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Volume 2 ; Book 6 0023

TOMBSTONE

Mining District

Cochise County

ARIZONA

Richard F. Hewlett Reports and Correspondence - 1971 to 1979

PRomo for Sierra
Mineral Management

SIERRA MINERAL MANAGEMENT

R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602 / 299-9736

Projects In

1971 MINERALS LIMITED
(A Limited Partnership)

The purpose of this memorandum is to summarize the status of Sierra's Advisory Board relating to projects approved for the 1971 MINERALS LIMITED Partnership.

1. Mexican Metals
   Dr. Lacy has briefly examined Santa Fe. Several other consultants have examined Santa Fe and El Azteca. More recently, Messrs. Norman E. Dausinger and Abraham N. Nasser have been retained through Mr. David Lowell to follow up any exploration on these properties. Presently, they are conducting a geochemical survey suggested as logical "follow-up" by Dr. Lacy. The results of this survey will dictate the further action on these properties.

   As an extension of our exploration in Mexico, Messrs. Lowell and Dausinger will generate other exploration targets.

2. Dixie - Buckeye
   This joint-venture is with Noranda. To date, Noranda has acquired about 20 sections of mineral claims or leases and is presently doing the claim discovery work by drilling. Aero-magentics and induced polarization geophysical surveys have been conducted. Kenyon Richard has spent several days in the field reviewing the geology with Noranda personnel and examining peripheral claim areas. Presently, our objectives are to reduce the area to the most favorable targets and test with drilling. Jim Briscoe (our new geologist) will conduct the follow-up mapping and geochemical surveys.

3. Cody - Superior
   This project relates to examining possible exploration targets in the Superior, Arizona area. Future expenditures are dependent on future board recommendations.

4. Phoenix
   American Smelting and Refining Company (ASARCO) has discovered copper mineralization east of their Silver Bell mine. American Metal Climax (AMAX) has acquired mining claims and leases around ASARCO's discovery area. The AMAX mineral property has favorable aeromagnetics and induced polarization surveys but more importantly is geologically favorable. This target will be tested with about 3 drill-holes and decisions concerning further exploration will be made by the Advisory Board at that time.

5. Minago

Consolidated Mining and Smelting Company of Canada has spent about $1,800,000 for exploration on their Minago mining property. About 15 intrusive targets have been located in the past by reconnaissance drilling and detailed geophysical surveys. To date, seven drill rigs are being utilized to test these targets. This area is a geological extension of the Manitobal Nickel Belt, the most famous mine of which is INCO's Thompson Lake. This project has been approved by Dr. Banfield of Behre Dolbear and Mr. Albert Koffman.

6. Capore

Four porphyry copper targets have been selected for further evaluation in Arizona. Any future exploration will depend on review of further geological evidence from these areas by the Advisory Board.

7. Commonwealth

This potential joint venture has been proposed but further information on this prospect will have to be submitted before final Advisory Board action can be taken.

8. Coyote Wash

Dave Lowell has been managing this project for Quintana to the point of drilling two deep holes. The assay results from these holes suggests the near proximity of a large porphyry copper deposit. This target was selected by Mr. Lowell after studying the structural geology and alteration features of two nearby large copper deposits belonging to Phelps Dodge and Kennecott Copper Corporation near Safford, Arizona. Several drill holes and geophysics are proposed to further evaluate this prospect.

9. Little Hills

American Metal Climax has conducted exploration near Oracle, Arizona for a porphyry copper deposit. They have mapped, conducted geochemical and geophysical surveys and drilled about ten holes. Kenyon Richard has examined the deposit and finds an interesting area of alteration and moly mineralization that deserves testing by drilling.

10. Volcanogenic

COMINCO has conducted an extensive program in eastern Canada searching for massive sulphide targets (such as TGS-Timmins). This joint venture will test by geophysics and drilling the targets identified by COMINCO. Dr. Banfield of Behre Dolbear, and Mr. Albert Koffman have recommended this project.

11. Tenneco - Sierra

Tenneco Minerals has outlined an area covering southern California, Arizona and New Mexico. Tenneco has been compiling regional reconnaissance data from this three-state area for many years and they have generated about 35 potential exploration targets. The crux of this relationship would be that the Advisory Board would examine each target submitted by Tenneco and decide if the 1971 Partnership should participate, and to what extent.

12. Clev - Sierra

Cleveland Cliffs has a regional project in the western U.S. that would be similar to the Tenneco regional project. No conflicts of interest would arrise due to the fact we are functioning on a "targets" first-right-of-refusal basis.

Reported by:

Richard F. Hewlett

Richard F. Hewlett

Acknowledged:

W.C. Lacy

Dr. W.C. Lacy

David Lowell

David Lowell

Kenyon Richard

Kenyon Richard

SIERRA MINERAL MANAGEMENT

R. F. Hewlett
President

PROJECT SUMMARY

1971 MINERALS LIMITED

4741 East Sunrise Drive
Skyline Bel Aire Plaza
Tucson, Arizona 85718
602 / 299-9736

	PROJECT	PARTICIPATION INTEREST	MINIMUM OBLIGATION	FUNDING REQUIREMENT FIRST	FUNDING REQUIREMENT SECOND	POTENTIAL INCREMENT
1.	Mexican Metals	49%	$ 25,000	$15,000/Apr 1	$10,000/Jun 1	$ 50,000
2.	Dixie-Buckeye	40%	40,000	30,000/Apr 1	10,000/Jun 1	50,000
3.	Cody-Superior	100%	3,000	3,000/May 1	-0-	20,000
4.	Phoenix	40%	64,000	30,000/May 1	34,000/Jun 1	75,000
5.	Minago	10%	200,000	100,000/May 1	100,000/Jun 1	-0-
6.	Capore	100%	2,000	2,000/Jun 1	-0-	25,000
7.	Commonwealth	40%	44,000	44,000/Aug 1	-0-	50,000
8.	Coyote Wash	40%	50,000	50,000/Jun 1	-0-	50,000
9.	Little Hills	40%	50,000	20,000/Jun 1	30,000/Jul 1	50,000
10.	Volcanogenic	40%	120,000	60,000/Jun 1	60,000/Jul 1	-0-
11.	Tenneco-Sierra	40%	350,000	50,000/May 1	150,000/Jul 1	300,000
12.	Clev-Sierra	65%	150,000	50,000/Jun 1	100,000/Aug 1	100,000
			1,098,000			770,000

TOTAL POTENTIAL $1,868,000

Committment Schedule

April 1	May 1	June 1	July 1	August 1
$45,000	$183,000	$336,000	$240,000	$144,000

1971 MINERALS PROJECT SUMMARY

Santa Fe & El Azteca

These mineral deposits are close to Anaconda's Cananea operating mine and American Smelting & Refining's new La Caridad mine near Nacozari, Sonora. These properties are optioned to the partnership and exploration is progressing as indicated by several geologic reports. Geophysics and geochemistry surveys have been completed and we are awaiting the results. Presently roads are being built for access and drilling. These are breccia pipe - intrusive porphyry copper targets. Dr. Lacy has visited the deposits and has layed-out an exploration program. American Metal Climax has requested a first-right-of-refusal to joint venture and manage properties. In such case, American Metal Climax would handle the Mexicanization and be the "buy-out partner" if we could prove-up an economic deposit.

Dixie - Buckeye

This property was first visited by Scott Hazen (our staff consultant) and later by other Sierra personnel. As an extension of our policy to joint venture with major mining companies, this property was offered (on a joint-venture basis) to Noranda who accepted our offer.

Noranda has acquired (for the partnership) about 30 sections. Surface samples indicate significant copper and silver mineralization and important nickel and cobalt values. Aer-magnetics have been flown for the area and Heinrichs Geo Exploration has finished 20 line-miles of induced polarization surveys which in total have outlined about 10 interesting anomalies which require testing by drilling. To date, the partnership has drilled approximately six shallow (200 ft.) holes. The assay results will be avilable shortly.

Cody

This project is directed at finding extensions of Newmont's Magma ore deposit at Superior, Arizona. Also, City Services has a new ore body in the area. To date, about 100,000 feet of drilling has been accomplished and all surface geology, geophysics and geochemistry. The foregoing indicates that further exploration is warranted. Our objective would be to prove-up enough additional "ore-grade" mineralization to have a sufficient tonnage for an economic mining operation.

Phoenix

This joint-venture with American Metal Climax is just east of the American Smelting and Refining Companies (ASARCO) Silver Bell mine. Our neighbor to the south of our 500 claim block is ASARCO who are presently drilling "ore-grade mineralization". Our target is a large porphyry copper deposit (similar to Silver Bell) in the pediment. It is the opinion of Dr. Lacy and Kenyon Richard that even though there is risk in this venture, there is a chance of "hitting and elephant." Obviously, American Metal Climax has mineral property with the same belief. There is favorable geology, structure, aeromag and induced polarization anomaly and ASARCO is drilling "ore-grade" (o.40% or better) intersections on the south portion of the aeromagnetic anomaly. We will be drilling this property very soon.

Minago

This joint-venture is with the Consolidated Mining and Smelting Company of Canada (COMINCO). They have spent $1,800,000 for; acquiring claims, geology, geochemistry, geophysical surveys and drilling. COMINCO has a very large area on the extension of the Manitoba nickel belt, the most famous of which is the Thompson mine of International Nickel. INCO produces 15,000 tons per day of nickel ore running 2.5% nickel (50 pounds of nickel at over $1.60 per pound). To date, COMINCO has discovered about 15 ultra basic intrusives that have a nickel mineralization. COMINCO is presently drilling these targets with seven drill rigs and this partnership furnishes about 1/3 of the drilling money for this seasons work. Drilling is on frozen muskege and lakes and therefore will be finished for this season in May. AMAX has a nickel discovery on the adjacent ground to the east.

Capore

This project is a reconnaissance program in Southern Arizona aimed at the discovery of porphyry copper, lead-zinc-silver, and gold deposits. To date, geological and structural maps have been compiled and made for the area. The geochemical survey is about 1/2 finished. In another two months, the above will be finished and the results will be compared with the geophysical maps being prepared. If results are satisfactory, property acquisition will start and the detailed project exploration will begin. We have been approached by several majors to joint-venture the initial phases of this program, but no decision has been made in this regard.

Little Hills

This project may be a joint venture with American Metal Climax. The target is a San Manuel or Kalamazoo type ore body. Each has 600 million tons of 0.75% copper. The San Manuel and Kalamazoo deposits are deep (2000 feet below the surface) and we would have to expect deep drilling on Little Hills. AMAX has done the geologic mapping, geochemistry and geophysical surveys and drilled about 10 holes. Results are a copper and molybdenum anomaly, a induced polarization and magnetic anomaly and weak but significant copper and molybdenum mineralization. The AMAX theory and our operating approach is that the past AMAX drilling did not explain the geochemical or geophysical anomalies (just as the case of San Manuel and Kalamazoo) and that a large copper ore body could lie at depth. David Lowell discovered Kalamazoo with one deep drill-hole (3000 feet) and we would risk three drill-holes to test this venture. If ore is found at depth, the property may be ammenable to surface mining. If this is the case, ore of a higher grade must be found in order to develop the property on an economic basis.

Volcanogenic

This project would be with COMINCO in eastern Canada. The target would be a "Texas Gulf Sulphur Timmins" type deposit (Kidd Creek). The TGS massive sulphide deposit is worth about $3 billion. COMINCO has about 10 targets they have staked and we would start geophysics and drilling this spring if our consultants approve the project.

Coyote Wash

Quintana and Dave Lowell have drilled two deep (3000 feet) holes just west of the Phelps Dodge and Kennecott copper ore deposits near Safford, Arizona. The partnership will drill one more deep hole close to the best grade hole drilled to date and several shallow holes to evaluate my near surface structure related to the mineral deposit.

SIERRA MINERAL MANAGEMENT

R. F. HEWLETT
President

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Projects In

1971 MINERALS LIMITED
(A Limited Partnership)

1. Mexican Metals (Santa Fe, El Azteca, etc.)
2. Dixie - Buckeye (Noranda Joint Venture)
3. Cody - Superior
4. Phoenix (American Metal Climax Joint Venture)
5. Minago (COMINCO of Canada Joint Venture)
6. Capore
7. Commonwealth (American Metal Climax Joint Venture)
8. Coyote Wash (Quintana Oil Co. Joint Venture)
9. Little Hills (American Metal Climax Joint Venture)
10. Volcanogenic (COMINCO of Canada Joint Venture)
11. Tenneco - Sierra (Tenneco Joint Venture)
12. Clev-Sierra (Cleveland Cliffs Joint Venture)

The 1971 Minerals Partnership has been formed with a nucleous of over 20 mineral deposits. Committed joint venture partners include Noranda, American Metal Climax, and Consolidated Smelting and Refining Company of Canada (COMINCO).

A four-man advisory board has been officially formed that had as an objective:

1. Unanimous approval for exploration of all projects selected for the 1971 Minerals Limited Partnership.

2. Consulting advise and project supervision of all 1971 projects.

3. Review of progress on each project with reports submitted to all limited partners.

Members of the advisory board are:

1. Dr. W.C. Lacy

2. Mr. Kenyon Richard

3. Mr. David Lowell

4. Dr. A.F. Banfield

5. Mr. Albert Koffman

6. Commodity specialist at large.

A diagram illustrating this boards activities and a resume of the members follows. Sierra staff closely involved with the 1971 minerals partnership are:

1. R.F. Hewlett - President

2. J.A. Smith - Project Coordinator

3. F.R. Hewlett - Office Manager

4. Albert Koffman - Geological Consultant

5. L. Walters - Field Geologist

6. S.W. Hazen - Staff Consultant

7. J.A. Briscoe - Staff Geologist

8. G.K. Williams - Geological Consultant

9. O.E. Bowen - Geological Consultant

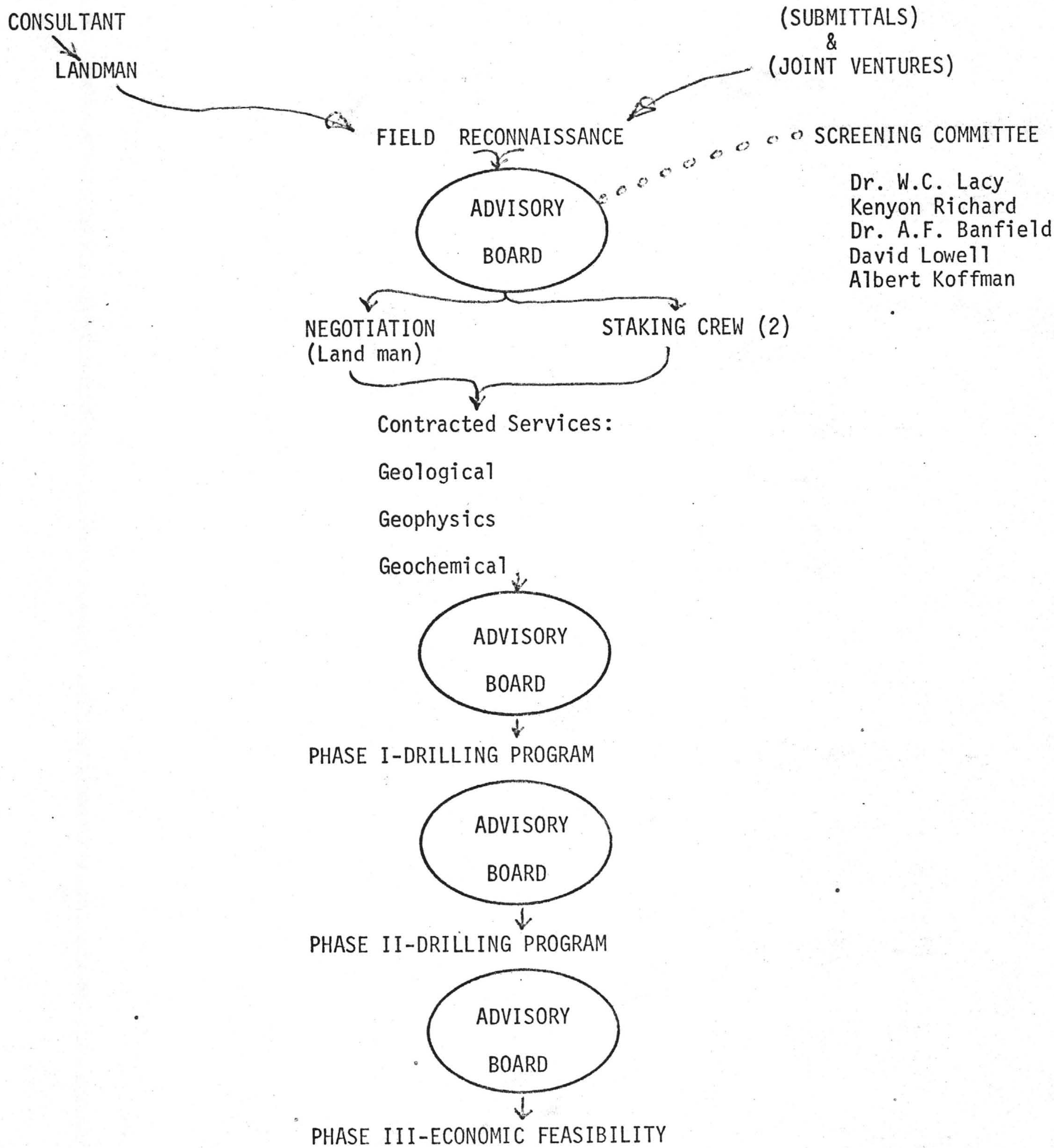
10. Dr. R.R. Nelson - Metallurgical Consultant

11. Mr. Norman Dausinger - Geological Consultant

Their resumes follow.

The 1971 Minerals Partnership utilizes Behre Dolbear in the same way as the 1970 Minerals Exploration Partnership.

PROJECT GENERATION, AND EXPLORATION



JAMES A. BRISCOE - CONSULTING GEOLOGIST

Awarded the degrees of Bachelor of Science and Master of Science in Geology from the University of Arizona, Tucson, Arizona.

Associated with Geodata Systems, Inc., of Orange, California, as Chief Geologist (1969-1970) managing an exploration budget of over one million dollars a year. In this capacity, designed regional exploration programs for base and precious metal deposits; designed, supervised and implemented research in lineament tectonic studies which resulted in original and specific exploration guides; designed and implemented a color aerial photographic system; hired and trained geologic personnel; participated in customer and investor relations, property acquisition and negotiations and many other facets involved in the business.

Employed by the American Smelting & Refining Co., Southwestern Exploration Department (1965-1969). Assigned as pit geologist, Silver Bell Unit, Arizona and was responsible for detailed mapping of open pit copper mines and logging exploratory diamond drill core. After one year, promoted to Resident-Exploration Geologist in charge of exploratory diamond drilling project, Silver Bell, Played key role in training geologists from ASARCO's Mexican subsidiary in the techniques of geologic mapping of mineral deposits and interpretation of leached porphyry copper capping. After one year, promoted to Exploration Geologist working out of the Tucson Office on assignments in Arizona and Utah. Later that year, became part of a two-man field office in California generating and pursuing their own projects in precious and base metal exploration. During this period, gained valuable experience in disseminated precious metal occurence of the Calico District and Carlin types and worked extensively on the gold mineralization of the Mother Lode region.

As an active participant in field trips, has examined most of the major underground and open pit copper and molybdenum mines in the Arizona-New Mexico-Mexico area including recent major discoveries. Additionally, has examined specialty metal (rare earth, tungsten, mercury and sulfue) deposits in the California-Nevada area.

Member A.I.M.E., American Society of Photogrammetry, the Arizona Geological Society, the Society of the Sigma Zi, Sigma Gamma Epsilon. Registered Geologist #518, State of California. Holds private pilot's license.

Experience Resume January, 1968

KENYON RICHARD

1937 B.S. degree Geological Engineering, Mackay School of Mines, University of Nevada.

1937-1945 Consolidated Copper mines Corp., Kimberly, Nevada --- Engineer, Geologist, Assistant Chief Geologist, Chief Geologist --- Ely (Robinson) property copper district.
....

Geological mapping (detail, surface and underground, reconnaissance, and regional), alteration, structure, enrichment, stratigraphy, aerial photography, churn drilling, core drilling, ore reserve estimation, reporting (progress, comprehensive, feasibility) all as related to practical problems at operating mines (underground and open pit, large and small), to ore search, and to examination and evaluation of outside prospects in Basin and Range Province. Principally Cu, but also Au, Ag, Pb, Zn, Mo, W. ....

Successful exploration programs (in conjunction with co-workers):

*Morris Brooks --- Ely District
**Old Glory-Veteran --- Ely District
*Emma Nevada-Ruth Connection --- Ely District

1945-1967 American Smelting and Refining Company

'45-'53 Geologist, San Francisco Office -- responsible for exploration in California; also worked in Nevada, Utah, Arizona, Colorado-- reported to Salt Lake Exploration Office. Worked total about 2 years during several trips to southern Peru --- reported directly to New York office. Work similar to that described in first paragraph, but mostly exploration.

'53-'63 Chief Geologist, Tucson Office. Considerable field work of various kinds, including regional exploration and involvement in geophysical programs, but duties mostly administrative -- in charge of 10 to 20 geologists covering southwestern and western U.S.--- reported to New York Office.

'63-'67 Chief Geologist, New York Office. Various degrees of administrative responsibility over 50 to 70 exploration geologists in 14 field offices in Canada, the U.S., Mexico, Central America, Peru, Chile, London, Australia and New Zealand.

Successful exploration programs (i.e., participation usually consisted of making early recommendations and following the projects through):

***Quellaveco, southern Peru
**Toquepala, southern Peru
**El Tireo, Silver Bell, Arizona
**Oxide, Silver Bell, Arizona
**El Tire Ext., Silver Bell, Arizona
**Mission, Pima District, Arizona
***North San Xavier, Pima District, Arizona
***Sacaton, Casa Grande, Arizona
***Michiquillay, northern Peru

(Note: *Mined out
**Being mined
***Not yet developed, but commercial

All are porphyry copper deposits).

MEMBERSHIPS:

Phi Kappa Phi (national scholastic society)

American Institute of Mining, Metallurgical and Petroleum Engineers.

Geological Society of America

Society of Economic Geologists

Mining Club, New York and Tucson

Arizona Geological Society

BIBLIOGRAPHY:

1948 "Drilling", in Mining Geology, by H.E. McKinstry, Prentice Hall, New York.

1954 with J.H. Courtright, "Structure and Mineralization at Silver Bell, Arizona": Mining Engineering, November and American Institute of Mining, Metallurgical and Petroleum Engineers Transactions, v. 199, p. 1095-1099. Discussion of paper in v. 202, p. 300.

1956 "Geologist-Metallurgist Cooperation in Porphyry Copper Exploration": Mining Engineering, July, p. 8-10.

1958 with J.H. Courtright, "Geology of Toquepala, Peru": Mining Engineering, February, p. 262-266, and Transactions A.I.M.E.

1959 with J.H. Courtright, "Some geologic features of the Mission deposit": Arizona Geological Society, Southern Arizona Guidebook II.

1960 with J.H. Courtright, "Some Cretaceous-Tertiary relationships in southern Arizona and New Mexico": Arizona Geological Society Digest, v. III.

1966 with J.H. Courtright, "Structure and Mineralization at Silver Bell, Arizona", in Geology of the Porphyry Copper Deposits, Southwestern North America, The University of Arizona Press, Tucson, Arizona, U.S.A., p. 157-163.

Additions to Experience Resume of January, 1968

1968 to Present

Consultation and field work on various exploration drilling programs involving evaluation of both prospects and operating mines, principally porphyry copper:

Peru--one operating mine and several prospects.
Arizona--several prospects.
Nevada--several prospects.
British Columbia--several prospects.
The Yukon--several prospects.
Ecuador--one prospect.
Australia--several prospects.
Philippine Islands--one operating mine and several prospects.
Borneo (Sabah)--one prospect.
New Guinea--several prospects.

BIBLIOGRAPHY:

"Process of Formation of Mineralizated Breccia Pipes"--paper read at the Annual Meeting of the Geological Society of America, November, 1969.

J. DAVID LOWELL

Consulting Mining Geologist

5211 N. Oracle
Tucson, Arizona 85704

Phone 887 — 5341
Area Code 602

Professional Qualifications

Education:

B.S. min. engr. University of Arizona 1949
M.S. geology Stanford University 1957
E. Geol. Prof. Engr. degree University of Arizona 1959
Univ. of Arizona Short Course Computers in Mineral Industry 1965
Participant 1969 Penrose Conference Depositional Environment Porphyry Coppers

Arizona Registered Geologist and Registered Professional Mining Engineer
Member AIME, Soc. Econ. Geol., Ariz. Geol. Soc., and Can. Inst. Min. & Met.

Experience:

American Smelting & Refining Co.: 2 years as mine engineer, shift boss and mine foreman 750 t/d underground mine.

U.S. Atomic Energy Commission: 3 years as geologist, project chief, and district geologist.

Ventures Ltd. of Canada and subsidiaries: 3 years as chief geologist, mine mgr., 35 t/d underground mine, and Western Mgr. (Int. Randwick Ltd.) and 2 years as resident mgr. and vice president (Southwest Ventures Inc.).

Utah Construction & Mining Co.: 2 yrs as senior geologist and district geologist.

Consulting geologist, Tucson, Arizona: January 1962-present date, for Newmont Mining Corp., Utah Construction Co., Kern County Land Co., American Metal Climax, Superior Oil Co., Callahan Mining Corp., N.Y. and H. Rosario Mining Co., Quintana Petroleum Corp., N.J. Zinc Co., American Cement Co., Occidental Petroleum Corp., Humble Oil Co., Bethlehem Copper Co., Penoles Mining Co., Union Pacific Railroad Co., Kaiser Aluminum Co., Kaiser Steel Co., Aluminum Co. America, Marcopper Mining Co., American Exploration Co., Dravo Corp., and a number of individual mine owners, lawyers, and mine investors. Expert witness in a number of legal proceedings for companies, individuals, and State of Arizona. Participated in exploration and/or development drilling projects for several major porphyry copper deposits.

Geographic location of work:

16 years, eight Southwestern states and Alaska
2 years in Mexico
1 year in Canada
1 year Dominican Republic, Honduras, Argentina, Peru, Chile, Iran, Philippines, etc.

Publications:

Eight papers most of which concerned with porphyry copper geology in Econ. Geol., Am. Jour. Sci., and AIME and GSA annual meeting abst.
Presented 1970 AIME Jackling Award Lecture.

Professional Offices:

Chairman, Yavapai Subsection, Amer. Inst. of Min. Engr., - 1957
Editor, Arizona Highway Geological Map, Ariz. Geol. Soc. - 1965
President, Arizona Geological Society - 1965-1966

Associated with J. W. Still, Consulting Mining Engineer, and L. C. Arnold, mining geologist

J. DAVID LOWELL
CONSULTING GEOLOGIST

5211 N. ORACLE TUCSON, ARIZONA 85704 PHONE 887-5341

March 8, 1971

Mr. Richard Hewlett, President
Sierra Mineral Management
4747 East Sunrise
Tucson, Arizona 85718

Dear Dick:

I was interested to hear about the projects which your Company has underway and was impressed that you have been able to become associated with a number of promising exploration ventures in a short period of time.

