subsequent to the execution of this agreement by the parties named in Section 1 may do so upon approval by CIPRA and by meeting contribution requirements as determined by CIPRA.

Parties commissioning special investigations on their own shall be solely responsible for the costs of such investigations. Any decision for the allocation of such costs toward participation shall be jointly agreed upon by all parties.

4. PERIOD OF PROJECT

4.1 This agreement shall be in effect through Phase 1 of the program being developed with the U.S. Bureau of Mines which shall last approximately three years. Each party shall be entitled to withdraw from participation by notice in writing at any time prior to final commitment by CIPRA to DOE to initiate the program. Such withdrawal shall be without penalty or costs other than those incurred by that party at the time of withdrawal. Furthermore, each party shall be entitled to withdraw from participation by notice in writing at the end of any contract year. The withdrawing party shall bear its proportion of the costs incurred up until that date. A withdrawing party shall be entitled to receive details of all research results obtained before that date. The agreement may be renewed for additional Phases by notice in writing of those parties that wish to continue with the program.

5. MANAGEMENT OF INDUSTRY PARTICIPATION

5.1 Industry participation shall be managed by a group in which all CIPRA members are represented. The group shall select, designate, and direct an individual participant or contract with an individual not in CIPRA to manage the industry participation. The costs of such management shall be included within the industry participants cost of the program. If such management is provided by a CIPRA member it will be allowable as in-kind contributions under Section 2 hereof. Such management shall include:

5.1.1 interaction with USBM,

5.1.2 accounting of CIPRA costs,

5.1.3 receipt & disbursement of CIPRA funds,

5.1.4 awarding & supervision of contracts or agreements made by CIPRA and/or USBM, and

5.1.5 disseminate or distribute through any media or communication, information pertaining to the industry participation.

6. USE OF RESEARCH DATA AND RESULTS

All of the CIPRA members shall to the extent permitted by the U.S. Department of Energy be entitled to make use of the results of the research program in their own mines or those of their wholly-owned subsidiaries.

IN WITNESS thereof, the parties have executed this agreement to be effective as of _____.

ASARCO _____

TITLE _____ _____

_____ _____

CYPRUS MINERALS CORPORATION _____

TITLE _____ _____

_____ _____

MAGMA COPPER COMPANY _____

TITLE _____ _____

_____ _____

JDS

ASARCO

Southwestern Exploration Division

December 28, 1990

R.L. Brown
New York Office

Surface Seals
Santa Cruz Drill Holes
Pinal County, Arizona

The Santa Cruz Joint Venture has approximately 170 exploration drill holes, water monitor wells, and water wells on its Santa Cruz property. All of these holes were drilled before 1982, prior to the enactment of laws regulating well construction. If these holes were drilled today, they would have been abandoned following specified procedures, or they would have been surface sealed and capped for future reentry. The term "surface seal" means cement sealing the annulus between the steel casing and the well bore from the surface to a depth of 20'.

Earlier this year the question arose as to whether or not the old Santa Cruz drill holes should be surface sealed. Mr. T.W. Johnson's May 23, 1990 letter to Mr. A. Raihl on this subject implies that the holes need to be surface sealed and that the SCJV should apply to the DWR for a variance because of the financial burden. The cost of establishing a surface seal is between $200 and $750 per drill hole, based on estimates by three drilling contractors.

The situation is as follows. No one has mentioned, quoted or produced a copy of a law that says old exploration drill holes have to be surface sealed. Recent laws state that old wells and other drill holes have to be capped with a tamper resistant, waterproof steel cap, but there is no mention of having to construct a surface seal.

An inquiry was made to the Arizona Department of Water Resources (DWR). The DWR, when asked if there is a law requiring surface sealing of old exploration drill holes, did not give a direct answer to that question. The DWR said the DWR has required the surface sealing of only a few old wells. These old wells were located in critical areas where contaminants were an obvious problem. The DWR added that constructing a surface seal on an old well is a horrible project; so horrible that most drillers won't touch the job.

It is apparent that the DWR has no program in effect or on the drawing boards that would require surface sealing of all old drill holes. The requiring of surface sealing of old holes is only done when there is a potentially hazardous situation.

Surface Seals
Santa Cruz Drill Holes

No such hazardous or environmentally dangerous situation is known to exist at Santa Cruz; nor is there any evidence to suggest that a problem exists. The land near all the old exploration drill holes sits idle. There is no farming, so there is no flooding of the land for irrigation or the use of agricultural chemicals.

There are hundreds more old exploration drill holes in Arizona similar to the old Santa Cruz drill holes. If the surface sealing of old exploration drill holes is ever thought to be necessary, it would be advisable to have industry evaluate the situation.

In conclusion, there is no justification for constructing surface seals on the old exploration drill holes. There is, however, work that needs to be done on the capping of the old exploration drill holes. All the old exploration drill holes will be examined to see if they have steel caps that are in compliance with recently passed laws. Holes that have lost their caps and holes with caps that are not in compliance with the law will be brought into compliance. All the old water wells were brought into compliance earlier in 1990.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

December 28, 1990

Jim Padilla

Steel Caps on
Exploration Drill Holes
Santa Cruz Project
Pinal County, Arizona

You are requested to examine each and every drill hole on the SCJV land to see if the steel cap is in compliance with the law. The law required each hole to have a 1/4" thick steel, tamper resistant, water-tight cap.

If a hole is not in compliance, you should weld on a 1/4" thick steel cap with a welding bead that runs completely around the steel cap. A number of the holes may have a steel collar and a steel plug, either of which can be taken off with a wrench. I would prefer that the collar and the cap be removed and a steel plate be welded directly onto the casing. If the collar and plug can not be easily unscrewed, weld both the collar and the plug so it will be tamper resistant.

There are a number of water level monitor wells that will not be welded shut. They will be left as they have been in the past, under lock and key.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Mining Department
Tucson, Arizona

December 28, 1990

Mr. A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Hydrogeology Section
Aquifer Protection Permit

Attached is my contribution to the section on well construction and hydrogeology in the Aquifer Protection Permit application.

H. G. Kreis

H. G. Kreis

HGK:brw
Attachment
cc: F. T. Graybeal w/att.
W. L. Kurtz "
J. D. Sell "

ASARCO Incorporated
JAN 1 1991
SW Exploration

WELL CONSTRUCTION AND TESTING

Mineral Exploration Boreholes

There are six mineral exploration boreholes within 500 ft of the test site as shown in Figure 4-1. These boreholes are SC-19, SC-35, SC-36, SC-49, C-1, and C-2. Borehole SC-19 was drilled in 1974 and 1975, and the wedged-out portion shown in Figure _____ was drilled in 1987. Boreholes SC-35, SC-36, and SC-49 were all drilled in 1977. Borehole C-1 was drilled in 1988 and 1989, and C-2 in 1989.

Boreholes SC-19, SC-35, SC-36, and SC-49 were drilled for the mineral exploration purpose of obtaining core for geologic logging and assaying. Boreholes C-1 and C-2 were drilled for the purpose of geologically evaluating the in situ test site.

Boreholes C-1, SC-19, SC-35, SC-36, and SC-49 have been permanently abandoned. Drill hole C-2 was cemented to prevent the upward migration of tracer solution and leach solution, but it was left in a condition that will allow future re-entry and wedge out drilling. This future drilling in C-2 will be done to obtain core samples of the leach interval after the leaching has taken place.

[Figure 4-1: Drill holes in and about the test site. This figure to be supplied by ELM&A.]

Note: C. Barter will write about the abandonment of these holes.

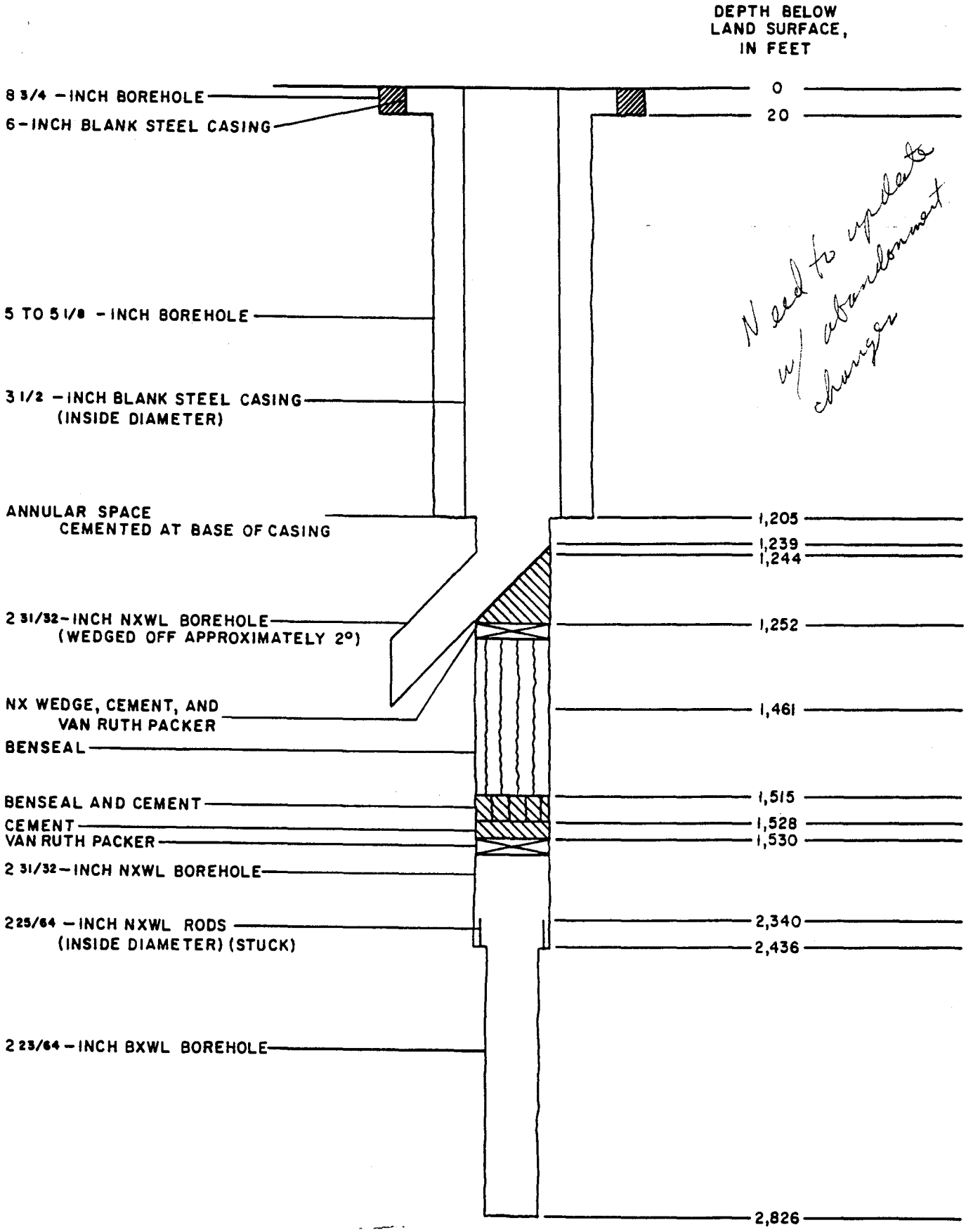


FIGURE 2. SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COREHOLE (D-6-4)13abd [SC-19]

ERROL L. MONTGOMERY & ASSOCIATES, INC.
TUCSON, ARIZONA

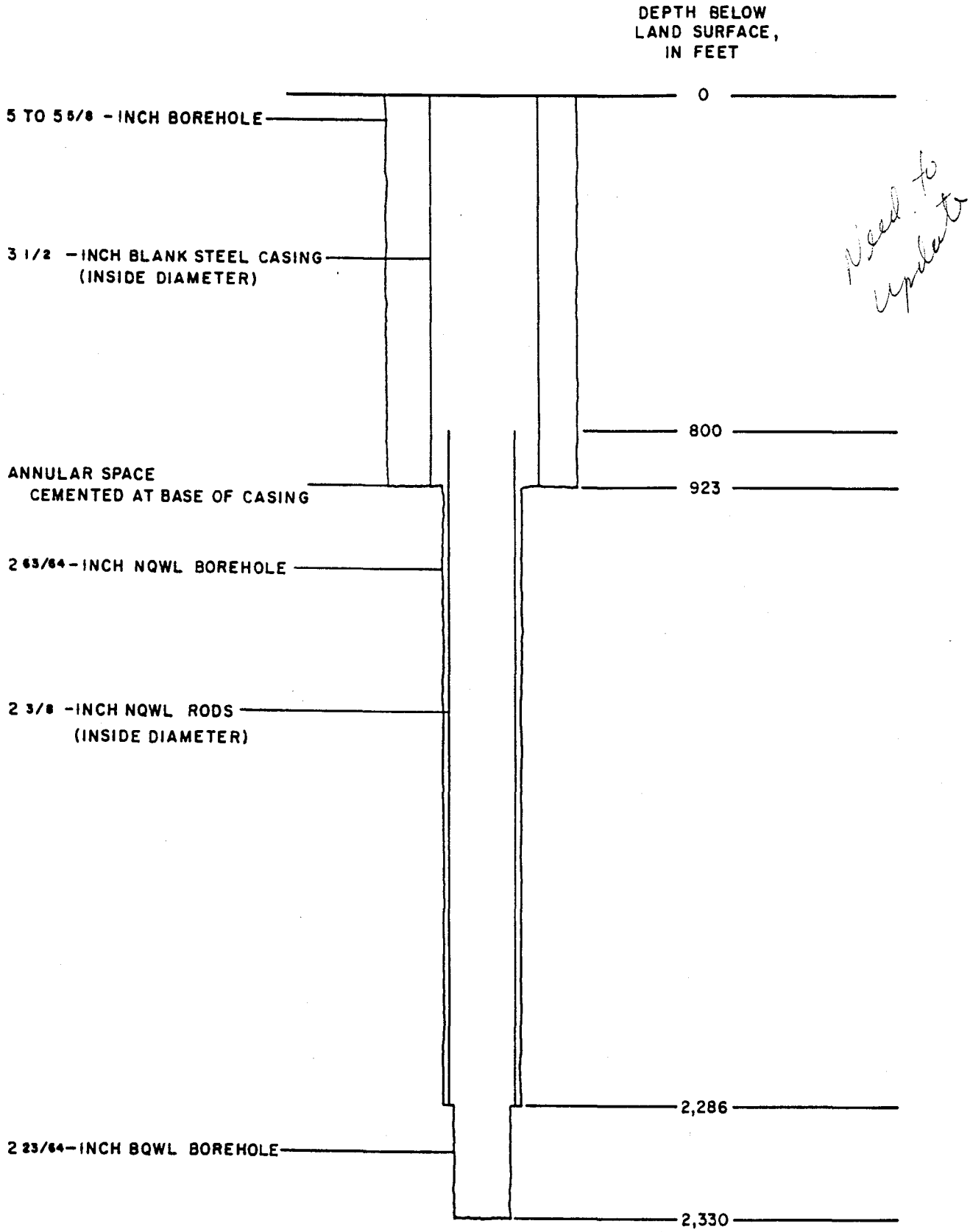


FIGURE 3. SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COREHOLE (D-6-4)13aca[SC-35]

ERROL L. MONTGOMERY & ASSOCIATES, INC.
TUCSON, ARIZONA

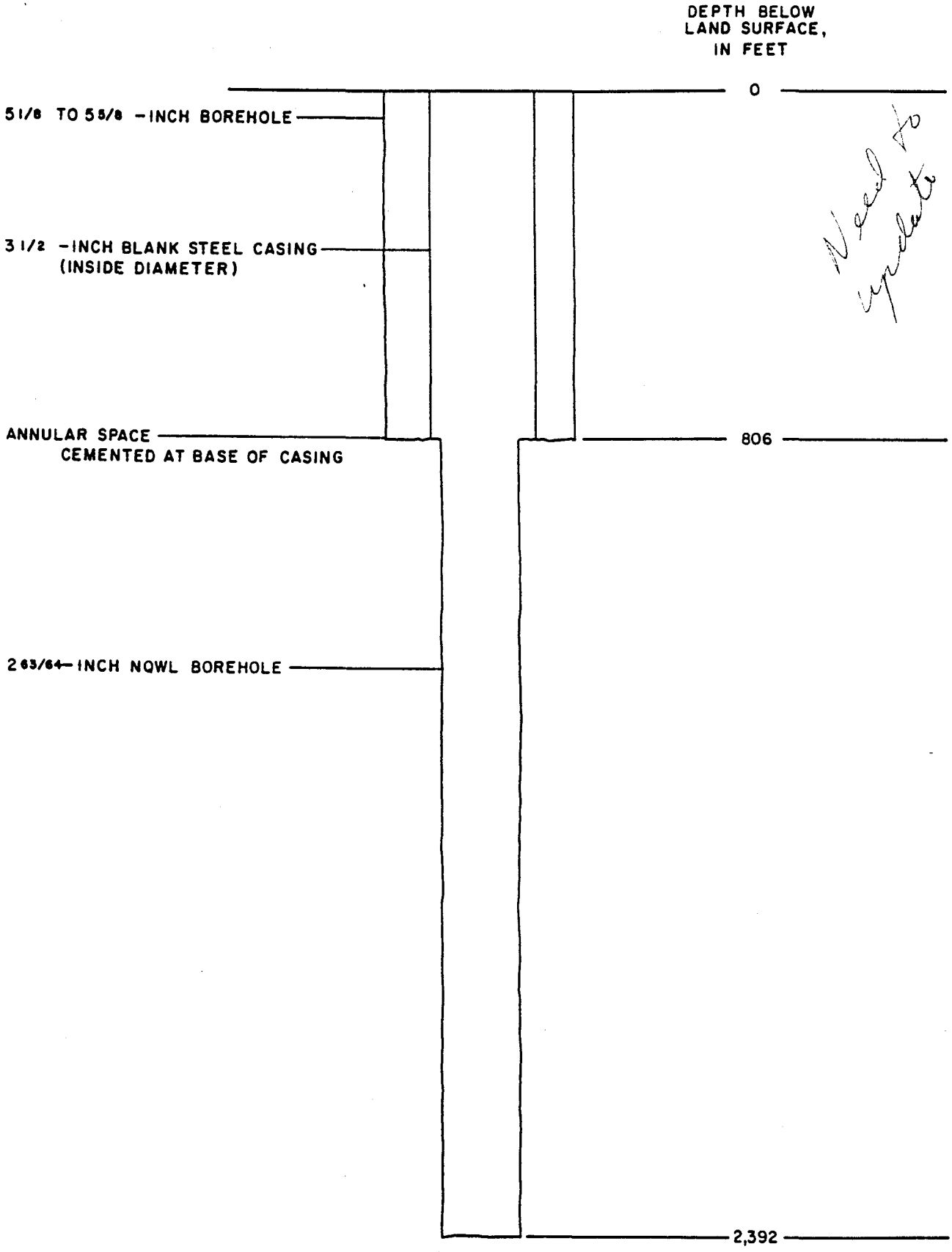


FIGURE 4. SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COREHOLE (D-6-4)13aac [SC-36]

ERROL L. MONTGOMERY & ASSOCIATES, INC.
TUCSON, ARIZONA

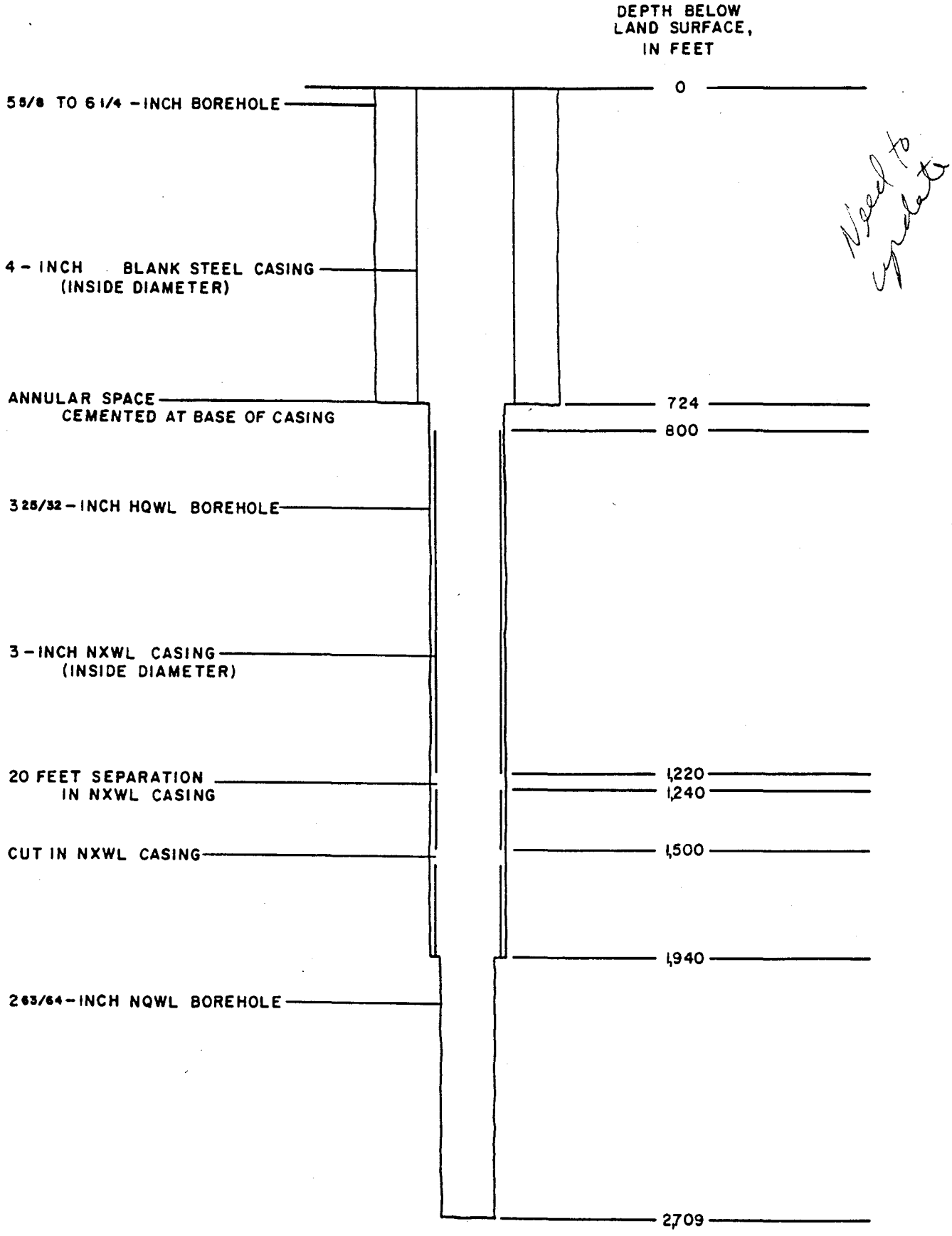
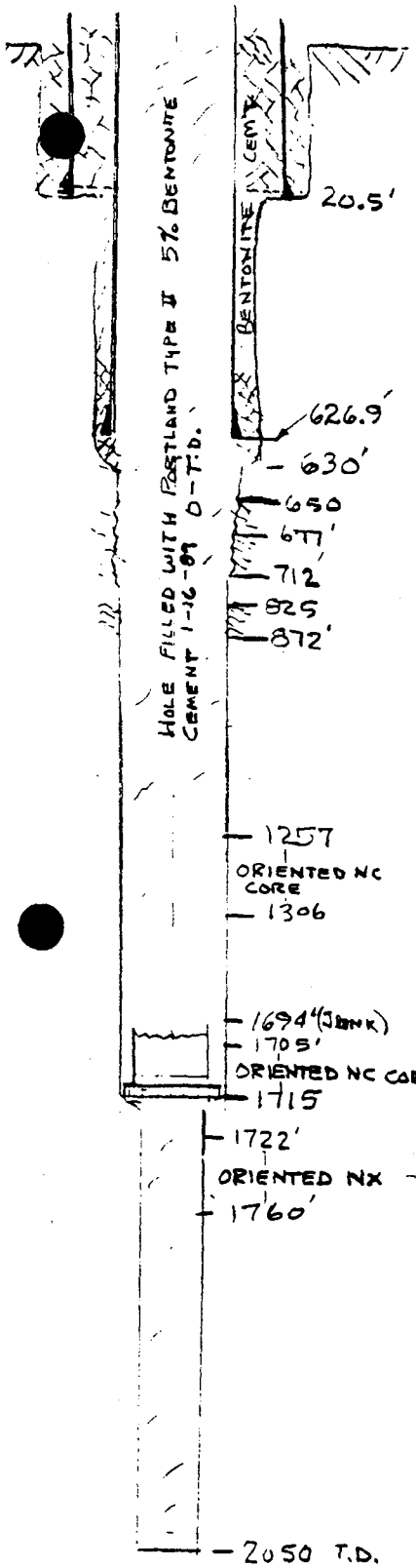


FIGURE 5. SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COREHOLE (D-6-4) 13aba [SC-49]

ERROL L. MONTGOMERY & ASSOCIATES, INC.
TUCSON, ARIZONA

HOLE DIAGRAM - MECHANICAL TAIL

Neen to draft



WELL Nº C1 COMP. DATE _____ GR ELEV. ±1310' KB ELEV. ≈1315

~~LOCAL~~ STATE PLANE COORDINATES 65,655 NORTH 49,514 EAST T6S, R4E, SEC13

HOLE SIZE	FROM	TO	REMARKS
12 1/4"	0	20.5	AIR ROTARY: START 11/28/88
6 3/4"	20.5	630	AIR/FOAM ROTARY: T.D. 11/30/88
3.685	630	1715	NC CORE
2.980	1715'		NX CORE

CSG SIZE	FROM	TO	KIND	WEIGHT	I. D.
8 5/8"	0	20.5	PLAIN END STEEL	28 LB/FT	8.017
4 1/2"	0	627'	BTC STEEL	9.5 LB/FT	3.965" DDFT
3.50"	0				

SURFACE CSG. CEMENTED WITH 9.1 FT³ = 7.0 SACKS PORTLAND TYPE II MIXED WITH 6 GAL./SACK WATER.