As I mentioned to you my time is mostly taken up by several retainer arrangements with mining and oil companies, and I could not guarantee to make available to you more than about three days a month at this time. It is probable that more time could be worked into the schedule on occasion and also probable that over a period of several months I might be able to shift responsibilities so as to make a little more time available. I also have other commitments which require me to take new prospects which come to my attention to other companies.

Clark Arnold and Julio Barranco who work for me will have only a little time available for the next 4-6 months but might have time available in the second half of 1971. We have the capability in our small organization to do an efficient job of handling exploration drilling projects, and there might be an occasion in the future when we could manage a project for Sierra.

I am associated with J. W. Still, consulting mining engineer. Jack was formerly manager of the Bagdad Copper operation and General Superintendent of Miami Copper Co. His specialty is preliminary feasibility studies, metal commodity studies, and design of mining systems--particularly bulk underground systems. He would be available to assist when an expert opinion on economics and production problems is required.

Mr. Still and I charge $300 per day plus expenses for our services. I charge $150 per day for Arnold's time, and cost plu 25% for other members of the staff. If Mr. Dausinger is to report to me in his work in Mexico I would charge 25% of the amount paid Dausinger.

I also understand that the arrangement which we discussed would involve a 2% stock option in Sierra Management in exchange for which I would supply off-the-cuff advice and opinions based on my experience and files. This function would consist mainly of telephone conversations with you.

I would be willing to enter into an arrangement as outlined above, and I appreciate having been considered for this associate arrangement with Sierra.

Yours very truly,

J. David Lowell

J. David Lowell

JDL:h

Personal Data - J. W. Still

Born October 21, 1900 - Tucson, Arizona

Married (Lillian C. Cronin) December 31, 1921 - 3 sons

Height - 5' 10 1/2" Weight - 192 lbs. Health - excellent

Educational:

Grade and High School in Tucson, Arizona - 1906 to 1917
College of Mines, Univ. of Arizona - 3 1/2 years - 1917 to 1921

Professional:

1921-1930	Miami Copper Co., Miami, Arizona - Jr. Engineer, Underground transitman, Stope & Efficiency Engineer, Office Engineer
1930-1934	Bagdad Copper Co., Bagdad, Arizona - Mine Supt.
1934 (6 mo.)	Benguet Consol. Mining Co., Philippines, Shift Boss
1934 (6 mo.)	Phelps Dodge Corp., Ajo, Ariz. Office Engineer
1935-1944	Bagdad Copper Co., Assistant Manager, General Manager
1944-1945	U.S. Government, Washington, D.C. - Commodity Specialist, Metal Reserve & Chief of Copper Section, Foreign Economic Administration
1945-1955	Miami Copper Company - Mine Supt. (1945-50), General Supt. (1950-55)
1956-1968	Partner, Still & Still, Prescott, Ariz.
1968 -	Associated with J. David Lowell, Tucson, Ariz.

Professional Organizations:

Member - American Institute of Mining, Metallurgical & Petroleum Engineers (AIME)

Director - Arizona State Section AIME

Other:

Member - Board of Governors, Arizona State Dept. of Mineral Resources - 1961-1969

Registration:

Registered Mining Engineer, State of Arizona - No. 2136

General Background on Consulting Work Done by J. W. Still

General mine consulting, including mine valuations, mining project feasibility studies for both open pit and underground mines, underground mine layouts for changes in mining systems, operating mine studies, mining tax cases, expert witness on mining lawsuits, appraisal of proposed and operating mines for either loans or mergers, prospect examinations.

List of Clients and References - on Some Major Work Done

Cerro Corporation	R. P. Koenig, President Cerro Corporation 300 Park Avenue New York, N.Y.
Quintana Minerals Corporation	Corbin J. Robertson, President Quintana Minerals Corporation 500 Jefferson Building Houston, Texas
United States Steel Co.	John Quinn, Chief Engineer United States Steel Co. Lander, Wyoming
Banner Mining Co.	Allan B. Bowman, President & General Manager Banner Mining Co. P.O. Box 5605 Tucson, Arizona
Atomic Energy Commission	Rafford L. Faulkner, Director Division of Raw Materials Washington, D.C.
State of Arizona	Stan Goodfarb, Assistant State Attorney Arizona State Highway Dept. Phoenix, Arizona
American Metal Climax, Inc.	R. J. O'Hara, Vice President Blackwell Zinc Division American Metal Climax, Inc. 1270 The Avenue of the Americas New York, N.Y.
Hanna Mining Co.	F. M. Chace, Chief Geologist The Hanna Mining Co. 100 Erieview Plaza Cleveland, Ohio

Bagdad Copper Corporation	David C. Lincoln, President Bagdad Copper Corporation 55 East Thomas Road Phoenix, Arizona
Dresser Corporation (Magnet Cove Barium Co.)	L. M. Hermes, Jr., General Manager Dresser Minerals P.O. Box 6504
Molybdenum Corporation of America	Dan M. Kentro, Vice President Molybdenum Corporation of America 230 Park Avenue New York, N.Y.

List of Personal References

Dr. C. A. Anderson (former Chief Geologist)
U.S. Geological Survey
345 Middlefield Road
Menlo Park, California

Dr. J. K. Gustafson, President
Homestake Mining Co.
100 Bush Street
San Francisco, California

Mr. Willard Johnson (former President of Magcobar)
1311A - 1st City National Bank Bldg.
Houston, Texas

Mr. Weston Bouret, Vice President
Utah Construction and Mining Co.
550 California Street
San Francisco, California

Mr. Ira Joralemon
315 Montgomery Street
San Francisco, California

Valley National Bank
Speedway and Swan
Tucson, Arizona

Resume of Staff Members of

J. W. Still and J. David Lowell, Associates
Consulting Mining Engineers and Geologists

Tucson, Arizona

L. Clark Arnold, Jr., geologist: BS & MS in geology, all requirements completed for Ph.D. except final acceptance of dissertation. Has a total of approximately three years field experience in porphyry copper exploration in the Southwest, Canada, and South America. Arnold has worked for the firm two years on full-time basis and over five years on a part-time basis.

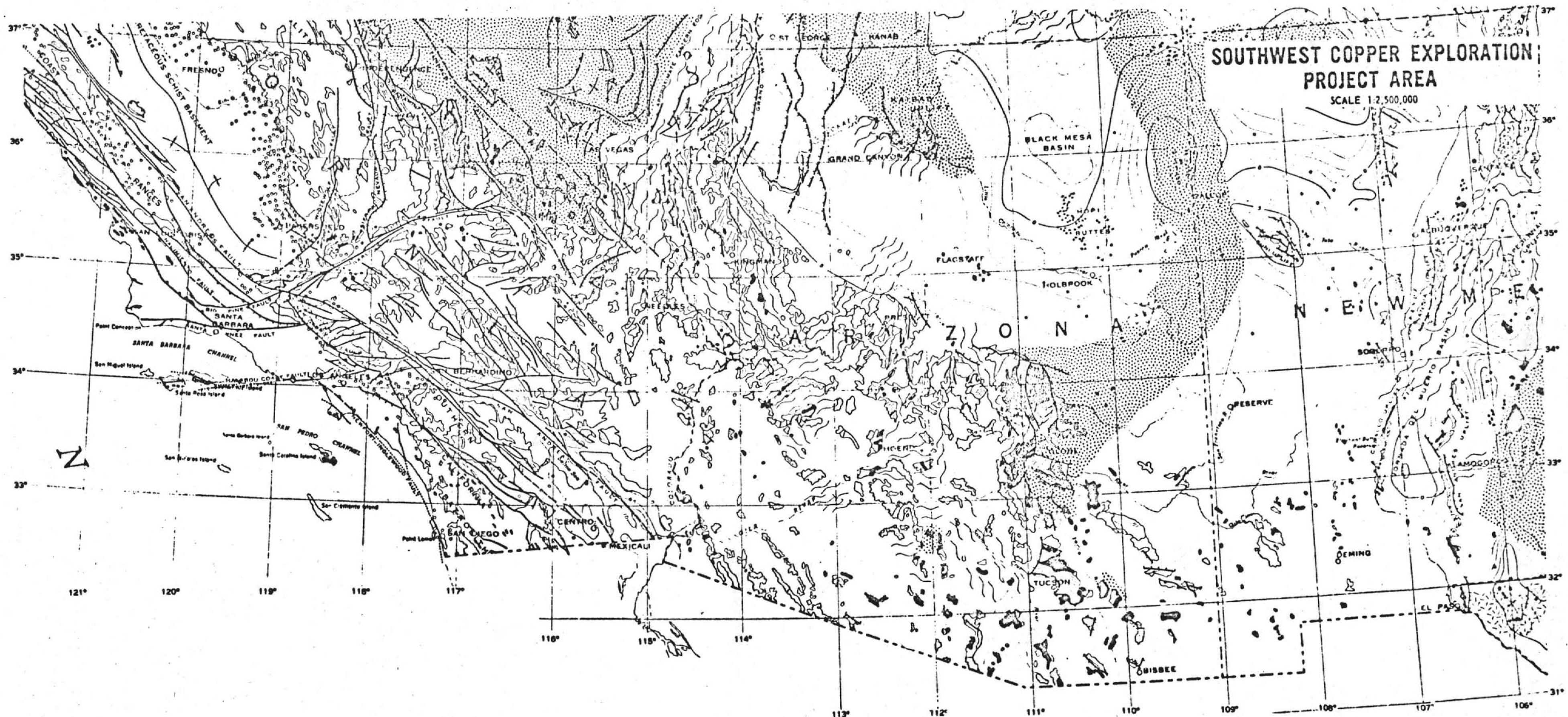
J. C. Barranco, geologic technician: college courses in geology, petrology, and mineral identification. Fluent Spanish and German. Five years experience as sampler, draftsman, field geochemical laboratory operator, supervisor of drilling projects, etc. Has worked for the firm five years.

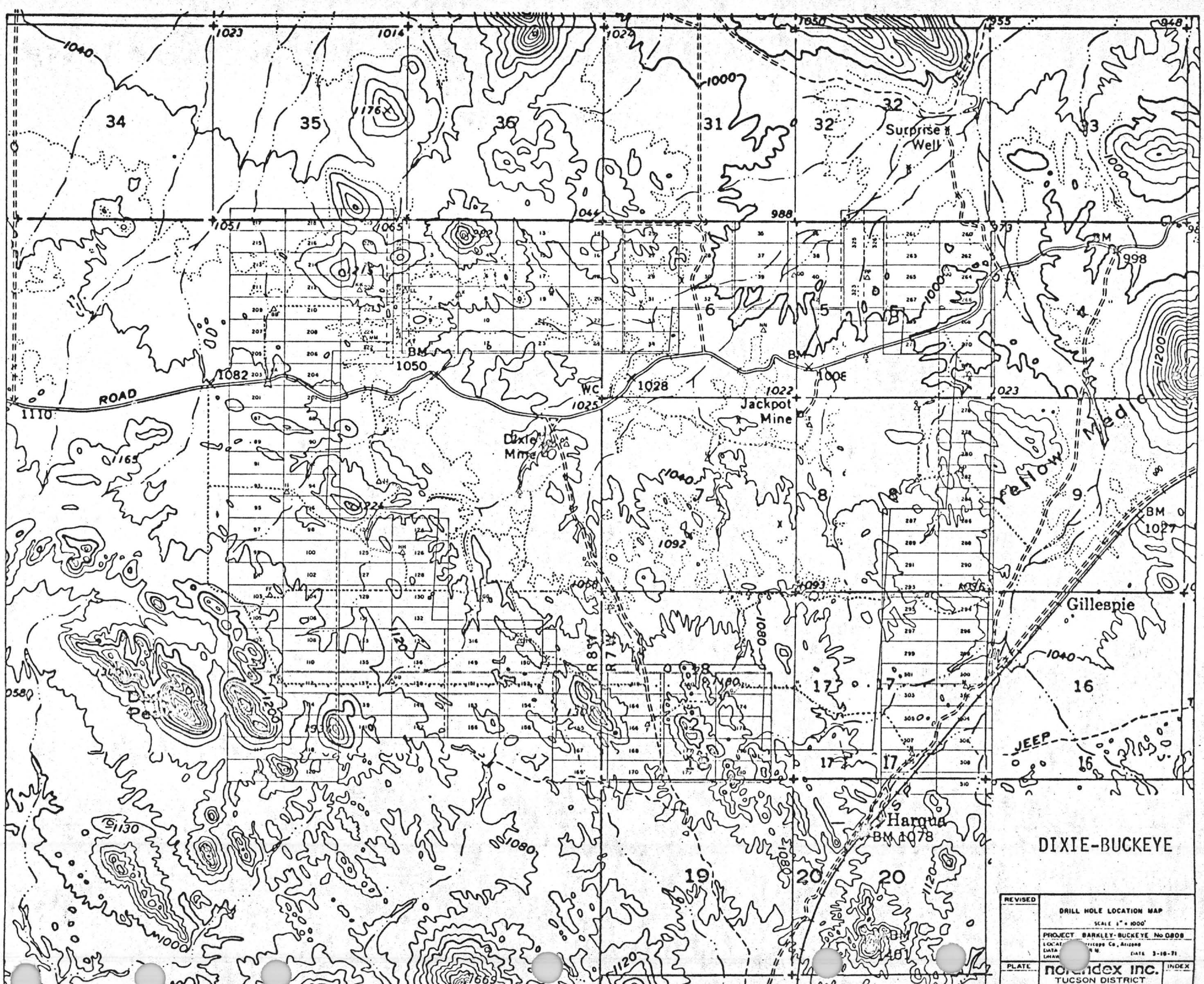
Helen R. Hauck, secretary: BA mathematics, registered medical and radiologic technologist, administrative and bookkeeping experience, technical editor, experience in offset printing, ad layout, geological editing and library research, ore reserve calculations, etc. Has worked for the firm five years.

H. Diane Wright, draftsman: BA in anthropology, all requirements completed for MS in geology except thesis, studied scientific illustration, geologic library research work. Has worked for firm six months.

The 1970 Jackling Award Lecture

TENNECO-SIERRA




ROAD
JEEP
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Jackpot Mine
Dixie Mine
Gillespie
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R7W
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DIXIE-BUCKEYE
REVISED
DRILL HOLE LOCATION MAP
SCALE 1" = 1000'
PROJECT BARKLEY-BUCKEYE No 0808
DATE 3-10-71
PLATE
TUCSON DISTRICT
INDEX

WILLARD C. LACY
4034 East Burns Street
Tucson, Arizona 85711

February 20, 1971

Mr. Richard F. Hewlett, President
Sierra Minerals Corporation
4741 East Sunrise Drive
Tucson, Arizona 85715

Santa Fe Claim Group
Nacazari, Sonora, Mexico

Dear Dick:

On February 13, in the company of Rene Moulinet, I visited the Santa Fe claim group -- located approximately 30 kilometers south-southwest of the town of Nacazri, Sonora, Mexico. Approximately 1/2 day was spent actually on the property, and the claim area was traversed on foot.

The Santa Fe claim group covers a bright red color anomaly that is a part of a more extensive zone of shattering and mineralization -- about 5 miles long and 1 mile wide trending generally east-west. See attached sketch.

The country rock is an andesite volcanic unit, with flow breccia phases, that is intruded by latite to quartz-monzonite porphyry and basalt dikes and latite breccia plugs or pipes.

The mineralization within the Santa Fe claim group is centered around a cluster of five or more of the latite breccia pipes or plugs with the cores of silicified and tourmalinized latite up to 300 feet or more in diameter showing local areas of favorable capping, and peripheral areas in the altered andesite rich in pyrite and chlorite.

There was no copper staining of the rocks either in the central breccia zones nor in the peripheral pyritic andesite zone -- though the peripheral zone was oxidizing with the formation of abundant ferrous sulphate as crusts on the rock faces and in the stream waters and stream bed. Also, no ferro-molybdite was identified with certainty in either zone. Most of the color anomaly was due to supergene effects of oxidizing pyrite reacting with the andesite.

There was no evidence of potassic alteration, an abundance of pyrophyllite was found in the central alteration zone.

A series of chips collected at 1/10 mile intervals across the southest portion of the color anomaly were sent for geochemical assay. Likewise, a sample of the propylitized andesite rich in pyrite from the outer fringe area was sent for assay. These results have not yet been received.

Conclusions:

Surface indications at the Santa Fe claim group are not particularly favorable for the discovery of a shallow orebody. There are possibilities, however, that in depth the extensive propylytic pyrite zone will change to a copper-bearing quartz-sericite zone. No prediction can be made as to likely depth. However, the rate of change in geochemical values in copper from the peripheral propylitic zone toward the silicified-pyrophyllite breccia centers may be indicative.

I would recommend that the initial steps be to:

1) Obtain a base map compiled from aerial photos on scale of 1:6,000 (1' = 500') to:

2) Carry out a geochemical sampling program using rock chip samples on a 500-foot grid-reducing to a 250-foot grid in areas where anonalous values appear, or in the vicinity of the latite breccia.

3) Prepare a geological map showing rock types, principal structural zones, alteration and mineralization, and fracture intensity.

On the basis of the above data a decision can be made as to the advisability of a drilling program and possible extension of claim holding.

The mapping and sampling should take a geological crew of two men approximately two weeks.

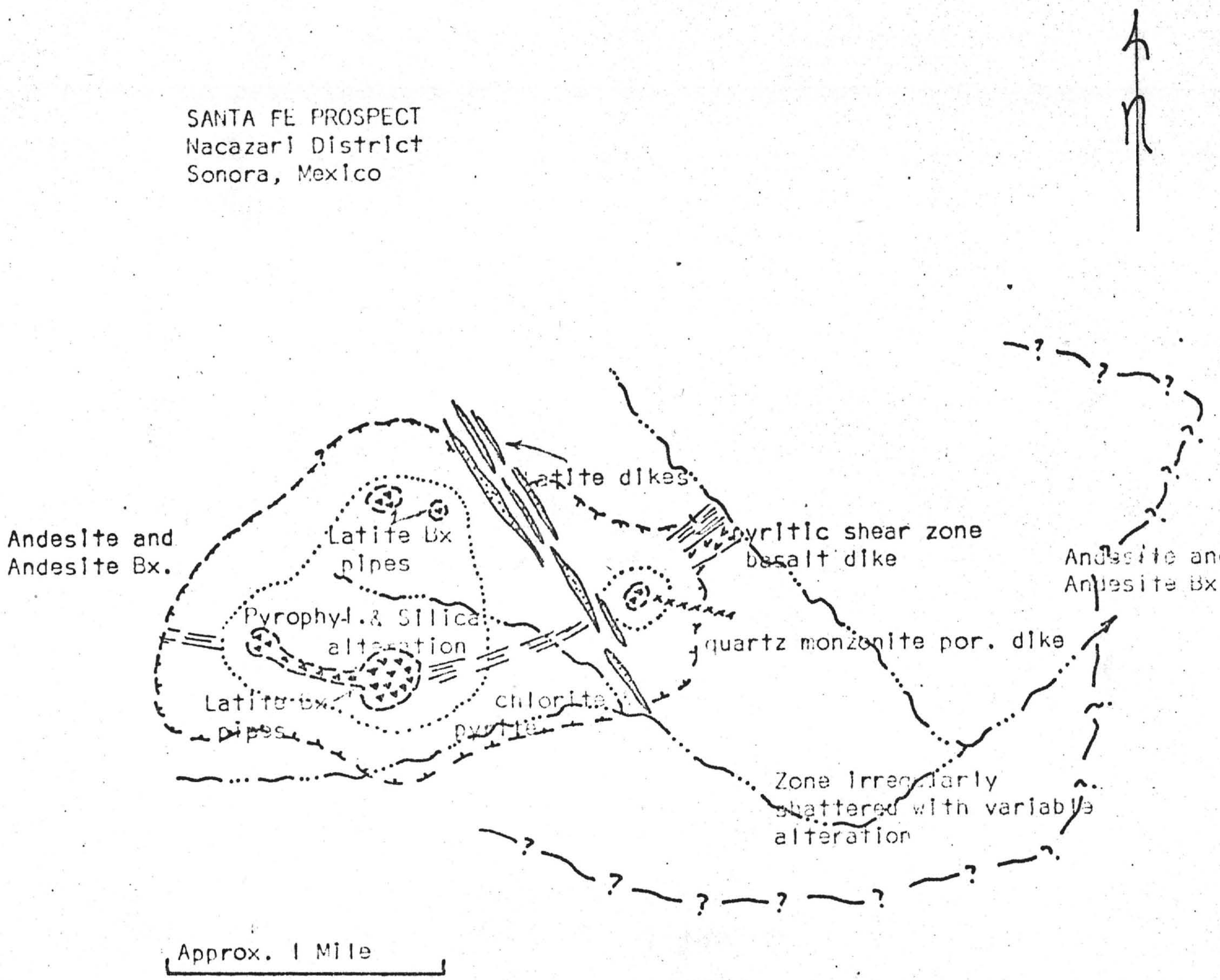
Sincerely,

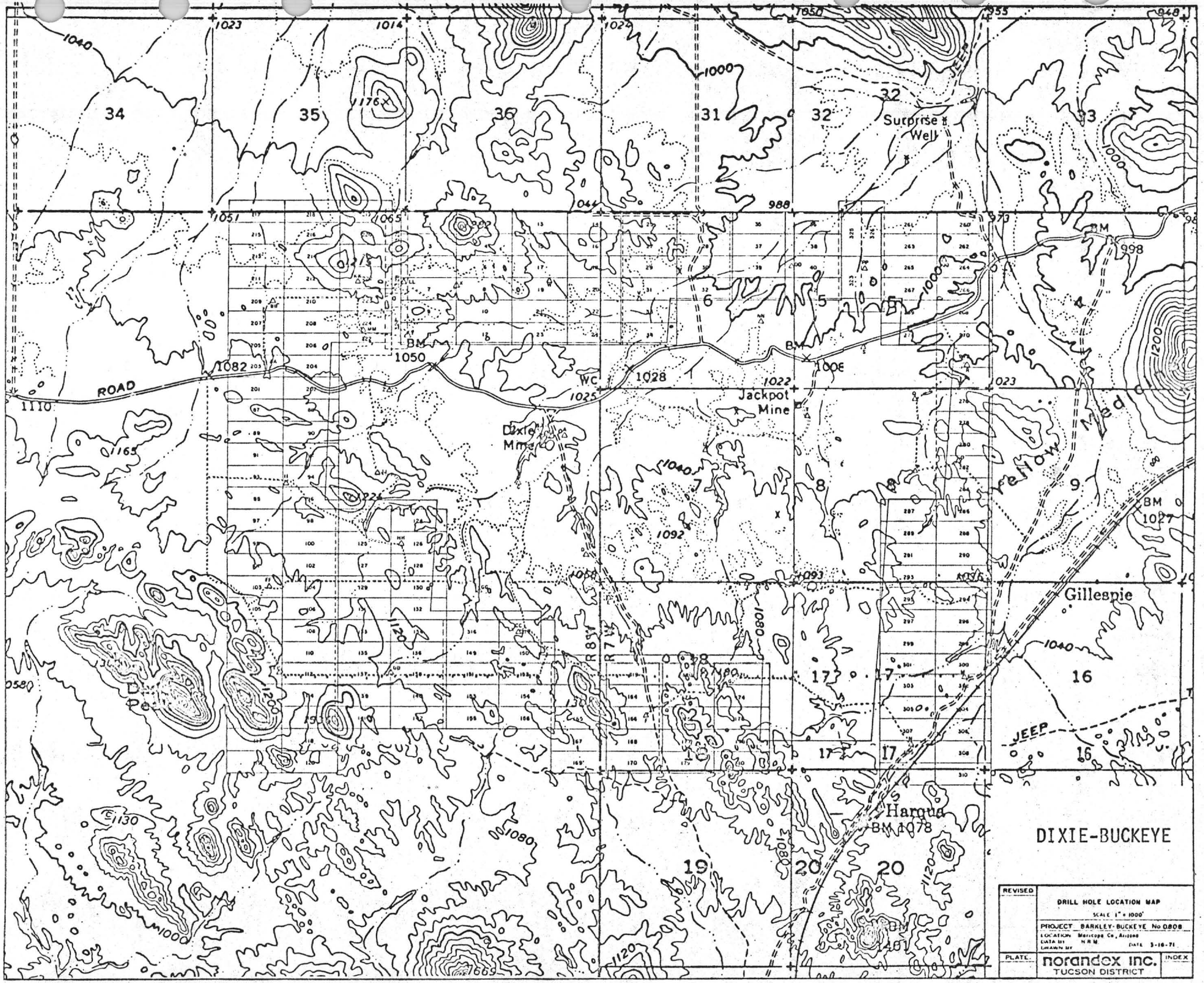
W. C. Lacy

Willard C. Lacy
Head, Department of Mining
and Geological Engineering

WCL/gs

SANTA FE PROSPECT
Nacazari District
Sonora, Mexico




DIXIE-BUCKEYE
REVISED
DRILL HOLE LOCATION MAP
SCALE 1" = 1000'
PROJECT BARKLEY-BUCKEYE No 0808
LOCATION Maricopa Co, Arizona
DATA BY N.R.M.
DATE 3-16-71
PLATE
norandex inc.
TUCSON DISTRICT
INDEX
Surprise Well
Jackpot Mine
Dixie Mine
Gillespie
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Yellow Medic
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Albert A. Koffman (4-8-71)

ALBERT A. KOFFMAN, P.ENG.
CONSULTING EXPLORATION AND MINING GEOLOGIST
702 CONFEDERATION BLDG., 457 MAIN STREET
WINNIPEG 2, MANITOBA

Bus. Ph. 943-1714
Res. 657 Oak St., 489-2080

April 8, 1971.

Mr. R.F. Hewlett,
President,
Sierra Mineral Management,
4741 East Sunrise Drive,
Skyline Bel Aire Plaza,
TUCSON, Arizona, 85718
U. S. A.

Dear Mr. Hewlett,

Re Cominco Ltd. Volcanogenic
Exploration Projects.

I have discussed the 8 exploration projects located in Saskatchewan, Manitoba and Ontario, with Mr. Art Asten and Mr. George Tikkanen of Cominco. The projects submitted to your group for participation are reasonable grass roots exploration areas. I am not too impressed with the Hamell Lake area in Saskatchewan or the Hughes Lake area in Manitoba, but these projects have been budgeted for only $21,000.00.

The total volcanogenic program is estimated at $240,000.00, and during my discussions with Cominco personnel they were reluctant to have a participant take only a part of the program. After reviewing the 8 projects in detail, I am advising you that for a cost of $120,000.00 to your group the entire project is a worthy exploration effort.

The following is a summary of exploration programs for each group:-

Hamell Lake, Saskatchewan. This program, on a 3,120 acres claim block, is estimated to cost $11,000.00. A 35 line mile Turam ground Electromagnetic survey is planned on the waters of Hamell Lake. This type of survey is able to pick up conductor zones that may carry economic mineralization up to a depth of 450 ft. This area is approximately 4 miles north-west of Hudson Bay Mining & Smelting operating mine and Hudson Bay did limited

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exploration in this area in 1936 before the advent of deep penetration Turam exploration technique. The work proposed will have to be done in November and December of 1971, when ice covers the waters of Hamell Lake. Should conductive zones be located a follow-up diamond drilling program is planned to test the Turam Electromagnetic zones located.

Hughes Lake Area, Manitoba. This program, on open ground, is estimated to cost $10,000.00, and is located 20 miles east of the Lynn Lake operating nickel mine of Sherritt Gordon Mines Ltd. A 200 line mile airborne E.M. and mag. survey at one-eighth mile intervals is planned for this area, which is a favorable volcanic belt. Should the airborne survey locate conductive areas, ground E.M. and mag. surveys would be done in the next stage of exploration.

Southern Indian Lake, Manitoba. This program, on 39 claims in five groups, is estimated to cost $9,000.00, and is located 80 miles south-east of Lynn Lake, Manitoba. Ground E.M. and mag. surveys were done on ground acquired after the release of an airborne Input geophysical survey done by the Manitoba Government. A ground E.M. and mag. survey has confirmed the existence of 4 E.M. mag. targets worthy of diamond drilling, and will be done forthwith.

Captain Group, Ontario. This program, on 18 claims, is estimated to cost $6,000.00, and is located 15 miles north of Larder Lake, Ontario. This ground was acquired in a volcanic belt of the general Timmins area. A ground E.M. and mag. survey totalling 20 line miles is planned for this area, together with geological mapping of the ground held. Further exploration will depend on the results of the initial exploration program.

Jellicoe, Ontario. This program, on an area comprising parts of six townships, is estimated to cost $30,000.00, and is located 30 miles west of Geraldton, Ontario. This area is underlain

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by acid and intermediate volcanics. There are several known base metal mineral showings in the area. An airborne E.M. and mag. survey using Sanders airborne helicopter equipment, totalling 950 miles, is planned for this area. Ground acquisition will depend on results of airborne survey.

Eab Property, Ontario. This program on 137 claims is estimated to cost $10,000.00, and is located 100 miles east of Pickle Lake, Ontario, being largely covered by the waters of Lake Eabamet. An airborne E.M. and mag. survey using Scintrex Otter airborne equipment, totalling 200 line miles, is planned for this area. The area to be explored is underlain by acid volcanics. Ground follow-up work will depend on the results of the airborne survey.

Keezhik Lake Area, Ontario. This program, on open ground, is estimated to cost $5,000.00, and is located 75 miles east of Pickle Lake, Ontario. An airborne E.M. and mag. survey using Scintrex Otter airborne equipment, totalling 250 miles, is planned for this area. The area to be flown is underlain by a volcanic complex. Ground acquisition and further follow-up work will depend on the results of the airborne survey.

Eagle Lake, Ontario. This program, on open ground, is estimated to cost $18,000.00, and is located 15 miles south-west of Dryden, Ontario. The area to be explored is a rhyolite-andesite contact on a major volcanic structure. Ground E.M. and mag. methods will be used in place of an airborne survey on this area. Geological work is planned in conjunction with the E.M. and mag. survey and ground acquisition will depend on the results of above work.

I have advised the Cominco management in Toronto that after the agreement is finalized between yourselves and Cominco I would be

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looking over their exploration work on a monthly basis, and submitting progress reports to your group. This was satisfactory to Cominco.

Respectfully submitted,

A A Koffman

Albert A. Koffman, P. Eng.,
Consulting Geologist.

Thomas J. Wallace (5-31-73)

TRANSCONTINENTAL RESEARCH & DEVELOPMENT CORPORATION

SUITE 1410 TUCSON FEDERAL TOWER
32 NORTH STONE AVENUE

TUCSON, ARIZONA 85701
602-884-9960

May 31, 1973

Mr. Richard Hewlett
Sierra Mineral Management
4741 East Sunrise Drive
Tucson, Arizona

SUBJECT: Cynide Leaching System

Dear Mr. Hewlett:

Based on the information and requirements as given at our meeting May 21st, 1973, the following observations and conclusions have been reached, and are offered for your consideration. It is, of course, understood that without laboratory testing, all calculations must of necessity be based on knowledge of soils mechanics and general knowledge of the regional soils. All calculations are for a 200 x 200 ft. Pad with a 50 ft. overburden.

The Pad, including waterproofing barrier, will be required to support 130,000 tons without critical shear.

The natural surface soils may be considered to have a coefficient of permeability of 10^{-3}, which of course, is relative free draining. Another aspect for consideration is the potential of these soils for subsidence under overburden pressure, and must be taken into account for design purposes.

Any approach to a rubber-lined method of seal would in the opinion of the writer, be ill advised, due to high rupture hazard, which could occure at any time during operations; forcing the abort of the entire system.

It remains, therefore, for you to evaluate the time and cost factors for an effective system using natural materials.

Two criteria must be satisified. First, the integrity of the Pad must be maintained in the continued presence of water, and two, must meet the permeability requirement. Our design calculations indicate a probable chemical cost to you in the order of between 4.72 to 6.30 dollars per sq. yd. This is chemical materials (F.O.B. Tucson), design, and on site supervision of Pad installation: engineering investigation not included.

Mr. Richard Hewlett
Sierra Mineral Management
4741 E. Sunrise Dr.
Tucson, Arizona

Due to the fact that these figures are well above that mentioned at our meeting, no great detail has been entered into. However, it may be that when you have investigated the alternatives, you will agree with us that this is probably the safest cheapest route to go, in which case I shall be happy to meet with you for more detailed discussions.

Trusting we have been able to help in some small measure.

Sincerely,

Thomas J. Wallace

Thomas J. Wallace
President

TJW/pi

N. H. Caruso (8-23-73)

8-23-73

PROGRESS REPORT

To: R. F. Hewlett, President

From: N. H. Carouso, Consultant

Subject: Progress Report

71 Minerals Project:

The 71 Minerals project area, southwest of Tombstone, Arizona, was visited with Mr. R. F. Hewlett, President, Sierra Mineral Management, on June 28, 1973, to inspect the project site, and discuss project goals. It was decided to resample the State of Maine Mine area dumps at a deeper level in the dumps to determine if the grade of silver changes with depth and also to collect representative samples for cyanidation tests to be run by the Reno Metallurgy Research Center, U.S.B.M., Reno, Nevada. A forty to fifty pound sample from each dump was collected and sent to the Reno Metallurgy Research Center. Mine dumps sampled were as follows:

	Ag. oz./ton	Au. oz./ton
State of Maine dump #2	3.8	trace
" #3	2.0	trace
" #4	2.8	trace
" #5	2.6	trace
" #6	1.4	trace
" #7	4.8	trace
" #8	3.2	trace
Triple X dump	3.7	trace
Triple X extension dump	4.5	trace
Bonanza dump	4.4	trace
North Bonanza dump	2.0	trace
Uncle Sam dump	1.1	trace
Brother Jonathan	3.0	trace
Solstice	3.4	trace
Merrimac	2.4	trace

The above assays were run by the Reno Metallurgy Research Center, and the results received by the writer while visiting the Center on August 17, 1973. Discussion of the visit will be reported in a subsequent part of the progress report.

On July 9, 1973, at a meeting at Miami, Arizona, Messrs. R.F. Hewlett, E. Escapule, John White and the writer discussed the Golden Sunlight Mill at Whitehall, Montana, which was to be dismantled and reconstructed at the 71 Minerals project area near Tombstone, Arizona. Immediately after the meeting, Mr. E. Escapule and his crew departed for Whitehall, Montana. Early the next morning the writer and his son, Mark, also departed for Whitehall, Montana, to inspect the equipment, take measurements of equipment and building, and assist Mr. E. Escapule in scheduling the priority of equipment to be dismantled and shipped to Tombstone, Arizona.

Upon inspection of the thickners at the Whitehall Mill, it was found that pulp had been left in the steel tanks when the mill was shut down about 1956, and along the air/solids line the walls of the tanks were pitted and in places rusted through. Two possible coatings to restore the tanks will be discussed later in this report. The agitator tanks are sound and will only require minor modification to conform to our flowsheet design. The balance of the major equipment all appears usable. The building will be erected at the Tombstone site and will be expanded using material from the Whitehall site and other sources.

It was decided to return via Denver, Colorado, and to contact MSI Industries, Inc., makers of the Marcy ball mill acquired from the Whitehall Mill, and order Instruction and Operations Manuals, to include Parts Lists and Foundation Drawings. This was done, however, as of August 22, 1973. The Manuals have not arrived. The ball mill foundation drawings are needed to complete our building foundation plans. While in Denver, Colorado, Mr. Charles Cito of Machinery Reserve of Denver, and Mr. Harold Grimes of Morse Bros. Machinery Co., were visited and I inspected some equipment which we may need for the Tombstone Mill. Mr. Charles Cito has followed up with additional quotations.

Before the return trip via Denver, Colorado, a gold property evaluation trip was made to the Ruby and Joe placer claims, situated on the St. Joe River, of eastern Idaho. The evaluation of this property will be covered by a separate report. Also a trip was made to Salt Lake City, Utah, for a meeting with Messrs. R.F. Hewlett and J. Bruce Stevenson pertaining to the Gibson Mine copper leaching operation and on the following day a meeting with Messrs. R. F. Hewlett, J.B. Stevenson, and Seth Horne, et al., regarding the acquisition of mining claims to expand the 71 Minerals project area.

Upon returning to Arizona during the week of July 24th, effort was directed toward calling and visiting local suppliers of used milling equipment, corrosion resistant coatings, gasket material for the thickner and agitator tanks, prefabricated forms for construction of tanks and sumps from concrete, Gunite contractors, electric motor rebuilders and suppliers. During this time much consideration was given to Tombstone plant site location for the cyanide counter current decantations plant and also the tailings disposal area. A site was selected near the State of Maine main shaft and the site was stripped to bedrock and then drilled by pneumatic drill to obtain samples for assay. Assay results and geological examination will determine if the site selected can be used. We will then set forms for the mill building foundation. However, we are waiting for the ball mill foundations drawings from USI Industries, Inc. Called Mr. Al Evans, Applications Engineer, for MSI Industries, Inc., Denver, Colorado, on August 22, 1973, and he assured me he will expedite our getting the foundation drawings. It is expected that we will set forms for the mill foundations next week.

Two types of tank coatings are being considered and will be evaluated by coating test material. One coating is called Elastron butyl base coating by United Paint Mfg., and the other is a catalytic 2-part nylon epoxy primer and a catalytic nylon modified epoxy enamel manufactured by Garlock Products. The test results should determine the product to be used; however, at this time I am partial to the nylon epoxy coating because, firstly, the cost is approximately one fourth the cost of the butyl base, evaluating from their respective specifications sheets, and secondly, I believe the Garlock product has been more widely tested by industry, expecially the mining industry.

Quotations on gasket material required for tanks, approximately 4600 feet, vary widely. Of the two quotations we have, one is for $114.00/100 feet and the other is for $24.80/100 feet. The $24.80/100 feet quote is my preference, both from cost and quality, as this gasket will be fabricated from Garlock neoprene by Helm Industrial Supply, Inc., Phoenix, Arizona, with one week delivery.

A meeting with Mr. Henry H. Rubin, Trelleborg, pertaining to rubber linings and wear point products was very informative and could lead to some applications at the Tombstone Mill.

A meeting with Mr. Thomas L. Muir, President, Phoenix Gunite, Inc. Costs and application of Gunite for our needs was discussed and Mr. Muir will send us drawings per my specifications and price quotations for construction of a 500 TPD leaching vat and a leach dump pad. The vat could be considered for both Tombstone and the Gibson Mine expansion.

Through Mr. C. Richardson, Denver Equipment Co., Tucson Office, I learned about a CCD cyanide plant that could possibly be acquired, at Atlanta, Nevada. We were unable to locate the last owner of the mill, so I decided that I would inspect the mill at the Atlanta Mine, Nevada, and at the same time attempt to determine the ownership. The trip to Nevada would also include visiting the Carlin Gold Mine and Cortez Gold Mine along with visiting and discussing test work results with Bureau of Mine personnel at the Reno Metallurgy Center, Reno, Nevada.

The Atlanta CCD cyanide plant is about a 500 TPD plant less the crushing plant and conveyors. The equipment is in good condition. The present owner is Mr. Rutherford Day, 1118 S.W. 8th Terrace, Ft. Lauderdale, Fla. 33345, phone (305) 527-0368, who purchased the equipment and buildings at a sheriff's sale on May 25, 1973 for $17,325. The appraised valuation is approximately $98,000 and assessed value at $32,500. I attempted to contact Mr. Day and was informed that he would be back in Florida on August 24, 1973, at which time I will ask him if he wishes to sell the mill and for how much.

The Carlin Gold Mine, Carlin, Nevada, was interesting. I visited with Mr. Jim McFarlane, Chief Engineer, and discussed the mill design and performance and also their dump leaching design and techniques. They plan to use stripped lake bed pads for dump leaching of their satellite deposits. Asphalt pads, 4 inches thick, sheared, at their millsite test area. This is similar to some of my experiences with asphalt pads. I found at the Gibson Mine that compacted local clay worked far superior to asphalt. The Carlin Mill was designed for 2000 TPD capacity and cost about $6,000,000 and about a year to build. They are now milling about 2400 TPD gold ore.

Heap leaching at Carlin Gold Mine is presently conducted on the abovementioned asphalt pads. They are 100 feet wide and 90 feet long, with four such pads in line and with approximately a 2.5% pad slope grade. They load to about a 10 foot lift and irrigate with rubber tubing outlets at 120 gpm per 90 X 100 feet pad. Leaching time is about 5½ days for a 60%

recovery. Carbon precipitation is used with a caustic strip.

The Cortez Gold Mine, Cortez, Nevada, was next visited and a detailed inspection of the mill was arranged by Mr. Don Duncan, Mine Manager. Messrs. Jim Smolik, Mill Superintendent; Reeve Fagg, Mill Foreman; Ed Walker, Refinery Operator; and Bob Baker, Metallurgist, all were very informative. The Cortez Mill was patterned after the Carlin Mill and it has a design capacity of 1600 TPD and cost about $7,000,000. They are milling about 2400 TPD, due to their efficient grinding section. Metallurgy is about the same as Carlin.

Mr. Don Duncan refused to discuss their heap leaching operation with the statement that it was company policy; however, I was able to piece together enough information to at least satisfy some of my curiosity. They are building heaps on stripped lake beds and then compacting mill tailings in the pad area. They eventually plan to build a 50 foot lift. The slope grade of their pads is about 5%. It appears that the gold content of the heap dumps was underestimated, because from a reliable source I learned that as of a week or so ago, they have already extracted 150% of the gold they estimated to be in the dumps. It looks like they may have used mill grade ore for their dump heaps.

The visit with U.S. Bureau of Mines personnel at the Reno Metallurgy Center, Reno, Nevada, was loke old home week. Most of the fellows that I worked with at the Center during the middle 1950's are still there. We discussed Bureau projects, past, present and potential future. Mr. R. Lindstrom, Supervisor Chemical Engineer, assured me that our State of Maine mine area dump samples will be processed in the near future. We need this data for our mill design at Tombstone; therefore, I am initiating test work to be conducted at the Arizona Bureau of Mines laboratory at the University of Arizona, Tucson, Arizona. Mr. Dave Rabb, of the Arizona Bureau of Mines, will expedite grinding and settling rate tests on our ore next week.

I believe that Mr. E. Morrice, Research Metallurgist, Reno Metallurgy Center, Reno, Nevada, is conducting a research project to study methods to benificiate argentiferous manganese ore that is common in certain areas of the Tombstone district and other localities of Arizona. I plan to send Ed Morrice samples of this type ore and information I have and also possibly assist funding of the research project by talking to Dr. T. Henrie, Assistant Director, U.S. Bureau of Mines, Washington, D.C.

I strongly urge that we implement the laboratory at Tombstone to enable us to do most or all of our test work. This is necessary for mill control and to test characteristics of custom ores ~~or~~ and to test samples from ~~for~~ whatever property is being evaluated by the company. If this suggestion meets with management approval, I will prepare a proposal of what equipment will be required and supervise the implementation of equipment and train the laboratory technicians

August 22, 1973

N.H. Carouso (9-15-73)

9-18-73

Jim Briscoe

Counter Current Decantation Cyanide Process for Tombstone, Arizona, Silver Ores

Introduction

The cyanide process was a very important metallurgical process, developed for the extraction of gold and silver from their ores.

The early development of the cyanide process is mainly attributed to John Stewart MacArthur and the Forrest brothers. It was first introduced into South Africa in 1890, and then it was widely used in Australia, Mexico and the United States.

From a historical standpoint, it is interesting to note that the first patent registered by MacArthur and the Forrests was on October 19, 1887. It covered the effectiveness of a weak solution of potassium cyanide as a solvent for gold and silver. The following year they patented the use of alkalies and zinc for precipitation of the precious metals from solution. The fact is that this old process revolutionized the gold and silver processing industry and is still basically the same process used today.

The flowsheet of a typical cyanide circuit will be discussed to familiarize the reader with the process. The crushed ore is ground in a ball mill in closed circuit with a classifier to a preselected fine size in the presence of an alkaline cyanide solution. The classifier overflow is thickened to remove the pregnant solution and produce an underflow which is subjected to agitation for final dissolution of gold and silver values. The agitator discharge is washed in a countercurrent decantation system consisting of several washing thickeners. Pulp is fed into one end and water into the other end, thus the flow of pulp and water is in opposite directions. The pulp becomes progressively lower in soluble content as it passes to the discharge end and the water at the discharge end increases in lime, cyanide, gold and silver strength to constitute the mill solution. The mill solution is then used in the grinding circuit and is further enriched in gold and silver content to form the pregnant solution from the primary thickener. The pregnant solution is precipitated using zinc dust and the barren solution after precipitation is recycled to the washing thickeners. The precipitate is refined to bullion by adding fluxes and smelting.

Flowsheet for Tombstone Mill

Cyanidation flowsheets consist mainly of two types, all-slime and sand leaching. The all-slime cyanidation flowsheet includes fine grinding and agitation in alkaline cyanide solution for dissolution of gold and silver values, whereas, sand leaching is usually a batch process treated in vats by percolation. Another type could be called sand-slime leaching and a modified version of this type will be discussed in another report and will cover my concepts of an agitated vat leaching process for crushed ore.

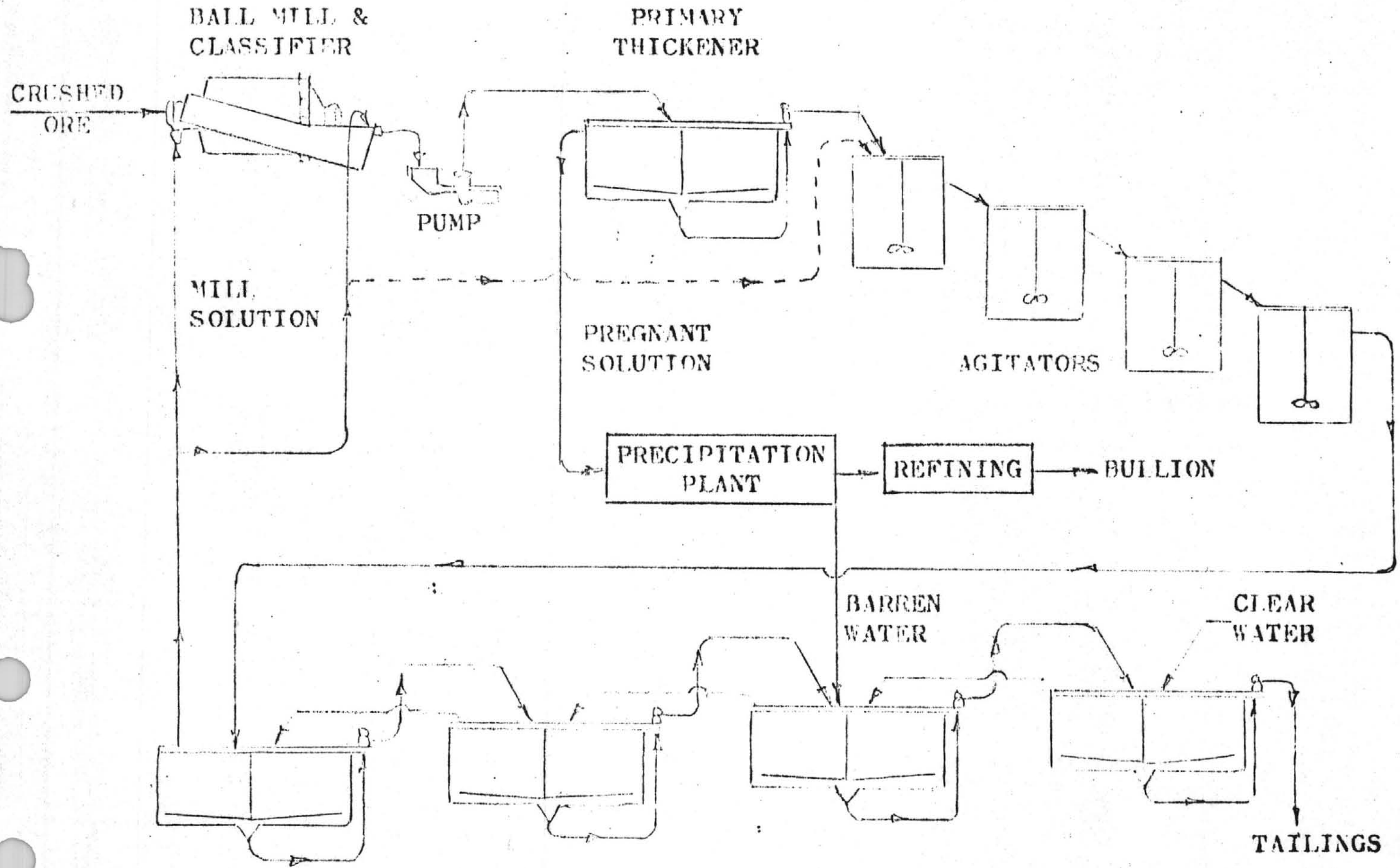
A typical flowsheet is included in this report. This type of flowsheet is industry approved and tested. Although this flowsheet appears similar to an all-slime type process, it will differ because a relatively coarse grind will be sought. Preliminary laboratory testing indicates that a coarse grind should give satisfactory recoveries of gold and silver values.

Settling rates favor a coarser grind and recoveries are not adversely influenced. Laboratory testing currently being conducted at the Arizona Bureau of Mines Laboratory in Tucson, will furnish the necessary data to finalize the mill design and plant operating

BY NHC DATE 9-18-73 SUBJECT .... SHEET NO. .... OF ....

CHKD. BY .... DATE .... TOMBSTONE, ARIZONA JOB NO. 71 MINERALS LTD.

CCD CYANIDE PLANT FLOWSHEET



COUNTER CURRENT DECANTATION THICKENERS

conditions.

A discussion of the various steps in the flowsheet will be presented and related to the equipment available from the Whitehall, Montana, mill.

Grinding

Single stage grinding utilizing the No. 66 Marcy Ball Mill in close circuit with the No. 1658-D Dorr Rake Classifier, should give the tentative optimum mesh size of grind at a thru-put of about 150 tons per day of ore, assuming that ball mill feed will be -½" screen fraction from the crushing plant.

To slightly increase the thru-put of the grinding circuit, one can consider several options; one, feed the mill with a smaller size screen fraction, two, increase the coarseness of grind, three, optimize by mill testing, the size and number of ball charge and type of liners, however, to substantially increase the daily tonnage, a second ball mill and classifier circuit should be installed.

Agitation

The propeller type agitators available from the Whitehall Mill are ideal for agitating a coarse grind product. Installation of an air agitation system to the agitators should be considered, especially to the rake Dorr type agitator.

Aeration is essential for successful cyanidation, to supply free oxygen. For efficient dissolving, it is necessary that oxygen come in physical contact with the gold and silver particles. Therefore, air bubbles should be well dispersed in the pulp. The agitators can be modified to accomplish this.

As in the grinding circuit, the calculated tonnage that can be treated by the available agitators is about 150 tons per day. This is assuming that 24 hour retention time in the agitators will be sufficient, however, 48 hours or a longer retention time may be required. Current laboratory tests, when completed, should give us this information.

To increase the retention time and also the tonnage, additional agitators will be required.

The agitator tanks and drive mechanism are in fairly good condition, however, the impellers must be reworked and possibly rubber covered.

Thickening

Thickening is an important part of a cyanide plant and is essentially a continuous mechanical process involving settling where excess solution is removed from the pulp.

The primary thickener removes pregnant solution which is sent to the precipitation plant for removal of gold and silver values from the solution. The counter current decantation thickeners wash the cyanide pulp to recover the solution and reject the solids to waste.

Free settling rate studies conducted at the Arizona Bureau of Mines Laboratory, Tucson, Arizona, indicate that the State of Maine dump ore tested had acceptable settling characteristics at a pH of 11.0, adjusted with lime at 2#/ton ore. The settling rate determined was 0.5 feet per hour and was dependent on a high pH. Lower pH degraded the settling rate. Based on this free settling rate, the available thickeners are capable of handling at least 70 tons per day of ore per thickener.

The thickeners can be installed in parallel. I recommend that the thickeners be installed in pairs, each higher in elevation than the preceeding thickener pair to allow the solution to flow by gravity, thus eliminating at least four pumps, if standby pumps are included.

The pulp will have to be pumped from the underflow of each thickener to the next thickener. This can be accomplished by either an adjustable stroke diaphragm pump or a slurry pump with pinch valve flow control. Either pumping systems are effective, however, the slurry pump-pinch valve system will lend itself favorably to future automatic control systems.

The five 30 foot diameter thickeners at the Whitehall Mill were all set at the same elevation. This arrangement requires many pumps, and in my opinion and experience as Chief Metallurgical Engineer for a 30,000 ton per day concentrator, will result in high maintenance costs and poor running time availability. Industry practice, and the two recently constructed cyanide plants in Nevada, use gravity flow for thickener solution.

The available thickeners are in need of repair. Pulp was left in the thickener tanks when the Whitehall Mill was shut down in the middle 1950's, and along the air-pulp interface, the tank walls are badly rusted. Badly rusted sections should be replaced or portions cut out and new plates welded in place. All tank sections should be sand blasted and when the tanks are assembled, they should be treated inside with a corrosion resistant coating. A 2-part catalytic nylon base epoxy primer and enamel will be tested as soon as received from the supplier. A butyl rubber coating, "Elastron", has been received and will be tested immediately.

The thickener drive mechanisms are in only fair mechanical condition and will have to be reworked.

Clarification and Precipitation

The equipment, although antiquated, appears to be useable. The leaf type clarifier filter and the sock type precipitation tank, typical of small cyanide plants in the past, can be reworked and used for initial production.

At a later date, pressure type clarifier filters and precipitate presses can be installed to update the precipitation plant.

Refinery

At present, refinery equipment is not available. It is believed that the Amex-Placer people plan to keep this equipment with their laboratory facilities at Whitehall, Montana; however, it would seem prudent for management to investigate.

Summary and Conclusions

It appears that about 150 tons of ore per day is the maximum tonnage that can be processed, utilizing the equipment acquired from the Whitehall mill. Upon completion of laboratory test work, plant design and operating conditions can be finalized.

Thickeners should be installed to benefit from gravity flow of solutions. Agitators should also be installed to benefit from gravity.

The thickener tanks must be repaired as well as the drive mechanisms. Agitator impellers should be rebuilt and possibly rubber covered.

The Oliver Vacuum Drum Filter, acquired from the Whitehall mill, should be reworked and available for use in the counter current decantation washing circuit as well as the two 22 foot diameter thickeners. It is quite evident that we will be crowded for pulp washing capacity.

Additional equipment will have to be acquired to expand the mill capacity. The writer has been active in investigating sources for equipment procurement.

This cyanide plant, with realistic engineering and careful construction practices, should be successful.