PRODUCTION CSG. CEMENTED WITH (±600'-630') 35 SACKS PORTLAND TYPE II CEMENT CORE HOLE: 712-677' 12/3/88 (LOST CIRC.); RE-CEMENT 677'-650' 12-6-88 (CAVING/SQUEEZING); CEMENT 825-872' 12/10/88 (LOST CIRC.);

PERFORATIONS	TYPE	DATE
TO		
TO		
TO		
TO		

REMARKS CASING-HOLE ANNULUS 0' TO 630' FILLED WITH BENTONITE MUD. CASING CEMENTED APPROX. 600' TO 627'. ORIENTED NC CORE TAKEN 1257' TO 1306' AND 1695' TO 1715'. NC ORIENTED CORE BARREL (CU-BE COMPOSITION) & BIT STUCK IN HOLE, 1694' TO 1715'. REDUCED TO NX BELOW 1715' (SET NX CASING 0-1694.5'); ORIENTED CORE 1722'-1760'.

TUBING AND PACKER DATA — NOT PERMANENT

AS OF _____ UNIT OR PUSHER _____

TBG SIZE _____ KIND _____

BOTTOM AT _____

SIZE / TYPE PACKER _____ AT _____

SIZE / TYPE PUMP _____ AT _____

REMARKS : _____

(ALL DEPTHS AND MEASUREMENTS CORRECTED TO GROUND LEVEL)

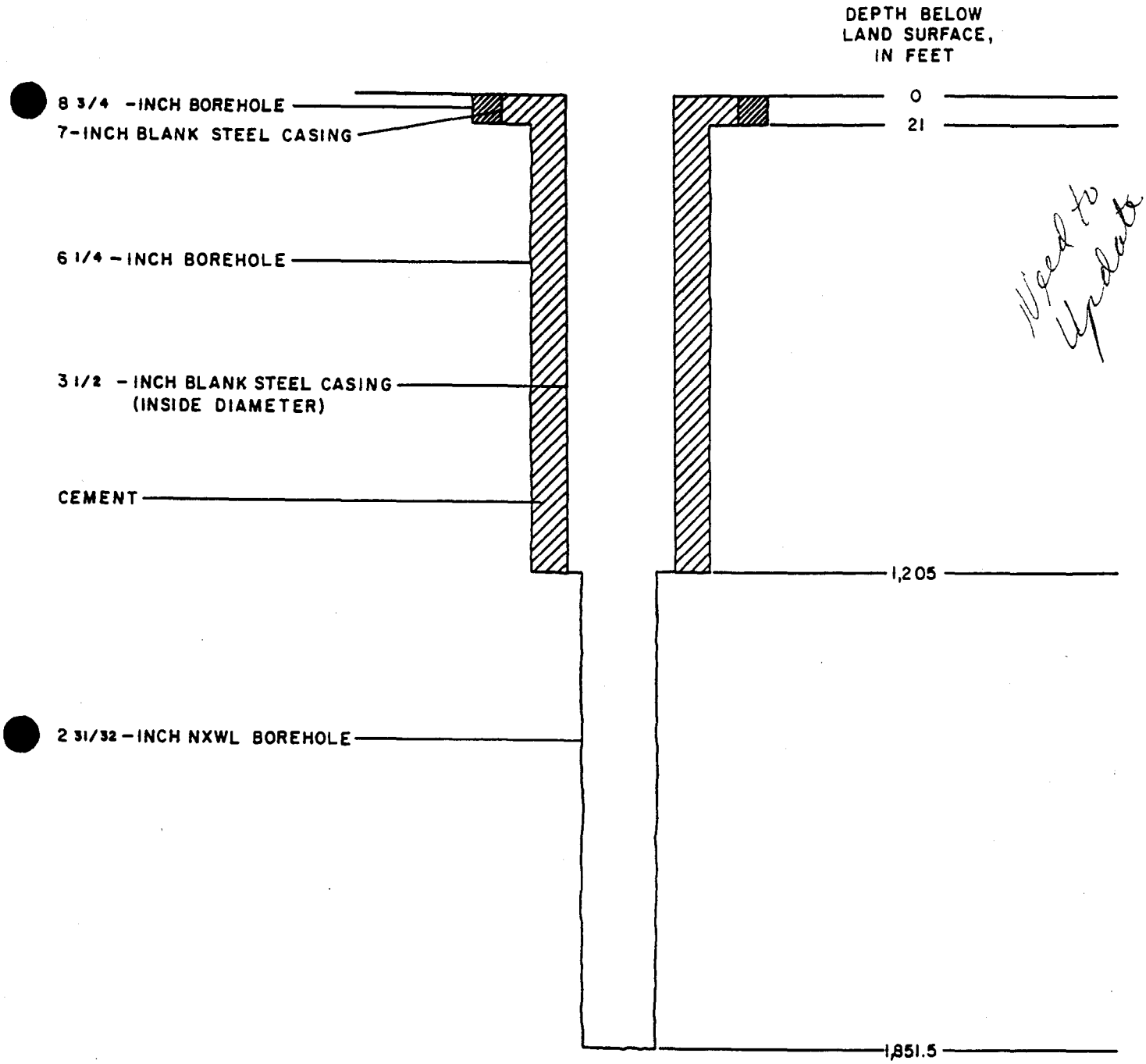


FIGURE 6. SCHEMATIC DIAGRAM OF CONSTRUCTION FOR COREHOLE (D-6-4)13abd[C-2]

SUBSURFACE HYDROLOGIC FEATURES

Bedrock Complex

The bedrock geology of the test site is known from the rotary cuttings and core of holes SC-19, C-1, and C-2 and from the rotary cuttings of test wells T-1, T-2, T-3, T-4, and T-5. All of the rotary cuttings and drill core from these holes were carefully logged for information on rock type, alteration, mineralization, fault structure, fracture abundance, fracture orientation, RQD (rock quality determination), and rock strength. All the core and rotary cuttings remain in storage and are available for examination at any time.

The bedrock geology is divided into two geologic environments for purposes of geologic and hydrologic description: the (1) leached capping which overlies the (2) copper oxide zone as shown in Figure 4-2. The overlying leached capping is present from the top of the bedrock, approximately 650 ft deep in general, to the top of the copper oxide zone, 1,180 ft to 1,260 ft deep. The copper oxide zone is present between the base of the overlying leached capping and a depth of 1,800 ft.

Overlying Leached Capping: The overlying leached capping is composed of 95% Precambrian granite which is known as the Oracle granite. The remainder of the rock is Laramide age quartz monzonite porphyry dikes and local traces of diabase.

All of these rocks have been altered by moderate amounts of sericite-clay replacement. Above a depth of 1,000 ft about 50% of the rock-forming minerals are sericite-clay replaced. Below 1,000 ft the total amount of sericite-clay is substantially less, averaging 30%. The sericite-clay replaces all of the biotite and plagioclase and variable amounts of orthoclase. Locally, remnants of unaltered secondary biotite remain in some of the quartz monzonite porphyry dikes.

All of the rocks have been totally oxidized. Goethite and hematite have replaced all of the former sulfide minerals which amounted to 3-6% of the rock prior to oxidation. Virtually all of the former copper mineralization has been leached out of the rock and deposited elsewhere. Only geochemical amounts of copper and rare traces of chrysocolla remain.

The rocks of the overlying leached capping have been weathered and fractured. Most of the fracturing is related to faulting. Because of the weathering and fracturing the core has a low RQD, and a substantial portion of the rock has a weak strength. The weathered and fractured rock of the overlying leached capping appears to be bottomed by a 10° to 40° dipping fault zone as seen in C-1 from 1,212 ft to 1,246 ft. Other than the apparent dip seen in the C-1 core, the attitude of the fault is not determinable from the present database.

Copper Oxide Zone: The copper oxide zone consists of an upper and a lower zone of copper oxide mineralization as shown in the cross section of Figure 4-2. The upper copper oxide zone is separated from the lower copper oxide zone by iron oxide capping (leached capping) containing no significant copper mineralization.

The upper copper oxide zone, the iron oxide capping, and the lower copper oxide zone are hosted in Precambrian granite, locally known as the Oracle granite, and minor amounts of Precambrian diabase and Laramide biotite quartz feldspar porphyry.

The abundance of these rock types in the test site between 1,200 ft and 1,800 ft is: Precambrian granite, 95%; diabase, 4.5%; and porphyry, 0.5%. Their abundance in the perforated interval, 1,570 ft to 1,770 ft, is: Precambrian granite, 98%; diabase, 1%; and porphyry, trace.

The diabase dikes are commonly less than 10 ft, but locally up to 30 ft, in vertical thickness. Most of the diabase intercepts occur between 1,400 ft and 1,500 ft in the drill holes. The diabase occurs in bifurcating dikes having shallow to near-horizontal dips. The porphyry dikes were intercepted in only

a few of the drill holes and the vertical thicknesses were generally 5 ft or less. The attitude of the porphyry dikes cannot be determined but porphyry contacts in a core hole suggested a dike with a moderate dip.

The Precambrian granite has a medium to coarse grained, hypidiomorphic granular texture. Prior to being altered by hypogene and supergene solutions, the Precambrian granite was composed of 4% biotite, 17% plagioclase, 40% K-feldspar, and 39% quartz. Sericite and lesser amounts of clay have replaced almost all of the plagioclase and biotite and a small amount of the K-feldspar. The composition of the altered granite in the upper copper oxide zone averages 41% quartz, 36% K-feldspar, 3% plagioclase, trace biotite, 6% clay, 9% sericite, 2% limonite, 2% chrysocolla, and 1% atacamite. Likewise, the lower copper oxide zone averages 46% quartz, 23% K-feldspar, 2% clay, 22% sericite, 2% limonite, and 5% atacamite. The composition of the altered granite in the iron oxide capping is similar to that of the upper copper oxide zone.

Copper mineralization between the top of the upper copper oxide zone and the bottom of the lower copper oxide zone consists of atacamite, chrysocolla, and local minor amounts of chalcocite. The composition of these copper minerals are as follows: atacamite, $Cu_2(OH)_3Cl$; chrysocolla, $CuSiO_3$; and chalcocite, Cu_2S.

The upper and lower copper oxide zones each have their own style of copper oxide mineralization. In the upper zone the chrysocolla and atacamite fill moderately and steeply dipping fractures. Generally the thickness of the chrysocolla and/or atacamite filled fractures is less than 0.1 in. The grade of copper in the upper copper oxide zone is commonly 0.5-0.8% total copper.

The lower copper oxide zone is a stockwork of atacamite that fills a myriad of microfractures. About 90% of the atacamite filled microfractures are less than 0.02 inches thick. About 10% of the atacamite occurs in fracture filled atacamite veins up to 0.1 inch in thickness, and these atacamite veins have moderate and steep dips. The lower copper oxide zone commonly contains 1-3% total copper.

The lower copper oxide zone with its high grade atacamite is characterized by totally indigenous iron oxide after former sulfide minerals. Elsewhere, particularly in iron oxide capping with no copper oxides, there is a high percentage of transported iron oxide mineralization that stains the rock with a distinct reddish brown color.

Rock qualities of the rocks in the test site between 1,200 ft and 1,800 ft are the result of fracturing, supergene healing processes, and alteration. Because the alteration of the granite is generally uniform, the relative strength of the granite from place to place is primarily a function of the degree of fracturing and, to a lesser extent, the degree to which the fractured rock has been healed by supergene processes.

The qualities of rock strength and fracturing in the test site are seen in the core of C-1, C-2, and SC-19. The rock qualities of the individual test wells cannot be determined from the rotary cuttings.

Core of the upper copper oxide zone is broken by an average of two broken fractures per foot of core, and it has an RQD of 40 percent. Neither of these two values take into account the great abundance of fractures and microfractures that didn't break or separate during the coring processes. The strength of the granite in the upper copper oxide zone is such that it requires one hammer blow to break.

Core of the lower copper oxide zone has an average of one to two broken fractures per foot and an RQD of 64%. The strength of the core in the lower copper oxide zone requires one hammer blow to break.

The orientation of fractures in the general area of the test site is known from orientated core that was obtained during the drilling of C-1. Orientated core was cut in C-1 from 1,259 ft to 1,306 ft, 1,695 ft to 1,705 ft, and 1,722 ft to

1,760 ft (Dahl, 1989)[1]. The attitudes of the fractures are summarized in Table 4-4 according to the type of mineralization occurring in the fracture.

Table 4-4. Fracture Orientation in C-1 (Dahl, 1989)

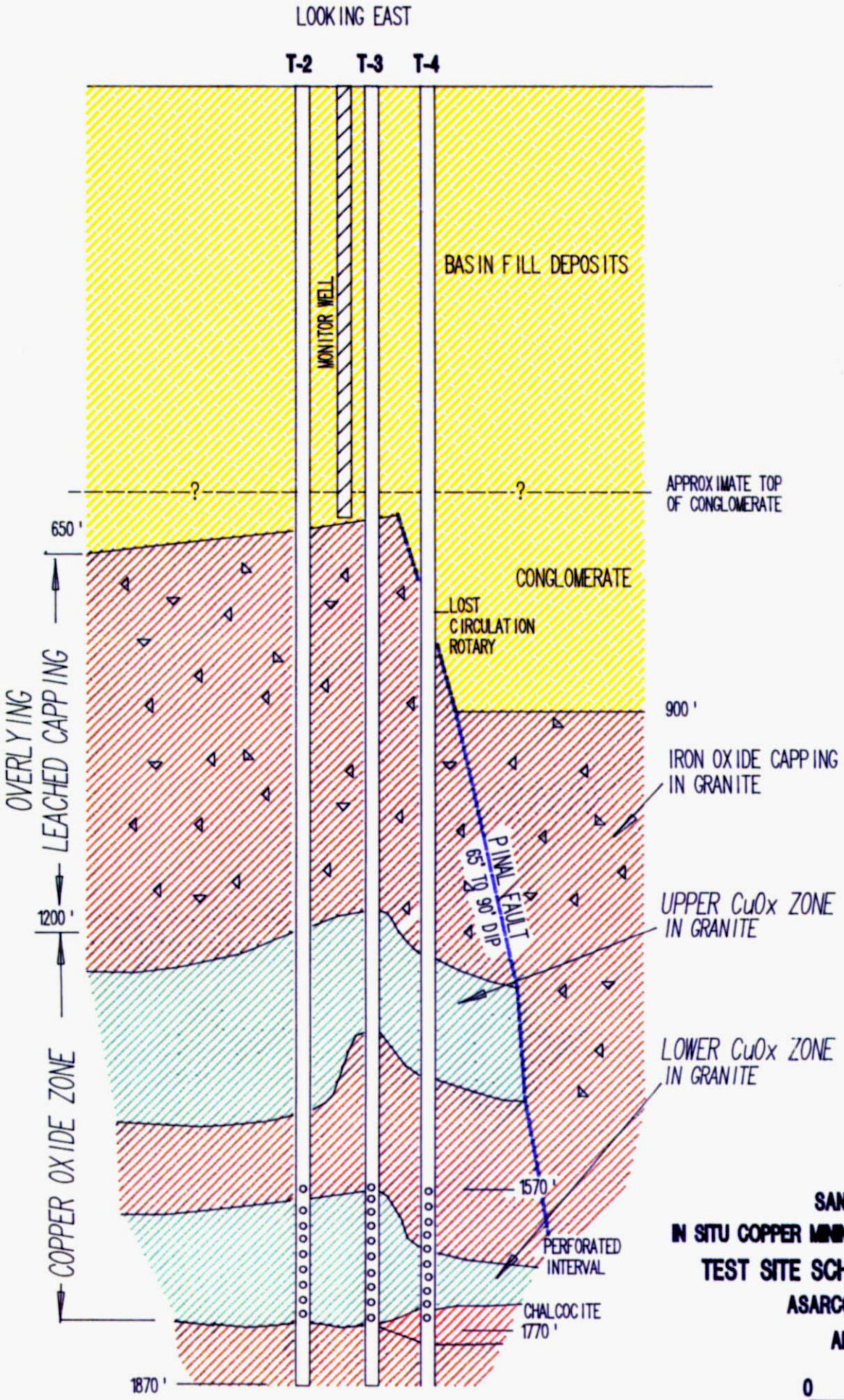
Fracture Mineralization	Number of Fractures	Attitude of Primary Fractures	Attitude of Secondary Fractures
Chrysocolla	33	N16°W, 80°NE	N69°W, 34°NE
Clay	208	N28°E, 5°SE	N20°E, 55°SE
Limonite	530	N68°E, 44°NW	N20°E, 52°SE
All Fractures	546	N66°E, 45°NW	N20°E, 52°SE

Between the upper and lower copper oxide zones there is some strong fracturing and some local fault gouge. In core hole C-2 there is: 1,361 ft to 1,391 ft, a fault zone with strong breakage of the rock, local gouge, and weak evidence of a moderate to steep dip; 1,420 ft to 1,472 ft, a fault zone with strong breakage of the rock, local gouge, and 45° to 60° dipping structure; and 1,497 ft to 1,506 ft, a fault zone with a total of 12 inches of gouge and 40° to 60° dipping structure. In SC-19 from 1,320 ft to 1,360 ft, 1,460 ft to 1,520 ft, and 1,580 ft to 1,610 ft, the rock is moderately to strongly broken with local minor gouge. The attitudes of these structures are not determinable from the present data base.

A fault, named the Pinal Fault, was intercepted in T-4 from 730 ft to 760 ft (see Figure 4-2). As interpreted from the geology of widely spaced (500-ft centers) exploration drill holes, the Pinal Fault strikes N65°W and dips 65° to 90° to the southwest. The Pinal Fault is a normal fault of post-conglomerate age. It down drops the top of bedrock 200 ft to 350 ft to the southwest.

The attitude of the Pinal Fault is such that it passes within 50 ft of the perforations in monitor well SM-1. At the 1,570 ft to 1,770 ft depth of perforations in the test wells, the Pinal Fault is estimated to be within 300 ft of T-4, the closest well to the Pinal Fault, at the depth of the perforations.

[1]Dahl, L.J., 1989, Oriented Coring Operations, Hole C-1; USBM in-house report.



SANTA CRUZ
IN SITU COPPER MINING RESEARCH PROJECT
TEST SITE SCHEMATIC SECTION
ASARCO Incorporated
APRIL 1990

0 200'

mn SC90 1206 HGK/dam tuc 04-20-90

ASARCO

Southwestern Exploration Division

December 28, 1990

A.R. Raihl

H.G. Kreis
Monthly Report
December 1990

During the month of December only a few days of time were charged to the in situ portion of the Santa Cruz Project. This work included:

- initiating a CSAMT-TEM survey over the test site and having to cancel it because of equipment problems and noise from the electric pumps;

- writing the bedrock geology section for the acquifer protection permit application; and

- preparing posters for the 1991 USGS McKelvey Forum.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO

Southwestern Exploration Division

December 28, 1990

R.L. Brown

H.G. Kreis
Monthly Report
December 1990

General Exploration

Work on the USBM-industry sulfide in situ leach proposal continued during December. On December 6th the USBM and industry people met at Asarco's Tucson Office, and they met again on December 13th with the DOE in the USBM's Washington, D.C. Office. Plans are being made for the USBM and industry to meet in January with people experienced in chalcopyrite leaching.

The industry participants have completed the preparation of an agreement to form an association called CIPRA. The CIPRA agreement will be available for signing by the participating companies in January.

At the December 6th meeting, Mr. Larson and Mr. Phillips, both of USBM, agreed to have CIPRA be the prime contractor to the DOE. After consulting with other USBM people they reversed their position, and requested that the USBM be the prime contractor. This latter request is being considered by industry. In either prime contractor situation, the program planning and the allocating of funds will be controlled by a joint USBM-industry management committee operating under a memorandum of agreement.

Santa Cruz Joint Venture

A memo on surface sealing old exploration drill holes was issued. Plans are being made to weld steel caps on holes that are not in compliance with state laws.

Santa Cruz In Situ Leach

My work on the in situ leach test is described in my memo to Mr. Raihl, and you are designated to receive a copy of that memo.

H. G. Kreis

H. G. Kreis

HGK:mek

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

JDS

ASARCO

Southwestern Exploration Division

December 28, 1990

J.D. Sell

Quarterly Report
Fourth Quarter 1990
H.G. Kreis

Santa Cruz In Situ Leach Project, EA-0438, Copper

Twenty-four and a half days were expended on giving presentations, field tours, and report writing.

Santa Cruz Project, EA-0075, Copper

Eight and a half days were spent on preparing several land acquisition evaluations and reports, researching and writing on surface sealing drill holes, and budgets.

General Exploration, Copper

A total of twenty-five days were used preparing for and attending USBM-industry meetings on the USBM's sulfide in situ leach proposal; reporting on these meetings; meeting with the DOE in Washington, D.C.; taking visitors to Mission and Ray Mines; and attending the Arizona Section of AIME.

Miscellaneous

Four days of vacation were taken during the fourth quarter.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: W.L. Kurtz

ASARCO

Southwestern Exploration Division

January 9, 1991

D. E. Crowell

Chalcopyrite Concentrate
for USBM Research

Jim Murphy, Group Supervisor at the USBM's Reno Metallurgy Research Center, has requested fifty pounds of chalcopyrite concentrate from a porphyry copper deposit. He wants the concentrate for use in researching the leaching of chalcopyrite mineralization.

I told Mr. Murphy that I thought Asarco could supply them with fifty pounds of chalcopyrite concentrate. Mr. Graybeal was informed of this request, and he suggested the request be turned over to you.

If you are in agreement, please have the concentrate sent to:

Jim Murphy
Reno Metallurgy Research Center
U.S. Bureau of Mines
1605 Evans Ave.
Reno, Nevada 89505

Thanks.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO

Southwestern Exploration Division

January 14, 1991

FILES

Presentation on
Santa Cruz In Situ

Formal presentations on the Santa Cruz In Situ Copper Mining Research Project were given by the undersigned to the following groups:

January 8th - Congressional staff from the offices of DeConcini, McCain, Udall and Kolbe.

January 10th - 40 members of the Casa Grande Economic Development Foundation.