Nicholas H. Carouso

Nicholas H. Carouso
Consultant

September 18, 1973

Larry K. Davidson (6-14-73)

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TWX: 910-931-2600

June 14, 1973

Sierra Mineral Management
4741 East Sunrise Street
Tucson Arizona 85700

Attention: Mr. Richard Hewlett

Gentlemen:

Proposal
Feasibility Study of Containment System
Proposed Heap Leaching Operation
Near Tombstone, Arizona
For Sierra Mineral Management

INTRODUCTION

In response to a request from Mr. Richard Hewlett of Sierra Mineral Management, we are pleased to submit this proposal for performing a feasibility study of alternative containment systems for a heap leaching operation near the abandoned Maine Mine to the south and east of Tombstone, Arizona. Mr. Larry K. Davidson of Dames & Moore was escorted on a tour of the site area by Mr. James A. Briscoe, exploration geologist for the project, on Friday, June 8, 1973. A topographic map of the site area was provided by Mr. Briscoe for use in preparing this proposal.

PROJECT DESCRIPTION

Sierra Mineral Management plans to extract silver from mine waste dump material near the abandoned Maine Mine by using a combination of heap leaching with a cyanide solution and cyanide milling. The pH of the leaching solution will be controlled at an alkaline level to prevent the formation of cyanide gas. Waste dump materials passing a No. 20 mesh screen will be milled, and the large sized material will be leached. Materials contained in the dumps are estimated to be approximately 20 to 30 percent finer than the No. 20 mesh. The same facilities will be used to precipitate silver from pregnant cyanide solution obtained from the leaching and milling operations.

Estimates of the volume of mine waste material available on the surface of the site range from 30 to 40-thousand tons. Work is currently underway on a head-frame for re-entry into the Maine Mine, and additional silver is expected to be contained within the "gob" located in many of the mine stopes. With additional prospecting, total reserves of leachable ore are expected to reach 100 to 130-thousand tons.

Present plans are to construct a leach pad of sufficient size to stack all of the leachable ore in the dumps over the surface of the site. Areal extent of this pad is expected to be on the order of 150 feet by 250 feet in plan dimensions. Ore will be stacked on the leach pads with scrapers, rather than by stackers and conveyor belts. Depending upon the economics of leach pad construction and transport costs, additional pads or pad area may be constructed as additional ore becomes available or the initial pad may be cleared of leached ore and restacked with the new ore.

The heap leach pad or pads will consist of graded areas of reasonably uniform slope, with a relatively impervious blanket or membrane at the ground surface to permit collection of pregnant leach solution percolating down through the overlying ore pile, without significant seepage loss into underlying soil or rock. Leach solution is normally collected in one or more sumps at the downslope edge of the pad. Dikes of a sprinkler system are commonly used on top of the leach piles to control the distribution of leaching solution.

PROPOSED STUDY

PURPOSE

The purpose of our study would be to evaluate the near-surface materials and topograph at two prospective leach pad locations on the site, one near the Maine Mine shaft and the other near the Fox Ranch; and to provide recommendations for leach pad construction procedures and materials at each site. Suitable lining materials would be of critical importance at both sites.

Primary consideration would be given to the use of compacted native materials for construction of the pads. The fine-grained soils in the low ground to the northeast of the Maine Mine are potential lining materials, possibly in combination with the soils at the pad site near the Fox Ranch. Various commercially-available additives which can be used in combination with natural soils would also be considered. Artificial linings or membranes will be considered, if necessary, for a workable solution; although these materials are normally more expensive than alternatives using native materials, and performance of these materials on a slope and under a stack of solid materials is sometimes unsatisfactory.

SCOPE

In order to accomplish the purpose of our study, we propose to perform the following scope of work:

1) Representative bulk sampling of native soil at the Fox Ranch pad site and any fine-grained soils in the area which may be available in sufficient quantities for use in lining construction (we understand that Mr. Briscoe may be able to perform this task);

2) Laboratory testing of the sampled materials to determine the compaction and permeability characteristics of these soils alone and possibly in combination with other soils or additives;

3) An office engineering program which will include,

   a) An evaluation of the engineering properties of alternative lining materials,

   b) An evaluation of required site preparation and grading and construction method for the lining material,

   c) Estimating seepage loss of leach solution for the lining alternatives;

4) A brief site visit to inspect test pits used for sampling and to verify available material quantity estimates;

5) Preparation of a final report which will summarize our findings and recommendations.

SCHEDULE

We are prepared to begin our work on the project within 2 to 3 days following your notification to proceed and receipt of the necessary soil samples from the site. We estimate that 3 to 4 weeks would be required to complete our work and submit a final report.

FEE

We propose to perform our study on a time-and-expense basis, in accordance with the attached schedule of charges. We estimate that our fee, including expenses, will be on the order of $2500 to $3000. For this estimate, we have assumed that field sampling could be performed by Mr. Briscoe, and that no equipment charges would be included. We would not exceed our estimated maximum fee without your prior authorization.

In the case of all new clients, it is the policy of Dames & Moore to request that an amount of money equal to our fee estimate be placed in an escrow account for payment of our billings upon receipt. Verification of this account is required before the work can be started. We hope that you will understand the firm's position on this matter.

INSURANCE

During the course of our work, we will provide workmens' compensation insurance as required by law, and public liability and property damage insurance in an amount in excess of $1,000,000.

* * *

It has been our pleasure to prepare this proposal for your consideration. We look forward to assisting you on this project. If you are in agreement with the contents of this proposal, please sign one copy in the space provided below and return it for our files. Receipt of a signed copy will be considered as your notification to proceed.

Very truly yours,

DAMES & MOORE

Larry K. Davidson

Larry K. Davidson
Associate

LKD/dls

Attachment

SIERRA MINERAL MANAGEMENT

____
Richard Hewlett

SCHEDULE OF CHARGES AND GENERAL CONDITIONS

DAMES & MOORE

UNITED STATES & CANADA

The compensation to Dames & Moore for our professional services is based upon and measured by the following elements, which are computed as set forth below.

PERSONNEL CHARGES

Charges for employees are computed by multiplying the total direct salary cost of our personnel by two and one-half. The total direct salary cost shall be a sum equal to the direct payroll cost (computed on a typical annual basis and expressed as an average hourly rate) plus 25 percent of same to cover payroll taxes, insurance incident to employment, holidays, sick leave vacations, etc. The time of a partner or retained consultant devoted to the project is charged at an assigned billing rate.

The 25 percent employee benefit factor is used for work performed by personnel assigned to offices in the United States and Canada. For work performed by personnel in our offices in other countries, it will vary depending on the employee benefits paid in the particular location.

When outside the United States, employees' and partners' total direct salary cost will be increased by the premium customarily paid by other organizations for work at that location.

Time spent in either local or inter-city travel, when travel is in the interest of the work, will be charged for in accordance with the foregoing schedule; when traveling by public carrier, a maximum charge of eight hours per day will be made.

EQUIPMENT CHARGES

Computer control of project costs will be billed at a rate of $1.25 per each $50 of job charges. Other Dames & Moore equipment, if used, will be billed at the rates noted in the Appendix.

OTHER SERVICES AND SUPPLIES

Charges for services, equipment and facilities not furnished directly by Dames & Moore, and any unusual items of expense not customarily incurred in our normal operations, are computed on the basis of cost plus ten percent. Such items include:

- Rental and operation of drilling equipment
- Erecting facilities for the performance of field tests
- Surveying services
- Shipping charges for equipment or samples
- Subsistence
- Fares of public carriers
- Rental vehicles
- Printing and photographic reproductions
- Long distance communications
- Special fees, insurance, permits and licenses
- Services of testing laboratories
- Services of explosives technicians

BILLING

Statements will be issued every four weeks, payable upon receipt, unless otherwise agreed.

Interest of 1½% per month (but not exceeding the maximum rate allowable by law) will be payable on any amounts not paid within 30 days, payment thereafter to be applied first to accrued interest and then to the principal unpaid amount. Any attorney's fees or other costs incurred in collecting any delinquent amount shall be paid by the Client.

In the event that the Client requests termination of the work prior to completion of a report, we reserve the right to complete such analyses and records as are necessary to place our files in order and, where considered by us necessary to protect our professional reputation, to complete a report on the work performed to date. A termination charge to cover the cost thereof in an amount not to exceed 30 percent of all charges incurred up to the date of the stoppage of the work may, at the discretion of Dames & Moore, be made.

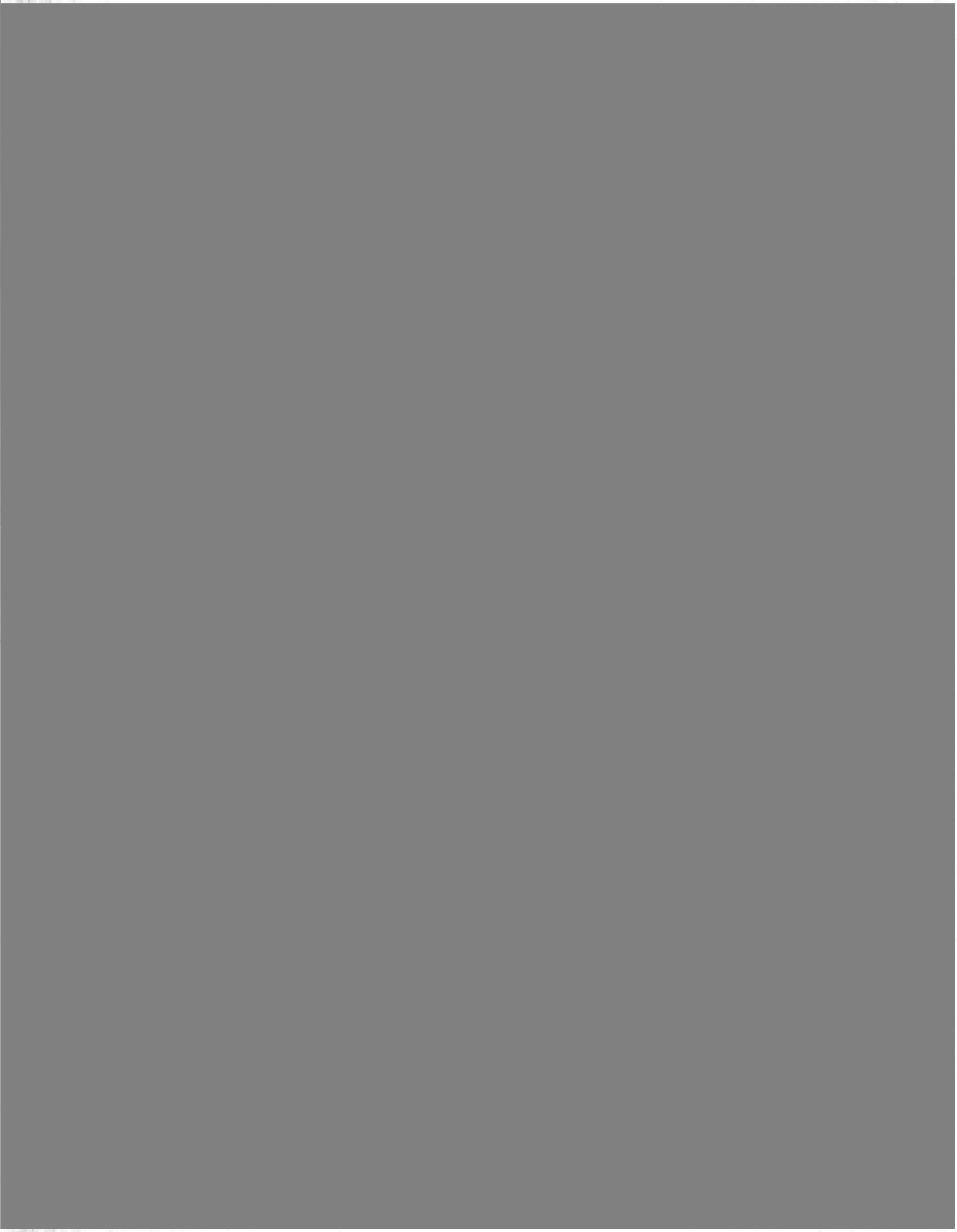
Rates are subject to change upon notification.

WARRANTY AND LIABILITY

Dames & Moore warrants that our services are performed, within the limits prescribed by our Clients, with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended in our proposals, contracts or reports.

Our liability to the Client for injury or damage to persons or property arising out of work performed for the Client and for which legal liability may be found to rest upon us, other than for professional errors and omissions, will be limited to our general liability insurance coverage, which we maintain in limits in excess of $3,000,000. For any damage on account of any error, omission or other professional negligence, our liability will be limited to a sum not to exceed $50,000 or our fee, whichever is greater. In the event that the Client does not wish to limit our professional liability to this sum, we will waive this limitation upon the Client's written request provided that the Client agrees to pay for this waiver an additional consideration of 4% of our total fee or $200, whichever is greater.

In the event the Client makes a claim against Dames & Moore, at law or otherwise, for any alleged error, omission or other act arising out of the performance of our professional services, and the Client fails to prove such claim, then the Client shall pay all costs incurred by Dames & Moore in defending itself against the claim.



"Here it Is! A Misplaced Decimal In The Curve Radius Inclination Formula."

Kenyon Richard (8-9-73)

KENYON RICHARD
Mining Geologist
1501 MIRACLE MILE
TUCSON, ARIZONA 85705

602-622-0953

443

August 9, 1973

Mr. Richard F. Hewlett
Sierra Mineral Management
4741 East Sunrise Drive
Skyline Bel Aire Plaza
Tucson, Arizona 85718

Tombstone District
Arizona

Dear Sir:

Two days were spent in the Tombstone District, July 5 with Jim Briscoe and July 11 with you and Briscoe.

Beforehand I had reviewed Butler and Wilson's U. of A. --Arizona Bureau of Mines Bulletin on Tombstone, Jan. 1938. The authors of this bulletin must have had many old mine maps in order to portray the geologic structure, the stratigraphy and the mine workings in such remarkable detail. They show no assays, probably because the map (and property?) owners would not permit publication of such data.

I get the impression from reading the history that, despite the fairly substantial gross production of $37 million, profit was mostly non-existant. Cost-price ratios were not much different than they are today, even with the current high silver price. The reason I believe that relative costs were so high during the district's hey-day was that too many feet of underground workings had to be driven for each ton of ore discovered and extracted. They did not have diamond drills, modern pumps or bulldozers.

Therefore, it seems to me that exploration today has a chance----rather long-shot----to find small but commercial ore bodies.

In order to accomplish this, old maps showing assays must be found. You have said that you expect to get maps of this kind from property owners with whom you are dealing.

The western part of the district where you are setting up your present operations received but little old-time mining activity as compared to the main, eastern portion. This doubtless was due to the presence of stronger surface expressions of mineralization in the east than in the west. This is meant in the overall mineralization sense, not just more small pockets of horn silver at the surface which was the principal ore guide of the earliest prospectors. The miners and engineers who quickly appeared in the district were, for the most part, good "mining geologists" by experience, though the name, as such, was not respected, nor was the capability even admitted except by crude terms like, "He has a nose for ore."

These early miners had good recognition of stratigraphy, structure, mineralogy, vein intersections, and the economic differences and significance between hypogene and supergene minerals.

The point is, you cannot beat these old operators at their own game, except (1) by consolidation of properties, (2) by reconstruction of the geometry of all mineral occurrences (in this connection Briscoe's detailed current field mapping is very important), (3) by determination of the actual distribution of values in the old mines and prospects, and (4) by use of bulldozers and diamond drills.

You will be lucky if you can keep your mill running very long. But the above four points will improve your luck quite a bit.

Without old assay maps in hand for analysis, it seems likely that, at best, actual undiscovered ore bodies are very small exploration targets in either the western or eastern portions of the old district. When all information has been put together, I would expect that a few relatively shallow drillholes will be recommended.

The large area of alteration with several small breccia pipes and dikes situated between the Tombstone and Charleston Districts proper is quite interesting. It is by far the strongest and largest zone of hydrothermal activity in the region. (I have not yet seen the old Charleston District.) It has several characteristics of porphyry copper deposits. (A reminder: There are a number of long, expensive steps between "deposit" and "ore" body----and longer financial steps between "ore body" and "production at continuing profit.")

The occurrence of small, relatively higher grade base and precious metal ore bodies is common around the fringes of some porphyry copper districts. Tombstone and Charleston may be in this category.

There are practically no surface occurrences of oxidized copper or silver minerals in this large alteration zone. This may have been due to a larger proportion of pyrite over copper, silver and other sulphides, with acid leaching having removed the latter from the surface and near-surface. Also, a good deal of the altered area is covered by alluvium.

There is a little limonite-after-chalcocite in local fracture zones and breccia pipes in the alteration zone, but not enough to indicate that substantial amounts of ore-grade material existed in the leached outcrops. Quartz-sericite alteration is fairly strong in most places.

The alteration mostly is in Uncle Sam porphyry, although some altered outcrops appeared to have clastic textures. In any case clastic units of the Bisbee Group are known to exist nearby. Much of the ore in the Tombstone (and maybe the Charleston) Districts occurred as hypogene replacements in limey beds in the lower horizons of the Bisbee and in the upper Paleozoic carbonate beds.

In the western part of the Tombstone area the Uncle Sam porphyry seems to be a thick sill. I would expect, though, that in the altered area under consideration it is a stock.

I would expect the altered stock and surrounding altered clastic sediments to contain disseminated pyrite with some chalcocite and chalcopyrite. These might constitute relatively shallow ore bodies, and that possibility is interesting enough to warrant drilling. First, though, the mapping should be finished, particularly the reconnaisance mapping including the Charleston area, which was discussed when we all were in the field.

Since you mentioned that several drillholes have been put down in the Charleston District, a couple of which had deep but long intercepts of 0.7(?)% Cu, I have been thinking that those intercepts might be mineralization in favorable carbonate beds in the lower Bisbee or the Paleozoic formations. This thought certainly enhances exploration possibilities where the same horizons probably extend into the alteration zone described above. Reconnaisance mapping of the region probably will give us a fair idea as to the depth of these limey beds. Even if surface exposures of these beds are too far away or too widely spaced to permit reasonable estimations of depth, this exploration possibility is sufficiently good right now, even with my presently rather limited knowledge of the region, for me to recommend two drillholes: (1) 1000' deep, inside the alteration zone in the Uncle Sam porphyry--preferably within one of the breccia pipes and (2) 2000' deep, outside of the porphyry but near it and hopefully, inside the alteration zone in carbonate rocks. The alteration zone should spread out in the carbonate horizons.

This drilling would not be conclusive, unless only disseminated pyrite is encountered.

Yours very truly,

Kenyon Richard

Kenyon Richard

Copies: one extra to Hewlett

R.F. Hewlett Report (1974)

SIERRA MINERAL MANAGEMENT

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R. F. HEWLETT
President

4741 EAST SUNRISE DRIVE
SKYLINE BEL AIRE PLAZA
TUCSON, ARIZONA 85718
602 / 299-9736

TOMBSTONE PROJECT

Possibilities for mine production by early 1974 are:

1. Waste dumps
2. Small high-grade underground production
3. Potential medium-sized open pit.

Cash requirements and potential cash flow are:

Project	Capital Requirement	Amount
Waste dumps	Plant (lease)	$250,000
Small underground	Mine equipment (lease)	50,000
Open pit	Exploration	50,000
		$350,000

Project	Potential Profit	Year
Waste dumps	$650,000	1974
Small underground	150,000	per year
Open pit	0-500,000	per year

Schedule of Activities follows:

1. Placer will analyze metallurgy and feasibility of moving Whitehall plant (on lease from MECL) to Tombstone.

2. Placer will review feasibility of mining "State of Maine" and we will then move down from Cordero (on lease from MECL) all required mining equipment (hoists, slushers, dozers, loaders, etc.)

3. " 71 ML" is attempting to form a corporation and merge Tombstone Mineral Reserves to obtain their plant (500 t.p.d.) and their 358 mining claims with gold-silver-and copper mineralization.

4. A lease has been proposed to Tombstone Development Corporation to explore and mine their patented claims that constitutes the largest holdings in the district.

5. A lease has been proposed to the Escapules for exploring, developing and mining the "State of Maine" and Santa Ana mines.

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Activity	Amount
Move Plant	$100,000
Move Cordero Equipment	10,000
Tombstone Reserves	$ 25,000 to $100,000
Tombstone Development	$ 25,000
Escapules	$ 50,000
	$210,000 to $285,000

TECHNICAL EXPLANATION

"71 Minerals" strategy is to tie up the entire Tombstone district to allow us enough time to select claims or mines that are desireable and drop claims that don't have much potential before the assessment deadline of September 1, 1973.

The mining property in the Tombstone district is owned by (in decreasing order of importance):

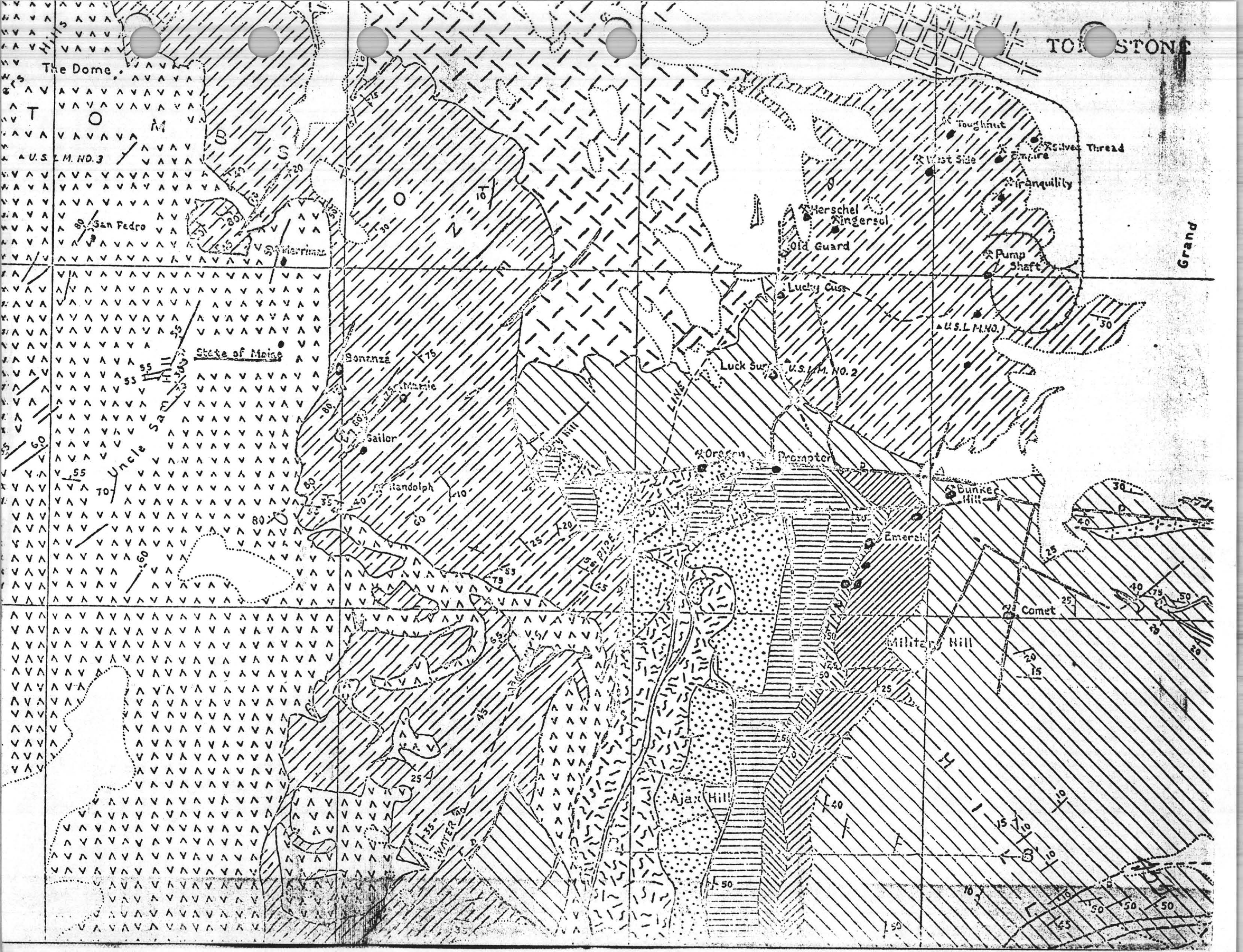
1. Tombstone Development
2. Escapules
3. Tombstone Mineral Reserves
4. Grace-Bonanza
5. Wayne Winters
6. Numerous small trusts, churches, etc.

On the map (on the following page) are shown the following:

Ownership Group	Location of Claims
1. Tombstone Development	All orange dots east of "State of Maine"
2. Escapules	Around and including "State of Maine"
3. T. Mineral Reserves	Unpatented claims south and east of 41° N. (Military Hill)
4. Grace-Bonanza	Bonanza mine due east of "State of Maine"
5. Wayne Winters	North of Military Hill and south of Emerald

Tombstone Development

All orange dots south of Tombstone (excluding "State of Maine" and Bonanza) are waste dumps owned by T.D. The detailed report on waste dump and open-pit potential is in exhibit A.


TOMBSTONE
The Dome
TOMBSTONE HILLS
U.S. L.M. NO. 3
San Pedro
Merrimac
State of Maine
Uncle Sam
Bonanza
Mamie
Sailor
Randolph
Toughnut
Silver Thread
West Side
Empire
Tranquility
Herschel
Ingersol
Old Guard
Pump Shaft
Grand
Lucky Cuss
U.S.L.M. NO. 1
Luck Sure
U.S.L.M. NO. 2
LINE
Oregon
Prompter
Bunker Hill
Emerald
Comet
Military Hill
PIPE
Ajax Hill
WATER

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Escapules

This property ("State of Maine") should be optioned and put into small scale underground production. This can be done for $30,000 excluding a plant. The potential for this property are:

1. Waste dumps (4.5 oz. Ag)
2. Small underground operation
3. Potential of a large underground operation
4. Potential for open pit ore.

Exhibit B shows the extent of the underground workings. I have examined these workings by ladder and rope and have taken some samples running from 147 to 225 ounces per ton. The average grade of gobb (old low-grade fill) is about 20 ounces which can be mined first.

The advantage of the old "State of Maine" workings is that we can put the mine back into production for relatively low start-up costs.

In addition to the "small" potential, there is the distinct possibility that there will be the same large high-grade bonanza one at depth as over in the Tombstone basin (due south of the town site). This is illustrated in exhibit C, where the ore is shown in cross-section as mined out stopes or levels. Notice that the ore is at and especially above the Naco limestone (8 level-bottom) up into the "Novaculite", blue limestone and Bisbee group limestones. The bottom of the "State of Maine" shaft is just going into Bisbee group limestones from a porphyry rock that is mineralized (that is where the past production came from). Therefore, there is a good chance that larger ore bodies exist at depth. (We can at least make money on the existing "lower grades".)

As I mentioned before, I have a tax lien on the San Juan mine.

Tombstone Mineral Reserves

This company is in bankruptcy and is an excellent possibility for us to control 358 unpatented mining claims with gold-silver mineralization and copper potential. Their 500 t.p.d. plant could be utilized in part by us with our White Hall plant. The T. Mineral Reserves plant is about two (2) miles from the "State of Maine" mine. Our electrolytic-oxidation process is superior to any in the district and we would have the only operating plant and could joint-venture or treat ore on a "custom basis".

Grace-Bonanza

This property is near Escapules and Mr. Grace contacted me recently and wants to make a deal with "71 ML".

Wayne Winters

"71 ML" has 15 mining claims under option in and around the Tombstone district. He has given us much free time for $100 per month. He is very helpful to us in consolidating property and arranging meetings for "71 ML". The value of his claims are discussed in Exhibit D.

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E X H I B I T A

Tombstone Development

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I

INTRODUCTION

TOMBSTONE DISTRICT

The Tombstone mining district is in the Tombstone Hills, about 21 miles northwest of Bisbee, and about 24 miles southeast of Benson, Arizona. The maximum elevation for this area is about 5300 feet above sea level.

PROPERTIES EXAMINED

Twenty-three (23) patented mining claims were selected, mainly those with mine dumps sufficiently large in tonnage to warrant re-handling and milling them or those in an area of geological interest.

The patented mining claims evaluated are tabulated in TABLE I.

II

SAMPLING PROCEDURE

Bulk samples were taken from each of the mine dumps and reduced in size for assay. Weight of bulk samples ranged from fifty (50) to one hundred (100) tons each. The size and location of the bulk samples was dependent on the size of the mine dumps and the area of expected influence. Bulk samples were coned and quartered using the backhoe-loader equipment until they were reduced in size to about two (2) tons, then they were trucked to a crusher-conveyor site, crushed, coned and quartered and finally split with a Jones splitter to a final weight of about ten (10) pounds. It is believed that the final samples represent very closely the content of the dumps sampled, at least to within the area of influence. The tonnage calculated for the dumps take this into consideration.

The method used to obtain and prepare samples for assay was decided upon in collaboration with Dr. Willard C. Lacy, Professor and Head of the Mining and Geological Engineering Department, College of Mines, University of Arizona, Tucson, Arizona.

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III

ASSAY RESULTS

Samples for assay were sent to Hawley and Hawley, Assayers and Chemists, Tucson, Arizona, to be assayed for gold, silver, lead, copper and in many cases for zinc, molybdenum and a few for manganese. The assay values are tabulated in TABLE II.

Copies of the original assay results from Hawley are included in APPENDIX I. of this report.

Arithmetical averages for grades of all the mine dumps sampled are as follows: gold, 0.018 oz./ton; silver, 1.86 oz./ton; lead, 0.55%; copper, 0.07%, for 28 samples; zinc, 0.76% for 11 samples; molybdenum, 0.004%, for 20 samples; and manganese, 4.56%, for 5 samples.

These averages are interesting as they somewhat indicate the grade of the mineralized material considered waste during certain active periods of mining in this district. However, it should be mentioned that many of the mine dumps have been selectively reworked and the concentrate shipped to smelters. Actually, these averages should be considered as minimums.

In contrast to these minimum values, perusal of the "Ore Shipping Records, from April 3, 1920 to February 28, 1923", gratefully furnished by Mr. Pete Giacomi of Tombstone, a copy of which is included in APPENDIX II of this report, indicate what was considered ore grade during this period and the arithmetical averages of grade and tonnage for selected mines are tabulated in TABLE III.

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IV

TONNAGE AND METAL CONTENT OF MINE DUMPS

The selected mine dumps were surveyed and their respective tonnages calculated. The total tonnage calculated for the twenty-three mine dumps sampled was 524,900 tons, and are considered accurate to ±10%. This tonnage excludes dump material which was considered waste and dump material outside of the area of sampling influence. Access to certain areas of larger dumps, that were not sampled, and to isolated smaller mine dumps would considerably increase the total tonnage, however, for this feasibility study, the additional expense did not seem justified. A value of 17.5 cubic feet per ton was used in calculating the tonnages of the mine dumps. This value was determined after weighing known volumes of average size distribution dump material.

The tonnages calculated and the metal content of the mine dumps sampled are tabulated in TABLE IV.

V

ECONOMIC CONSIDERATIONS

An attempt to place dollar value to the mine dump material generated the following data:

1. Weighted averages for grade of all the mine dumps sampled were: gold, 0.021 oz./ton; silver, 1.36 oz./ton; and lead, 10.9 lb./ton. Weighted averages for grade of copper, zinc, molybdenum and manganese, based on available assays were: copper, 1.19 lb./ton, for 338,300 tons; zinc, 2.41 lb./ton, for 108,600 tons; molybdenum, 0.099 lb./ton, for 326,700 tons; and manganese, 48.9 lb./ton, for 14,500 tons.
2. Metal content of mine dumps sampled: gold, 10,975 oz.; silver, 715,500 oz.; lead, 5,707,320 lb.; copper 461,780 lb., based

on 388,300 tons; zinc, 261,134 lb., based on 108,600 tons; molybdenum, 31,346 lb., based on 326,700 tons; and manganese, 708,340 lb., based on 14,500 tons. Metal content of copper, zinc, molybdenum and manganese was based on tonnages covered by available assays. Because gold and silver were the metals of prime importance in the feasibility study, the other metals were assayed to assist in determining their distribution and their importance for inclusion in metallurgical testing to develop an economically feasible flowsheet for their extraction.

3. Assuming 90% extraction for the gold and 85% extraction for the silver content of the dumps, at the following market price of $90.00/oz. for gold and $2.41/oz. for silver, gives the recoverable dollar value of $888,975 for gold, and $1,464,678 for silver, or a gross of $2,354,677; this gross excludes lead, zinc, copper, molybdenum and manganese. The exclusion of these elements in this economic evaluation is justified until laboratory testing indicates the feasibility of extracting them. However, their presence is certainly significant in the overall evaluation as they have potential dollar value.
4. An estimate for handling and treatment costs would be about $2.75 per ton, in a 200 TPD pilot production type plant or approximately $1,444,000, leaving a net gross of $910,677.
5. Assuming the pilot production plant would cost approximately $250,000 for a 200 TPD operation, one would realize a nice profit from an operation of this type, and the advantages derived would be meaningful. Advantages would be the familiarity with ore treatment characteristics, resulting in refinement of the flowsheet, which of course would have to be developed by

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laboratory testing, which would include all the recoverable values in the mine dump material. The recoverable dollar value of lead could be approximately $720,000, based on a lead price of $0.14/lb., and the copper, zinc, molybdenum and manganese would also enhance the recoverable dollar value that could be expected from treating the mine dump material.

The decision to consider construction of a pilot production plant should be based on the following criteria:

1. An active exploration program, to determine if potential open pit type mining sites exist in this area, and the ore reserves that could be expected.
2. The development of an effective flowsheet, by laboratory testing, to economically extract all or most of the valuable metals in the mine dumps and/or developed ore.

VI

OPEN PIT MINING POTENTIAL

During the field work of this feasibility study, potential open pit type mining sites were under consideration. One of the areas which appeared to warrant further consideration is that area of Tombstone Basin which contains the Silver Thread, Tranquility, Head Center, Contention, Empire, Toughnut, and West Side mines, and another area would be the Lucky Cuss-Herschel Zone.

In the first area, it is reported by B.S. Butler, E.D. Wilson, and C.A. Rasor, in the "Geology and Ore Deposits of the Tombstone District, Arizona," that the ore occurs (1) in the faulted segments of the dike, (2) in brecciated footwall zones of these segments, and (3) in limestone beds of the shale sequence.

From the same reference, the second area of interest, the Lucky Cuss-Herschel Zone has the following statement: that the ore deposits

41A

in and associated with the Lucky Cuss fault zone are of three types -- veins in the Lucky Cuss fault, veins in the northeast fissures, and limestone replacement deposits associated with the northeast fissures. Mining in both areas of interest was developed to the surface.

These areas should offer excellent targets, for a detailed evaluation by geological, geophysical, drilling and computer techniques.

VII

METALLURGICAL CONSIDERATIONS

The prime metals considered in this report are gold and silver which could be beneficiated by using the cyanidation method. Concern is expressed by some as to the expected recovery of silver from manganiferous ores. This could present a problem in dump material of high manganese content. However, most of the dumps sampled appear to be not too high in manganese content.

Two processes which have been developed to treat silver ores high in manganese are the Caron Process and the McClusky Process. The Caron Process utilizes a roast in a reducing atmosphere, the higher manganese oxides are reduced to manganous oxides which render them amenable to cyanidation. Laboratory tests followed by plant-scale testing gave the following results: Direct cyanidation of ore containing 2-10% MnO_2 gave 50% extraction of the silver, the Caron Process extracted 92% of the gold and 90% of the silver. The McClusky Process utilizes a sulphur dioxide treatment which dissolves the manganese minerals which are then precipitated by a lime emulsion and oxidized to the manganic state by aeration. In this state the manganese no longer affects the extraction of silver by cyanidation.

To fully exploit the potential dollar value of the Tombstone ores, a comprehensive laboratory testing program is recommended. The testing program should include flotation tests, pressure leaching tests, to solubilize the base metals present and possibly effect their extraction, and liquid ion exchange for upgrading and separation. New chemical extraction techniques should definitely be explored.

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TABLE I. PATENTED MINING CLAIMS EXAMINED

NAME OF MINE	LOCATION
Bob Ingersoll	Sec 11, T 20 S, R 22 E
Boss	Sec 11, T 20 S, R 22 E
Bunker Hill	Sec 14, T 20 S, R 22 E
Comet	Sec 23, T 20 S, R 22 E
Contention Little Joe Shaft Pump Shaft Main Workings Shaft	Sec 11, 12 & 14, T 20 S, R 22 E
Defence	Sec 11, T 20 S, R 22 E
Emerald	Sec 14 & 23, T 20 S, R 22 E
Empire	Sec 11 & 12, T 20 S, R 22 E
Free Coinage	Sec 9, T 20 S, R 22 E
Grand Central	Sec 14, T 20 S, R 22 E
Herschel	Sec 11, T 20 S, R 22 E
Lucky Cuss	Sec 11 & 14, T 20 S, R 22 E
Old Guard	Sec 11, T 20 S, R 22 E
Oregon	Sec 14, T 20 S, R 22 E
Prompter	Sec 14, T 20 S, R 22 E
Rattlesnake	Sec 14, T 20 S, R 22 E
San Pedro	Sec 8, T 20 S, R 22 E
Silver Plume	Sec 14 & 23, T 20 S, R 22 E
Silver Thread	Sec 11 & 12, T 20 S, R 22 E
Toughnut	Sec 11, T 20 S, R 22 E
Tranquility	Sec 11 & 12, T 20 S, R 22 E
West Side	Sec 11, T 20 S, R 22 E

TABLE II. MINE DU[illegible] ASSAY RESULTS

SAMPLE NO. AND NAME OF MINE	Gold oz./T	Silver oz./T	Lead lb./T	Copper lb./T	Zinc lb./T	Moly lb./T	Manganese lb./T
B.I. #1 (Bob Ingersoll)	0.005	1.08	6.4	0.8	28.8	0.02	---
BS #1 (Boss)	0.037	2.39	9.2	1.8	9.0	---	---
B.H. #1 (Bunker Hill)	0.030	3.59	26.4	3.8	48.0	0.10	---
B.H. #2 (Bunker Hill)	0.007	3.10	24.0	---	36.6	---	---
CMT #1 (Comet)	0.015	0.91	3.8	0.6	---	0.02	---
L.J. #1 (Contention)	0.017	1.07	10.0	0.2	8.0	0.02	---
CONT #1 (Contention)	0.022	1.06	6.0	0.6	---	0.02	---
CONT #2 (Contention)	0.010	0.77	4.2	---	---	---	---
CONT #3 (Contention)	0.027	1.33	6.4	---	---	---	---
DF #1 (Defence)	0.010	1.25	7.8	0.6	24.2	---	---
EMER #1 (Emerald)	0.020	1.59	21.8	3.0	---	0.02	---
EMER #2 (Emerald)	0.020	2.10	22.4	5.6	---	0.02	---
EMER #3 (Emerald)	0.010	0.90	7.6	1.2	---	0.02	---
EMP #1 (Empire)	0.080	1.90	15.6	1.4	---	0.30	---
F.C. #1 (Free Coinage)	0.005	0.95	0.5	0.2	0.2	0.02	8.6
G.C. #1W (Grand Central)	0.010	0.22	2.6	---	---	---	---
G.C. #2 (Grand Central)	0.010	0.97	23.8	0.2	3.2	0.02	---
HER #1 (Herschel)	0.015	3.47	6.0	1.4	---	---	---
L.C. #1 (Lucky Cuss)	0.040	2.98	20.8	1.4	15.2	0.02	---
O.G. #1 (Old Guard)	0.015	1.34	6.0	0.8	10.8	---	11.6
ORE #1 (Oregon)	0.005	5.52	14.2	2.8	---	---	159.0
ORE #2 (Oregon)	0.002	3.27	12.8	2.8	---	---	139.0
PRMT #1 (Prompter)	0.005	3.63	16.0	---	---	---	138.0
RTLS #1 (Rattlesnake)	0.005	2.33	11.6	1.4	---	---	---
S.P. #1 (San Pedro)	0.005	4.48	5.4	2.2	---	0.06	---
SLP #1 (Silver Plume)	0.002	0.45	4.2	0.6	---	---	---
S.T. #1 (Silver Thread)	0.025	1.33	13.0	0.6	---	0.12	---
SET #1 (Sulphuret)	0.022	0.66	6.2	0.6	3.6	0.10	---
TN #1 (Toughnut)	0.015	0.87	10.0	1.0	---	0.18	---
TN #2 (Toughnut)	0.005	0.36	3.8	0.2	---	0.04	---
TR #1 (Tranquility)	0.060	3.22	19.8	1.8	---	0.16	---
TR #2 (Tranquility)	0.022	0.85	4.8	0.4	---	0.04	---
W.S. #1 (West Side)	0.012	1.36	11.8	1.0	---	0.12	---
ARITHMETICAL AVERAGE	0.018	1.86	11.1	1.4	17.1	0.07	91.2

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TABLE III. ARITHMETICAL AVERAGES OF ORE SHIPMENTS

APRIL 1920 THROUGH MARCH 1921

NAME OF MINE	TONNAGE	Gold, oz./T	Silver, oz./T
Bunker Hill	99.5	0.035	15.45
Emerald	118.5	0.010	8.00
Grand Central	1,437.5	0.140	13.75
Lucky Cuss	5,559.5	0.056	16.92
Oregon	3,865.5	0.013	23.00
Prompter	9,688.0	0.017	16.50
San Pedro	431.5	0.170	27.15

APRIL 1920 THROUGH FEBRUARY 1923

NAME OF MINE	TONNAGE	Gold, oz./T	Silver, oz./T
Contention	3,639.0	0.198	13.57
Empire	158.5	0.240	13.48
Head Center (Yellow Jacket)	1,738.0	0.200	14.50
Silver Thread	4,738.0	0.270	25.47
Toughnut	5,203.0	0.170	27.45
Tranquility	1,977.5	0.320	22.46
West Side	1,237.5	0.560	38.58

TABLE IV. MINE D[illegible]S METAL CONTENT

SAMPLE NO.	TONNAGE ± 10%	Gold Total oz.	Silver Total oz.	Lead Total lb.	Copper Total lb.	Zinc Total lb.	Moly Total lb.	Manganese Total lb.
B.I. #1	10,500	52.5	11,340	67,200	8,400	426,800	210	
BS #1	3,400	125.8	4,624	31,280	6,120	30,600		
B.H. #1	15,300	459.0	54,927	403,920	58,140	734,400	1,530	
B.H. #2	10,500	73.5	32,550	252,000		384,300		
CMT #1	13,000	195.0	11,830	49,400	780		260	
L.J. #1	2,000	34.0	2,140	20,000	400	16,000	40	
CONT #1	11,800	259.6	12,508	70,800	7,080		236	
CONT #2	97,700	977.0	75,229	410,340				
CONT #3	16,300	440.1	21,679	94,320				
DF #1	24,200	242.0	30,250	188,760	14,520	585,640		
EMER #1	40,000	800.0	63,600	872,000	120,000		800	
EMER #2	1,600	32.0	3,360	35,840	8,960		32	
EMER #3	7,000	70.0	6,300	53,200	8,400		140	
EMP #1	41,100	3,288.0	78,090	641,160	57,540		12,330	
F.C. #1	200	1.0	190	100	40	40	4	1,720
G.C. #1W	10,000	100.0	2,200	26,000				
G.C. #2	10,000	100.0	9,700	238,000	2,000	32,000	200	
HER #1	6,800	102.0	23,596	40,800	9,520			
L.C. #1	18,200	728.0	54,236	378,560	25,480	276,640	364	
O.G. #1	10,200	153.0	13,668	61,200	8,160	110,160		118,320
ORE #1	1,000	5.0	5,520	14,200	2,800			159,000
ORE #2	1,500	3.0	4,905	19,200	4,200			208,500
PRMT #1	1,600	8.0	5,808	27,200				220,800
RTLS #1	3,000	15.0	6,990	252,000	4,200			
S.P. #1	1.500	7.5	6,720	8,100	3,300		90	
SLP #1	12,000	24.0	5,400	50,400	7,200			
S.T. #1	17,000	425.0	22,610	221,000	10,200		2,040	
SET #1	4,100	90.2	2,706	25,420	2,460	14,760	410	
TN #1	18,000	270.0	15,660	180,000	18,000		3,240	
TN #2	32,000	160.0	11,520	121,600	640		1,280	
TR #1	9,200	552.0	29,624	182,160	16,560		1,472	
TR #2	29,200	642.4	24,820	140,160	11,680		1,168	
W.S. #1	45,000	540.0	61,200	531,100	45,000		5,500	
	524,900	10,974.6	715,500	5,707,320	461,780	261,134	31,346	708,340
					(388,300T)	(108,600T)	(326,700T)	(14,500T)

TOTALS BASED ON ABOVE TONNAGES

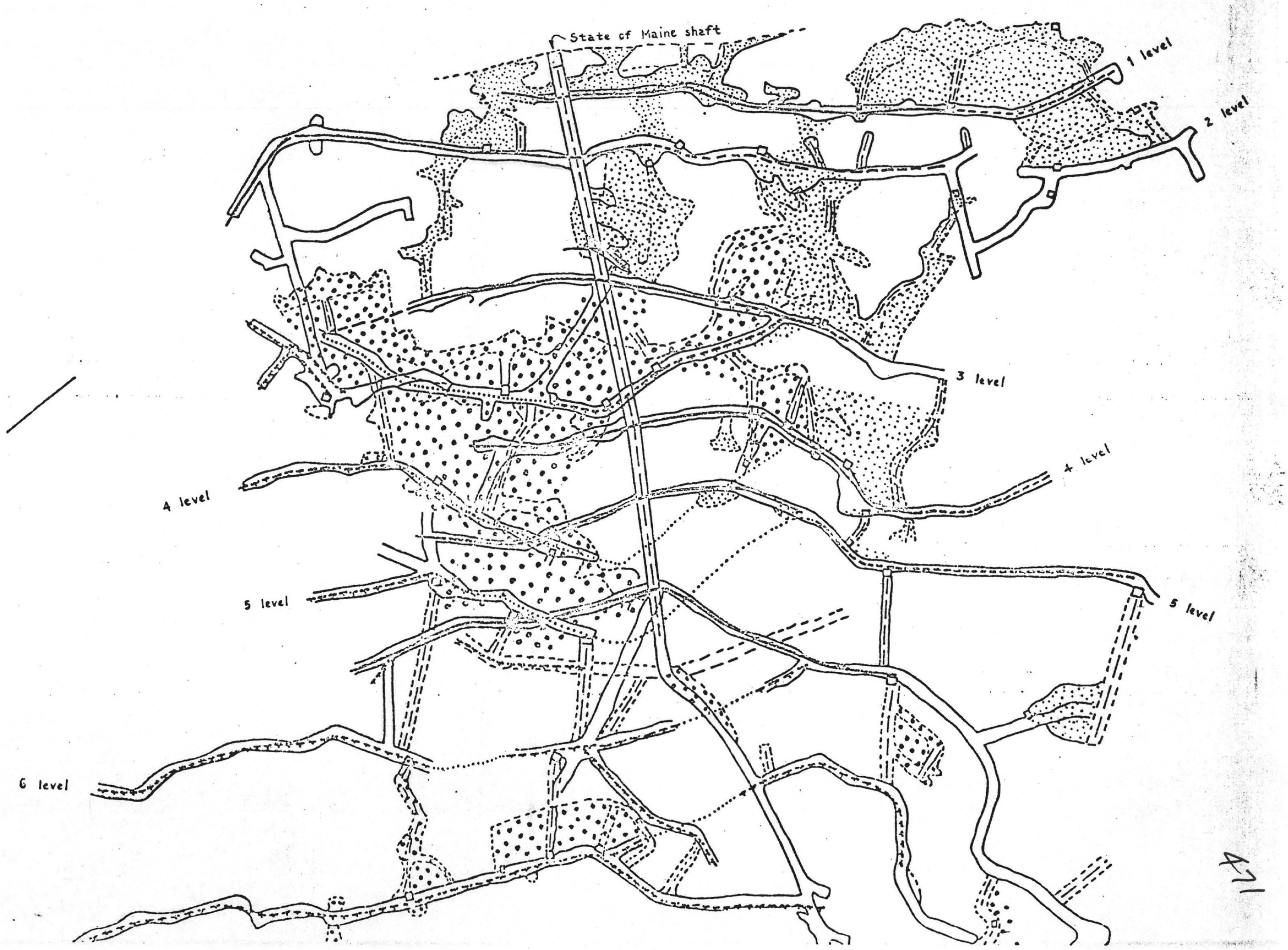
470

E X H I B I T B

"State of Maine"

underground workings

and other data



State of Maine shaft
1 level
2 level
3 level
4 level
4 level
5 level
5 level
6 level

471

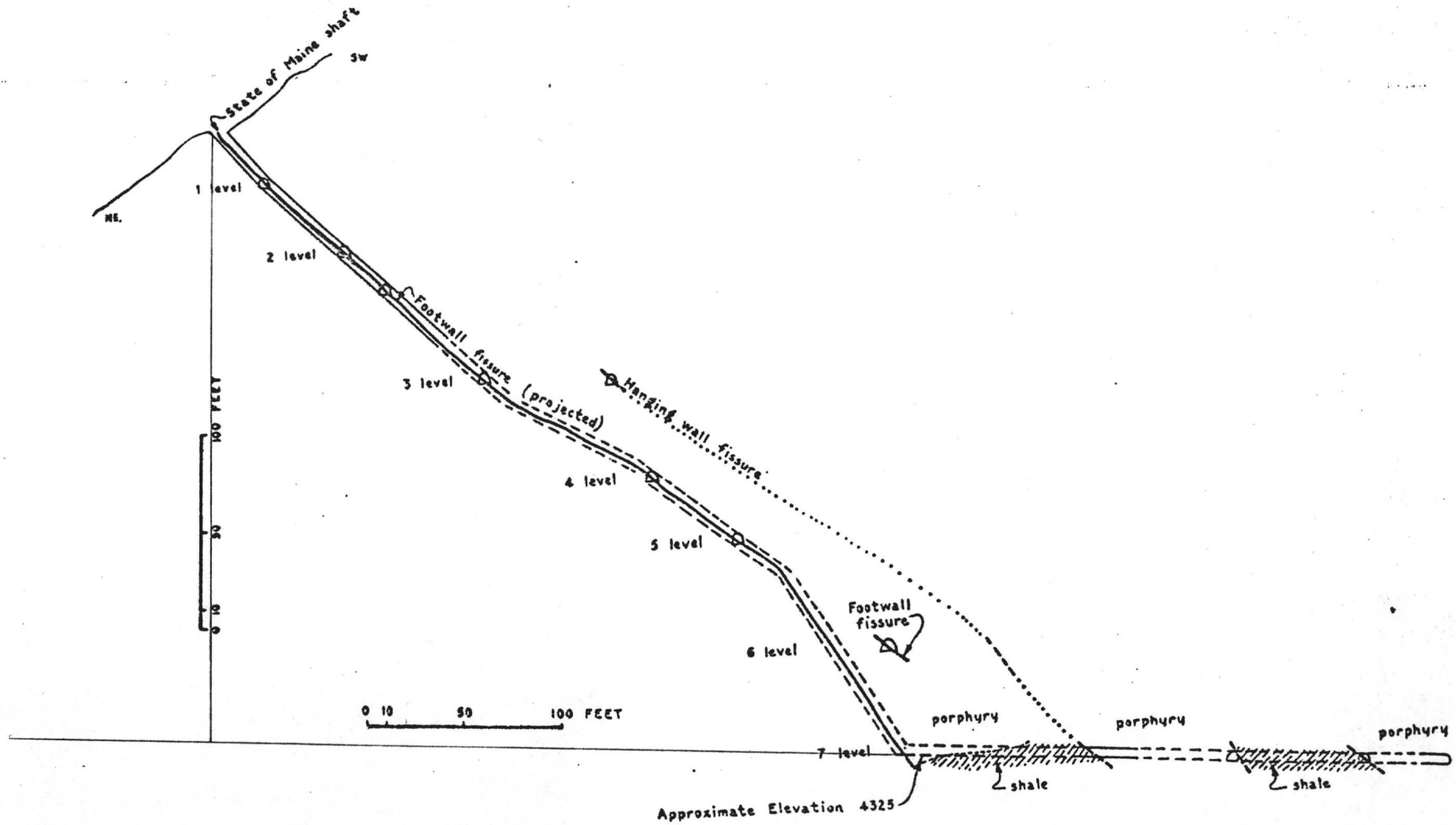
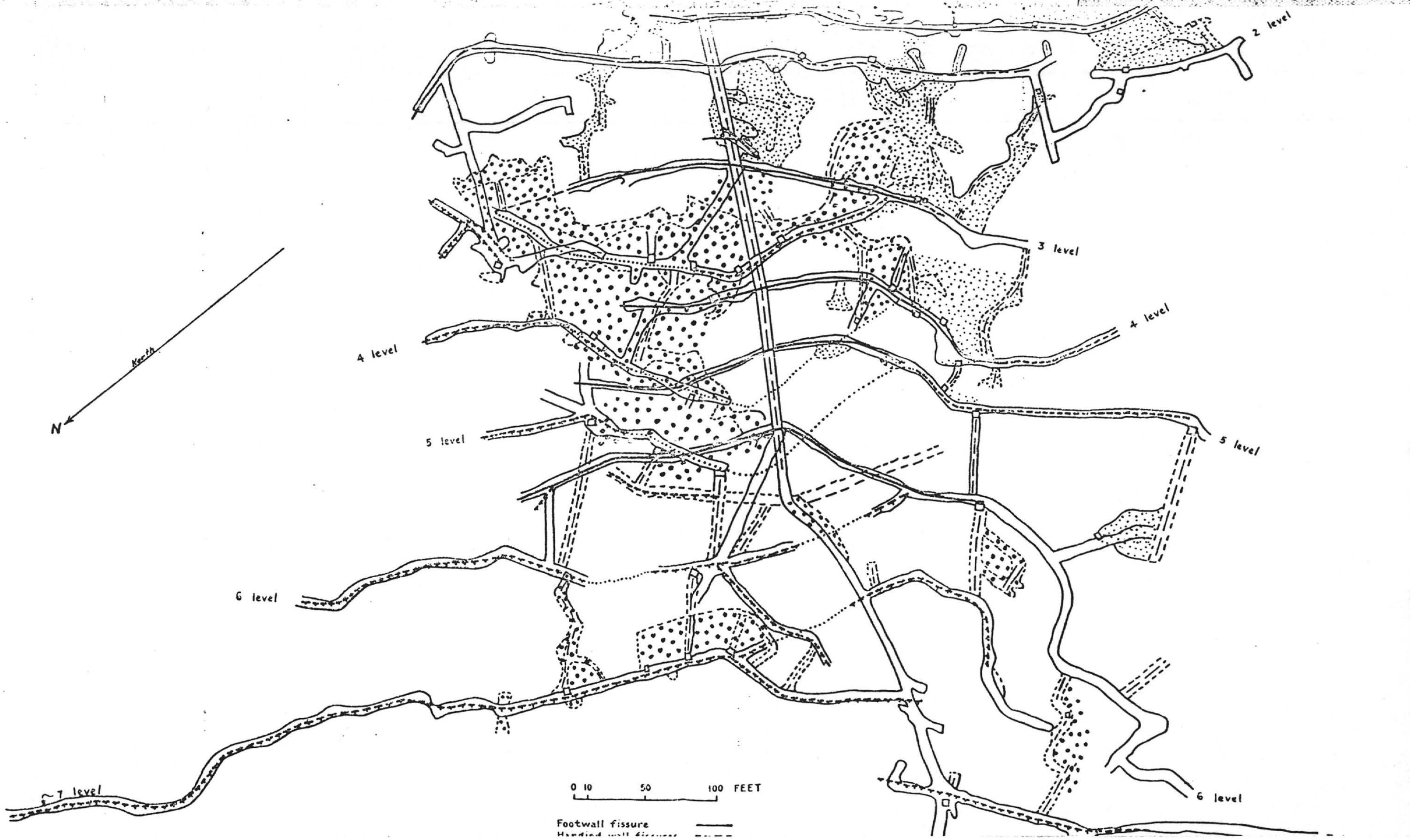
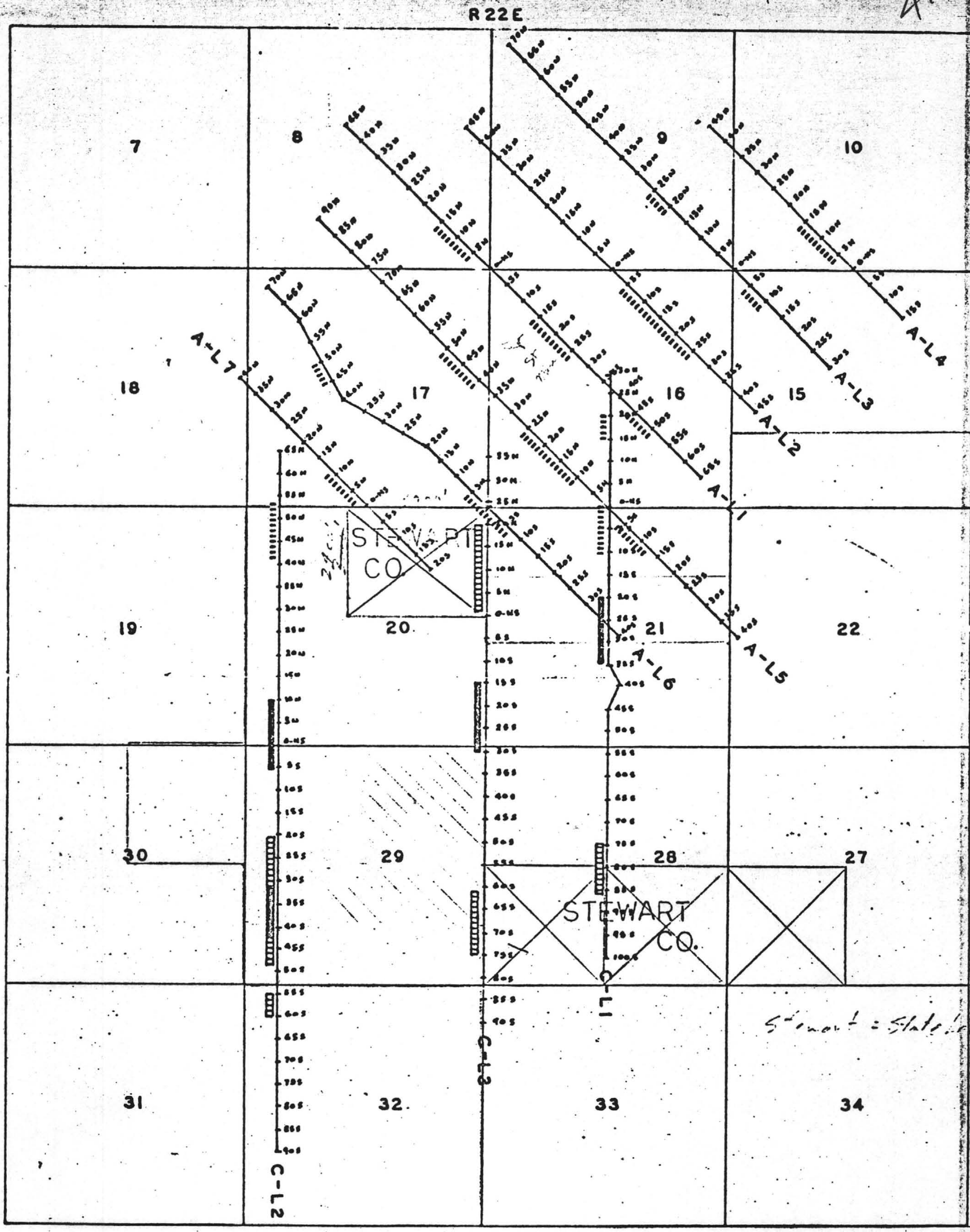