Casa Grande Mayor Jimmy Kerr said he is considering having someone talk to the Chamber of Commerce about the in situ project. He will contact us if the C.C. wants a presentation on the in situ project.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: F.T. Graybeal
A.R. Raihl
W.L. Kurtz
J.D. Sell

ASARCO

Exploration Department
Southwestern United States Division

FAX (617)-258-5802

January 15, 1991

Mr. Carl R. Peterson
Dept. of Mechanical Eng., Rm 3-455a
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Dear Mr. Peterson:

Please be advised that Albert R. Raihl will not be attending the DOE/USBM/ASME Workshop for Nuclear Waste Cleanup. Mr. Raihl has asked me to attend in his place and be the Industry Leader for the In Situ Treatment and Containment breakout meeting.

I have agreed to this, and am looking forward to participating in the workshop.

Sincerely,

Hank Kreis

Henry G. Kreis
Senior Geologist and
In Situ Leach Site Manager

HGK:mek

bl.cc: A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

January 18, 1991

Dr. Donald H. Davidson
SAIC
1710 Goodridge Drive
Mail Stop T-2-2-1
McLean, Virginia 22102

Dear Don:

You are invited to participate in the USBM-industry meeting on sulfide in situ leaching. As you know, the meeting will be held February 12th and 13th in Tucson.

Details of the agenda are being prepared, and I will send them to you as soon as they become available.

Sincerely,

Hank

HGK:mek

Henry G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

January 18, 1991

DOE Meetings
Sulfide In Situ Leach

To Whom It May Concern:

The enclosed write-up describes the results of discussions with the DOE. The write-up is intended for those who wanted to participate in the discussions but could not participate.

By copy of this letter, I am asking those who participated for additions and corrections.

If there are any questions, please feel free to call me.

Sincerely,

H.G. Kreis

HGK:mek

cc: W. Larson - USBM
S. Young - Magma
J. Dobson - Cyprus
F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P. O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

H. G. Kreis
Asarco Inc.
January 16, 1991

DOE MEETINGS

The DOE has talked to the USBM and industry on two different occasions. The first time was a conference call between Bill Obenchain, Bill Larson, and the undersigned. The second time was a joint DOE-USBM-industry meeting at the USBM's Washington D.C. office. The information learned at these meetings is described in this memo.

History

The sequence of events that brought the DOE, the USBM, and industry together were explained by Mr. Obenchain. Some years ago the Kenworth Initiative was enacted to help the steel industry become more competitive with foreign steel producers. The scope of the initiative was expanded to include aluminum and copper with the enactment of the Steel and Aluminum Energy Conservation and Technology Competitiveness Act of 1988. The DOE was given the responsibility to carry out the intent of the act, and the DOE assigned Mr. Obenchain to manage the copper portion of the program.

Mr. Obenchain told us some generalities about his background. Mr. Obenchain has a metallurgical engineering degree from the University of Pittsburgh, and he has done some work in the copper industry. He worked for a contracting company and installed hoods on converters at Magma's smelter. Apparently he is the only person in the DOE that knows anything about the copper industry. He has been with the DOE for the last three years.

Mr. Obenchain, after being assigned the copper industry portion of the steel initiative, began contacting the copper companies to obtain research proposals. He said he contacted all the major producers but found no interest whatsoever.

Because of this lack of industry interest, Matt McMonaco and Peter Salmon-Cox, both from the DOE, contacted Bob Kaplan of the USBM Washington, D.C. office one and one half years ago. The DOE asked the USBM if the USBM would be interested in submitting a copper industry proposal. The USBM was interested, and in December of 1989 the USBM invited certain copper producing companies to a meeting at the USBM's Washington office. This was the sequence of initial events that lead to the joint USBM-industry proposal that is presently being developed.

Proposal Review Process

The DOE explained the DOE process for reviewing proposals submitted to the DOE. When the DOE receives a proposal, it is processed according an established procedure. The first step is for the DOE to make a preliminary review.

The preliminary review is done either in or out of house depending on the degree of in house expertise. There are ten requirements that must be addressed in the proposal, and the preliminary review process checks to see that each of the ten requirements has been addressed. (The ten requirements are described in the DOE's Management plan of May 1989.) If all the requirements have not been addressed, the proposal is returned to the party that submitted the proposal. If all ten requirements have been addressed to the DOE's satisfaction, the proposal is sent out for a detailed review.

The detailed review is done by an expert who is knowledgable of the subject covered by the proposal. The expert would probably be from industry, from academia, or from the government. The DOE mentioned a couple of possible copper industry experts, John Onopolis (sp.?) and Glen Harris. Mr. Onopolis has a smelting background and is retired from Newmont. Mr. Harris is also a former Newmont employee.

The expert does the detailed review on a volunteer, no cost basis; consequently, the expert takes his time. It often takes two months for the expert to complete the detailed review.

Once the detailed review has been completed, the proposal goes before the Project Review Board (PRB). At this time, Mr. Obenchain becomes an advocate for the proposal. As an advocate for the proposal, it becomes his job to "sell" the proposal to the PRB.

The DOE has provided very little insight into the PRB and the PRB's review process. It is not known who sits on the PRB. Nor is it known when the members of the PRB are first introduced to a proposal. It might be helpful to have more insight into the PRB and the PRB review process.

Once a proposal has been approved by the PRB and accepted by the DOE, a statement of work and a contract are negotiated and prepared by the Idaho National Engineering Laboratory (INEL). At some point in this part of the process, a CPU letter is prepared for the INEL. No one knows what CPU stands for, but the letter does give the INEL the authority to spend funds for the contracted statement of work. The CPU letter takes about a month to obtain. Also, at some other point in this part of the process, the Department of Defense Audit Association makes sure that the proposed contractor for the work has satisfactory accounting and auditing procedures for handling government contract work.

Once the contract and the funding is in place, work can proceed. The INEL is then responsible for overseeing the work.

The INEL handles proposals, project agreements, contracts, and administration for DOE research projects. The INEL is managed and operated by EG&G Idaho Inc., a management and operating contractor for the DOE. There are 10,000 employees at INEL, of which 400 are actual DOE employees. About 10 of the employees are associated with Mr. Obenchain.

Funding

The amount of funding for a proposal submitted to the DOE is determined by the cost of achieving the proposal's goal. The funding has to be adequate to carry the program to completion, the achieving of the goal. The DOE will not fund a program that is less than complete. The completion of a program, incidentally, is usually characterized by a field test.

Some rough limits on the level of funding were identified. A proposal costing a total of $100,000 was deemed to small to be of interest to the DOE. The most expensive program the DOE has at this time is $25,000,000, but in time the most expensive program is expected to be $45,000,000.

Funding for a proposed program should start out at low cost in the first year or two. At this time the DOE would be hard pressed to absorb an expenditure of $800,000 in the first year, and it would be hard for the DOE to come up with $5,000,000 or more in any of the following years.

Once the DOE has accepted a program and begun to fund it, the DOE funding is provided on an annual budget basis. It is possible the DOE might not be able to provide funding at some point in a program; however, thus far the DOE has never failed to fund an on going program.

Funding for a program is paid 70% or less by the DOE and 30% or more by non federal sources such as industry or a state government. The DOE's 70% or less funding level must be achieved at the end of each year and each phase. However, there is some sort of flexibility; because occasional variances, like 80% DOE funding, would be considered acceptable. Non federal contributions in excess of 30% can be carried as credit into future years.

The DOE is presently in a position to enter into a contract having major funding in 1992. Funding for 1992 is already being locked up.

Payments In Kind: Nothing generates discussion like payments in kind. Every time this topic is discussed previous statements

are repeated, something new is added, and a little better understanding is achieved. The subject of payments in kind is not fully understood by the USBM or industry, and more discussions with the DOE are necessary. Highlights of payment in kind discussions with the DOE are described in the following paragraphs.

Easily identified payments in kind are those that occur after the contract has been signed. They are commonly in the form of lab work, management, various types of similar services, and rent value of facilities. The value of these payments in kind are easy to establish, particularly when good records are kept.

Obtaining payment in kind credit for previously done work is difficult. Apparently the DOE has never given credit for previous work. An example was cited in which one organization had done a substantial amount of research towards reaching a certain objective. Falling short of the objective, this organization submitted a proposal to the DOE to carry this research forward to reach the objective and, in the process, requested payment in kind credit for the previous work. The proposal was not accepted by the DOE because the DOE would not give credit for the previous work.

Previous work is considered of no value unless the work has been sold (or purchased) in an arms length transaction. Mr. Obenchain conceded that possibly a case could be made in which previous work would replace work that would have otherwise been necessary after the signing of the contract. But, this would be "an uphill fight".

One can obtain payment in kind credit for previous work by conducting this work within 90 days of the signing of the DOE contract. The length of time can be extended by writing a letter requesting an extension. The maximum length of extension was not given. An example of 180 days was quoted; so an extension must give a total of at least 180 days.

The payment in kind value of an ore deposit was brought up for discussion, and it was apparent this topic had never been considered by the DOE prior to discussions with the USBM and industry. Mr. Obenchain didn't think an ore deposit for study and test work had any in kind value. After some discussion, he thought that perhapes an in kind value might be established if one could demonstrate a similarity to values established in the normal course of mining agreements. Further discussion likened the development of the ore deposit to the construction of a building in which to conduct test work; ie, a facility on which rent would normally be charged as payment in kind. Thus far, this rental concept seems to have the most merit for establishing in kind payment for the use of an ore deposit.

Intellectual Property

Ownership: The DOE takes first ownership of all intellectual property developed under the steel and aluminum initiative. (This is different from other DOE research programs where, for example, a college professor might be the owner of a patent generated from DOE research.) Once the DOE becomes the owner of a patent, the patent is immediately transferred to a holding company.

The holding company has to be a legal entity. It could be CIPRA, one of the participating CIPRA companies, a contracted company, or a company established for the purpose of holding the intellectual data. The holding company is responsible for the intellectual data and for facilitating the transfer of technology to the market place. This allows both the participating companies and the industry to benefit.

Licensing: The holding company must have everything it needs in order to license the intellectual property. If a participating company(ies) holds a patent necessary for the licensing of the intellectual data, the DOE may require that patent to be put under the control of the holding company.

The holding company transfers the use of the intellectual property to industry through licensing agreements. Each and every company licensed to use the technology is charged for its use, even participating companies. Participating companies pay a licensing fee, and nonparticipating companies pay a royalty. The licensing fee is substantially less than the royalty.

The licensing fee and the royalty are charged so that the federal government can recoup 150% of the DOE's cost in the research program. Once the 150% has been recouped, the Federal Government and the DOE interests in the program are completed severed, and the intellectual property is left in the holding company under the ownership of the participating companies (or CIPRA).

The rate of payment at which the federal government recoups the 150% is negotiated during Phase I of the program. There was no discussion as to why it is done at this time, or if it can be done at some other time.

Patent Infringement: DOE research programs and other research programs are free to use any intellectual data. The DOE said that research never infringes on patents; and, thus, there is no need for concern about patent infringement when doing research. Patents, incidentally, have a 17 year life; consequently, many of the older copper in situ leaching type patents will be expiring at about the time any DOE sponsored research is completed.

Proposal Support

A proposal submitted to the DOE will benefit by having a well rounded support base. Such support can be obtained as follows.

Industry Support: The DOE is interested in supporting industry more than an individual mining company or a government agency. Consequently, it is important to show industry support. In our case it would be helpful to show the support of the Arizona Mining Association and have letters of support from other copper mining companies. Another way to show industry support is to have an industry advisory group.

Congressional Support: From what has been heard on the street, the DOE is sensitive to the intent of Congress. Although the DOE is not influenced by Congress, the DOE likes to know what Congress is attempting to accomplish. It is Congress, after all, that determines how much funding the DOE will receive for research programs. Therefore, any sign of political support for concepts promoted by a proposed research program would be helpful.

Academic Support: Having academic support is a good indication of a well rounded research program. One way of showing this support is to show university research funding in the proposal.

Government Agency Support: As with academic support, the support of a government agency, such as the USBM, is valuable to have. It is additional evidence of the worthiness of a proposal.

Identity and Presence: It is important for the people in DOE to develop a knowledge of the people, corporations, and government agencies that have developed the proposal and have the responsibility for carrying out the intent of the proposal. Meetings with the DOE, corporate annual reports, corporate public relations type information, and personnel resumes can all be used to help develop a respectful working relationship with the DOE.

H. G. Kreis

Henry G. Kreis

ASARCO

Exploration Department
Southwestern United States Division

June 18, 1991

Mr. S. Swan
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Dear Steve:

Here are duplicates of all my slides taken during the salt tracer test.

Sincerely,

Hank

H.G. Kreis

HGK:mek
encs.

cc: A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

June 19, 1991

A.R. Raihl

Porosity of
Atacamite Rocks
Santa Cruz Deposit

Brent Hiskey of the UofA Copper Research Center would like to have porosity values of the high grade atacamite rocks found in the Lower Copper Oxide zone. He needs this information to help interpret the results of his leach test work on the 4" core. I think the USGS and USBM porosity values on the split core would be helpful to Hiskey, but we probably ought to have the USBM's permission to release this information to Hiskey.

H. G. Kreis/mek

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell

J.D.S. 6/11/91

FROM: J. D. SELL

TO: H G Kreis

Have you done the assessment drilling on your 55 claims yet?

Jim

6-18-91

Drilling is in progress

H.K.

ASARCO

Southwestern Exploration Division

July 3, 1991

FILE NOTE

1990-1991 Assessment Year
Santa Cruz Project
Pinal County, Arizona

For the record, between June 15 and June 19, 1991 the following work and improvements were done and performed as follows:

1. Drilling

   Cissell Drilling Co.
   P.O. Box 1048
   Casa Grande, AZ 85222 $5,675.00

   Drilled 3 holes (350 ft. total)
   and deepened 1 hole (100 ft.)

2. Supervision

   H.G. Kreis

Total Claims

NIK Claims	46
Chavo Claims	9
Total	55

W.D. Gay

WDG:mek

cc: W.L. Kurtz
J.D. Sell
H.G. Kreis

ASARCO

Southwestern Exploration Division

July 8, 1991

A.R. Raihl

Trailer Permits
Santa Cruz Project

In a June 12, 1991, Fennemore Craig memorandum from M.V. Grayson to D.L. Burton, Ms. Grayson remarked that "Building and Safety informed me that permits have been pulled for the two trailers at the saline injection facility." Ms. Grayson concluded our trailer permits had been terminated.

I told Roger Brooks, Pinal County Office of Planning and Development, of Ms. Grayson's remark, and asked if we needed any permits for our office trailer, a storage mobile mini trailer, or a laboratory mobile mini trailer. Mr. Brooks remembered Ms. Grayson's visit and explained that our permit files were pulled from the current files and put into the archive files. He said we are permitted and nothing needs to be done for the three trailers.

H. G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell

ASARCO

Exploration Department
Southwestern United States Division

July 8, 1991

Mr. Brent Hiskey
UofA Copper Research Center
4717 E. Ft. Lowell
Tucson, AZ 85712

Re: Santa Cruz Porosity Data

Dear Brent:

Here is the USGS and USBM porosity data on the Santa Cruz split core samples. Both Steve Swan of the USBM and Phil Nelson gave verbal approval to release this data to you.

If you should have any questions, please feel free to call me in Casa Grande, 602-836-6249.

Sincerely,

Henry G. Kreis / mek

Henry G. Kreis

HGK:mek
enc.

cc: F.T. Graybeal (w/o enc.)
J.D. Sell (" ")
A.R. Raihl (" ")
S. Swan (USBM) (" ")
P. Nelson (" ")

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

FAX

July 8, 1991

F.T. Graybeal
New York Office

AIME Abstract
Santa Cruz Project
Pinal County, AZ

Attached for your review is a preliminary abstract of our talk for the 1992 National AIME meeting in Phoenix. The abstract is to be no longer than 100 words.

If you have any comments, changes, or suggestions, please let me know. The abstract has to be submitted to AIME by August 1.

H.G. Kreis

HGK:mek
att.

H.G. Kreis

cc: W.L. Kurtz
J.D. Sell
A.R. Raihl

H.G. Kreis
July 5, 1991

ABSTRACT

GEOLOGY OF THE SANTA CRUZ PORPHYRY COPPER DEPOSIT

H.G. Kreis, ASARCO INCORPORATED, Tucson, AZ
F.T. Graybeal, ASARCO INCORPORATED, New York, N.Y.

The Santa Cruz porphyry copper deposit, with its geologic mineral inventory of soluble copper mineralization in excess of one billion tons at 0.55% Cu, is one of the larger known copper oxide deposits of its type in the world.

The deposit consists of supergene atacamite ($Cu_2(OH)_3Cl$), chrysocolla, and chalcocite all of which are underlain by hypogene chalcopyrite mineralization. The deposit is present at depths of 1200' to 3200' and is buried beneath more than 600' of post mineral basin fill deposits and conglomerate.

The deposit and its well developed zoning patterns of hypogene alteration and mineralization are commonly offset by normal faults.

ASARCO SANTA CRUZ INC.

SANTA CRUZ
COPPER MINING RESEARCH PROJECT
P.O. Box H
Casa Grande, Arizona, 85222
Phone: 602-836-6249
Fax: 602-836-0179

DATE: 7-11-1991

TO: W.L. KURTZ / J.D. SELL

COMPANY: ASARCO

FAX NUMBER:

ASARCO
JUL 12 1991

FROM: H. KREIS

COMPANY:

MESSAGE (if any): Figure of CONCENTRATION VRS TIME

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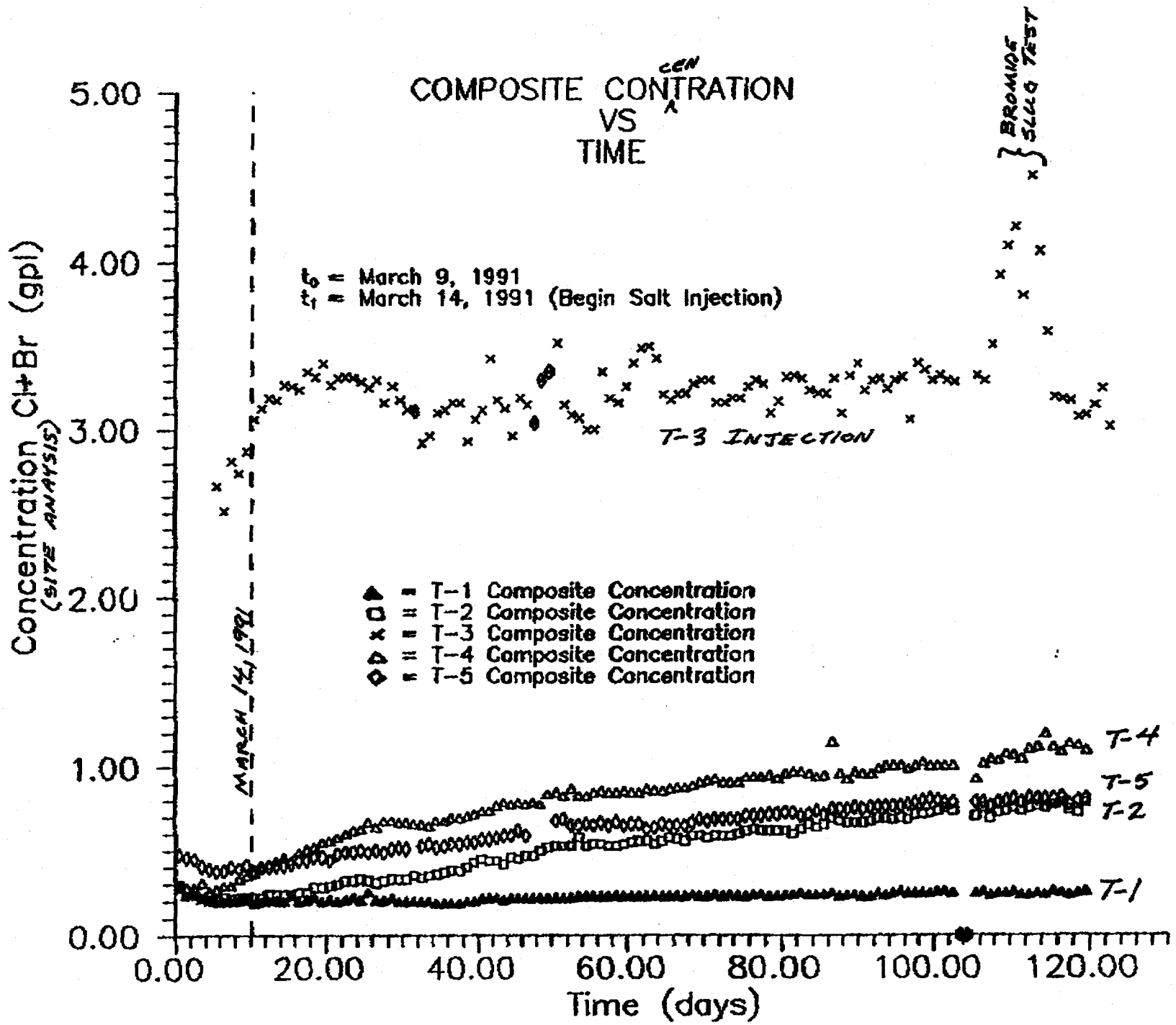
FOR QUESTIONS CONCERNING THIS TRANSMISSION CALL: 602-836-6249


COMPOSITE CONCENTRATION
VS
TIME
Concentration Cl+Br (gpl)
(SITE ANAYSIS)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
20.00
40.00
60.00
80.00
100.00
120.00
Time (days)
t_0 = March 9, 1991
t_1 = March 14, 1991 (Begin Salt Injection)
MARCH 14, 1991
T-3 INJECTION
BROMIDE SLUG TEST
▲ = T-1 Composite Concentration
□ = T-2 Composite Concentration
× = T-3 Composite Concentration
△ = T-4 Composite Concentration
◇ = T-5 Composite Concentration
T-4
T-5
T-2
T-1

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

ASARCO Incorporate

JUL 1 5 1991

SW Exploration

JDS

JOB NUMBER TAJ 728A
July 12, 1991
ITANKSED 5-17-1991

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REPORT OF ANALYSIS

Analysis of 1 Sample

ITEM	SAMPLE NO.	Au* (ppb)	Ag* (ppm)	As* (ppm)	Ba* (ppm)	Br* (ppm)	Ca* (%)	Co* (ppm)	Cr* (ppm)	Cs* (ppm)
1	ITANKSED	< 19.	< 8.	1000.	< 300.	4500.	< 2.	11.	330.	< 2.

ITEM	SAMPLE NO.	Fe* (%)	Hf* (ppm)	Hg* (ppm)	Ir* (ppb)	Mo* (ppm)	Na* (ppm)	Ni* (ppm)	Rb* (ppm)	Sb* (ppm)
1	ITANKSED	10.9	< 1.	< 5.	16.	45.	50300.	< 170.	< 36.	5.1

FILE

Charles E. Thompson
Arizona Registered Assayer No. 9407

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

JOB NUMBER TAJ 728A
July 12, 1991
ITANKSED 5-17-1991

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

REPORT OF ANALYSIS

Analysis of 1 Sample

ITEM	SAMPLE NO.	Sc* (ppm)	Se* (ppm)	Sn (%)	Sr* (%)	Ta* (ppm)	Th* (ppm)	U* (ppm)	W* (ppm)	Zn* (ppm)
1	ITANKSED	8.2	< 11.	.77	< .16	< 2.00	15.	46.	< 4.	< 76.

ITEM	SAMPLE NO.	La* (ppm)	Ce* (ppm)	Nd* (ppm)	Sm* (ppm)	Eu* (ppm)	Tb* (ppm)	Yb* (ppm)	Lu* (ppm)
1	ITANKSED	13.	INT.	INT.	1.7	< .3	< .9	< .5	< .13

NOTE: INT. denotes interference.

cc: Mr. J. D. Sell

REGISTERED ASSAYER CERTIFICATE 9425 WILLIAM LEHMBECK

7/12/91

Charles E. Thompson

William L. Lehmbeck
Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

ASARCO

Exploration Department
Southwestern United States Division

July 19, 1991

Ms. Diane Marozas
U.S. Bureau of Mines
5629 Minnehaha Ave South
Minneapolis, MN 55417

Dear Diane,

Under separate heading you will receive three samples from the Santa Cruz test site.