Plate XXVI.—Cross section through State of Maine Mine, looking southwest.



2 level
3 level
4 level
4 level
5 level
5 level
6 level
6 level
7 level
North
N
0 10 50 100 FEET
Footwall fissure

474



INDUCED POLARIZATION AND RESISTIVITY SURVEY
COMPOSITE OF CAB AND AUSTRAL SURVEYS
TOMBSTONE AREA, COCHISE COUNTY, ARIZONA
SCALE 1:24000

STATE LEASE

SUFACE PROJECTION OF ANOMALOUS ZONES
DEFINITE
PROBABLE
POSSIBLE

I.P. LINES
A=AUSTRAL
C=CAB

NOV. 19[illegible]

45

SOUTHWESTERN ASSAYERS & CHEMISTS, Inc.

REGISTERED ASSAYERS

FELIX K. DURAZO
WIL WRIGHT
ARIZONA REG. NO. 5675

P. O. BOX 7517
TUCSON, ARIZONA 85713

710 E. EVANS BLVD.
PHONE 602-294-5811

Austral Oil Company
2700 Humble Building
Houston, Texas

JOB # 002703
RECEIVED 6-27-68
REPORTED 6-27-68

SAMPLE NUMBER	GOLD OZ.*	SILVER OZ.*	LEAD %	COPPER %	ZINC %		MOLYBDENUM %
# 7 fine State of Maine	Nil	4.54					
# 8 State of Maine (course:	Nil	4.94					

REGISTERED ASSAYER
CERTIFICATE 5675
WILLIAM D. WRIGHT
Date Signed
Arizona U. S. A.

CHARGE $ 8.00

476

	CaO % calcium	MgO % mag.	Fe % iron	S % sulphur	SiO_2 % silica	INSOL %	Al_2O_3 % aluminum
6	.52	.30	2.79	.34	72.5	2.8	4.5
Fide. C. S. of M. (?) ⑦	.56	.27	3.06	.22	75.0	11.1	3.9
Sust(C) S. of M (?) ⑧	.65	.22	2.30	.16	73.5	12.7	3.5
9	.93	.23	3.50	.14	76.5	.80	3.4
10	3.95	.39	3.45	.07	70.0	11.7	3.0
11	16.6	.98	3.40	.05	47.50	7.7	4.1
B.J. ⑫	1.99	.65	2.97	.04	67.7	13.1	3.9
13	2.07	.44	3.01	.09	70.7	8.8	5.1

[Seal, partly illegible: Registered ... 5309 (?) Wilbur E. Wright (?) ... Signed ... Arizona U. S. A.]

$ 431.00 less 10% quantity discount of 43.10

dumps (?)

CHARGE $ 432.90

[illegible] Gold and Silver reported in troy oz. per 2,000 lb. ton.

INVOICE

477

SOUTHWESTERN ASSAYERS & CHEMISTS, Inc.

REGISTERED ASSAYERS

FELIX K. DURAZO
WIL WRIGHT
ARIZONA REG. NO. 5875

P. O. BOX 7517
TUCSON, ARIZONA 85713

710 E. EVANS BLVD.
PHONE 602-294-5811

Austral Oil Company
2700 Humble Building
Houston, Texas

JOB # 002740
RECEIVED 7-2-68
REPORTED 7-7-68

SAMPLE NUMBER	GOLD OZ.*	SILVER OZ.*	LEAD %	COPPER %	ZINC %		MOLYBDENUM %
95L: ✓							
190 ND. ✓		.06					
30 S. ✓	Nil	3.00					
50 W. ✓		.34					
433 L:							
105 NW ✓	Nil	2.34					
60 S ✓	Nil	5.24					
175N50W ✓	Nil	.62					
195L:							
76 S ✓	Nil	7.26					
105 ND. ✓	Nil	8.66					
356L 136ND. ✓	Nil	9.28					
356L100 ND. ✓	Nil	1.52					
300L							
77ND. 41W ✓	Nil	8.12					
141L-30S	.003	21.06					
161L 35 NG. ✓	Nil	6.32					
480L							
164S 117W	Nil	Trace					
dumps #12 Brother Jonathan	Nil	1.94					

REGISTERED ASSAYER CERTIFICATE NO. 5875 WILLIAM WRIGHT Date Signed Arizona U. S. A.

st. of Maine

$ 52.00

12/69 418

Doré' beads.

#96	=	17.8 mg	Winze S of M
#97	=	52.3 "	Raise B.J.
#98	=	16.6 "	30' N of S. end 1st level
#99	=	14.3 "	Pilot #2 Heads
#100	=	16.3 "	Pilot #1 Heads
#101	=	8.4 "	10' N of S. end
#102	=	7.0 "	S. side of winze
#104	=	13.0 "	50' N of winze
#108	=	4.0 "	10' N of S. end
#109	=	6.5 "	B.J. S. end.
#110	=	3.3 "	Pilot #1 Tails
#111	=	13.0 "	Point of High Dump B.J.
#118	=	4.0 "	Pilot #2 Tails

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
P.O. Box 50106, 1700 W. Grant Rd., Tucson, Arizona 85703

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION	GOLD oz/ton	SILVER oz/ton	LEAD	ZINC	COPPER	MO	Mn %		
# 1	< 0.005	224.95					0.011		
# 2	< 0.005	146.80					0.009		

TO: Sierra Minerals
4741 East Sunrise Drive
Tucson, Arizona 85718

REMARKS: Single determination

CERTIFIED BY: [signature]

REGISTERED ASSAYER CERTIFICATE 6384 H. E. RICHARD Date Signed Arizona U.S.A.

CHARGES:
PREPARATION $ 1.80
ANALYSIS $ 14.00

ACCT.: SIERRA MINERALS

DATE REC'D: 2/28/73

DATE COMPL.: 3/5/73

tuc 346954

$ 15.80

479

48

EXHIBIT C

"State of Maine"

deep potential

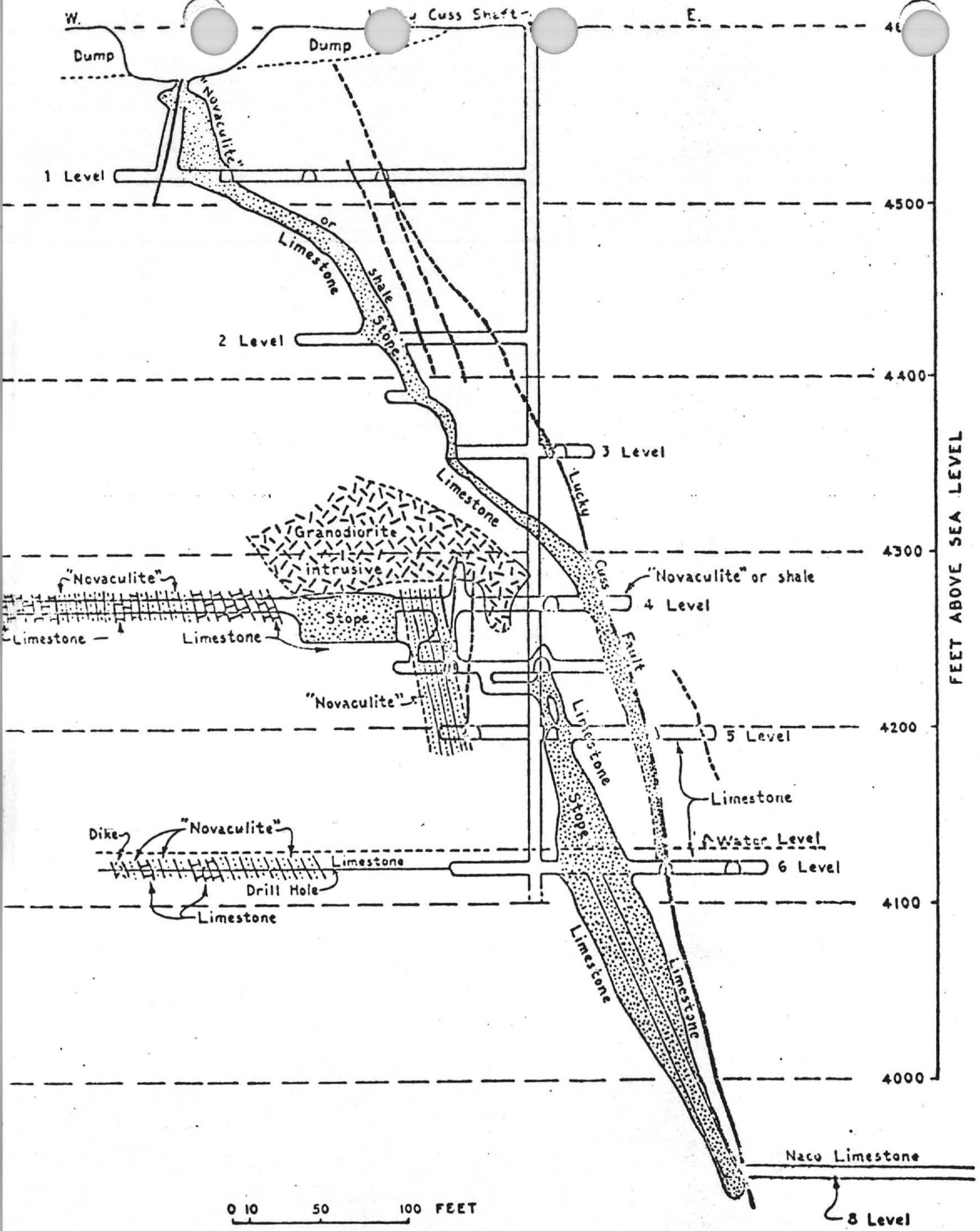
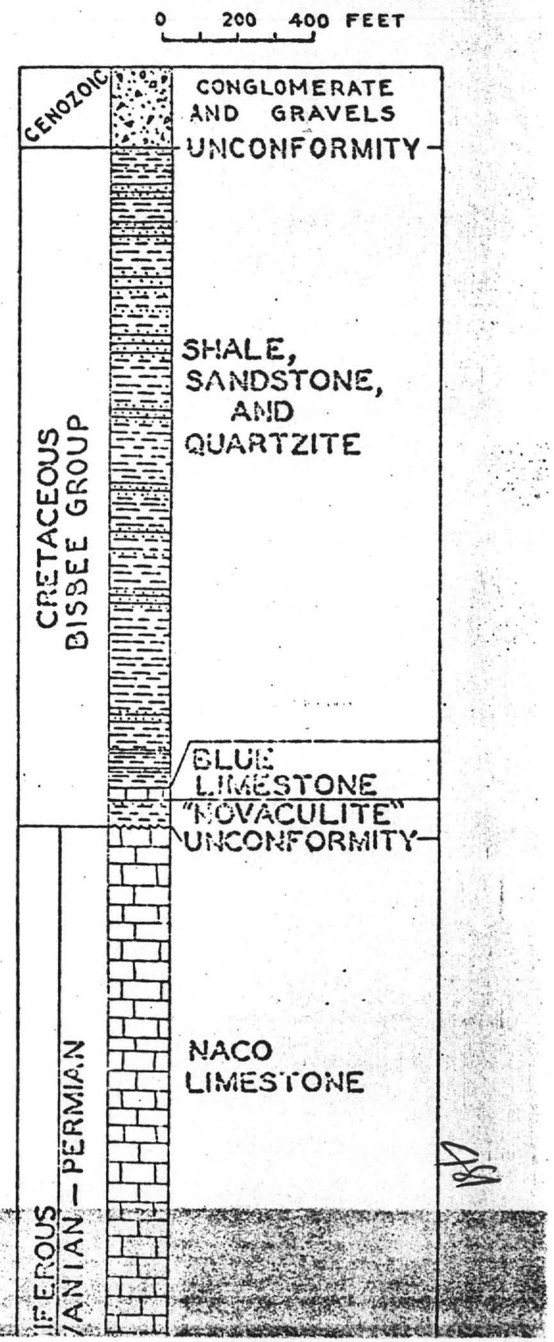


Plate XIII.—Cross section through Lucky Cuss workings at main shaft, looking north. (After F. L. Ransome and C. L. Poindexter.)

GENERALIZED COLUMNAR SECT
TOMBSTONE, ARIZONA



482

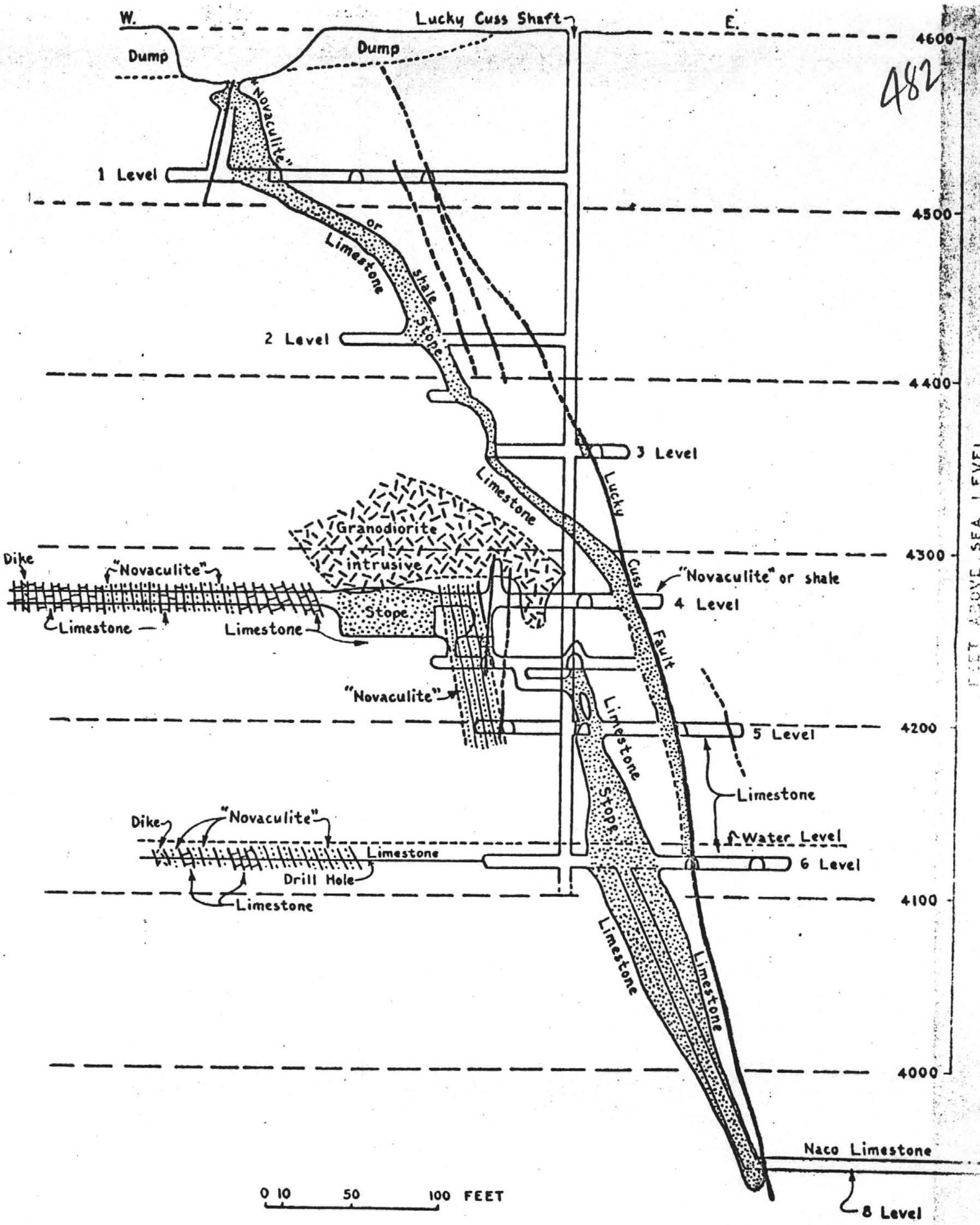


Plate XIII.—Cross section through Lucky Cuss workings at main shaft, looking north. (After F. L. Ransome and C. L. Poindexter.)

GENERALIZED COLUMNAR SECTION
TOMBSTONE, ARIZONA

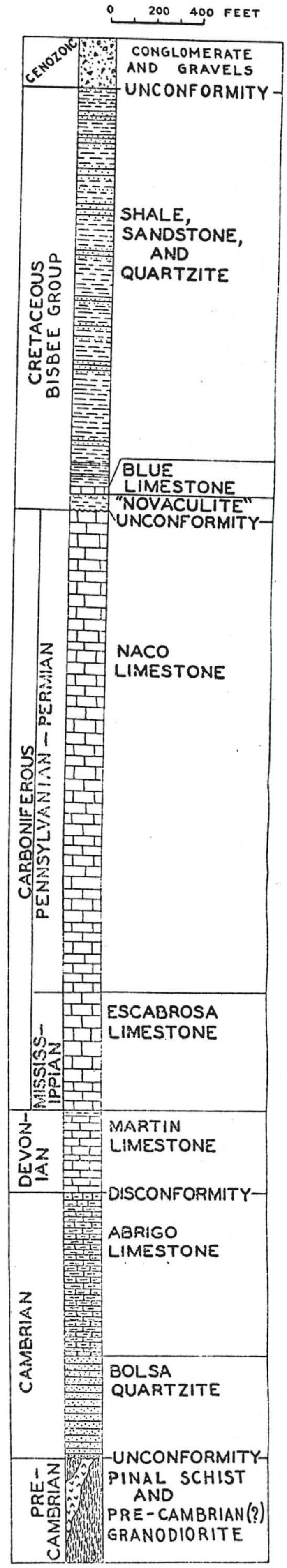
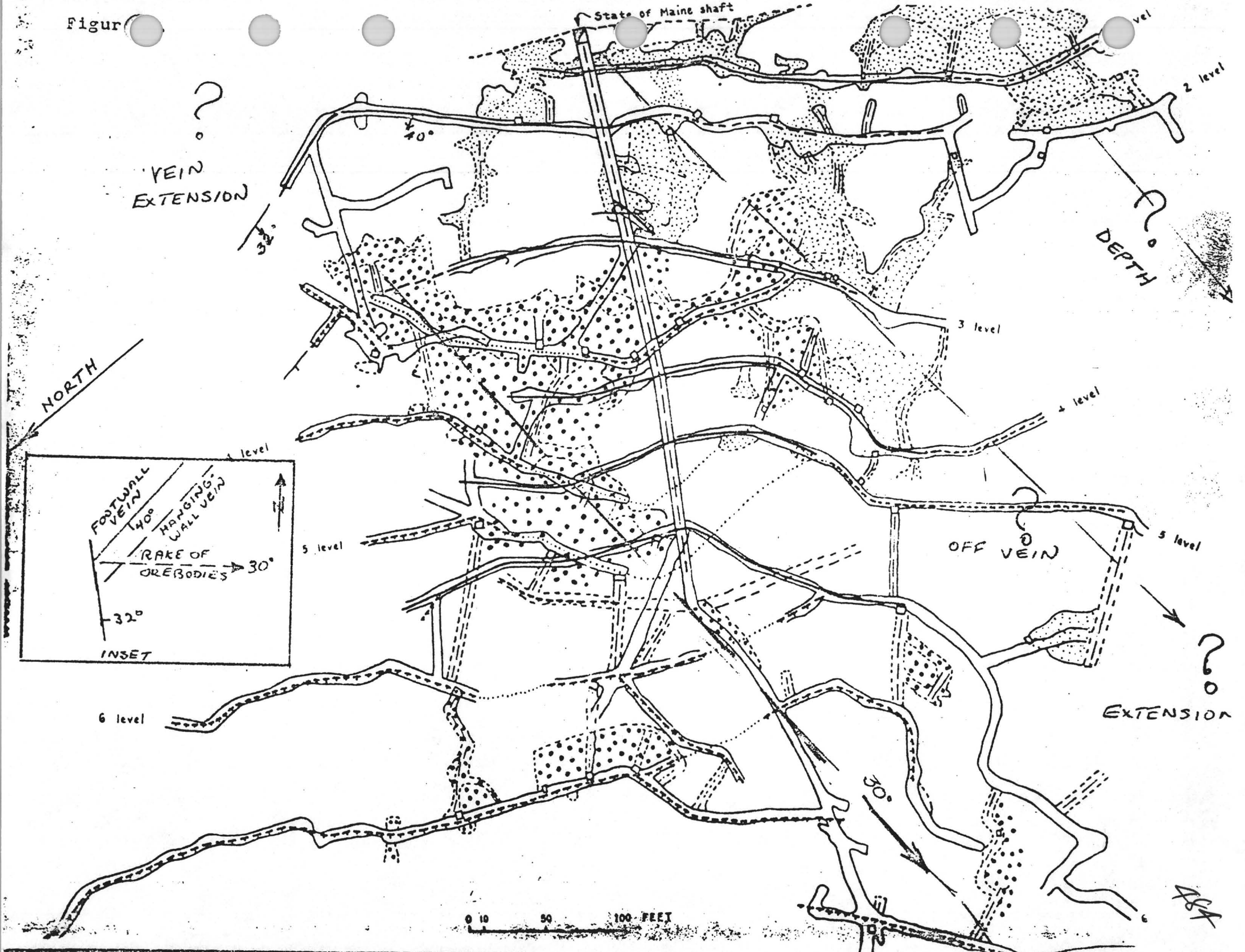


Plate II

Figur


State of Maine shaft
2 level
3 level
4 level
5 level
6 level
40°
32°
30°
?
VEIN EXTENSION
DEPTH
OFF VEIN
EXTENSION
NORTH
FOOTWALL VEIN
40°
HANGING WALL VEIN
RAKE OF OREBODIES
30°
32°
INSET
0 10 50 100 FEET

484

485

E X H I B I T D

Wayne Winters Properties

TOMBSTONE DISTRICT--Solely owned by Winters.

Patented:

Side Wheel--Developed to the point where production could be started from underground on a small scale within five shifts.

Rattling Boy--Ore developed for surface mining where production could begin on the first shift.

Wauban--Minerals only. Can be reached eventually by drifting underground from Side Wheel shaft. Some anomolies (IP) on ridge.

Hugenot--Unprospected in recent years.

Honeycomb--An old working. Some ore showing in 250-foot inclined shaft. Needs thorough prospecting.

Nicholas--An old operation currently undergoing additional exploration. Appears to be an excellent prospect.

TOMBSTONE DISTRICT--Properties in which Winters has an interest.

Sultana patented claim--Owns 10 percent of the mineral rights. A possible prospect. Did produce a little lead carbonates in the early days.

Blue Top Group--Five unpatented claims in Section 15. Associates on these.

Black Beauty Claim--Small fraction that adjoins the Wauban on the east. Associates on this.

HARTFORD DISTRICT--Solely owned by Winters.

Pinetree, New Strike, #2, White Fawh, Mountain Lion, Mammoth, Lost Chance. (Mineral survey #1811). 101.895 acres in Secs. 34 & 35--23 20. Forest Service owns surface. Winters owns patented minerals. (Lutz tunnel, etc.)

ORO BLANCO DISTRICT--Solely owned by Winters.

LAURA Patented lode claim (gold). 20 acres.

Doran's Folly--Unpatented gold placer, 20 acres. Currently contested in United States District Court by the Forest Service.

HEWLETT ASSAYS ??

HEWLETT MANAGEMENT

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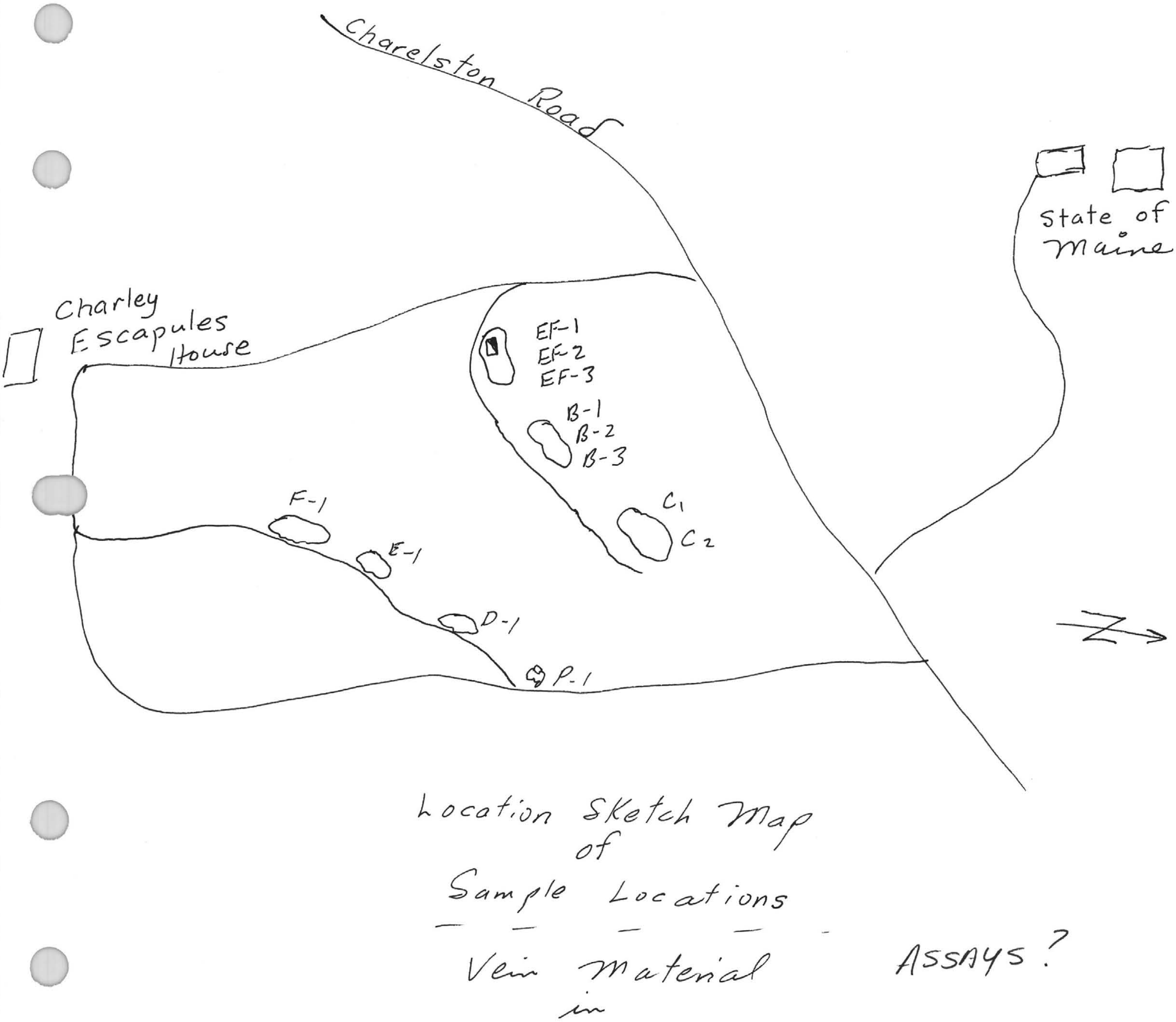


Location Sketch Map
of
Sample Locations

Vein Material
in
Dumps

Assays?

TOMBSTONE

	GOLD		SILVER		
Sample	Cyanide	Fire Assay	Aqua Regia	Cyanide	Fire Assay
Side W.heel South D.	.013	-	.00	.00	-
Side W. Center D.	.013	-	.00	.00	-
Side W. Shaft	.017	.025	.00	.00	9.14
Em.erald Dump	.000	-	.00	.00	
Mn	.000	.010	.00	.00	3.49
Nicolas Dump-Top	.000	.010	.00	3.03	3.89
Nicolas Dump-Bottom	.007	.005	.63	3.07	1.49
RFH; D-1	.010	.005		.63	5.60
RFH; F-1	.033	.005		2.83	19.22
RFH;					
Dumps A	.010			1.57	
Dumps B	.020			1.40	
Dumps C	.003			2.83	

TOMBSTONE

SKYLINE LAB

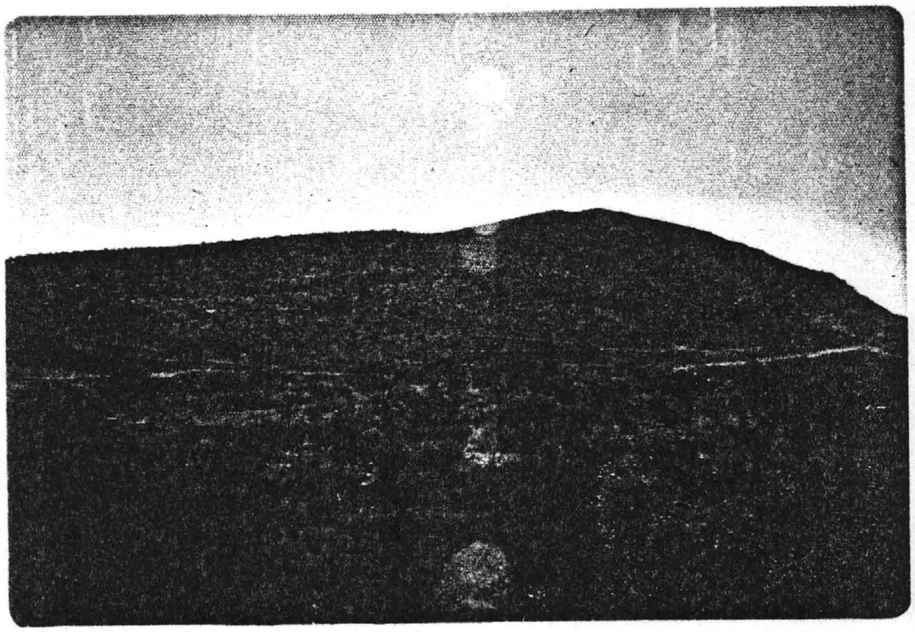
SAMPLE	COPPER	LEAD	ZINC	IRON	MANGANESE	GOLD	SILVER
RFH; DUMP F-1	2,600	10,000	9,500	9.0%	20.4%	.005	19.22
RFH; DUMP D-1	-	-	-	7.4%	10.1%	.005	5.60
NICOLAS; DUMP- MN	-	-	-	1.6%	21.5%	.010	3.49
NICOLAS; DUMP- TOE	385	-	-	1.3%	1.17%	.005⁻	1.49
NICOLAS; DUMP- TOP	730	-	-	1.8%		.010	3.89
SIDE W.; DUMP- NORTH	-	-	-	2.0%	16.2%	.025	9.14
	ALL PPM;			ALL %		TROY OUNCES/TON	

10,000 PPM= 1 %

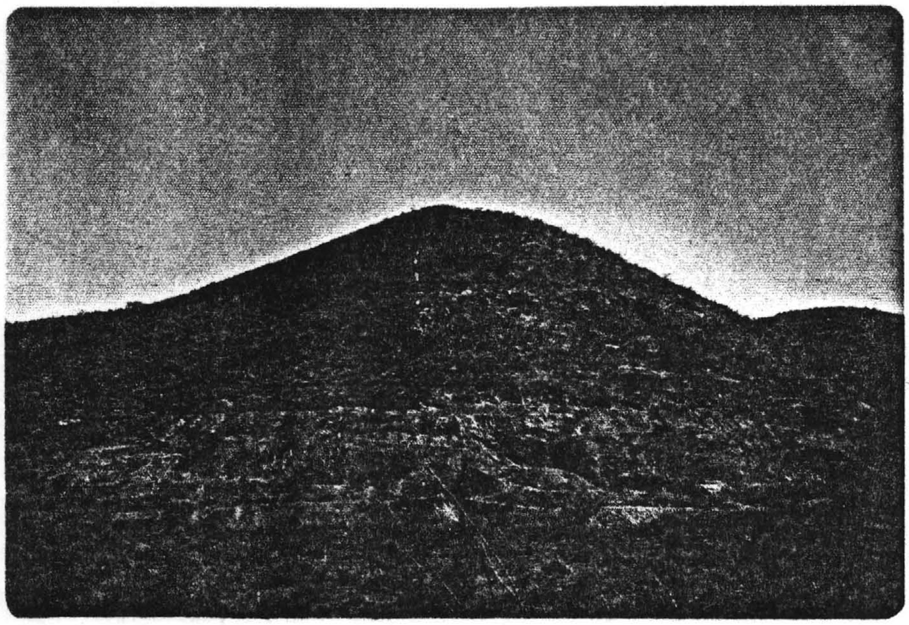
= 20#/TON

EMERALD MINE/DUMP
(LOOKING SE).
SIDEWHEEL TO
RIGHT-CENTER

SIDEWHEEL-
RATTLING BOY
AREA

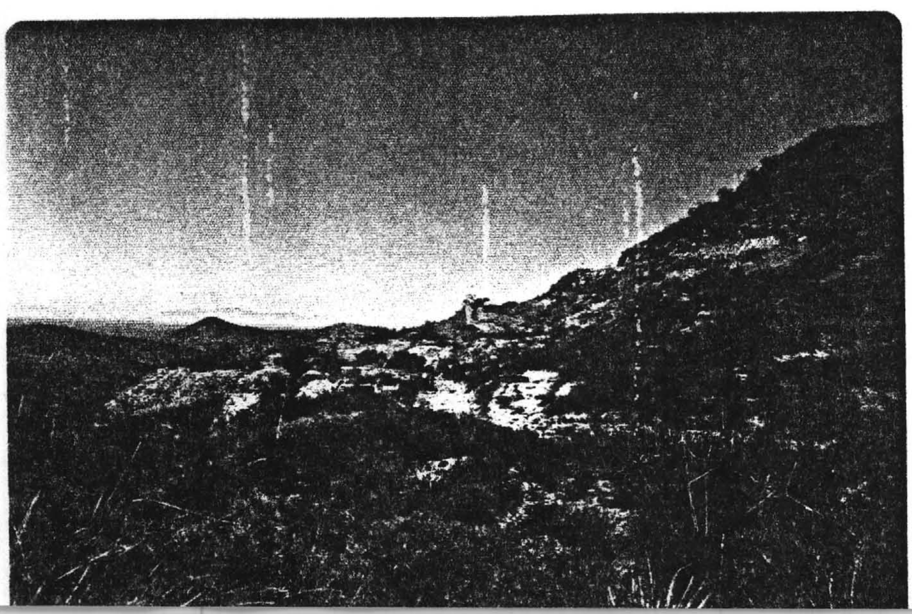


SIDE WHEEL
LOOKING SOUTH



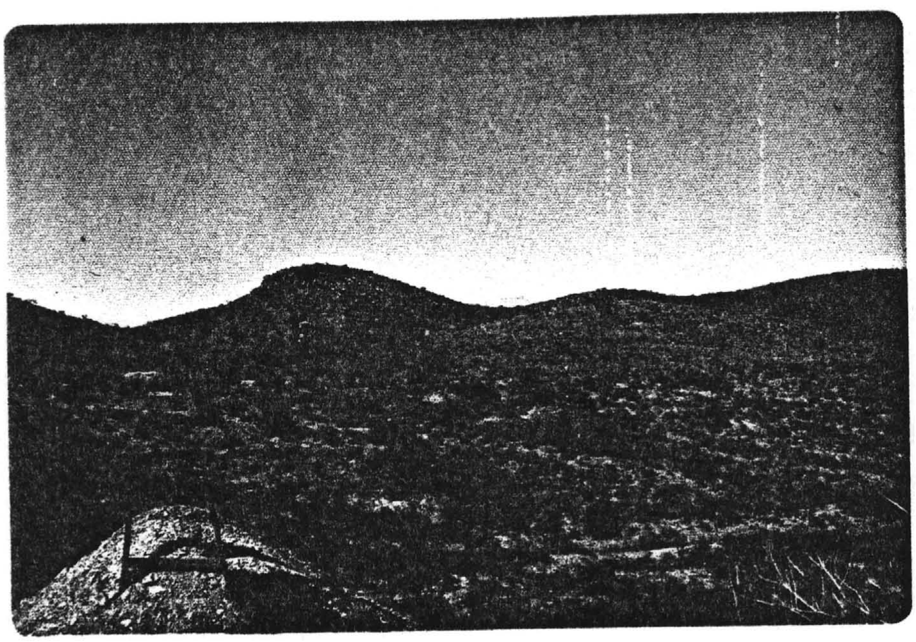
SIDE WHEEL
LOOKING EAST

SIDE WHEEL
LOOKING EAST



SIDE WHEEL
LOOKING NORTH

Famous Nicolas Mine with Head-Frame in Center



Looking west from Side Wheel to Nicolas Area.

Hewitt Report (1974?)

1974?

METALLURGICAL TESTING

Tombstone problem ore types classified by leaching characteristics are as follows:

1. High-iron and clay;eastern portion of District from the Empire to Grand Central along the Contention Dike.

2. Sulfide ores

3. Argentojarosite

4. Manganese carbonate-oxide minerals

5. Silicious interstitial minerals

6. Carbonaceous ores

7. Oxidized sulfide ores.

These ore types cause serious precious metal recovery problems when using cyanide.

In addition to the chemical-mineralogical problems caused by these ore types, physical problems that cause poor recovery when '71 Minerals leached the heap are:

1. Clays and fines caused blinding and would not percolate.

2. Coarse ores could not leach into the rock;values locked inside the rock were not exposed to leaching.

Screen analysis of various coarse and fine fractions of the ore from all of the dumps appears in the ore reserve section. Notice that there are good values in the coarse;it is economical to crush and re-leach;"IPS" will yield high recovery of the crushed ore.

Cyanide

Ore from the Contention area (no manganese) was sampled and one split was digested with acid (aqua regia) and an equal split was digested with cyanide. Results from 24 tests show that cyanide recovered only 35% of the precious metal values (see the following table). Careful study of these results show that the acid digest recovered about 6½ fold more gold than the cyanide digest. However, the cyanide digest recovered 1¼ fold more silver than the acid digest. This is due to:

A. Cyanide does not break down the encapsulating carbonates that prevent the gold from complete leaching.

B. Acid breaks down silicious gold ores that cyanide does not chemically attack.

C. Acid breaks down gold-limonite-clay complexes that are only slightly effected by cyanide.

D. Silver nitrate formed with aqua regia is partially precipitated by the chlorine ion (from the hydrochloric acid); silver cyanide complex is more stable than the gold chloride complex. Ag

Manganiferous ores were leached with cyanide and aqua regia. Emerald ores were the very fine ore, and showed that cyanide leached only 11% of the gold leached by the acid.

Sodium thiosulfate

Sodium thiosulfate is an effective solvent for silver. Following are the results:

Concentration (gr/l)	Silver Leached (t.oz./ton ore)	Troy Oz. Ag per Gr. Hypo per liter
20	1.33	.067
10	1.23	.123
5	1.00	.200
2½	.73	.292
1¼	.48	.384
.625	.32	.512
.3125	.22	.704

TOMBSTONE
Solvent Comparison

Sample Location	ACID Aqua Regia Gold	ACID Aqua Regia Silver	BASE Cyanide Gold	BASE Cyanide Silver
	Precious Metal Recovery (t.oz./ton ore)			
1-Heap/Dump	.105	.24	.003	.15
2-No. Ramp(N)	.075	.30	.009	.27
3-No. Ramp(S)	.090	.42	.030	.45
4-Dump	.075	1.14	.009	1.56
5-Dump,small	.090	1.02	.024	1.65
6-Dump,larger	.180	.69	.015	1.08
7-Dump, LN.	.150	1.05	.015	3.75
8-Large Dump	.150	.30	.009	.36
9-Dump-south	.150	.30	.012	.06
10-N. end pad	.075	.21	.009	.24
11-Y-gate	.267	.54	.015	.27
12-PT;west	.081	1.05	.030	1.98
13-PT;W/M	.048	2.67	.015	1.02
14-PT;M	.120	1.68	.015	2.76
15-PT;E	.075	1.02	.027	1.17
16-PT;Rojo	.075	.99	.003	.24
17-L.Cont(S)	.207	1.95	.057	3.48
18-L.Cont(N)	.120	.93	.012	.69
19-P.Shaft(E)	.120	.24	.018	.27
20-P.Shaft(W)	.072	.27	.027	.48
Flora Morrison	.264	.69	.006	.09
Tailings	.096	.84	.030	1.20
Cont.Dump(W)	.120	1.74	.024	1.26
Cont.Dump(E)	.102	1.08	.039	2.28
	.121	.89	.018	1.12

This is very similar results to that produced previously with Tombstone ores(see Metallrgical Testing Section).

Also, notice the similar leaching rates and recoveries of Hypo and cyanide.

It was also shown that a weak Hypo solution and cyanide in combination leached about the same amount of silver, but Hypo and cyanide leached 150% more gold than cyanide.

Using .5 grams/liter Hypo leach solution, we have obtained for many days a .25 t.oz. silver preg, which conforms with our leaching tests.

Halide-Sodium Hypochlorite System

Halide-sodium hypochlorite systems have been proven an effective solvent for Tombstone ores. Also, a halide-sodium hypochlorite system is a very effective pre-treatment prior to cyanidation.

For all Tombstone ores, pre-treatment with NaCl-NaOCl increases the gold and silver recovery by over 200%.

The following graph presents silver solubility test results for Tombstone silver ore in a 3% NaOCl solution with various amounts of salt(chloride ion). It is obvious that salt is important for our pretreatment.

Refractory Silver Minerals

Silver Sulfide Ores;

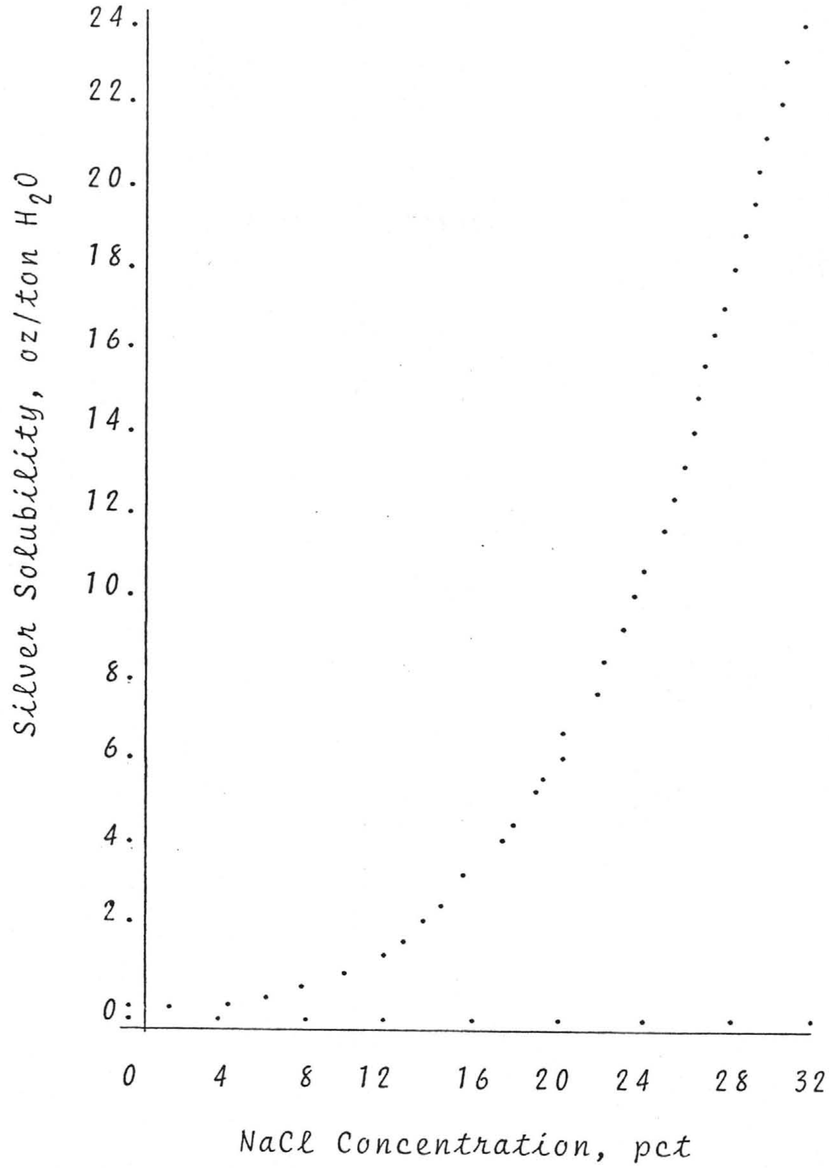
Silver sulfide minerals can be converted to soluble silver chlorides by sodium hypochlorite-brine leaching system. Argentite is leached in an oxidizing brine by:

$$Ag_2S + 4OCl^- = 2AgCl + SO_4^{=} + 2Cl^-$$

Silver chloride is soluble in either a cyanide solution as a cyanide complex or in a brine solution containing excess chloride ion as the tetrachloro complex, as:

(1). $AgCl + 2CN^- = Ag(CN)_2^- + Cl^-$

(2). $AgCl + 3Cl^- = AgCl_4^{-3}$



Solubility of silver ores from Tombstone in a 3% NaOCl solution with varying NaCl.

Manganiferous Ores;

There are basically two oxide manganese minerals, as:

Mn Valence	Formula
II	MnO
IV	MnO_2

In order to dissolve the above, the following acids are required:

Mn(IV)	.....	Reducing Acid -----	H_2SO_3
Mn(II)	.....	Any Acid -----	H_2SO_4

The reaction for such a system can be expressed as follows:

$MnO_2 + SO_2 + MnSO_4$

Solid Gas Aquous

$H_2O + SO_2 + \frac{1}{2} O_2 = H_2SO_4$

Gas Gas Aquous

Also, the oxide iron minerals would be soluble in an acid media:

$Fe_2O_3 + 6H^+ = 2Fe^{+3} + 3H_2O$

PRE-TREATMENT

"Pre-Treatment" has come to mean anything done to an ore before cyanidation. However, it may not be required or desireable to use cyanide as the final gold solvent.

Common "problem ores" at Tombstone are as follows:

A. Ore with precious metal values more uniformly distributed within the competent rock than on fractures (or fracture planes). This is only a problem for heap leaching; crushing can now be done for maximum value liberation and IPS is used to enable excellent perculation during heap leaching.

B. Dump or other ores with clay and fines that inhibit percolation in heap leaching; IPS allows percolation.

C. Acidic kaolinitic clays (common along the Contention Dike) are real pH problem for using cyanide, as well as the poor percolation in heap leaching problem. IPS solves the percolation problem, while non-cyanide solvents are by far more economic.

D. Montmorillinite clays are common at Tombstone because they form in limestone environments (see Clay Technology section at end of "IPS"/next chapter). These clays cause blinding.

E. The oxygen has been consumed in the heap by copper forming a cuprous cyanide complex. Also, the height of a 100 feet contributes to the depletion of oxygen lower in the heap as solutions percolate in depth.

F. Manganiferous ores have gold and silver "locked" mineralogically.

PRE-TREATMENT
of
Various Problem
Precious Metal Ores
for
HEAP LEACHING

Size/Value Distribution	Mineralogy
Permeability	Physio-Chemical
Disseminated-Open Pit	Carbonaceous Ore
Dump Ore; Clay/Fines	Refractory Ores
Acidic Kaolinitic Clay	Sulfide Minerals
Tailings	Tellurides

Drilling & Blasting!!!

Loading

+ Degree of Crushing Analysis +
+ Selection +

Crushing

Application of IPS Solution

Spray on Ore Truck

Spray on Conveyor Belt

Hauled by Truck

Elevated onto Heap

Ore "Heaped" onto Pad

Application of IPS Solution

Spray while Dozer is pushing, leveling, and ripping

Curing-"Set"

Ore Mineralogy

Ore pH/E_h

Carbon-Bond Polymers

Oxidants

+IPS Analysis+
+ Selection +

Flocculant

+Reagent and Gold+
+Solvent Analysis+
+ Selection +

Spray Heap

Collect Effluent
Preg Pond

Recover Values in Plant
Ion-Exchange Resins
Sodium Sulfide (Ag)

Carbonaceous and Reducing Ores

The organic material in the Tombstone ores creates a problem similar to Tombstone gold and silver ores that are in an oxygen deficent environment in the heap (reducing environment).