Iron Oxide capping, 55 pounds of core:
T-1, 1040'-1045', 1048'-1053', 1056'-1061'.

Upper CuOx zone, 55 pounds of rotary cuttings:
T-2, 1250'-1330' (taken from duplicate samples).

Lower CuOx zone, 55 pounds of rotary cuttings:
T-2, 1670'-1750' (taken from duplicate samples).

Each of the three samples is contained in several bags, and all the bags for each sample need to be mixed and blended before using the sample is any way.

Sincerely,

Hank

Henry G. Kreis
Site Manager

HGK:dma

cc: A.R.R
F.T.G
W.L.K.
J.D.S.

ASARCO Incorporated
JUL 24 1991
SW Exploration

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

July 22, 1991

F.T. Graybeal

AIME Abstract
Santa Cruz Project

I liked the Santa Cruz geology abstract you wrote. One correction was made in the abstract (650' not 550' to bedrock).

I have sent the abstract to AIME along with the appropriate form and a brief bibliography of the speaker, the undersigned.

H. G. Kreis

HGK:mek

H.G. Kreis

cc: A.R. Raihl
W.L. Kurtz
J.D. Sell

ASARCO

Exploration Department
Southwestern United States Division

July 25, 1991

Mr. S. Swan
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Dear Steve:

Enclosed for your review is an abstract for "Geology of the Santa Cruz Porphyry Copper Deposit, Pinal County, Arizona." As you know, this talk will be presented to the AIME at the national meeting in Phoenix in 1992.

Also enclosed is a rough draft outline of the talk I will be giving to the Intermountain Section AIME on August 8, 1991.

Sincerely,

Hank

Henry G. Kreis

HGK:mek
encs.

cc: F.T. Graybeal (w/encs.)
W.L. Kurtz (" ")
J.D. Sell (" ")
A.R. Raihl (" ")

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

Abstract

GEOLOGY OF THE SANTA CRUZ PORPHYRY
COPPER DEPOSIT, PINAL COUNTY, ARIZONA

H.G. Kreis
ASARCO Incorporated, Tucson, AZ

F.T. Graybeal
ASARCO Incorporated, New York, NY

The Santa Cruz deposit is located 7 miles west of Casa Grande, Arizona where it is concealed under 650-3000 ft. of post-mineral clastic and volcanic rocks. Mineralized host rocks are Precambrian granite and minor diabase both cut by small, irregularly distributed Laramide porphyritic intrusions.

A central zone of potassic alteration with disseminated chalcopyrite-pyrite and minor bornite-magnetite grades outward into quartz-sericite-pyrite alteration with low copper content. Veins of any size or type are uncommon. Supergene enrichment of hypogene sulfides formed a chalcocite blanket which was extensively oxidized to atacamite and chrysocolla.

Post-oxidation faulting cut the deposit into several separate blocks; one block is probably the Sacaton mine located 4 miles northeast. Santa Cruz, including an area formerly known as the Casa Grande West deposit, contains 1.5 billion tons averaging 0.6% Cu of which 65 percent is oxidized.

H.G.K.
7-20-1991

/

SANTA CRUZ
IN SITU COPPER MINING RESEARCH PROJECT

I. Introduction /. (title)
- A. mining research project
  - 1. develop new technique for mining copper
  - 2. mine copper deposits otherwise not minable
- B. cooperative program
  - 1. SCJV and USBM
    - a. SCJV, 50-50 JV, subsid. of Asarco & Fpt.-McMoRan
    - b. Asarco, prime contractor
  - 2. cost share: 25% industry and 75% US Gov.
  - 3. started, Sep. 1988
  - 4. planned 5 year program, actual 6 years
  - 5. $23mm total cost ($16mm committ., $8.5mm spent)
- C. test site
  - 1. located in Casa Grande, Arizona 2. (loca.)
  - 2. on Santa Cruz Copper Oxide Deposit 3. (aerial)

ROUGH DRAFT

II. Santa Cruz Copper Oxide Deposit
- A. soluble copper
  - 1. dilute sulfuric acid
  - 2. geologic inventory: 1 billion tons, 0.55% Cu
  - 3. 460' av. thickness, 1200' to 3200' deep
- B. typical porphyry copper deposit
- C. genesis
  - 1. chalcopyrite to chalcocite to CuOx
- D. atacamite (Cu chlorite), chrysocolla, chalcocite 4. (rocks)
- E. permeability, all fractured controlled
  - 1. fract. often clogged with CuOx
- F. strongly fractured, from microscopic to fault zones

III. Objective of in situ research project 5. (objectives)
- A. determine operating and capital costs
- B. demonstrate environmental compatibility
  - 1. obtain environmental permits
- C. to achieve objectives
  - 1. program divided into 5 phases

IV. Five phases of program 6. (phases)
- A. Phases 1 and 2 ($9mm expenditure)
  - 1. complete all drill holes, done
  - 2. generic manual on in situ leaching
  - 3. salt tracer test, nearing completion
- B. Phase 3
  - 1. obtain environmental permits
  - 2. construct SX-EW plant ($8mm)
- C. Phase 4
  - 1. operate in situ leach test
- D. Phase 5
  - 1. decommission site
  - 2. evaluate results

V. Field test design
- A. method, design — 7. (site plan)
  - 1. plan view
    - a. 5 spot pattern
    - b. 90' inject. to recov.
    - c. 4 monitor wells
  - 2. cross section — 8. (cross sect.)
    - a. wells
    - b. geology
      - (1) rock types
      - (2) aquifer
      - (3) upper chy.-ata., 0.6% Cu
      - (4) lower high grade atacam., loc. to 3% Cu
  - 3. concept of leaching
    - a. inject 5% sulfuric acid
    - b. move through fract. & dissolve Cu
    - c. pump to surface and extract Cu in SX-EW plant
    - d. reacidify and recirculate
  - 4. benefits
    - a. low capital and operating costs
    - b. no subsidence
    - c. no pits, dumps, tailings

DRAFT

VI. Construction of wells
- A. test wells — 9. (site aerial)
  - 1. oil field technology and services
  - 2. drill large diameter holes — 10. (rig & casing)
  - 3. casing — 11. (Well construction)
  - 4. cementing
  - 5. 200' perforated
  - 6. acidized perforations and wall rock
    - a. cleaned acid out of wells
- B. test well equipment
  - 1. injection well — 12. (injec. well)
  - 2. recovery well — 13 (recov. well)
    - a. Grundfos submersible pumps
  - 3. data recorder
- C. monitor wells, 4 in basin fill aquifer — 14 (monitor well)
  - 1. all equipped with pumps
  - 2. sampled on regular basis
  - 3. check for any effects test have on aquifer
    - a. none to date
    - b. don't expect to see any
- D. process water well
  - 1. 1/2 mi. from test site

VII. Physical plant
- A. salt tracer mixing plant — 15 (tracer plant)
  - 1. storage tanks
  - 2. salt mixing facilities
  - 3. injection pump
- B. laboratory & field office
- C. evaporation pond
  - 1. double lined w/ leak detection system

D. planned SX-EW pilot plant ($8mm cost) 16 (SX-EW)

1. layout
2. upto 50gpm, upto 3 TPD Cu

VIII. Test work

A. prior to drilling test wells 17 (cross sect.)
1. established background water quality of area
2. established hydrologic qualit. of basin-fill aquifer
3. drilled hydrologic characterization test well

B. during well construction
1. geophysical logs
a. porosity, permeability, rock qualities & chem.
b. fluid flow profiles during water injection
2. water pressure injection-fall off tests
a. run in upper and lower CuOx zones
b. run using packer and down hole shut in tool

C. after casing and cementing
1. cement bond logs
2. casing integrity test

DRAFT

D. after perforating casing
1. pressure communication tests 18 (press. inj.)
a. inject water and measure water level rises
2. pumping tests
a. pump and measure water level declines
3. salt tracer test
a. reasons for test
1) demonstrate no fluid or press. commun. between test horizon and basin fill aquifer during test work
2) info. on porosity, permeability, communica.
b. method of salt tracer test 19 (salt tracer)
1) inj. 3 gpl Cl and 0.2 gpl Br into inj. well
2) measure rate of increas. Cl & Br, rec. wells
3) presently at conclusion of this test
4) results show no communication of any type with basin fill aquifer
5) prelim. results of fluid flow appear to justify next step -- acid leach test
6) results will be eval., next 2 months
4. CSAMT geophysical survey 20 (CSAMT)
a. basically a rock resistivity survey
b. run to try to detect salt and acid solutions
1) has possible environmental application to check for fugitive solutions

IX. Future test work

A. conduct pilot scale acid leach test 21 (inj. well)
1. anticipate injecting solution of 5% sulfuric acid at 25 gpm with a surface pressure of 275 psi.
2. will recover solution at a rate of 26 gpm, 1 gpm excess to keep soln. moving to rec. wells
4. to prevent a build up of chloride and other elements in recirc. solution, will put some rafinate into

evap. ponds
5. measure operating parameters (op. costs 22 (op. param.)
a. permeability
b. well communication
c. sweep efficiency
d. solution loading -- gpl copper grade of rec. soln
6. produce SX-EW copper
7. contin. monitoring all parameters of basin fill aquif.

B. run leach test for 1 to 1.5 years
C. decommission site
D. publish all data and results of test work

DRAFT

X. Public, government, corporate relations
A. public
1. professional people 23. (Az. Hydro.)
a. Ariz. Hydrologic Soc.
b. mining industry
2. local people
a. concerned citizens and community leaders
b. newspaper articles 24. (newspaper)
c. USBM public information program
3. video tape 25 (DeConcini)
B. Federal government
1. Senator Deconcini and other congressional people
2. USBM visitors
3. USFS visitors
C. State government
1. Dept. of Eniv. Quality
2. Dept. of Water Resources
3. state legislators
D. corporate
1. visits and presentations to senior exec. and board mem
E. environmental
1. Sierra Club

XI. Conclusion 26. (blackness)
A. completed test wells and preliminary field tests
B. results to date are sufficiently encouraging to justify next step, the acid leach test
C. expect to apply for aquifer prot. permit by end of 1991
D. expect to start acid leach test in late 1992 or early 1993, subject to permitting delays

ASARCO

Exploration Department
Southwestern United States Division

VIA FAX 612-725-4526

August 6, 1991

Ms. Diane Marozas
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Dear Diane:

Here are six core samples that are to be trimmed for surface area measurements. The samples, being shipped under separate heading, are:

SC-46	1622'	altered porphyry with moderate amount of chrysocolla and atacamite
SC-46	1586'	altered porphyry with very small amount of chrysocolla and atacamite
C-1	1063'	altered granite, leached, iron oxide capping
C-2	1288'	altered granite with moderate amount of chrysocolla and atacamite
C-2	1739'	altered granite with abundant atacamite and traces of chrysocolla
SC-19	1275'	altered granite with very small amount of atacamite except for atacamite vein on extreme edge of core (which can be trimmed off).

If more samples are needed, they probably can be taken from the core samples used for the porosity test work.

Sincerely,

Hank

Henry G. Kreis

HGK:mek

cc: A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell
D. Davidson
S. Swan

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

SKYLINE LABS, INC.
1775 W. Sahuaro Dr. • P.O. Box 50106
Tucson, Arizona 85703
(602) 622-4836

REPORT OF ANALYSIS

JOB NO. TAJ 728
August 13, 1991
ITANKSED 5-17-1991

ASARCO Incorp

AUG 1 5 1991

SW Exploration

ASARCO INCORPORATED
Attn: Mr. H.G. Kreis
Southwestern Exploration
P.O. Box 5747
Tucson, AZ 85703

Analysis of 1 Sample

ITEM	SAMPLE NUMBER	Pb (ppm)	K2O (%)	CaO (%)	Fe (%)	Al2O3 (%)
1	ITANKSED	130.	.70	1.4	13.0	5.8

ITEM	SAMPLE NUMBER	SiO2 (%)	Cl (%)	H2O (%)	Temp* (°c)	L.O.I.* (%)
1	ITANKSED	33.5	7.5	95.4	200	10.1
					400	3.5
					550	2.4
					800	3.4

*NOTE: L.O.I. obtained at these temperature.

cc: Mr. J. D. Sell

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK STATE OF ARIZONA

8/13/91

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

James A. Martin
Arizona Registered Assayer No. 11122

ASARCO

Southwestern Exploration Division

August 15, 1991

FILE

Texaco Visit
Santa Cruz Test Site
Pinal County, Arizona

In mid August Mr. Frank D. Charron of Texaco Inc. made an unannounced visit to the Santa Cruz Test Site. His business card gives the following information about his position and address:

Special Project Geologist
Alternate Energy and Resources Department
Texaco Inc.
1670 Broadway
Denver, CO 80202-4899

303-860-3560

Mr. Charron talked with Randy Offield at the test site and inquired about our progress and wondered if we were in commercial production. Upon hearing we were not in commerical production, he mentioned he would tell the appropriate Texaco people not to include any royalty income in next years budget.

Mr. Charron mentioned he was familiar with the property and that he is the only one who has any idea of where the property is located.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl
W.E. McCulloch - Freeport

ASARCO

Southwestern Exploration Division

August 16, 1991

F.T. Graybeal
New York Office

Publicity
Santa Cruz JV
Pinal County, AZ

On August 16, 1991 the Casa Grande Dispatch published the enclosed article on the SCJV's $7,500 donation to the Casa Grande Valley Historical Society.

H. G. Kreis

HGK:mek

H. G. Kreis

cc: D.N. Noyes - NYO
W.L. Kurtz
J.D. Sell
A.R. Raihl
S. Swan
W.E. McCulloch, Jr. - Freeport

tenc

County and State

Coolidge Gym Named After Popular Coach P. 5

Lifestyle

CG Historical Society Gets Funds for Journal P. 7

Dear Abby

Welcome to Our House — Now Go Home P. 7

Pinal County's Daily Newspaper

CASA GRANDE DISPATCH

80th Year

CASA GRANDE, ARIZONA 85222 FRIDAY, AUGUST 16, 1991 NO. 193 VOL. 80 35¢ per copy

ASARCO

Southwestern Exploration Division

August 19, 1991

A.R. Raihl

Metallurgy Sample
Santa Cruz Project
Pinal County, Arizona

The 122 pound sample of wet drill cuttings submitted to Metcon Research on December 1, 1989 was taken from T-4, 1740' to 1750'. The sample consisted of altered granite with atacamite and minor chrysocolla.

H G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
S. Swan - USBM
C. Barter - Montgomery
D. Davidson - SAIC

ASARCO

Exploration Department
Southwestern United States Division

August 21, 1991

Mr. Ron Medhi
Cyprus Casa Grande
Box C-9
Casa Grande, AZ 85222

Dear Mr. Medhi:

During the week of September 23rd, I will be taking three people from the U.S. Bureau of Mines and Priscilla Robinson on a tour of several SX-EW plants in Arizona. The USBM people, Jon Ahlness (Group Supervisor), Dan Millenacker (Hydrologist), and Joe Pugliese (Mining Engineer), are all from the Twin Cities Research Center. As you know, Priscilla Robinson consults for us on the Santa Cruz In Situ Copper Mining Research Project.

We would like to have a tour of your Cyprus Casa Grande SX-EX plant. The most convenient time for us is 9:00 AM on Thursday, September 26, 1991.

If you have questions, please call me at 602-792-3010.

Sincerely,

Hank Kreis

HGK:mek

H.G. Kreis

bl.cc: F.T. Graybeal
W.L. Kurtz
A.R. Raihl
J.D. Sell

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

August 26, 1991

Mr. Dennis Mortensen
P.O. Box 1559
Claypool, AZ 85532

Dear Mr. Mortensen:

On September 24th, I will be taking three people from the U.S. Bureau of Mines on a tour of SX-EW plants in the Miami-Ray area of Arizona. The USBM people are Jon Ahlness (Group Supervisor), Dan Millenacker (Hydrologist), and Joe Pugliese (Mining Engineer); and they are from the Twin Cities Research Center.

The USBM people want to learn about SX-EW plants in general. This will help them address the environmental aspects of the proposed Santa Cruz SX-EW pilot plant in Casa Grande.

We would like to have a tour of your SX-EW plant near Miami, Arizona. The most convenient time for us is 9:00 AM on Tuesday, September 24, 1991.

If you have any questions, please call me at 602-792-3010.

Sincerely,

Hank Kreis

HGK:mek

Henry G. Kreis

bl.cc: F.T. Graybeal
W.L. Kurtz
A.R. Raihl
J.D. Sell

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

August 26, 1991

A.R. Raihl

Pinal Fault
Phase I and II
Technical Report
Santa Cruz Project

The description of the Pinal Fault in my November 25, 1991, contribution to the Phase I and II Technical Report has been revised. This revised description and a revised Figure 4-2 accompany this memo.

Those having a copy of my contribution to the Phase I and II Technical Report are being notified, by copy of this memo, of this text revision.

H. G. Kreis

H. G. Kreis

HGK:mek
Accompaniments

cc: R.L. Brown
F.T. Graybeal
W.L. Kurtz
J.D. Sell
W.E. McCulloch, Jr. (Freeport)
S. Swan (USBM)
D. Davidson (SAIC)
C. Barter (Montgomery)

Revised Text, 8-26-1991

The Pinal Fault, shown in Figure 4-2, is interpreted to be a normal fault with 250 ft to 350 ft of displacement. It is interpreted to strike N65°W and dip between 65° and 90° to the southwest.

The existence of the Pinal Fault is based on the interpretation of depths to bedrock in about a dozen exploration drill holes on 500 ft centers. The depth to bedrock in drill holes on the south side of the Pinal Fault are 250 ft to 350 ft deeper than the depth to bedrock in drill holes on the north side of the Pinal Fault. The change in the depth to bedrock across the Pinal Fault is interpreted to have resulted from post-conglomerate age, normal displacement on the Pinal Fault.

Further evidence of the Pinal Fault is interpreted to exist in test well T-4. In T-4 it appears the Pinal Fault downdropped the top of bedrock 100 ft in relation to the other test wells. At the conglomerate-bedrock contact in T-4, there is abundant gouge-like clay, and immediately above the gouge-like clay, 300 gpm drilling mud was lost for a period of time during rotary drilling. An alternative interpretation is that the clay is part of a discontinuous fossil soil zone developed by weathering of the conglomerate before it was covered and preserved by the basin fill deposits.

Assuming the Pinal Fault was intercepted in T-4 at the conglomerate-bedrock contact, the interpreted attitude of the Pinal Fault places it within 50 ft of the perforations in monitor well SM-1. The interpreted position of the Pinal Fault at depths of 1570 ft to 1770 ft, where the test wells have been perforated in the lower copper oxide zone, places it outside the test site as shown in Figure 4.2. The test well nearest to the Pinal Fault at this depth is T-4 which is located an estimated 300 ft or less northeast of the Pinal Fault.

It is not known if the Pinal Fault in the bedrock is more or less permeable than the wall rock. It may have various combinations of relatively higher and lower permeability along the course of the fault.

shown in the cross sections of Figures 4-3 and 4-4. In C-2 there is: 1,361 ft to 1,391 ft, a fault zone with strong breakage of the rock, local gouge, and weak evidence of a moderate to steep dip; 1,420 ft to 1,472 ft, a fault zone with strong breakage of the rock, local gouge, and 45° to 60° dipping structure; and 1,497 ft to 1,506 ft, a fault zone with a total of 12 inches of gouge and 40° to 60° dipping structure. In SC-19 from 1,320 ft to 1,360 ft, 1,460 ft to 1,520 ft, and 1,580 ft to 1,610 ft, the rock is moderately to strongly broken with local minor gouge. The attitudes of these structures are not determinable from the present data base, but future geophysical log interpretations may help to determine their attitudes.

Within the immediate boundaries of the test site there is no core above a depth of 1,200 ft so the only nearby core above 1,200 ft is in C-1. In C-1 between the top of bedrock at 627 ft and a depth of 1,246 ft the rock, granite and porphyry, is strongly faulted and weathered. The core was so strongly broken that the RQD for most of the interval was zero and the remainder was low (Figure 4-12).

The weathered and broken rock in C-1 from 627 ft to 1,246 ft is bottomed by a 10° to 40° dipping fault zone seen in C-1 from 1,212 ft to 1,246 ft. Other than the apparent dip seen in the core, the attitude of the fault is not determinable from the present data base.

8/26/91 INSERT REVISED TEXT

~~A fault, herein named the Pinal Fault, was intercepted in T-4 from 730 ft to 760 ft (see Figure 4-2). As interpreted from the geology of widely spaced (500-ft centers) exploration drill holes, the Pinal Fault strikes N65°W and dips 65° to 90° to the southwest. The Pinal Fault is a normal fault of post-conglomerate age. It down drops the top of bedrock 200 ft to 350 ft. The Pinal Fault zone caused lost circulation drilling problems by taking up to 300 gpm, the rate of circulating drilling mud at the time.~~ in T-4

~~The attitude of the Pinal Fault is such that it passes within 50 ft of the perforations in monitor well SM-1. At the 1,570 ft to 1,770 ft depth of perforations in the test wells, the Pinal Fault is estimated to be within 300 ft of T-4, the closest well to the Pinal Fault, at the depth of the perforations.~~

The orientation of fractures in the general area of the test site is known from orientated core that was obtained during the drilling of C-1. Orientated core was cut in C-1 from 1,259 ft to 1,306 ft, 1,695 ft to 1,705 ft, and 1,722 ft to 1,760 ft (Dahl, 1989).

The attitudes of the fractures are summarized in Table 4-4 according to the type of mineralization occurring in the fracture. All of the attitudes of the copper oxide mineralized fractures were measured in the 1,259 ft to 1,306 ft interval which is in the upper zone of the copper oxide mineralization.

4.7 COPPER RESERVES

The geologic copper reserves in the in situ leach test site are known from the copper intercepts in core holes, C-2 and SC-19, and rotary holes, T-1 to T-5. The exact locations of these copper intercepts are known from surveys of drill hole collars and from down hole directional surveys. The locations of the

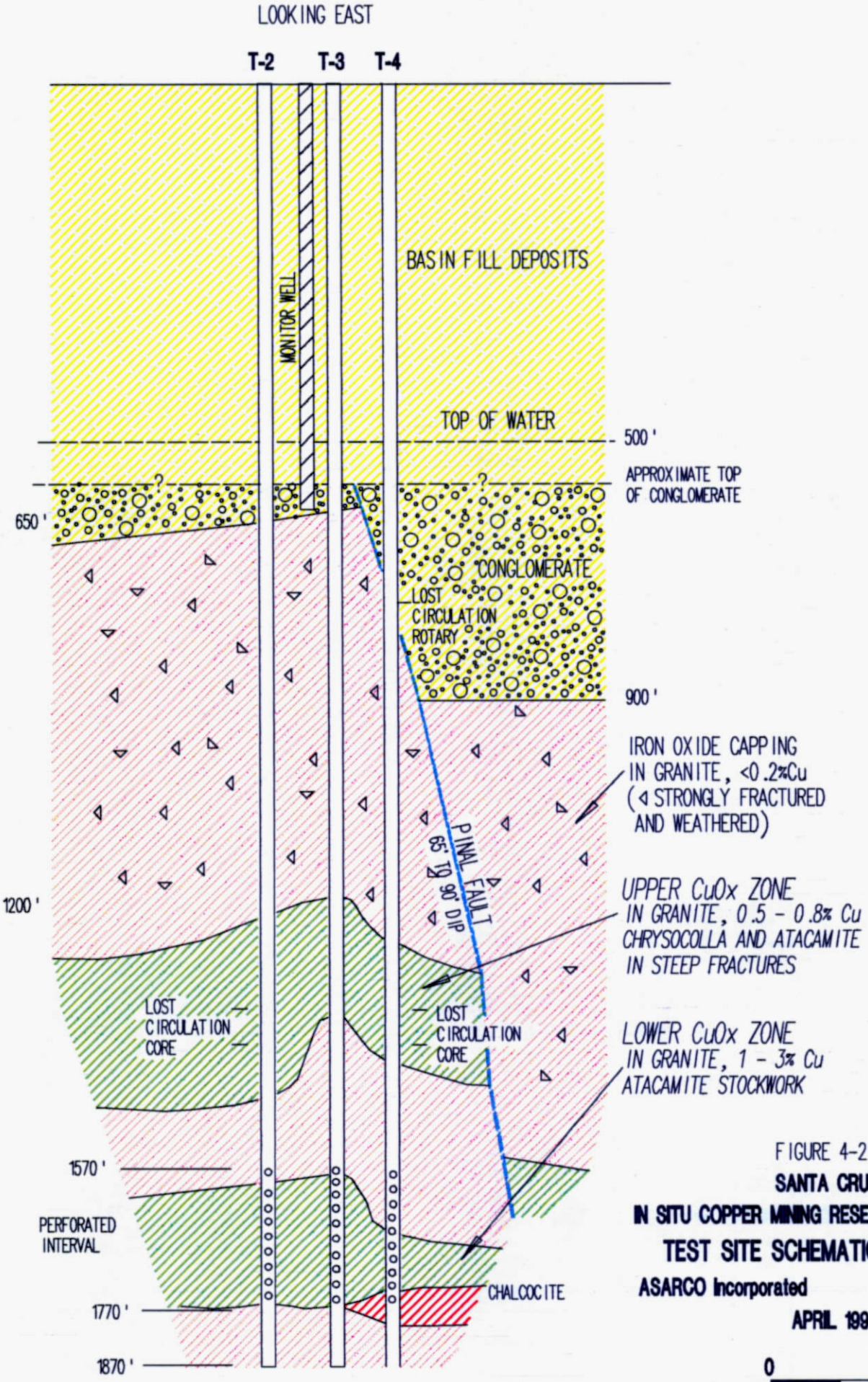


FIGURE 4-2

SANTA CRUZ

IN SITU COPPER MINING RESEARCH PROJECT

TEST SITE SCHEMATIC SECTION

ASARCO Incorporated **H.G.Kreis**

APRIL 1990

mn SC-6938 HGK/dam tuc 04-20-90

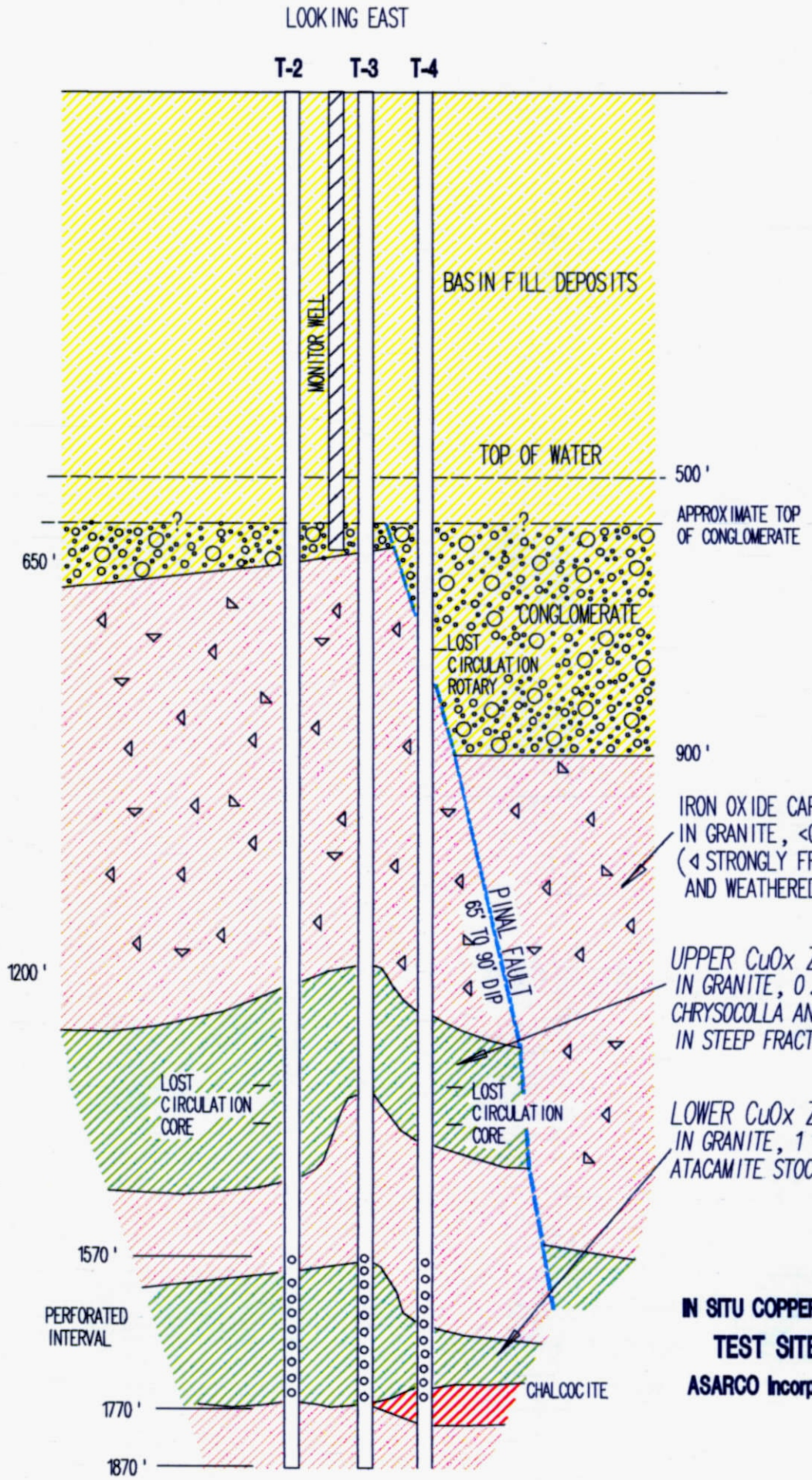


FIGURE 4-2

SANTA CRUZ

IN SITU COPPER MINING RESEARCH PROJECT

TEST SITE SCHEMATIC SECTION

ASARCO Incorporated **H.G.Kreis**

APRIL 1990

0 200'

mn SC-6938 HGK/dam tuc 04-20-90

ASARCO

Exploration Department
Southwestern United States Division

VIA FAX

September 4, 1991

Mr. S. Swan
U.S. Bureau of Mines
Twin Cities Research Center
5629 Minnehaha Avenue South
Minneapolis, Minnesota 55417

Re: SX-EW Plant Visits

Dear Steve:

Plans for the USBM tour of SX-EW plants are taking shape. Attached is a list of the tentative schedule as it now stands. Mr. Scartaccini is making the arrangements for the Magma Copper visits, and he anticipates making the requests to visit next week. I will let you know as soon as plans are finalized.

Ms. Robinson is planning to attend only those SX-EW tours on September 25th and 26th.

Sincerely,

Hank

Henry G. Kreis

HGK:mek

cc: A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell
P. Robinson

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

USBM TOUR OF SX-EW PLANTS

Tentative Schedule (Sept. 4, 1991)

September 23	USBM people fly into Phoenix		
September 24	9:00 AM	Cyprus Miami (1)	Dennis Mortensen
	1:30 PM	Magma, Miami (3)	
September 25	9:00 AM	Asarco Ray Mine (2)	Frank Jones
	1:30 PM	Magma, San Manuel (3)	
September 26	9:00 AM	Cyprus Casa Grande (2)	Kermit Behnke
	1:00 PM	Santa Cruz Site (2)	Hank Kreis

(1) tentative verbal approval
(2) confirmed approval
(3) request for visit in progress

September 27 USBM people return to Minneapolis

Suggested Accommodations (1)

Night of September 23	Copper Hills Inn, Miami, 602-425-7151
" " " 24	" " " " " " "
" " " 25	Holiday Inn, Casa Grande
" " " 26	Casa Grande or Phoenix

(1) Make own accommodations

10/24/81

FROM: W. L. KURTZ

TO: Walt McCullough

Here's a budget effort by Kreis who can not comment on my questions since he's away on vacation until end of October.

Guess this will suffice for you.

cc: H.G. Kreis
F.T. Graybeal
A.R. Raihl
J.D. Sell

COPY for HGK and more on HGK's memo

ASARCO

Southwestern Exploration Division

October 4, 1991

HGK- See next page and send a copy of the Graybeal approved final figure to McCullugh

W.L. Kurtz

Proposed 1992 Budget
Santa Cruz Project
Pinal County, Arizona

Kurtz
10/9/91

To meet Walt McCulloch's present need for a 1992 Santa Cruz budget, I put together a budget proposal. A copy is attached for review by you and those receiving a copy of this memorandum.

The proposed 1992 Santa Cruz budget is similar in all respects to the proposed Santa Cruz budget for 1991. The proposed 1992 Santa Cruz budget, like the proposed 1991 Santa Cruz budget, has funds budgeted for work on land acquisition; and, as before, the funds budgeted for land acquisition work may or may not be used.

H.G. Kreis

HGK:mek

H.G. Kreis

cc: F.T. Graybeal (via FAX)
A.R. Raihl
J.D. Sell

H.G. Kreis
Asarco Inc.
Oct. 10, 1991

PROPOSED 1992 SANTA CRUZ BUDGET*

for what - give us detail

for what

why not 250

Property taxes	$126,000
Environmental (land purch.)	50,000
In situ, oxide, non USBM	40,000
Legal	30,000
Salaries	16,000
Outside prof. serv.	8,000
Farm admin./maint./repair	5,000
Donations to community	3,000
Materials and supplies	2,000
Travel	3,000
Overhead	3,000
Total of above	$286,000

*Exclusive of costs chargeable to the USBM-SCJV cooperative agreement, which for Asarco's half are chargeable to EA-0438.

Remarks:

-The Parks-Salyer land was paid off in full in March 1991. There will be no further land payments.

-Property taxes may be lowered in the near future because of a recently signed grazing lease and ongoing legal efforts to lower the property taxes.

-Farm costs, but not farm income, are charged to an EA.

-The SCJV is committed to donate $2500 to the Casa Grande Valley Historical Society in 1992 and again in 1993. Additional donations to worthy causes in the Casa Grande area are being considered. — + as

one do not think we should become a cash source for Casa Grande. Let's leave it at the Historical Society as our "good deed."

ASARCO

Exploration Department

ASARCO Incorp.

SEP 17 1991

SW Exploration

September 9, 1991

A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Cooperative Agreement C0289001
Discussions with "Casa Grande Dispatch" Reporter

On August 30 and September 3, 4, and 6, 1991, a period of time during which you and Priscilla Robinson were on vacation, I had discussions with Susan Wootton, a reporter for the "Casa Grande Dispatch". Ms. Wootton had numerous questions, some of which were asked at the USBM public information program last year, and many of which concerned groundwater.

The following text describes some of the more important questions and topics of discussion that will be of particular interest to you and Ms. Robinson. Fred Graybeal, Charlie Barter, Steve Swan, and Don Davidson were kept abreast of discussions with Ms. Wootton at the time they were occurring.

Following discussions with Ms. Wootton and hearing about other people she has contacted, it became apparent she is focusing, at least in her own mind, on groundwater and the effect in situ leaching has on groundwater. There is no way of knowing at this time how she will treat the subject of groundwater in her upcoming article, scheduled for publication on September 18, 1991.

Ms. Wootton contacted a number of people to learn about groundwater in areas of past and present in situ leaching. She made no mention of contacting people on any topic other than groundwater. She mentioned contacting Arizona Toxic Information and talking to Michael Gregory, a Sierra Club member. She also contacted the ADWR, the ADEQ (including Abigail Myers), and people knowledgeable of the Pinal Creek superfund site at Miami, Arizona. In our last conversation, she gave consideration to contacting the Sierra Club.

Some of her efforts were obviously devoted to finding an unidentified property(ies) where: (1) "in situ leaching poisoned an aquifer" (quote from an unidentified source of information) and (2) "in situ leaching contaminated the groundwater" (quote from Mr. Gregory of Arizona Toxic Information, possibly in reference to Zonia-French Creek). Unable to find out if such properties truly existed, Ms. Wootton thought Don Davidson, with his experience on prior in situ leach programs, could provide some information on this subject. She requested to talk to him. I explained it would not be

appropriate for Mr. Davidson to talk about properties owned by others without their permission to do so. Furthermore, it has been over ten years since Mr. Davidson worked on other in situ properties and he would have no way of knowing what has happened to these properties over that long period of time.

Following this discussion about Mr. Davidson, I called him. He was provided with the details of my discussion with Ms. Wootton so he would be prepared in the event she contacted him. To date, Mr. Davidson has not been contacted by Ms. Wootton.

Seeking information on in situ leaching groundwater contamination in Arizona, Ms. Wootton talked to a number of people in the ADEQ. She learned from them that no one knows of any groundwater contamination due to in situ leaching, but no one would go so far as to say there wasn't such a situation. Someone at the ADEQ, I think she said Ms. Myers, explained to her that the Zonia-French Creek situation was not a true in situ leach operation and, thus, could not be compared to the Santa Cruz in situ leach site. Also, she learned from contacts with the superfund people that contamination in Pinal Creek at Miami was not known to have been caused by in situ or block cave-in place leaching.

Ms. Wootton contacted Abigail Myers of the ADEQ to learn what the ADEQ thought about and expected from in situ copper leaching operations. Ms. Wootton learned from Ms. Myers: (1) the ADEQ will be looking for restoration of Santa Cruz test site groundwater to drinking water standards and (2) groundwater in the Santa Cruz test horizon meets drinking water standards.

The ADEQ's position, as stated by Ms. Myers, and how to handle this matter was discussed at length with Mr. Graybeal and Mr. Barter. I called Ms. Wootton back, and explained, among other things, that restoration of groundwater conditions is something that has to be discussed and negotiated between the ADEQ and the SCJV. It is not something that can be decided unilaterally by one party or the other. It was suggested to Ms. Wootton that she talk to someone in the ADEQ having more experience, someone like Roger Kennett, Ms. Myer's supervisor. Ms. Wootton did not like this suggestion, and she did not want to go over Ms. Myers head. Furthermore, she said it was too late to make corrections in the article and expressed concern about press manipulation. After further discussion she relented by saying she would take this matter up with her boss and her journalism class. She said, if she were to go back to the ADEQ, she would have to get the fears of the Sierra Club in order to balance the article. This statement about "getting fears" collaborated with an earlier statement she made to me. A few days before, she mentioned having to go out and "dig up people expressing fear" as a way of balancing her article.

On another matter, Ms. Wootton talked to the ADWR and was told the SCJV can pump 100 acre-feet per year. She then wanted to know why we needed such a large allotment when we said we would only use 10 acre-feet per year of water. After detailed discussions with Charlie Barter, I told her our water

use permit involved the recovery half of our injection-recovery program and explained this topic was too complex without a thorough explanation; an explanation best handled by you, Mr. Barter, and Ms. Robinson. She decided to delete this topic from her article. You may wish to do some follow-up work with Ms. Wootton on this topic.

In consideration of the above and from other details of my conversations with Ms. Wootton, I think she is need of more detailed information, complete with lots of explanation, on groundwater and groundwater permits, particularly the aquifer protection permit.

H. G. Kreis

H. G. Kreis

HGK:brw

cc: S. A. Swan
W. E. McCulloch
F. T. Graybeal
D. M. Noyes
W. L. Kurtz
J. D. Sell
P. Robinson

ASARCO

Exploration Department
Southwestern United States Division

September 9, 1991

Mr. Rolf von Oppenfeld
Fennemore Craig
Two N. Central Ave.
Suite 2200
Phoenix, AZ 85004-2390

Dear Mr. von Oppenfeld:

Enclosed is a map of Section 13, T6S, R4E showing 55 acres of surface disturbed land. This 55 acres of land was disturbed prior to this date for purposes of in situ mining research. Our in situ mining research will continue for several more years, but no additional land surface is expected to be disturbed.

It is my understanding this 55 acres of surface disturbed land will be part of a group application regarding storm water run off.

Sincerely yours,

Hank Kreis

HGK:mek

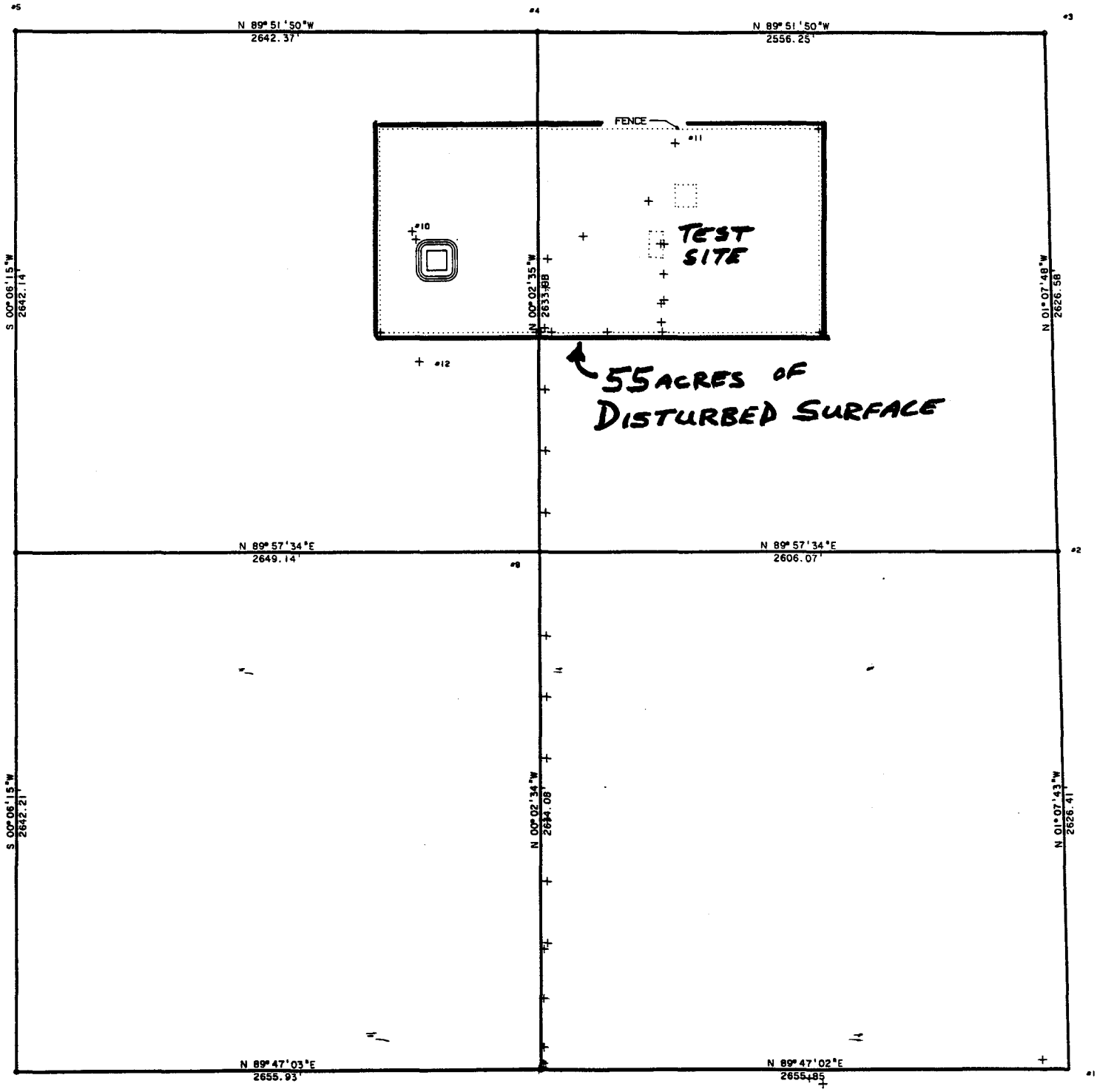
Henry G. Kreis
Site Manager

cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

SECTION 13

T6S. R4E. G & S R B & M



ASARCO

Mining Department
Tucson, Arizona

September 9, 1991

A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Cooperative Agreement C0289001
Used Oil Disposal

Attached are copies of information I obtained while researching used oil disposal for the Project.

H. G. Kreis

H. G. Kreis
Site Manager

HGK:brw
Attachments
cc: S. A. Swan w/att.
F. T. Graybeal w/o att.
W. L. Kurtz " "
J. D. Sell " "

ASARCO Incorporated
SEP 12 1991
SW Exploration

ASARCO

Mining Department
Tucson, Arizona

Bell

September 9, 1991

ASARCO Incorporated

SEP 1 2 1991

SW Exploration

A. R. Raihl
Project Manager
Santa Cruz Project
TUCSON OFFICE

Santa Cruz Project
Cooperative Agreement C0289001
Used Oil Disposal

As requested, the undersigned researched the disposal of used oil, and the findings are discussed in this memorandum. Based on the findings, recommendations are made for minimizing liability exposure in disposing of used oil from the Santa Cruz In Situ Copper Mining Research Project (Project).

In researching used oil disposal, three companies in the used oil business were investigated. These companies were Metro Oil Corporation (Tucson), Tri City Oil Corporation (Phoenix), and Arizona Oil Recyclers Association (AORA, Phoenix). The undersigned talked extensively with Daryl Moon of Metro Oil and Eugene Gard of Tri City Oil, and was introduced by Mr. Gard to George Bolduc of AORA.

The EPA was contacted in regard to these companies, and the EPA said to contact the ADEQ. The ADEQ was contacted, and from the ADEQ it was learned that about a half dozen different groups in the ADEQ have some sort of jurisdiction over the oil recycling companies. After numerous telephone calls to the ADEQ, it was learned that the ADEQ is preparing to issue a letter of warning to one of the three used oil companies identified above. It will be two or three weeks before the letter is sent to the party being warned. Once the letter is sent, the ADEQ will be willing to identify the party being warned. The ADEQ will be contacted in two weeks to check if the letter was sent and, if sent, to whom it was sent and why the company was being warned.

Conclusion and Recommendation

For disposing of Santa Cruz used oil, the recommended company to use is Metro Oil Corporation. This recommendation is made subject to contacting the ADEQ in a couple of weeks for the reasons described above.

The management of Metro Oil seemed more responsible, conservative, and long-term oriented than the operators of the other two used oil companies. Furthermore, Metro Oil has been in the used oil business for over 20 years and has served Mission, Silver Bell, and Sacaton for many of those years.

Using Metro Oil will by no means eliminate exposure to environmental liability. The exposure to environmental liability using Metro Oil is similar to the exposure using AORA or Tri City Oil. The only difference is the management of Metro Oil seemed more responsible and, hopefully, more responsive to changes in regulations.

Within the limited amount of research that was done for this memorandum, nothing was found that would eliminate all environmental liability associated with the sale of Santa Cruz used oil to used oil recyclers. For reasons which will become apparent later in this memorandum, this is particularly true when selling very small lots of used oil which, in the normal course of business, are commingled with the used oil of other originators.

At the end of this memorandum there are several suggestions for minimizing environmental risks when selling used oil. Unfortunately, most of these suggestions are not practical for small shipments such as we have from Santa Cruz.

Near Future Changes in Used Oil Industry

As learned over a period of several months, the regulations and business structure of the used oil industry are subject to possible changes in the near future. These near future changes are likely to occur on both the federal and state regulatory levels and on the state business level.

Possible changes on the federal regulatory level include having used oil declared a hazardous waste. According to an April article in "Business Week", the EPA is being pressured to declare used oil a hazardous waste. If this happens, substantial regulatory changes will happen along with changes in the way used oil is handled, processed, and consumed.

Possible changes on the state business level include efforts to merge two or more used oil companies into one company. The two merging companies, Tri City Oil and AORA, are trying to merge in the form of a public corporation. Tri City Oil and AORA are making offers to Metro Oil and other oil recyclers in Las Vegas, Denver, and Albuquerque to join them. If Tri City Oil and AORA are successful in merging, they plan to build a used oil recycling facility in Arizona.

Most of these changes are the direct and indirect result of environmental pressures and new rules and regulations. The used oil industry in Arizona is described as being strongly regulated but poorly enforced. However, the enforcement of regulations in Arizona seems to be increasing as various state agencies sort out their respective responsibilities, learn how to enforce the regulations, and develop appropriate field methods for enforcement.

Metro Oil Corporation, Tucson

Metro Oil Corporation (EPA No. AZD 077536019) owns facilities located at 3165 E. 48th Street in Tucson. The facilities consist of a small office building

and several storage tanks having a total capacity in the ballpark of 50,000 gallons. The tanks rest on the ground with no impermeable barrier under the tanks.

Daryl Moon, President of Metro Oil Corp., says his company is a family owned and operated business. He, his three sons, and other family members handle much of the operation. He said he has been in the business for 21 years and hopes to turn it over to his sons when he retires. He has received offers to merge with Tri City Oil and AORA; but, with all the changes taking place in the used oil business, he is uncertain on what to do with the offer.

Tri City Oil Corporation, Phoenix, and
Arizona Oil Recyclers Association (AORA), Phoenix

Tri City Oil (EPA No. AZT 050010693) and AORA (EPA No. AZD 085459212) present themselves to the public as being independently owned and operated companies. However, they work very closely together, and the owners of each of the two companies are in business together in a company known as Bogart. Furthermore, as previously mentioned, Tri City Oil Co. and AORA are in the process of merging into a stock owned company. Eugene Gard, the operator and apparent owner of Tri City Oil, describes George Bolduc, the operator and apparent owner of AORA, as being the brains of their joint operations.

The assets of Tri City Oil consist of its customer base and the haul trucks necessary to service its customer base. All of the other equipment used by Tri City Oil is leased from Bogart.

Likewise, the assets of AORA consist of its customer base and haul trucks, and all of the other equipment used by AORA is leased from Bogart.

Tri City Oil operates out of leased facilities located at 3015 E. Whitton Ave. in Phoenix. These facilities were previously owned by BS&W Energy Corp., a bankrupt predecessor of AORA. They are currently owned (or managed) by the bank which held (or holds) the mortgage to the property.

Tri City Oil's leased facilities consist of several used oil tanks, varying in size from 30,000 to 200,000 gallons and having a combined capacity of 400,000 to 600,000 gallons, and a couple of small buildings used for offices. There is contamination from oil products in the ground under part of the site where dry wells are located. Supposedly, drill hole samples taken beneath the storage tanks, all of which rest directly on gravel and soil with no impermeable barrier, showed no evidence of contamination.

ADEQ regulatory people visit the Tri City Oil facilities several times per month. According to Mr. Gard, these visits are more for seeking Mr. Gard's advice on used oil regulatory matters than for inspections.

Tri City Oil and AORA have joint plans to construct a new facility for processing used oil into lubricating products for reuse. The facility will be located in either the Coolidge or Maricopa area. Earlier this year, Mr. Gard was positive the construction of this facility would be well under way by

mid-summer of this year. However, the construction has not yet started because of problems with land acquisition.

Mr. Gard was vague on discussing where Tri City Oil sends its used oil. He said Tri City Oil sends its used oil where the market prices are high. Apparently, most of it goes to California where it is burned to reclaim the energy content. Some of it was being burned in Arizona earlier this year.

Most of the used oil picked up by Tri City Oil is checked for water, dirt, halogens which are diagnostic of some types of hazardous waste, and metal content. Tri City Oil checks its used oil when enough used oil has been collected to fill a 30,000 gallon tank. Some of the used oil is not being checked, because the used oil is being checked at its California destination.

Tri City Oil ships its used oil to California under a hazardous waste manifest. This is done in case something in the oil makes it fall under a hazardous waste classification. Mr. Gard says this protects both the shipper and the originator of the used oil.

It is difficult to assess the environmental liability associated with using Tri City Oil. It became apparent that protecting the originator of used oil from liability is not high on Tri City Oil's list of priorities. It could not be determined if some of the used oil was being used or sold in a way which could create liability to the originator of the used oil.

Mission Unit

The Mission Unit is using the services of Metro Oil, and has used Metro Oil for a large number of years. It was said that Metro Oil also serviced Silver Bell and Sacaton.

Mission Unit presently uses a purchase order agreement with Metro Oil. In the past a contract was used. Mission pays for analytical services to demonstrate the used oil is free of hazardous or undesirable contaminants.

Ray Complex and Hayden Plant

Both the Ray Complex and Hayden Plant use Tri City Oil. Ray has used Tri City Oil for 3 or 4 years. Ray has a mutual understanding with Tri City Oil that used oil from Ray is to be used for recycling purposes. The shipping documents state the used oil is to be used for recycling purposes, and the shipping documents are kept on file for several years.

Environmental Liability Exposure

Originators of used oil who sell their used oil to companies such as Tri City Oil, AORA, and Metro Oil (or other purchasers of used oil) are exposed to environmental liability. Exactly how much liability and risk is difficult to determine without further detailed investigation and legal opinion.

There appears to be significant liability exposure to the originator in several aspects of the used oil business. This liability exposure exists from the initial pick up of the used oil through the consumption of the used oil to some undeterminable time in the future. Most of the liability is associated with: (1) commingling of one's used oil with possibly contaminated used oil of another originator, (2) the possibility of an environment damaging accident during shipment, (3) the possibility of an oil spill or oil seepage causing ground contamination at storage facilities, and (4) the ultimate use of the used oil.

Apparently neither Tri City Oil nor Metro Oil carry environmental liability insurance. Tri City Oil and Metro Oil each carry a million dollars worth of liability insurance on their trucks, and Metro Oil carries an additional one million dollar umbrella policy. Judging from vague replies to questions on environmental liability insurance coverage, their insurance coverage probably does not cover environmental damage unless, perhaps, the environmental damage was the direct result of a vehicular accident.

There was nothing to suggest that Metro Oil, AORA, and Tri City Oil have sufficient assets to pay for much, if any, of the remedial costs resulting from environmental damage. Consequently, in the event of environmental damage, the originator(s) may be held financially responsible for environmental remediation and other costs.

To minimize liability exposure in the sale of used oil and other petroleum products such as diesel fuel, the following is suggested:

(1) When making large bulk purchases of petroleum products save properly labeled representative samples for future analysis in the event such analysis is ever needed. Such future analysis may be necessary to check if the product was contaminated at the time of purchase. Some petroleum products are produced from recycled materials. It is possible the recycled materials used in manufacturing the product were contaminated with hazardous compounds. Consequently, petroleum products produced from recycled materials could be contaminated with hazardous compounds at the time of purchase.

(2) At the time used oil is to leave the site, save appropriately labeled representative samples. This sample can be used to document the quality of the used oil immediately prior to shipment.

(3) Have a written agreement with the purchaser that covers the following:

    (a) Commingling with used oil from other originators

    (b) Environmental liability

    (c) How the used oil will be used

Although not practical in our case, shipping by the truckload may allow direct shipping to the place of consumption without the used oil being commingled. This will keep the oil clean during transport (i.e., not commingled with possibly contaminated oil from other originators) which will minimize environmental liability exposure.

(4) If it can be arranged, try to avoid allowing the used oil to be stored at any storage facilities. The storage facilities at both Metro Oil and Tri City Oil appear to have environmental risks associated with their use. At both storage facilities the tanks and the loading/unloading equipment rest directly on the ground with no underlying impermeable barrier. The storage tanks are impounded by poorly constructed and/or maintained containment dikes. Tri City Oil's leased site has known ground contamination, and the possibility exists for ground contamination under the storage tanks in spite of the reported drill hole results to the contrary. Storage tanks with containment dikes, but no underlying impermeable barriers, are probably the industry norm. However, the potential for ground contamination, both preexisting and future, and the subsequent liability exposure to originators is something that can not be overlooked.

(5) Do not sell used oil directly to energy recovery burners. In doing so one becomes a marketer and subject to regulation.

(6) Maintain and save appropriate shipping documents that identify where the used oil is going and its intended use. When shipping by the truckload, weighing the haul truck before and after loading and at the point of delivery should be considered.

If there is any more work you want done on this matter, such as a legal agreement for used oil disposal, please let me know.

H. G. Kreis
Site Manager

HGK:brw

cc: S. A. Swan
F. T. Graybeal
W. L. Kurtz
J. D. Sell

ASARCO

Southwestern Exploration Division

September 13, 1991

F.T. Graybeal
New York Office

Main St. Program
Downtown Assoc.
Casa Grande, Arizona
Santa Cruz Project

Enclosed is a recent front page article on the Main Street Program of Casa Grande's Downtown Association. The Downtown Association, as you would expect, has the full support of Donovan Kramer.

The subjects in the photograph, Mr. McCarville and Mr. Miller, were given an informal presentation and tour of the in situ test site on September 5th.

The Downtown Association's request for a financial contribution from the SCJV is discussed in my September 10th memo to you.

H.G. Kreis

H.G. Kreis

HGK:mek
Enc.

cc: D.M. Noyes
W.L. Kurtz
J.D. Sell
T.E. Scartaccini
W.E. McCulloch - Freeport
S.A. Swan - USBM
P. Robinson
A.R. Raihl

Pinal County's
Daily Newspaper

CASA GRANDE DISPATCH

CASA GRANDE, ARIZONA 85222 FRIDAY, SEPTEMBER 6, 1991 NO. 210 VOL. 80

ASARCO

Southwestern Exploration Division

September 13, 1991

A.R. Raihl

Publicity
Santa Cruz Project
Pinal County, AZ

Attached is an article from the "Tri Valley Dispatch" section of the September 11th issue of the "Casa Grande Dispatch." The article describes an exhibit with a section on mining. The exhibit is located at the Pinal County courthouse courtyard in Florence.

The article and the exhibit demonstrate a favorable attitude towards mining.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: D.M. Noyes
F.T. Graybeal
W.L. Kurtz
J.D. Sell
T.E. Scartaccini
W.E. McCulloch - Freeport
S.A. Swan - USBM
P. Robinson

TRI-VALLEY DISPATCH

"SERVING OVER 14,000 FAMILIES IN THE CASA GRANDE, GILA AND SANTA CRUZ VALLEYS"

Supplement to the Casa Grande Dispatch, Coolidge Examiner, Florence Reminder and Blade-Tribune and Eloy Enterprise

a Grande, Ariz. TRI-VALLEY DISPAT

Display

n

JDS

ASARCO

Exploration Department
Southwestern United States Division

September 13, 1991

Mr. Douglas R. McGregor,
Oxide Operations Manager
Magma Copper Company
P.O. Box M
San Manuel, Arizona 85631

Dear Mr. McGregor,

I have been informed by Mr. Tom Scartaccini that he made arrangements with you for a small group of our associates to visit your San Manuel SX/EW plant. We will arrive at your plant at 1:30PM on Wednesday, September 25th, and we will ask for Mr. Mike Eamon.

Our group will consist of Mr.Jon Ahlness, a group supervisor with the USBM; Mr. Dan Millenacker, a hydrologist with the USBM; Mr. Joe Pugliese, a mining engineer with the USBM; Ms. Priscilla Robinson, a consultant for our cooperative in situ leach project in Casa Grande; and the undersigned. As mentioned by Mr. Scartaccini, our group is only interested in visiting the SX/EW plant.

On behalf of myself and the others in the group, I thank you for your hospitality. If you or anyone else in your company would like to visit our In Situ Copper Mining Research Project is Casa Grande, please let me know, and I will arrange for a presentation and tour.

Sincerely yours,

Henry G. Kreis

cc: T.E. Scartaccini

bl.cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Southwestern Exploration Division

September 17, 1991

F.T. Graybeal

Public Relations
In Situ Leach Project
Santa Cruz Project

The attached article on apparent water contamination at the Zonia Mine is worth reading again. It was originally circulated in July 1990.

The subject of this article and its contents may be the source of rumors heard by Ms. Wootton of the Casa Grande Dispatch. The article describes water from Zonia as being toxic to fish and poisonous to cattle.

H.G. Kreis

H.G. Kreis

HGK:mek
Att.

cc: D.M. Noyes
A.R. Raihl
S.A. Swan
J.D. Sell
P. Robinson
W.E. McCulloch

PRISCILLA ROBINSON
CONSULTANT
P. O. BOX 5591
TUCSON, ARIZONA
85703
(602)620-0366

ASARCO Incorporated
JUL 11 1990
SW Exploration

July 9, 1990

To: Santa Cruz Project Team
From: Priscilla Robinson

Re: Report of Zonia open pit mine, in situ experiment and proposed landfill.

The enclosed article appeared in the latest edition of the Sierra Club newsletter. Elements to note are the description of the early in situ attempt, including blasting, failure to recapture the leach solution and consequent water quality problems. The report is instructive for us because it identifies all the potential problems that we must address. (I am making no judgement about the accuracy of the story, about which I know nothing.)

You will also note that the present controversy relates to a current proposal to use the pit as a landfill.

Bureau personnel should anticipate questions concerning the Zonia mine and be prepared to respond with information about the extensive environmental safeguards built into our project that make such an outcome impossible. If the Bureau personnel know about the Zonia case and are comfortable talking about it, fine. However, it is not necessary to know anything about the Zonia mine, just be able to explain why this cannot happen to the Santa Cruz Project.

Copies to: Lou Wade, Bill Larson, John Ahlness, Steve Swan, Dan Millenacker, Al Raihl, Hank Kreis, Charlie Barter, Jim Magner.

ASARCO

Southwestern Exploration Division

September 17, 1991

VIA FAX

F.T. Graybeal
New York Office

Hydrology Talk and Paper
By Dr. Errol Montgomery
Santa Cruz In Situ Project

Dr. Errol Montgomery has requested permission to present a talk on Santa Cruz groundwater protection. The talk would be presented to the "Second USA/USSR Joint Conference on Environmental Hydrology and Hydrogeology" in Washington, D.C., during May 1993. A manuscript of his talk would then be published in the proceedings of the conference.

He would like the title of his talk to be GROUNDWATER PROTECTION MEASURES, SANTA CRUZ IN SITU COPPER MINING RESEARCH PROJECT, PINAL COUNTY, ARIZONA. The accompanying September 16, 1991 letter from Dr. Montgomery describes in detail the subject of his talk.

Dr. Montgomery's talk is in the best interest of the Santa Cruz In Situ Copper Mining Research Project. There will be no cost to the SCJV or the USBM since the cost of the talk would be borne by Montgomery and Associates.

In the absence of Mr. Raihl, I recommend Dr. Montgomery be given permission to present his talk and have it published in the proceedings of the conference. This permission would be subject, of course, to submitting his manuscript to the SCJV and the USBM for review.

By copy of this letter, I am asking Mr. Swan of the USBM and Mr. McCulloch of Freeport-McMoRan to consider Dr. Montgomery's request.

Dr. Montgomery must submit the title of his talk to the conference organizers by September 30, 1991. Consequently, a prompt reply would be appreciated by Dr. Montgomery.

H.G. Kreis

H.G. Kreis

HGK:mek
Accompaniment

cc: S.A. Swan (USBM)
W.E. McCulloch (Freeport)
A.R. Raihl
W.L. Kurtz
J.D. Sell
C.F. Barter (ELM&A)

ERROL L. MONTGOMERY & ASSOCIATES, INC.
CONSULTANTS IN HYDROGEOLOGY

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LAURA J. STRAUSS, P.G.

September 16, 1991

H. G. Kreis
ASARCO INCORPORATED
P. O. Box 5747
Tucson, Arizona 85703

Dear Mr. Kreis:

Via this letter, I am requesting permission from Santa Cruz Joint Venture Partners, and the participants in the Santa Cruz In Situ Copper Mining Research Project, to present a technical hydrogeologic paper on the environmental aspects of the project. The title of the paper would be: GROUNDWATER PROTECTION MEASURES, SANTA CRUZ IN SITU COPPER MINING RESEARCH PROJECT, PINAL COUNTY, ARIZONA. I have been invited by the organizing committee of the "Second USA/USSR Joint Conference on Environmental Hydrology and Hydrogeology" to present a technical paper at the conference to be held in Washington D.C., in May 1993. Presentation of the paper would include preparation of a manuscript, and subsequent publication of the manuscript in the proceedings of the 1993 conference. I am enclosing a copy of the letter of invitation from the organizing committee and a copy of the paper that I delivered at the first conference, held in Leningrad in June 1990. This enclosed paper was subsequently included in the proceedings of the 1990 conference.

The proposed paper for the 1993 conference would be based on hydrogeology work conducted by Montgomery & Associates for the Santa Cruz In Situ Copper Mining Research Project. The paper would briefly describe the involvement of the Santa Cruz Joint Venture partners and the U.S. Federal Bureau of Mines, and would give a brief conceptual description of the ore body and the mining process. I would plan to provide substantial detail for: 1) the design of the underground facilities with respect to protection of the aquifer systems, including design and construction of the injection and recovery wells, the monitor wells, and the hydrogeologic characterization well; 2) conduct of the environmental protection aspects of the research project, including monitoring for groundwater level and hydrochemical response during pressure testing, saline tracer testing; and acid solution testing; and 3) the Aquifer Protection Permit process with the Arizona Department of Environmental Quality. The paper would not include information related to volatile organic compounds produced during casing perforation operations for wells at the Santa Cruz site.

The cost for the work for preparation of the paper and for travel to the conference would be borne solely by Montgomery & Associates; no costs related to preparation of the paper would be charged to the Santa Cruz project.

I will appreciate your assistance in obtaining the requested permission. If you have questions, or if you require further information, please contact me.

Very truly yours,

ERROL L. MONTGOMERY & ASSOCIATES, INC.

Dr. Errol L. Montgomery

Enclosures

AMERICAN INSTITUTE OF HYDROLOGY

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Senior Vice President
Dr. L. Douglas James
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August 5, 1991

RECEIVED

AUG 7 19

MONTGOMERY & ASSOC., INC.

Errol L. Montgomery
Errol L. Montgomery and Assoc. Inc.
1075 East Fort Lowell Rd. Suite B
Tucson, AZ 85719

Dear Mr. Montgomery:

On behalf of the Organizing Committee, we would like to invite you to present a paper at the upcoming "Second USA/USSR Joint Conference on Environmental Hydrology and Hydrogeology" to be held on May 16-20, 1993 in Washington, DC.

The First USA/USSR Joint Conference, organized by the American Institute of Hydrology, Leningrad Mining Institute, and the U.S.S.R. Academy of Sciences, took place June 18-21, 1990 in Leningrad, U.S.S.R. This conference was very successful and viewed by Soviet scientists as the most significant hydrologic meeting to take place in U.S.S.R. in the last 70 years.

The objective of the Second Conference is to discuss "Industrial and Agricultural Impacts on the Hydrologic Environment." All pertinent topics will be considered such as

- effects of regional changes in industrial practices on the regional water cycle and on local hydrological system function,
- effects of management practices on minimizing contamination,
- hydrologic impacts of global climate changes, especially of global warming,
- point and non-point contamination, both of industrial and agricultural origins,
- protection programs and legal constraints,
- techniques, remedial measures, and monitoring needed to alleviate impacts.

We would like to extend again our invitation for you to participate in this important conference by presenting a paper. Based on the preliminary favorable indication of the participants of the first conference, we feel that we will be able to bring together most of the leading hydrologists and hydrogeologists from the U.S. and the U.S.S.R.

In order to make this conference successful, we are asking you to present a paper on a topic of your choice, rather than having the choice of the presentation made by us. We hope that you will accept our invitation to participate. If you are able to attend, please send the title of your suggested presentation by September 30, 1991.

We look forward to hearing from you in the near future.

Sincerely,

Joseph S. Rosenshein, Ph.D.

Alexander Zaporozec, Ph.D.

Co-Presidents of Organizing Committee

ADMINISTRATIVE OFFICE 3416 University Ave., S.E. Minneapolis, Minnesota 55414 Telephone (612) 379-1030

AMERICAN INSTITUTE OF HYDROLOGY

First USA/USSR Joint Conference on Environmental Hydrology and Hydrogeology

A selection of papers presented by American hydrologists at the USA/USSR joint conference held in Leningrad, USSR, June 18-21, 1990

Editors

John E. Moore, Roman A. Kanivetsky, Joseph S. Rosenshein, Chester Zenone and Sandor C. Csallany

KENDALL/HUNT PUBLISHING COMPANY
2460 Kerper Boulevard P.O. Box 539 Dubuque, Iowa 52004-0539

Proceedings, First USA/USSR Joint Conference on
Environmental Hydrology and Hydrogeology
American Institute of Hydrology
Pp. 228-239

Patterns of Ground Water Movement in Water Wells East Salt River Valley, Arizona, USA

E.L. MONTGOMERY, A.A. MESSER, and R.H. DEWITT

Errol L. Montgomery & Associates, Inc.
Tucson, AZ 85719

ABSTRACT

Fluid-movement investigations were conducted at 10 production water wells to determine patterns of ground water flow in wellbores under non-pumping and pumping conditions and to estimate rates of downward transport of ground water contaminants. Borehole television surveys were conducted to determine casing conditions and to document perforated intervals and the occurrence of cascading water. Temperature, spinner flowmeter, and brine tracer flowmeter surveys were conducted to obtain information on patterns of ground water flow in the wells. Results for non-pumping conditions indicate that rate of downward flow of ground water in the wells ranged from about eight to 25 liters per second. Under non-pumping conditions, substantial downward transport of contaminants occurs via large capacity water wells. Results for pumping conditions indicate that most of the pumped water is yielded to the wells from the upper and middle aquifer units. Because large amounts of ground water enter the wells from upper aquifer units and exit the wells into lower aquifer units under non-pumping conditions, the chemical composition and temperature of ground water pumped from lower aquifer units was similar to chemical composition and temperature of ground water from upper units.

INTRODUCTION

Investigations of fluid-movement were conducted over a 16-month period at 10 production water wells which yield ground water from a thick basin-fill alluvial aquifer. Locations for the wells are shown on **Figure 1**. Well construction details are given in **Table 1**. The basin-fill aquifer is informally classified into the Upper, Middle, and Lower Alluvium units. The purpose of the investigations was to determine patterns of ground water flow in production water wells under non-pumping and pumping conditions and to estimate rates of downward transport of volatile organic compounds.

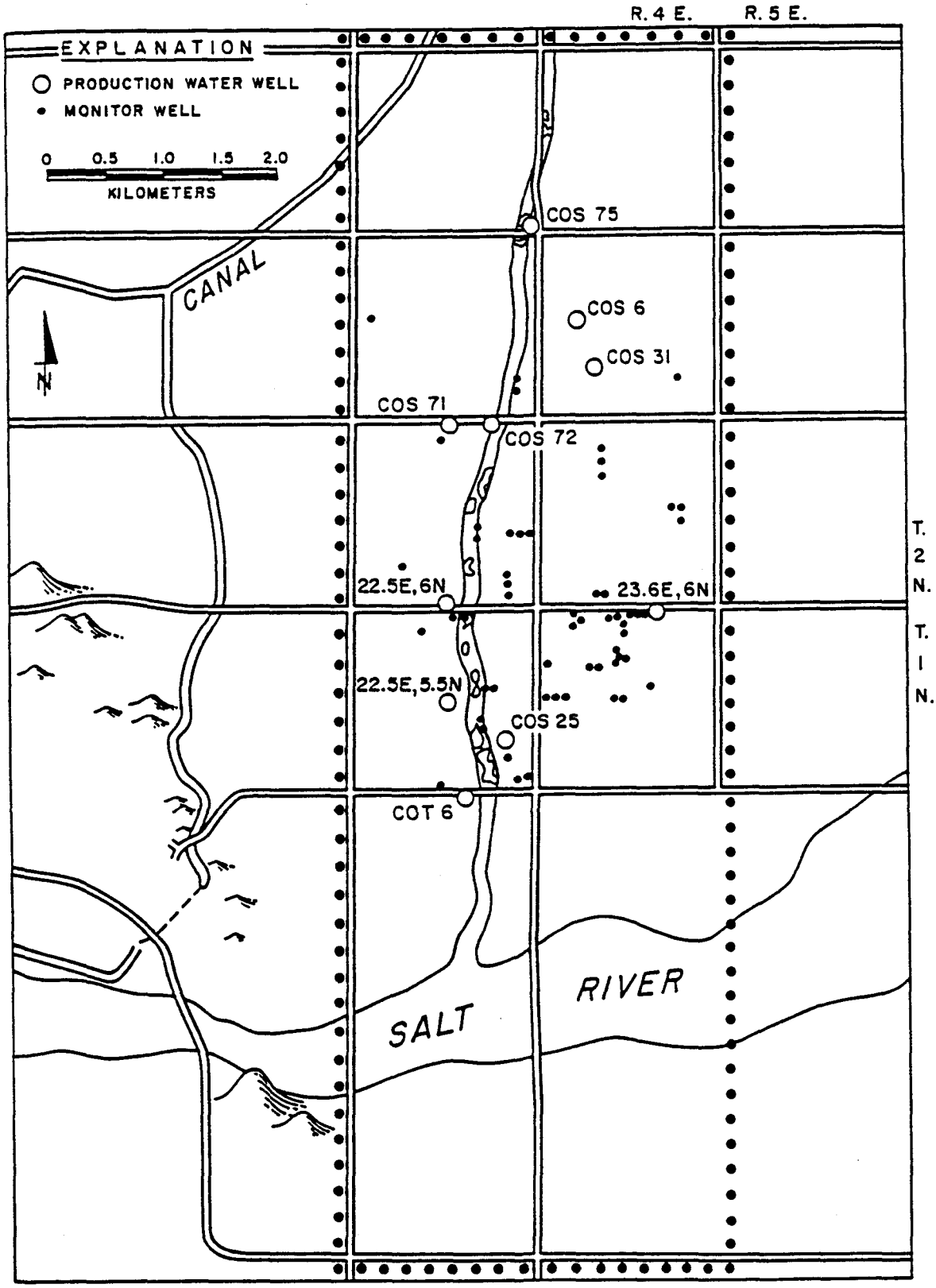

FIGURE 1. Location map

TABLE 1. Records for production water wells used for fluid-movement investigations

STATE WELL NUMBER	IDENTIFIER[a]	DATE COMPLETED	DEPTH DRILLED (meters below land surface)	CASING DIAMETER (cm)[b]	CASING DEPTH (meters)	PERFORATED INTERVAL (meters below land surface)	PUMPING RATE (l/sec)[c]	NON-PUMPING WATER LEVEL DEPTH (meters)[d]	NON-PUMPING WATER LEVEL DATE MEASURED
(A-1-4) 1abb1	[SRP 23.6E,6N]	1941	150	46 61	0-61 0-147	--- 61-141	51	50	1986
(A-1-4) 2dbb	[SRP 22.5E,5.5N]	1948	186	51	158	64-154	103	53	1986
(A-1-4) 2ddb	[COS 25]	1977	213	41 36	0-152 148-213	107-146 148-213	66	47	1987
(A-1-4)11aba	[COT 6]	1960	320	51	320	62-316	83	46	1987
(A-2-4)23ddd1	[COS 75]	1959	366	51 41	0-149 149-366	37-146 144-?	107	70	1987
(A-2-4)25bcd	[COS 6]	1953	395	51 41	0-141 141-395	30-140 145-367	83	70	1987
(A-2-4)25cdb2	[COS 31]	1957	396	51 41	0-215 209-396	92-212 215-393	144	67	1987
(A-2-4)35aab2	[COS 72]	1958	300	51	300	61-296	120	62	1987
(A-2-4)35abb1	[COS 71]	1958	305	51 41	0-152 149-305	41-148 152-302	145	62	1987
(A-2-4)35dcc2	[SRP 22.5E,6N]	1952	201	51	201	41-195	158	55	1987

[a] Identifier
SRP - Salt River Project
COS - City of Scottsdale
COT - City of Tempe

[b] cm - centimeters

[c] l/sec - liters per second

[d] Depth in meters below land surface

HYDROGEOLOGY

The wells where the investigations were conducted are located near Phoenix, Arizona, in the east part of the Salt River Valley, in the Basin and Range geologic province of North America. The Salt River Valley basin is a complex geologic structural depression of Cenozoic age which contains sedimentary rocks derived from erosion of the adjacent mountain blocks.

Upper Alluvium Unit

The Upper Alluvium unit consists of unconsolidated sand, gravel, cobbles, and boulders; thickness ranges from about 34 to 53 meters. The saturated part of the unit comprises a thin basal zone; average saturated thickness is about six meters (Montgomery & Associates, 1987). Analysis of lithology and of borehole geophysical logs for the saturated part of the Upper Alluvium unit at monitor well sites suggests that average porosity may be about 30 to 35 percent. Comparison of lithology of the saturated strata with sediments for which measurements of specific yield have been made (Poland and others, 1949; Johnson, 1967; Montgomery, 1971; and Davidson, 1973) suggests that average specific yield may be about 15 to 20 percent. Results of 12-hour single borehole pumping tests at 14 monitor wells indicate that hydraulic conductivity of the unit ranges from about 20 to 160 meters per day; average is about 65 meters per day.

Middle Alluvium Unit

The Middle Alluvium unit is weakly cemented and consists of interbedded clay, silt, silty sand, and gravel strata; at most locations clay and silt strata are dominant. Thickness ranges from about 110 to 180 meters. Where penetrated by wells, the Middle Alluvium unit comprises a semi-confined aquifer. In the past, the Middle Alluvium unit was assumed to be the least productive of the aquifer units in the east part of the Salt River Valley (Halpenny, Harshbarger, and Greene, 1967; and Arteaga and others, 1968). Laney and Hahn (1986) indicate that the Middle Alluvium unit is the principal water bearing unit in the east Salt River Valley area.

Average depth to ground water level in monitor wells completed in the unit is about 50 meters. Average vertical hydraulic gradient from the Upper Alluvium unit to the Middle Alluvium unit is about 0.36 and is downward. Comparison of lithology of the saturated strata with sediments for which measurements of specific yield have been made (Poland and others, 1949; Johnson, 1967; Montgomery, 1971; and Davidson, 1973) suggests that average specific yield of the Middle Alluvium unit may be about five percent. Laney and Hahn (1986) report hydraulic conductivity of the Middle Alluvium unit in the east part of the Salt River Valley ranges from about 6.2 to 30.8 meters per day. Results of 12-hour single borehole pumping tests at 10 monitor wells indicates that hydraulic conductivity of the upper part of the unit ranges from about 0.3 to 29 meters per day; average is about 8.0 meters per day. A 10-day aquifer test was conducted at a production water well perforated over the full thickness of the aquifer. During the aquifer test water level data were obtained from 13 observation wells. Results of the aquifer test indicated average hydraulic conductivity of about 6.3 meters per day and transmissivity of about 500 square meters per day.

Lower Alluvium Unit

The Lower Alluvium unit consists of a heterogeneous mixture of weakly- to firmly-lithified gravel, boulders, sand, sandy clay, silty sand, and interbedded clay units. Thickness ranges from approximately 60 to 180 meters. The unit comprises a confined aquifer and yields large amounts of ground water to wells. Average depth to ground water level in monitor wells completed in the unit is about 62 meters. Average vertical hydraulic gradient from the Middle Alluvium unit to the Lower Alluvium unit is about 0.08 and is downward. Comparison of lithology of the saturated strata with sediments for which measurements of specific yield have been made (Poland and others, 1949; Johnson, 1967; Montgomery, 1971; and Davidson, 1973) suggests that average specific yield of the Lower Alluvium unit may be about 10 percent. Results of a 12-hour single borehole pumping test indicate that hydraulic conductivity of the upper part of the unit is about 13 meters per day.

FLUID-MOVEMENT INVESTIGATION PROCEDURES

The wells where the fluid-movement investigations were conducted range in depth from 150 to 396 meters, and casing diameters range from 36 to 61 centimeters. Perforated intervals for the wells begin as little as 30 meters below land surface, and extend to as deep as 393 meters. During conduct of the investigations, borehole geophysical logs and samples of ground water for laboratory chemical analyses were obtained under non-pumping and pumping conditions.

Borehole television and caliper surveys were conducted to determine casing and wellbore conditions and to identify perforated intervals. Natural gamma-ray surveys were conducted to investigate lithology. Temperature, spinner flowmeter, and brine tracer flowmeter surveys were conducted to obtain information on patterns of ground water flow in the wellbores under non-pumping and pumping conditions. After patterns of flow in the wellbores were identified, depth specific ground water samples for laboratory chemical analyses were obtained under non-pumping and pumping conditions.

Borehole Television

Borehole television surveys were conducted using downhole underwater television cameras. Wellbore conditions were monitored at land surface and were recorded. Borehole television surveys permit inspection of: condition of the casing, location of perforated intervals, changes in casing diameter, and obstructions in the well that could result in damage to logging equipment. The surveys are also useful for observation of cascading water, and of oil on the water surface.

Natural Gamma-ray

Under favorable conditions, natural gamma-ray logs are conducted to estimate lithology and the results are used for stratigraphic correlation. Natural gamma-ray logs are records of the amount of natural gamma radiation emitted from the borehole wall. In general, the natural gamma activity of granitic rocks and organic-rich clayey sediments is much higher than that of "clean" quartz sands and carbonate minerals. Because natural gamma-ray activity of granitic sediments in the Lower Alluvium unit is generally higher than that of the Middle Alluvium unit, the natural gamma-ray log is useful in determining the location of the contact between the Middle and Lower Alluvium units. Baseline shifts in natural

gamma-ray logs occur where changes in casing diameter and casing wall thickness occur.

Caliper

Caliper surveys were conducted to provide a continuous record of casing diameter. Changes in casing diameter cause baseline shifts in natural gamma-ray, spinner flowmeter, and brine tracer flowmeter logs.

Temperature

Temperature surveys were conducted to determine the temperature of ground water in the wellbore. Under no-flow conditions, a geothermal gradient ranging from 2.0 to 2.3 degrees Celsius per 100 meters of depth would occur (Keys and MacCary, 1971). Changes in the gradient and offsets on the temperature log are interpreted to indicate intervals where ground water enters the wellbore. Intervals of uniform temperature indicate the occurrence of substantial vertical flow in the well.

Spinner Flowmeter

Spinner flowmeter surveys were conducted to measure velocity of vertical ground water flow in the production water wells. The spinner flowmeter consists of an impeller or "spinner" that is free to rotate as water moves past. Velocity measurements using the spinner flowmeter can be made by continuous traverse or at stationary positions in the wellbore.

For velocity measurements by continuous traverse, the flowmeter is raised or lowered in the wellbore at a constant rate. Intervals where ground water enters or exits the wellbore are indicated by deflections in opposite directions on logs for the uphole and downhole surveys. For velocity measurements at stationary positions, flowmeter measurements are conducted at regular intervals in the wellbore and are compared to determine the pattern of flow. For an interval of uniform casing diameter, an increase in spinner counts per second in the direction of flow indicates that ground water is entering the wellbore, and a decrease in spinner counts per second in the direction of flow indicates that ground water is exiting from the wellbore.

The spinner flowmeter measures only vertical flow, and spinner counts per second may be anomalously low at points where ground water entering the wellbore results in turbulent flow. Spinner flowmeter measurements at stationary positions are more susceptible to turbulence in the wellbore than measurements conducted by continuous traverse. Because flow velocity varies with casing diameter, ground water flow patterns are difficult to determine in intervals near changes in casing diameter. Because of frictional drag along the sides of the casing, flow velocities are highest in the center of the wellbore, and variation in measured velocities may occur due to the position of the flowmeter in the horizontal cross-section area of the well. Variation in measurements may also result from interference caused by debris which was dislodged from the casing wall by the logging cable and falling past the spinner flowmeter.

The lower limit of measurable velocity for the spinner flowmeter used in this investigation is about two meters per minute. Initial measurements with the spinner flowmeter at stationary positions under non-pumping conditions indicated that vertical flow velocities for some wells were less than the limit of measurement for the spinner flowmeter. Under pumping conditions, flow velocities were relatively large, and useful results were obtained. Less definitive results were obtained under non-pumping conditions. For testing under

non-pumping conditions at six of the wells, the spinner flowmeter was equipped with a 25-centimeter diameter funnel to direct more of the ground water flow past the impeller, thereby increasing the flow velocity to measurable levels. Flows of as much as 3.2 liters per second for 36-centimeter casing, as much as 4.4 liters per second for 41-centimeter casing, and as much as 6.3 liters per second for 51-centimeter casing are not detected by the spinner flowmeter.

Brine Tracer Flowmeter

Surveys of brine tracer travel times were conducted using a modified fluid resistivity sonde. At stationary measurement positions, a five cubic centimeter slug of sodium chloride brine was injected into the wellbore from a chamber located 1.2 meters above the resistivity electrodes. The travel time of the brine slug was used to compute velocity of vertical flow. Tests conducted in a 31-centimeter diameter column of water indicate that under no-flow conditions the brine slug moves downward at a rate of 1.2 centimeters per second as a result of the contrast in density between the brine solution and the water in the test column. Where data were sufficient, maximum rate of vertical flow in the wellbore under non-pumping conditions was computed; results are summarized in Table 2.

Ground Water Samples

Ground water samples for laboratory chemical analyses were obtained at selected depths in the wells. The ground water sampling tool consisted of a 2-liter stainless steel chamber capable of obtaining samples of ground water at specific depths in the wellbore. After each ground water sample was obtained, the sampling tool was cleaned by washing with deionized water and detergent, rinsing with deionized water, rinsing with methanol, and drying in air. Prior to sampling, air was purged from the chamber using nitrogen gas; the nitrogen gas was removed by evacuating the chamber using a vacuum pump. Several ground water sampling tools were used so that sampling could proceed while alternate tools were being cleaned and prepared for re-use. Ground water samples were transferred from the sampling tool into 40-milliliter and 1-liter sample bottles and standard U. S. Environmental Protection Agency protocol procedures were followed.

FLUID-MOVEMENT INVESTIGATION RESULTS AT WELL COS-72

Fluid-movement investigations were conducted at 10 production water wells. Details of results for investigations conducted at well COS-72 are considered to be representative of results obtained for the 10 wells investigated, and are given herein. Well (A-2-4)35aab2[COS 72] was constructed to a total depth of 300 meters using cable tool drilling methods; construction was completed in March 1958. Well construction details are given in Table 1. Results of fluid-movement investigations for the well are summarized on Figure 2. Analysis of the driller's log suggests that the well penetrates the Upper Alluvium unit from land surface to a depth of 46 meters, penetrates the Middle Alluvium from 46 to 201 meters, and bottoms in the Lower Alluvium unit at a depth of 300 meters.

TABLE 2. Summary of brine tracer flowmeter measurements for downward flow under non-pumping conditions

STATE WELL NUMBER	IDENTIFIER[a]	CASING DIAMETER FOR MEASURED INTERVAL (centimeters)	MEASURED INTERVAL (mtrs,bls)[b]	BRINE TRACER TRAVEL TIME (seconds)	ESTIMATED GROUNDWATER VELOCITY (cm/sec)[c]	AVERAGE DOWNWARD FLOW RATE (l/sec)[d]
(A-2-4)25cdb2	[COS 31]	51	137-198	24	3.9	7.6
(A-2-4)35abb1	[COS 71]	51 41	137-152 152-198	15 15	6.9 6.9	10.7
(A-2-4)23ddd1	[COS 75]	51 41	85-140 146-171	10 8	11.0 11.0	20.2
(A-2-4)35aab2	[COS 72]	51	84-168	9	12.3	24.6
(A-2-4)35dcc2	[SRP 22.5E,6N]	51	91-122	21	4.6	8.8

[a] Identifier
COS - City of Scottsdale
SRP - Salt River Project

[b] mtrs,bls - meters below land surface

[c] cm/sec - centimeters per second

[d] l/sec - liters per second

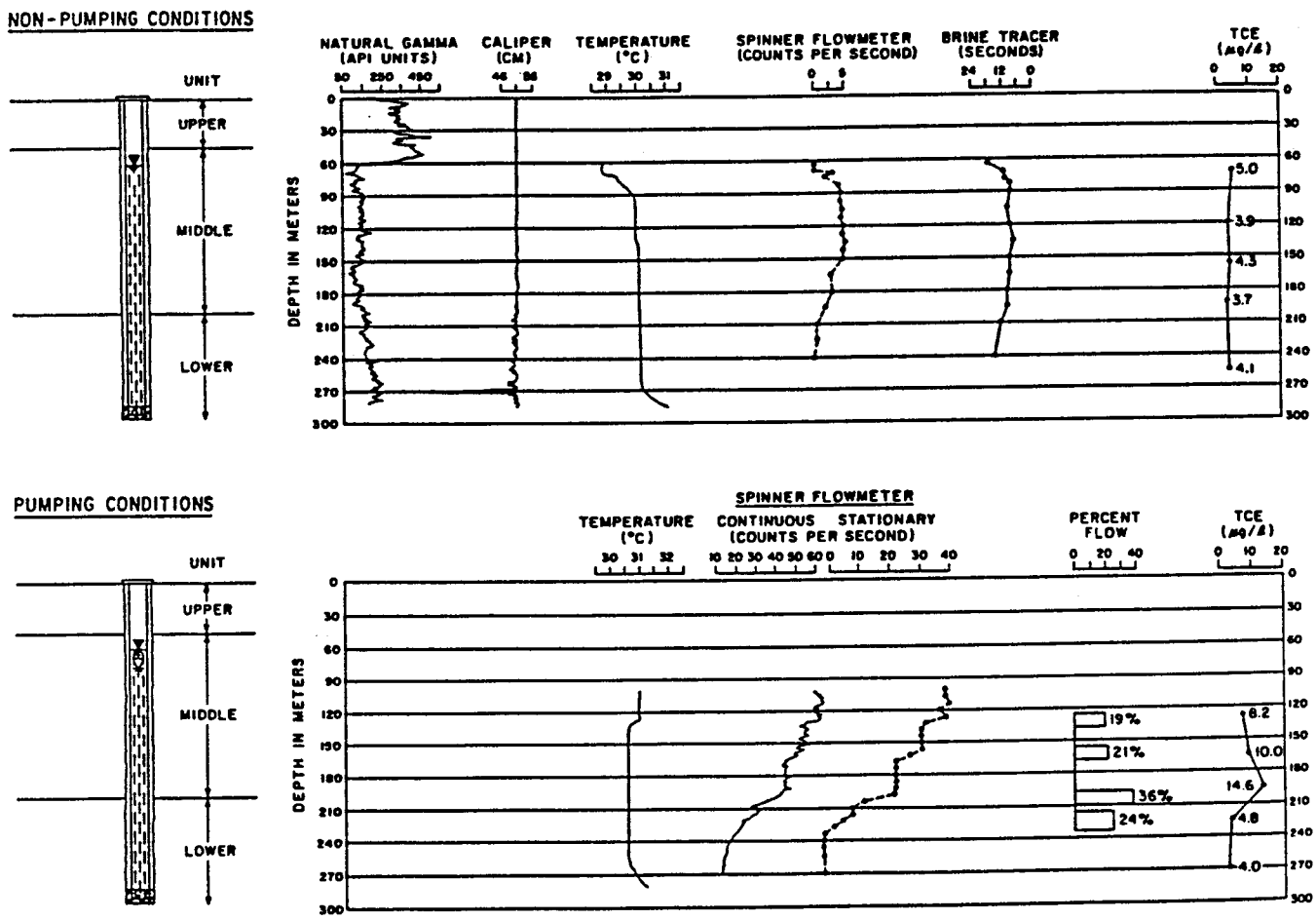

FIGURE 2. Results of fluid-movement investigations for well (A-2-4)35aab2 [COS 72]

PATTERNS OF GROUND WATER MOVEMENT IN WATER WELLS
EAST SALT RIVER VALLEY, ARIZONA, USA

Wellbore Conditions And Construction Details

The borehole television survey for well (A-2-4)35aab2[COS 72] indicated that Mill's knife perforations occur from 61 meters below land surface to total televised depth of the well. Ground water was cascading into the wellbore at a depth of 61 meters. Depth to non-pumping water level was 62 meters. Encrustation on the well casing was substantial and perforations appeared to be mostly closed throughout the perforated interval. Ground water in the wellbore was turbid below about 259 meters, and turbidity increased with depth. Total well depth at the time of the borehole television survey was 288 meters.

Wellbore Investigations: Non-Pumping Conditions

Borehole geophysical surveys conducted under non-pumping conditions included natural gamma-ray, caliper, temperature, spinner flowmeter, and brine tracer flowmeter. Analysis of the borehole television, temperature, spinner flowmeter, brine tracer flowmeter, and ground water chemistry results for well (A-2-4)35aab2[COS 72] indicates that under non-pumping conditions:

1. Ground water cascades into the wellbore at the top of the perforated interval at 61 meters, 15 meters below the top of the Middle Alluvium unit. Ground water may be flowing down the annulus between the casing and the borehole wall, possibly from the Upper Alluvium unit.

2. Most of the ground water enters the wellbore from the upper part of the Middle Alluvium unit in the interval from 70 to 73 meters; additional ground water enters in the interval from 73 to 91 meters, and at 137 meters.

3. Substantial downward movement of ground water occurs from non-pumping water level to a depth of 271 meters. Downward flow rate of about 25 liters per second occurs in the interval from 84 to 168 meters.

4. Ground water exits the wellbore into the lower part of the Middle Alluvium unit and into the Lower Alluvium unit in the interval from 152 to 271 meters.

5. Concentration of trichloroethene in ground water samples ranged from 3.7 to 5.0 micromhos per liter; average was 4.2 micromhos per liter.

Wellbore Investigations: Pumping Conditions

A submersible electric pump was installed in the well on May 4, 1987. The pump intake was set at a depth of 100 meters below land surface. A 10-centimeter diameter PVC access pipe for borehole geophysical logging tools was installed to immediately below the pump intake and a 2-centimeter diameter galvanized steel sounder access pipe was installed to immediately above the pump intake.

The well was pumped for a period of 389 minutes on May 5, 1987, and borehole geophysical logs and ground water samples for pumping conditions were obtained. Average pumping rate was about 84 liters per second. Pumping water level near the end of the pumping period was about 78 meters below land surface and was 22 meters above the pump intake. After pumping rate and water level had stabilized, borehole geophysical surveys were conducted and included temperature and spinner flowmeter.

Analysis of the temperature, spinner flowmeter, and ground water chemistry results for well (A-2-4)35aab2[COS 72] indicates that under pumping conditions:

1. Ground water enters the wellbore from the Middle Alluvium unit in the intervals from 128 to 140 meters and 158 to 171 meters, and from the Lower Alluvium unit in the intervals from 201 to 213 meters and 219 to 262 meters. Ground water that enters the wellbore above the pump intake could not be surveyed.

2. For the interval surveyed, most of the ground water entering the wellbore under pumping conditions is yielded from the Lower Alluvium unit.

3. Upward movement of ground water occurs in the wellbore from about 262 meters to the pump intake. Downward movement of ground water would be expected to occur in the perforated interval above the pump intake, but could not be surveyed.

4. Measurable upward flow of more than 6.3 liters per second was detected at a depth of 238 meters.

5. Concentration of trichloroethene in a composite ground water sample obtained at the wellhead was 7.2 micrograms per liter. Concentration of trichloroethene in ground water samples obtained from below the pump intake ranged from 4.0 to 14.6 micromhos per liter.

SUMMARY OF RESULTS OF FLUID-MOVEMENT INVESTIGATIONS

Results of the investigations indicate that substantial downward transport of volatile organic compounds, including the industrial solvent trichloroethene, occurs from the Upper Alluvium unit to the lower part of the Middle Alluvium unit and to the Lower Alluvium unit via non-pumped and unsealed water wells. Under non-pumping conditions, substantial downward flow occurred in each of the 10 wells where investigations were conducted. Ground water which may contain volatile organic compounds seeps or cascades from the Upper Alluvium unit through openings in the blank casing or through the perforated casing into six of the 10 wells. Ground water from the Upper Alluvium unit may move down the annulus outside the blank casing in other wells. Below the non-pumping water level, ground water enters the wellbores from the upper part of the Middle Alluvium unit, via the upper part of the perforated intervals. Ground water exits the wellbores from the lower part of the perforated intervals to the lower part of the Middle Alluvium unit and to the Lower Alluvium unit. Downward flow rates in the wellbores were measured in five wells under non-pumping conditions and ranged from about eight to 25 liters per second; average was about 15 liters per second. Under non-pumping conditions, downward transport rates of trichloroethene in the wellbores were computed for five wells and ranged from about four to 114 liters per year; average was about 38 liters per year.

Results of spinner flowmeter surveys for pumping conditions, at the 10 wells where investigations were conducted, indicate that most of the pumped water is yielded to the wells from the Middle Alluvium unit. Smaller amounts of ground water are yielded to the wellbores from the Lower Alluvium unit. Historic pumping rates from the wells ranged from about 50 to 160 liters per second. During the fluid-movement investigations, the wells were pumped at rates ranging from 35 to 100 liters per second. When the wells are pumped, a fraction of the transported volatile organic compounds are recovered with the pumped water from the lower part of the Middle Alluvium unit and from the Lower Alluvium unit.

Because substantial amounts of ground water which enter the wellbore from the upper aquifer units exit the wellbore and enter the lower aquifer units under non-pumping conditions, the chemical composition and temperature of ground water pumped from the lower aquifer units, during pumping periods of short duration, are similar to chemical composition and temperature of ground water from the upper units.

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TRI-VALLEY DISPATCH SEPT. 18, 1991

(4)

SEP 18 '91 15:06 CREATIVE BUSINESS SERVICES

VIA FAX: 602-473-3342

ASARCO

Exploration Department
Southwestern United States Division

September 19, 1991

Mr. Gene Santellanes Jr.
General Foreman
Magma Copper Company
P.O. Box 100
Miami, Arizona 85539

Dear Mr. Santellanes:

I have been informed by Mr. Tom Scartaccini that he made arrangements with you for a small group of our associates to visit your SX/EW plants. We will arrive at your Pinto Valley plant at 1:30 PM on Tuesday, September 24th, and we will ask for you.

Our group will consist of Mr. Jon Ahlness, a group supervisor with the USBM: Mr. Dan Millenacker, a hydrologist with the USBM; Mr. Joe Pugliese, a mining engineer with the USBM; and the undersigned. As mentioned by Mr. Scartaccini, our group is only interested in visiting your SX/EW plants.

On behalf of myself and the others in the group, I thank you for your hospitality. If you or anyone else in your company would like to visit our In Situ Copper Mining Research Project in Casa Grande, please let me know, and I will arrange for a presentation and tour.

Sincerely yours,

Hank Kreis

Henry G. Kreis

HGK:mek

cc: T.E. Scartaccini

bl.cc: F.T. Graybeal
W.L. Kurtz
J.D. Sell
A.R. Raihl

:ed P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

JDS

ASARCO

Southwestern Exploration Division

September 19, 1991

A.R. Raihl

Subsidence Monitoring
In Situ Test Site
Santa Cruz Project
Pinal County Arizona

As planned, the Santa Cruz in situ test site area will be monitored for subsidence before, during, and after the copper leaching phase of the In Situ Copper Mining Research Project. Although no subsidence due to in situ copper leaching is predicted, the monitoring results are expected to demonstrate no such copper leaching subsidence occurred.

Subsidence monitoring will be done by surveying a network of subsidence survey monuments for relative vertical movement. The surveying of the subsidence monuments will be done by survey techniques employing a greater degree of accuracy than is found in routine land surveys. The success of subsidence monitoring will depend largely on the design of the network of subsidence monuments.

The design of the network of subsidence monuments is based on several factors. Firstly, a subsidence monument is needed in the middle of the area most likely to subside due to copper leaching. Secondly, one or more subsidence monuments is needed outside the area in which any subsidence due to leaching might occur. Thirdly, the design of the monitoring network has to take into account the possibility of subsidence due to the extraction of groundwater for farm irrigation. And, lastly, the construction of the survey monuments should minimize near surface effects such as swelling and shrinking clays.

The layout of the subsidence monuments is shown on the accompanying map. Subsidence monument SUB-1 is located in the center of the area most likely to experience the greatest degree of copper leaching, the triangularly shaped area between T-2, T-3, and T-4. If copper leaching subsidence does occur it is most likely to occur over the top of this area of leaching.

Subsidence monuments SUB-2, SUB-3, and SUB-4 are located a safe distance from the area in which subsidence might occur. This safe distance allows for subsidence cracks to come up from a depth of 1800 feet at an angle of 60 degrees from the horizontal. Consequently, subsidence monuments SUB-2, SUB-3, and SUB-4 are located about 2000 feet from SUB-1. These three

monuments are laid out so that lines connecting SUB-1 with each of the three monuments are equally spaced, 120 degrees apart, from each other.

There is a reason for having three subsidence monuments outside the area of possible subsidence. Three subsidence monuments (SUB-2, SUB-3, and SUB-4) are needed about SUB-1 in the event subsidence from groundwater withdrawal occurs in the area of the subsidence monuments. These three subsidence monuments will help identify if groundwater withdrawal subsidence (associated with farm irrigation) occurs in the area outlined by SUB-2, SUB-3, and SUB-4. If subsidence from groundwater withdrawal does occur, the network of subsidence monuments will help to quantify the relative degree of subsidence across the network of subsidence monuments. This information would then be used to help interpret whether or not any subsidence due to copper leaching occurred.

The individual subsidence monuments are designed, as shown in the attached figure, to provide a representative survey point on the surface of the ground. The purpose of the survey point is to provide a survey point that will move with the surface of the ground if and when ground surface subsidence occurs. The individual monuments are designed to minimize the effects of near surface swelling and shrinking caused by the wetting and drying of soil by rain water.

All of the subsidence monuments will be constructed exactly the same. This will minimize changes in elevation caused by features unrelated to surface subsidence. For example, they will all experience the same degree of expansion and contraction caused by changes in temperature. Thus the monuments will show no relative change in elevation due to temperature changes.

Once the survey monuments have been constructed and allowed to sit for a month or two, they will be surveyed to establish relative elevations between the monuments. This elevation survey will employ the use of a second order level and a second order rod. Such an elevation survey is expected to close within a couple hundreds of a foot when run from, say, SUB-1 to SUB-2 to SUB-3 to SUB-4 to SUB-1.

Assuming it will be a year or two after the initial survey before copper leaching starts, the monuments will be surveyed again just before the leaching starts. This second survey will check for any differences in elevation caused by groundwater withdrawal or any other causes. The next

survey will be done at the termination of copper leaching and again a year to two later.

The cost of constructing and surveying the subsidence monuments is estimated to be $9,000. The estimated costs are itemized in the following table.

Estimated Construction and Surveying Costs

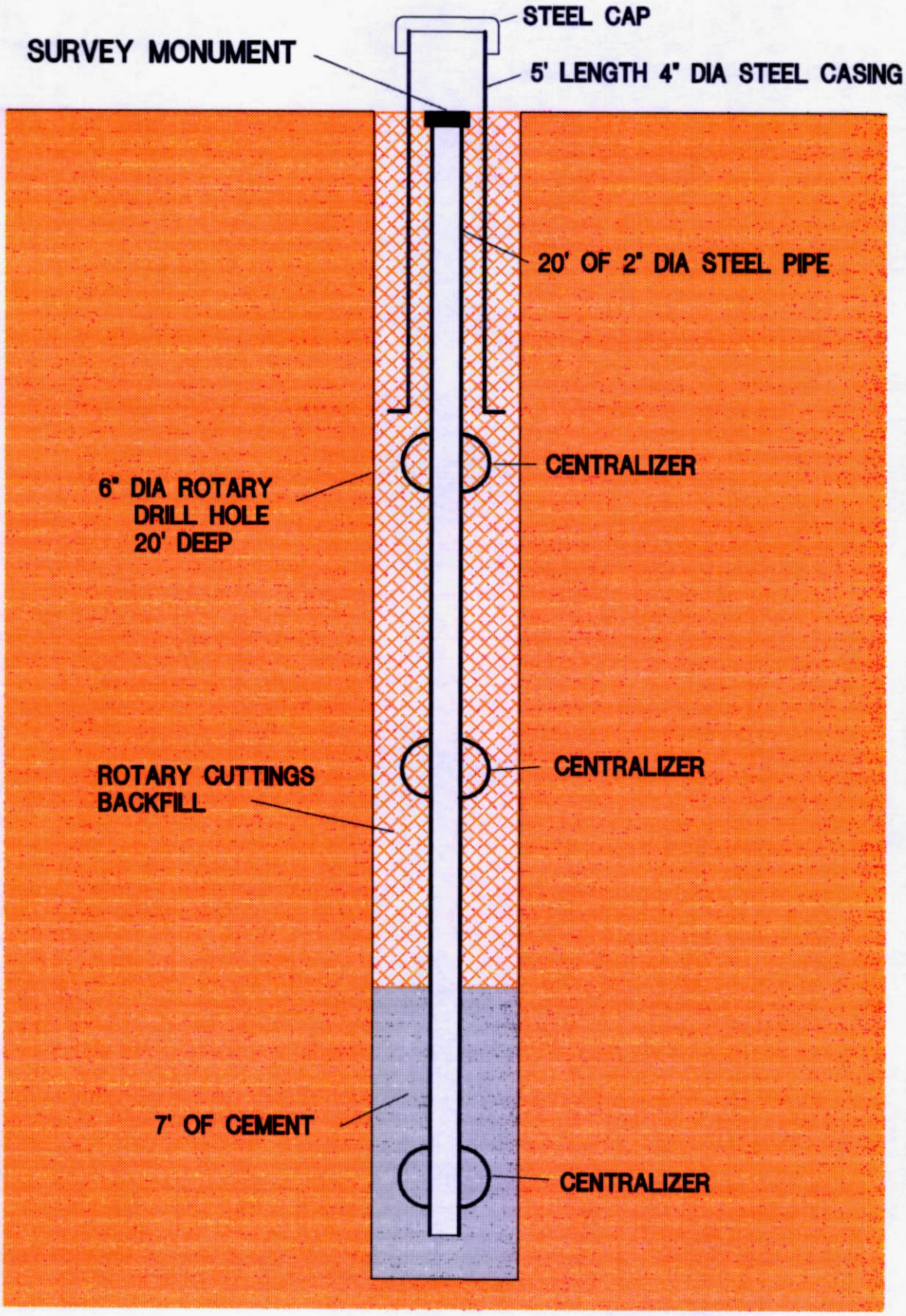
Construction:	
Drilling four, 6" diam. holes 20' deep	$1,000
Labor, cement, and other materials	1,000
Surveying:	
Preconstruction survey of hole locations	500
Initial survey, elevation and coordinates	2,000
Pre leach survey	1,500
Post leach survey	1,500
Year or two after post leach survey	1,500
Total	$9,000

In summary, the subsidence monitoring network for the detection of surface subsidence associated with copper leaching consists of four subsidence monuments. These four subsidence monuments, all constructed alike, will provide reliable points of reference for measuring relative elevation changes in the surface of the ground. The subsidence markers are strategically located, as shown on the attached plan map, to provide a basis for identifying and measuring surface subsidence caused by the copper leaching. The cost to construct, survey, and resurvey the monuments is estimated at $9,000.

H. G. Kreis

H.G. Kreis

cc: S.A. Swan (USBM)
F.T. Graybeal
W.L. Kurtz
J.D. Sell



NOT TO SCALE

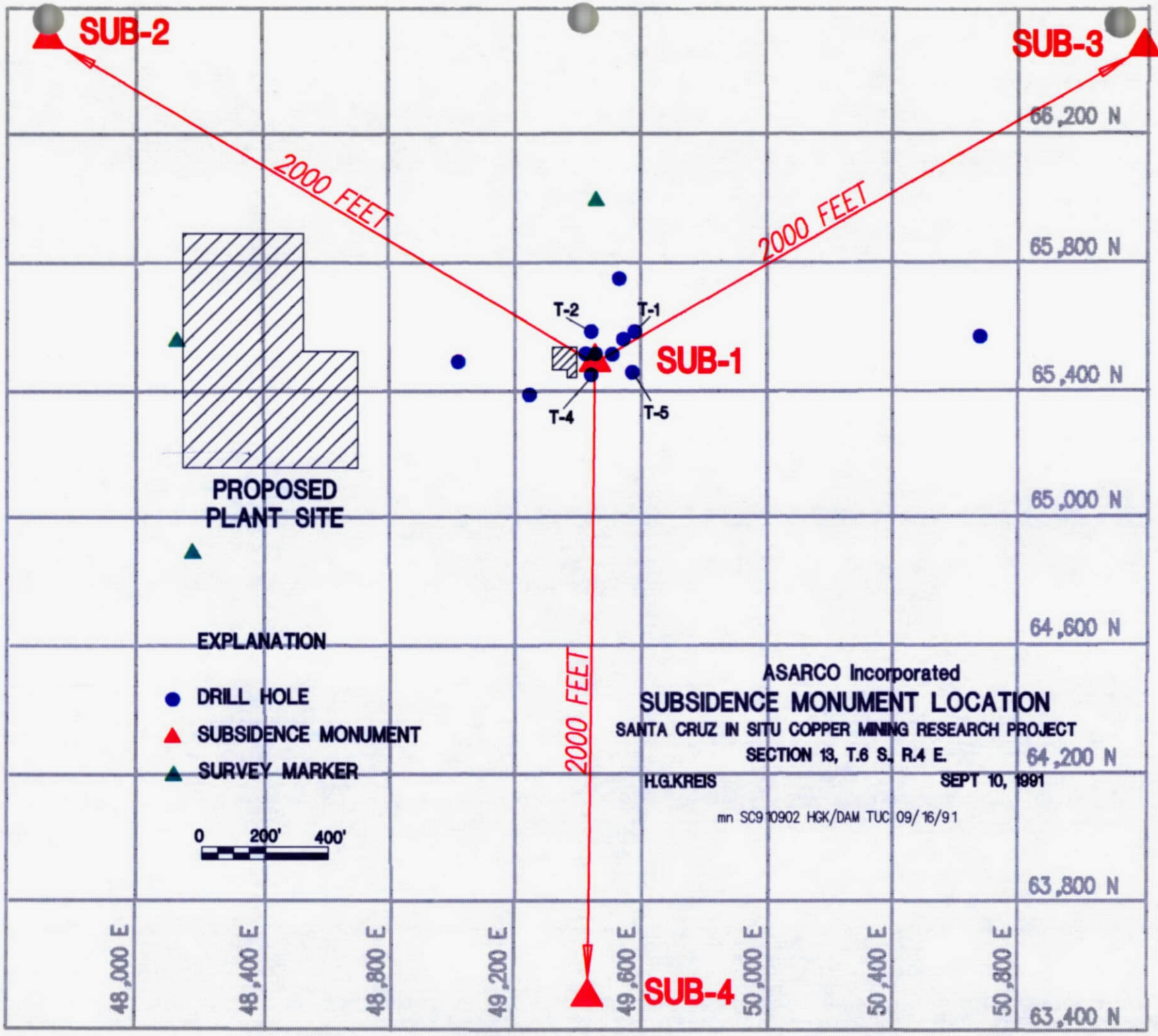
ASARCO Incorporated

SUBSIDENCE MONUMENT CONSTRUCTION

SANTA CRUZ IN SITU COPPER MINING RESEARCH PROJECT

H.G.KREIS **SEPT 10, 1991**

mn SC910904 HGK/DAM TUC 09/18/91


SUB-2
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PROPOSED
PLANT SITE
EXPLANATION
DRILL HOLE
SUBSIDENCE MONUMENT
SURVEY MARKER
0 200' 400'
ASARCO Incorporated
SUBSIDENCE MONUMENT LOCATION
SANTA CRUZ IN SITU COPPER MINING RESEARCH PROJECT
SECTION 13, T.6 S., R.4 E.
H.G.KREIS
SEPT 10, 1991
mn SC910902 HGK/DAM TUC 09/16/91
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VDS

FROM: J. D. SELL 9/20/91

TO: HG Kreis

Subsidence Monitoring

Interesting paper.

2 comments:

1. Why not cement the movement holes so as to catch the bottom of the 5' length of 4" dia steel casing?

2. Should you in the future care to survey between SUB-2 & SUB-4 (to close your triangle & thus make one large & 3 small △ for better resolution) you may find the plant site in the way for visual contact

JDS

9/27/91

FROM: W. L. KURTZ

TO: H Kreis
J Sell
A Raitt

Santa Cruz

Walt McCullough needs by mid-end October

1) Santa Cruz Operating budget – non in situ 1992

2) Research budget 1992

Please deal directly w/ McCullough

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Gene Santellanes Jr.
Leaching General Foreman
Magma Copper Company
P.O. Box 100
Miami, Arizona 85539

Dear Mr. Santellanes:

Thank you for arranging the September 24th tour of your Pinto Valley and Miami SX/EW plants for the USBM. Mr. Jon Ahlness (USBM), Mr. Dan Millenacker (USBM), Joe Pugliese (USBM), and I were given informative tours by Mr. Jim Shea and Mr. Tom Blair.

Please keep in mind my standing invitation for you or anyone else in Magma Copper to visit our In Situ Copper Mining Research Project in Casa Grande.

Thanks again.

Sincerely,

Hank Kreis

Henry G. Kreis
Site Manager

HGK:mek

bl.cc:

T.E. Scartaccini
A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell
S.A. Swan (USBM)
J. Ahlness (USBM)

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Dennis K. Mortensen
Vice President and General Manager
Cyprus Miami Mining Corporation
P.O. Box 1559
Claypool, Arizona 85532

Dear Dennis:

Thank you for arranging the September 24th tour of your SX/EW plant for the USBM. Ed Bilson gave us an excellent tour of your SX/EW plant and leaching operations. The tour was very informative and Cyprus' hospitality was greatly appreciated by all of us.

Please keep in mind my standing invitation for you or anyone else in Cyprus to visit our In Situ Copper Mining Research Project in Casa Grande.

Thanks again.

Sincerely,

Hank Kreis

HGK:mek

Henry G. Kreis
Site Manager

bl.cc:

TE Scartaccini
AR Raihl
FT Graybeal
WL Kurtz
JD Sell
SA Swan (USBM)
J Ahlness (USBM)

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Douglas R. McGregor
Oxide Operations Manager
Magma Copper Company
P.O. Box M
San Manuel, Arizona 85631

Dear Mr. McGregor:

Thank you for arranging the tour of your SX/EW plant. Mr. Mike Eamon and Mr. Jackson Jenkins gave an informative tour to Mr. Jon Ahlness (USBM), Mr. Dan Millenacker (USBM), Joe Pugliese (USBM), and me. Ms. Priscilla Robinson had other commitments and was sorry she could not attend.

Please keep in mind my standing invitation for you or anyone else in Magma Copper to visit our In Situ Copper Mining Research Project in Casa Grande.

Thanks again.

Sincerely,

Hank Kreis

Henry G. Kreis
Site Manager

HGK:mek

bl.cc:

TE Scartaccini
AR Raihl
FT Graybeal
WL Kurtz
JD Sell
SA Swan (USBM)
J Ahlness (USBM)

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Rana Medhi
General Manager
Cyprus Casa Grande Corporation
Box C-9
Casa Grande, Arizona 85222

Dear Mr. Medhi:

I want to thank you for arranging the September 26th tour of your SX/EW plant. Mr. Kermit Behnke, Mr. Dave Shade and Mr. Fritz Mathias gave Mr. Jon Ahlness (USBM), Mr. Dan Millenacker (USBM), Mr. Joe Pugliese (USBM), Ms. Priscilla Robinson (consultant), and me a very informative tour.

The hospitality shown by Cyprus, both here and in Miami, was greatly appreciated by all of us.

Please keep in mind my standing invitation for you or anyone else in Cyprus to visit our In Situ Copper Mining Research Project in Casa Grande.

Thanks again.

Sincerely,

Hank Kreis

Henry G. Kreis
Site Manager

HGK:mek

bl.cc:

TE Scartaccini
AR Raihl
FT Graybeal
WL Kurtz
JD Sell
SA Swan (USBM)
J Ahlness (USBM)

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1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Bruce K. Malone
General Manager
Ray Mine
P.O. Box 8
Hayden, AZ 85235

Dear Bruce:

Thank you for arranging the tour of your SX/EW plant for the USBM, Priscilla Robinson, and me. Frank Jones gave us an excellent tour, and it was greatly appreciated by all of us.

Please keep in mind my standing invitation for you or anyone else from Ray Mine to visit our In Situ Copper Mining Research Project in Casa Grande.

Thanks again.

Sincerely,

Hank Kreis

Henry G. Kreis
Site Manager

HGK:mek

bl.cc:

T.E. Scartaccini
A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell
S.A. Swan (USBM)
J. Ahlness (USBM)

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

ASARCO

Exploration Department
Southwestern United States Division

September 30, 1991

Mr. Edward Z. Fox, Director
Arizona Dept. of Environmental Quality
2005 North Central Avenue
Phoenix, Arizona 85012

Re: Omnibus Hazardous Waste Act
of 1991 (H.B. 2121)
Solid Waste Facility Notice

Dear Mr. Fox:

The attached Solid Waste Facility Notice is being submitted to you as required by Section 37 of the Omnibus Hazardous Waste Act of 1991 (House Bill 2121).

Very truly yours,

Henry G. Kreis

Henry G. Kreis
Site Manager

att.

bl.cc:

A.R. Raihl
F.T. Graybeal
W.L. Kurtz
J.D. Sell
D.F. Skidmore

NOTE: I was waiting for and never received a copy of the Solid Waste Facility Notice before it was submitted to the ADEQ. Consequently, I have attached a letter from Robert Anderson which has a copy of the notice enclosed.

H.G.K. (10/30/91)

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

LAW OFFICES

FENNEMORE CRAIG

A PROFESSIONAL CORPORATION

SUITE 290
6263 NORTH SCOTTSDALE ROAD
SCOTTSDALE, ARIZONA 85250-5402
(602) 257-5400
FACSIMILE: 602-945-4932

SUITE 2200
TWO NORTH CENTRAL AVENUE
PHOENIX, ARIZONA 85004-2390
(602) 257-8700
TWX: 910-950-4608
FACSIMILE: 602-257-8527

SUITE 1030
ONE SOUTH CHURCH AVENUE
TUCSON, ARIZONA 85701-1620
(602) 624-9312
FACSIMILE: 602-662-7363

ROBERT D. ANDERSON
(602) 257-5392
PHOENIX

October 1, 1991

ASARCO Incorporated

OCT 7 1991

SW Exploration

Mr. Henry G. Kreis
Site Manager
Exploration Department
ASARCO Incorporated
Southwestern Mining Department
P.O. Box 5747
Tucson, Arizona 85703-0747

Dear Hank:

Enclosed is a conformed copy of the solid waste notice we filed October 1.

Sincerely,

Rob

Robert D. Anderson

RDA:cb
Enc.
cc: Patrick J. Maley (w/enc.)

ASARCO

Exploration Department
Southwestern United States Division

OCT 1991
RECEIVED BY
DEQ DIRECTOR

September 30, 1991

Mr. Edward Z. Fox, Director
Arizona Dept. of Environmental Quality
2005 North Central Avenue
Phoenix, Arizona 85012

Re: Omnibus Hazardous Waste Act
of 1991 (H.B. 2121)
Solid Waste Facility Notice

Dear Mr. Fox:

The attached Solid Waste Facility Notice is being submitted to you as required by Section 37 of the Omnibus Hazardous Waste Act of 1991 (House Bill 2121).

Very truly yours,

Henry G. Kreis

Henry G. Kreis
Site Manager

att.

ASARCO Incorporated P.O. Box 5747 Tucson, Az 85703-0747
1150 North 7th Avenue (602) 792-3010

SOLID WASTE FACILITY NOTICE
(Section 37, Omnibus Hazardous Waste Act of 1991)

A. Facility Name and Mailing Address:

Santa Cruz Joint Venture
c/o ASARCO Santa Cruz
P.O. Box 5747
Tucson, Arizona 85703

B. Legal Description by Township, Range and Section:

T6S, R4E, Section 13

C. Major Design Features:

Plant trash is collected in a dumpster (approximately 6 feet by 5 feet by 5 feet) and eventually hauled offsite by a private waste management firm.

D. Type and Volume of Waste Handled:

Approximately one dumpster of plant trash is generated every two weeks.

E. Methods of Waste Management:

Wastes are stored in suitable on-site containers pending pickup by waste management firm.

F. Measures Taken to Protect the Environment and Public Health:

Suitable containers are utilized. Also, areas in which wastes are stored are secured from public access.

G. Summary of City, County, State and Federal Permits:

The facility operates pursuant to a temporary Aquifer Protection Permit, Permit No. P-101431T.