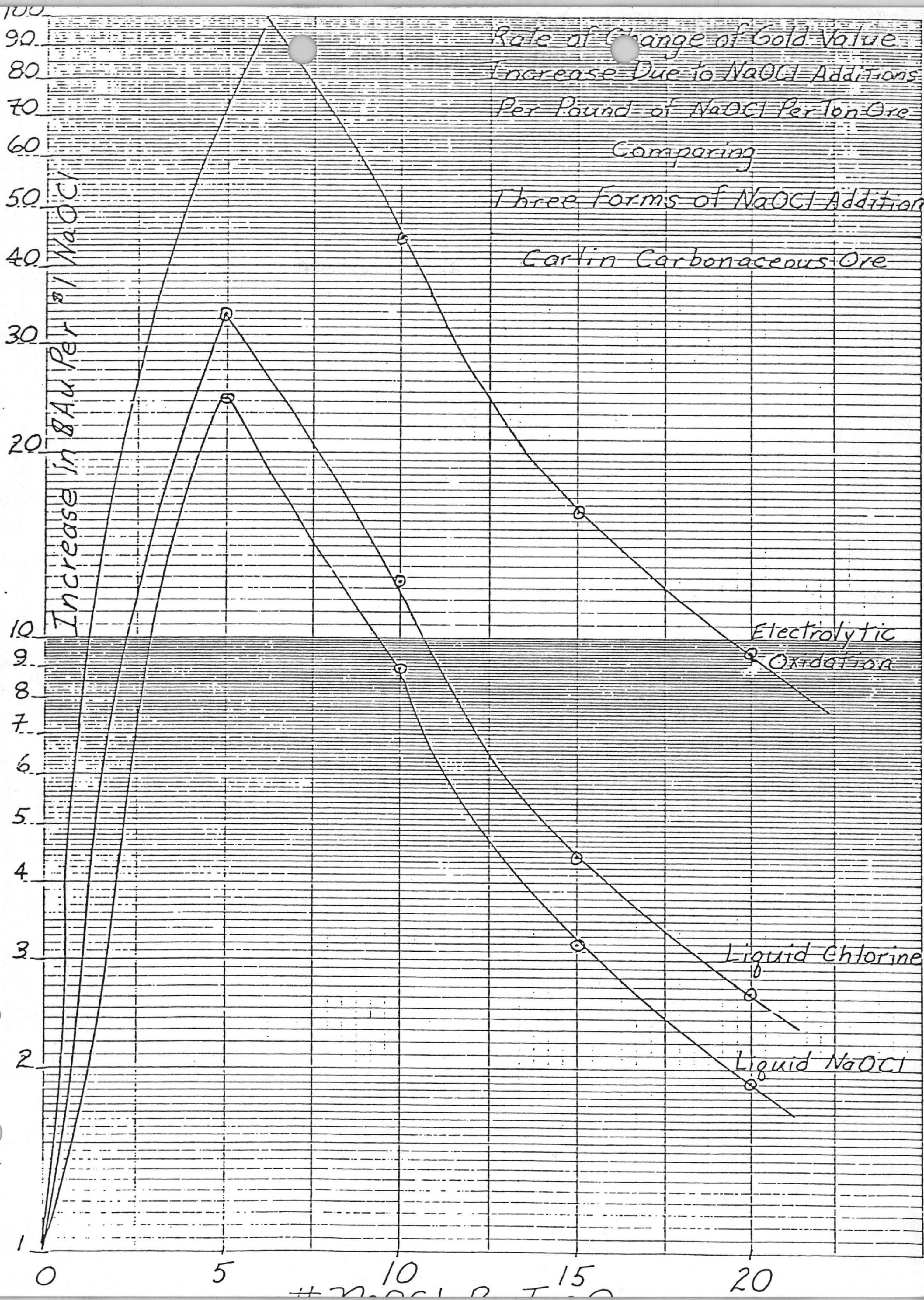
The degradation of organic substances buried in fine-grained sedimentary rocks depends upon the depth of burial and the Geothermal Gradient. This temperature-time relationship is also affected by the exhaustion of available oxygen, lowering the E_h of the sediment. The oxidation reaction takes place faster than the decarboxylation of this organic matter, making oxidation a better choice of pre-treatment than chemical break-down. Total dehydrogenation of organic (carbon bond) substances results in graphite. Other substances produced are fats, carbohydrates, proteins, and amino acids.

The problem basic to the leaching of carbonaceous and reducing ores is that when cyanide is used, the gold-cyanide complex ($Au(CN)_2^-$) is absorbed by the carbon components in the ore. Most tests run on carbonaceous ores show that only about 30% of the gold can be extracted by using a cyanide leach. Because this is on crushed and pulverized ore for mill treatment, that recovery (30%) makes milling uneconomical. Carbonaceous limestones and shales at Tombstone exhibit this phenomeon.

Newmont has applied a technique developed by the U.S. Bureau of Mines at their Carlin gold mine. They use sodium hypochlorite as an oxidant. I have used hypochlorite for this same purpose for the last several years, and it is clearly one pre-treatment reagent that is effective on reducing and other carbonaceous ores. In fact, the use of salt (NaCl) as a source of chlorine was used for gold leaching before the development of cyanide (pre-1900). There are three ways to add hypochlorite to an ore for pre-treatment, which are:

1. Add sodium hypochlorite directly in solution
2. Add liquid chlorine directly
3. Add hypochlorite by in situ generation

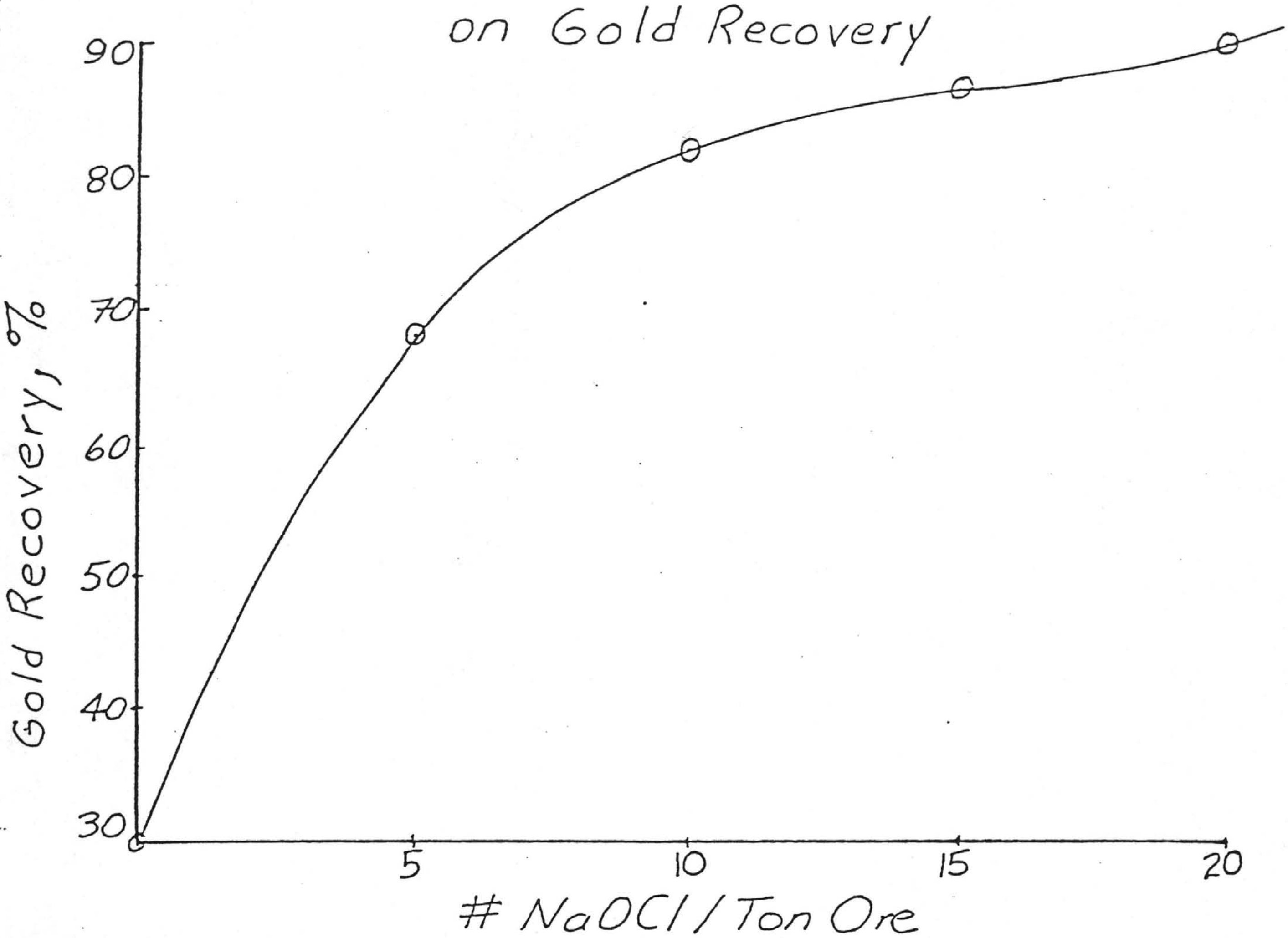
The following figure presents the increase in gold value due to the hypochlorite pre-treatment for Carlin carbonaceous ores. Note that in addition to showing the response of the ore to pre-treatment, I have compared the economics of the three methods of pre-treatment using hypochlorite.

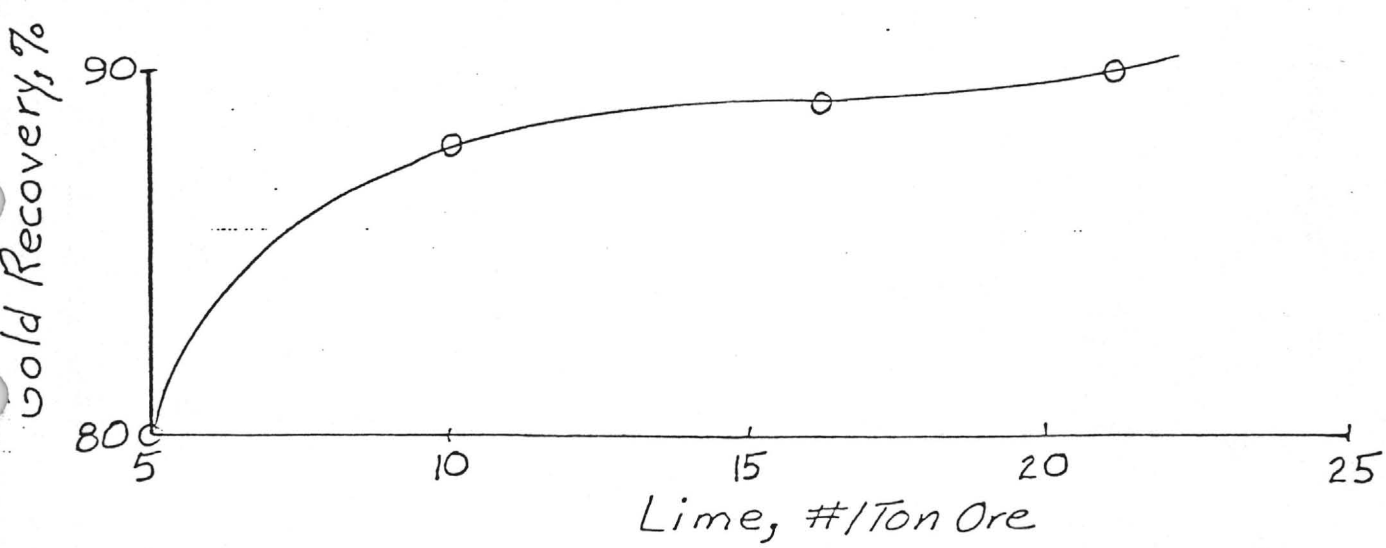


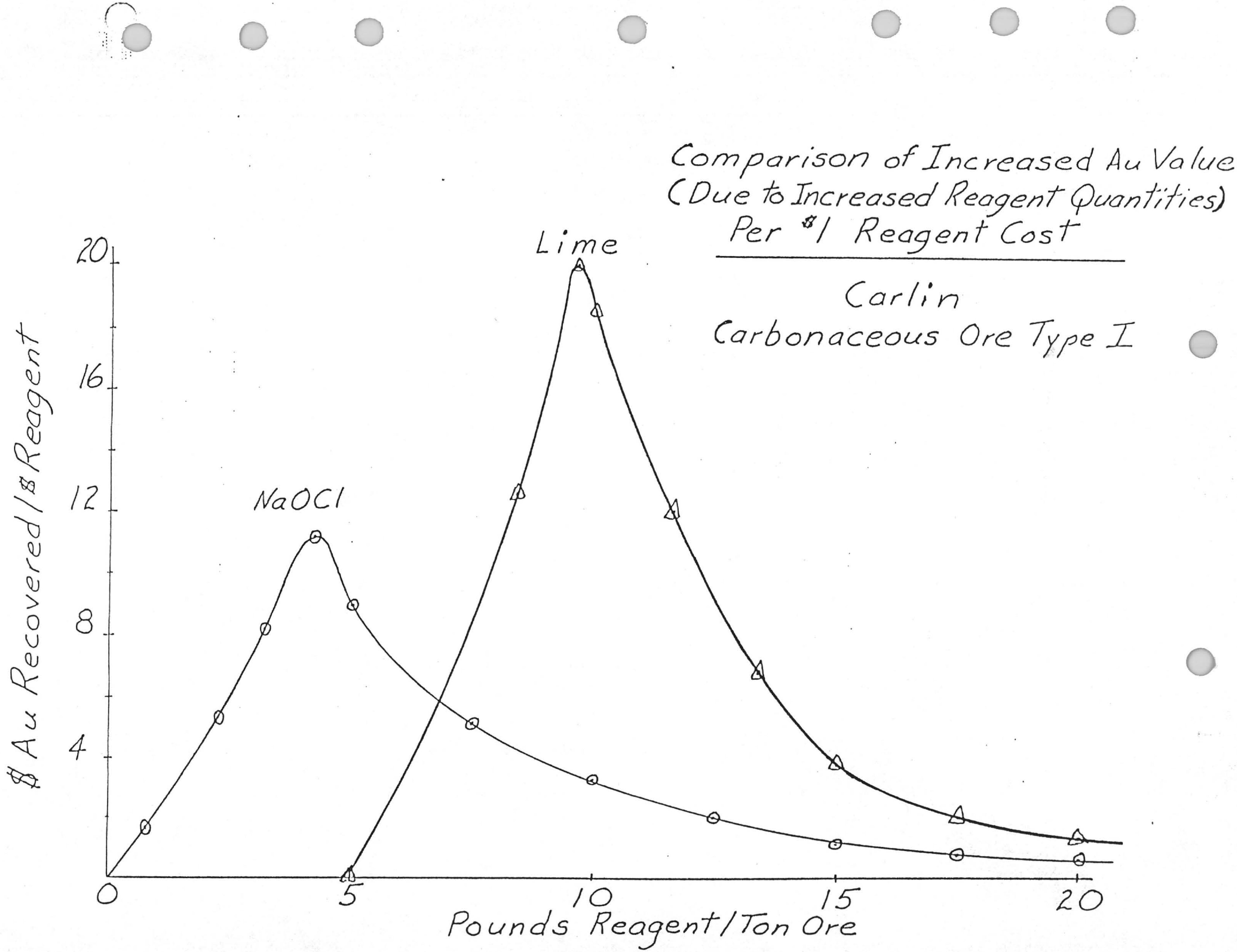
Rate of Change of Gold Value
Increase Due to NaOCl Additions
Per Pound of NaOCl Per Ton Ore
Comparing
Three Forms of NaOCl Addition
Carlin Carbonaceous Ore
Increase in $Au Per #1 NaOCl
Electrolytic Oxidation
Liquid Chlorine
Liquid NaOCl
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0
5
10
15
20

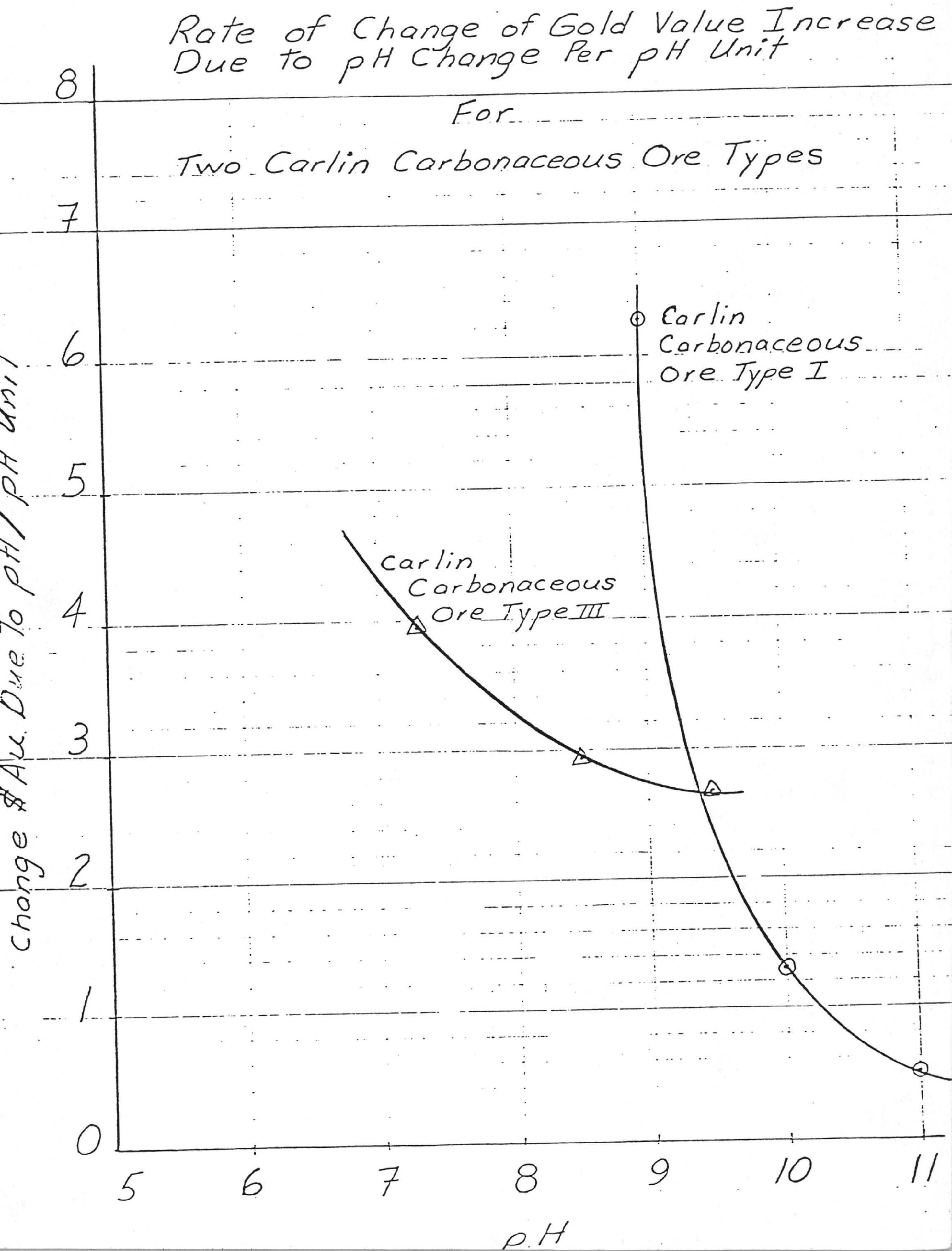
Carbonaceous Ore

Effect of Quantity of NaOCl & Lime on Gold Recovery






Comparison of Increased Au Value
(Due to Increased Reagent Quantities)
Per $1 Reagent Cost
Carlin
Carbonaceous Ore Type I
Lime
NaOCl
$ Au Recovered / $ Reagent
20
16
12
8
4
0
5
10
15
20
Pounds Reagent / Ton Ore


Rate of Change of Gold Value Increase Due to pH Change Per pH Unit
For
Two Carlin Carbonaceous Ore Types
Carlin Carbonaceous Ore Type I
Carlin Carbonaceous Ore Type III
Change $ Au Due To pH / pH Unit
pH
0
1
2
3
4
5
6
7
8
5
6
7
8
9
10
11

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BASIC METALLURGY

Pre-Treatment

A. Oxidized Sulfides

Sulfuric acid is formed when water is circulated over the ore on the heap. The amount of oxidized sulfides present determines the increase in acidity due to the addition of water(circulation). For example, the pH of the "leaching-water-source" could start at 6 and then lower to 5 due to the H_2SO_4 formed in the circulation solution.

An effective utilization of the acid solution as a solvent is by adding salt.

The $H_2SO_4 + NaCl = HCl + Na_2SO_4$

The formation of HCl is useful as follows;

1. There are numerous silver compounds that are soluble in acids and not NaCN
2. The ore then consumes the acid and the pH becomes more basic.

B. Un-Oxidized Sulfides

Acid pre-treatment solvents that dissolve silver sulfides are;

Mineral	Solvent
Argentite	HCl
Acanthite	H_2SO_4
Both of above	NAOCl

SILVER COMPOUNDS SOLUBLE IN ACID SOLUTIONS BUT NOT CYANIDE

Name	Formula
Silver acetylide	Ag_2C_2
" orthoarsenate	Ag_3AsO_4
" orthoarsenite	Ag_3AsO_3
" benzoate	$AgC_7H_5O_2$
" bromate	$AgBrO_3$
" carbonate	Ag_2CO_3
" chlorate	$AgClO_3$
" perchlorate	$AgClO_4$
" ferricyanide	$Ag_3Fe(CN)_6$
" fluride	AgF
" fluosilicate	$Ag_2SiF_6 \cdot 4H_2O$
" fulminate	$Ag_2C_2N_2O_2$
" iodate	$AgIO_3$
" mercury iodide(ic)	$2AgI \cdot HgI_2$
" nitrate	$AgNO_3$
" nitrite	$AgNO_2$
" nitroprusside	$Ag_2Fe(CN)_5NO$
" peroxide	Ag_2O_2
" palmitate	$AgC_{16}H_{31}O_2$
" metaphosphate	$AgPO_3$
" propionate	$AgC_3H_5O_2$
" salicylate	$AgC_7H_5O_3$
" selenide	Ag_2Se
" sulfate	Ag_2SO_4
" (Pyrargyrite)	Ag_3SbS_3
" (Proustite)	Ag_3AsS_3

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C. Base Metals

Copper oxide minerals(including sulphates, carbonates, etc.) are soluble in both sulfuric and hydrochloric acids. It is very important not to get copper in the zinc-precipitation system because copper retards silver precipitation(replacement) and the refinery will penalize for copper content.

Lead salts interfer with the zinc precipitation from a cyanide solution.

These will settle during the acid phase, but enough settling time must be allowed.

Solvent Selection

A. Sodium chloride (NaCl)

Use of salt was discussed in pre-treatment. Free chlorine ion is very important for good dissolution of silver and gold. Higher recovery is obtained in the cyanide phase by using weak salt solutions.

B. Sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$)

Sodium thiosulfate is a very effective solvent for silver. I have extensively utilized "hypo" on a commercial scale at Tombstone for leaching underground and circulating to the plant at 60 GPM for about 6 months. Hypo does not interfer with cyanide;they can be used together. Hypo can be used in a pH range of 3 to 12. For numerous reasons, Hypo should be used in very weak solutions; its dissolution rate for silver and its decomposition rate. Also, sunlight effects Hypo. However, it can very effectively and economically be utilized.

Following are the results of composite halide silver ores(Tombstone, Reville, Packard, & Candelaria) that have been tested with Hypo.

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C. Sodium hypochloride (NaOCl)

Sodium hypochloride is an effective solvent for oxide minerals as gold and silver. Also, it is a good oxidant and a strong base; in a 14% solution the pH is 12.5. Sodium hypochloride is a good solvent to use in the pre-treatment phase because if it follows the use of salt, the oxidation acts like HNO_3 in changing the valence and gold(as well as silver) dissolves-just like aqua regia.

Utilization of NaOCl as an oxidant and source of free chlorine prior to the cyanide phase is very effective because gold and silver chloride complex is dissolved by the more stable cyanide complex. Also, the addition of oxygen increases the dissolution rate of gold and silver in cyanide; it has been shown that 6 ppm oxygen is necessary for the most efficient dissolution rate. Also, the dissolution rate drops off very rapidly with decreasing amounts of oxygen.

D. Cyanide (NaCN)

Cyanide is the most commonly used gold and silver solvent. Dissolution rates for silver are much slower than for gold, and it was pointed out that oxygen is necessary.

Elsner's fundamental cyanid-silver equations are:

<u>Halides</u> $2Ag + 4NaCN + O + H_2O = 2AgNa(CN)_2 + 2NaOH$

<u>Sulfides</u> (1) $Ag_2S+5NaCN+O+H_2O=2NaAg(CN)_2+NaCNS+2NaOH$

(2) $Ag_2S + 4NaCN = 2NaAg(CN)_2 + Na_2S$

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Basic silver-cyanide problems and their solution are:

Basic Problem	Solution
Slow dissolution rate	Stronger solutions and good perculation-lower vertical lifts on the heap; adds oxygen. Pre-Treatment with acid solvents. Add oxidants.
Oxygen requirement	Above, plus spray(as rainbird); monitor preg at base of heap-keep at 6 ppm free oxygen.
Sulfates of iron; ppt. silver in heap	Decompose with lime
Sulfide solutions ppt Ag	Add $Pb(C_2H_3O_2)_2$ - allow to settle
Soluble Pb salts interfer with Zn precipitation	Precipitate and settle with acid pH--design large settling ponds
Silver sulfides are hard to dissolve with CN	Pre-treatment with NaCl and NaOCl
Tetrahedrite, sulf-antimonides, and sulf-arsenides are hard to dissolve in CN	Pre-treatment with NaCl, H_2SO_4, $FeCl_3$, and NaOCl
Oxidized Zn & Cu oxides, carbonates, and hydrates and soluble sulfides---cause high CN consumption	Numerous pre-treatment; basically acid with NaCl and NaOCl

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Economic Analysis

To determine the optimum selection of solvents, various bench-shaker tests should made followed by barrel leach tests. These are as follows:

1. Silver dissolution rate per solvent
2. Optimum solvent concentration.

Suggested initial test increments for each solvent are:

Solvent	Solvent Concentration Increments
Sod. thiosulfate	1/2. 3/4, 1, 2, 5 grams/liter
Sod. chlorite	1, 2, 5, 10, 20 grams/liter
Sod. hypochlorite	5, 10, 20, 50 ml/liter of 14 % soln.
Ferric chloride	1/4, 1/2, 1, 5 grams/liter
Aqua regia	5, 10, 20, 50 ml/liter
Cyanide	1/2, 3/4, 1, 1.5, 2 grams/liter
HCl	5, 10, 20 ml/liter
HNO_3	5, 10, 20 ml/liter

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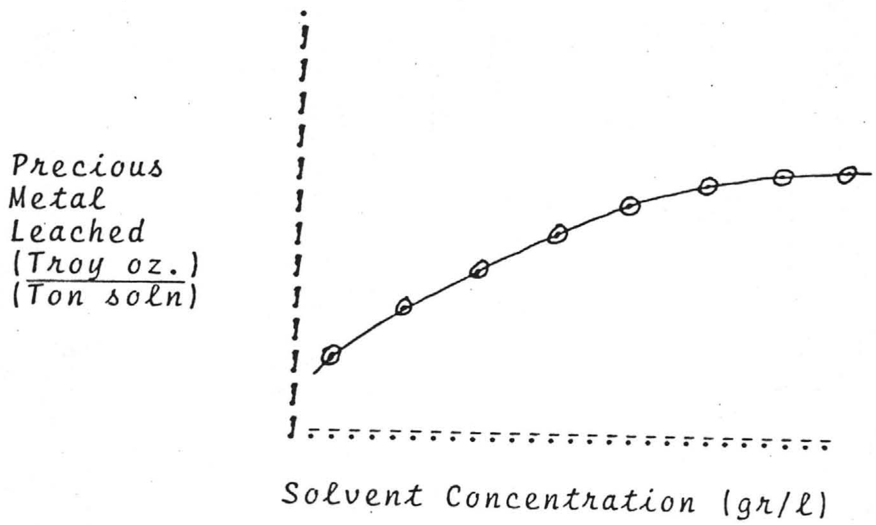
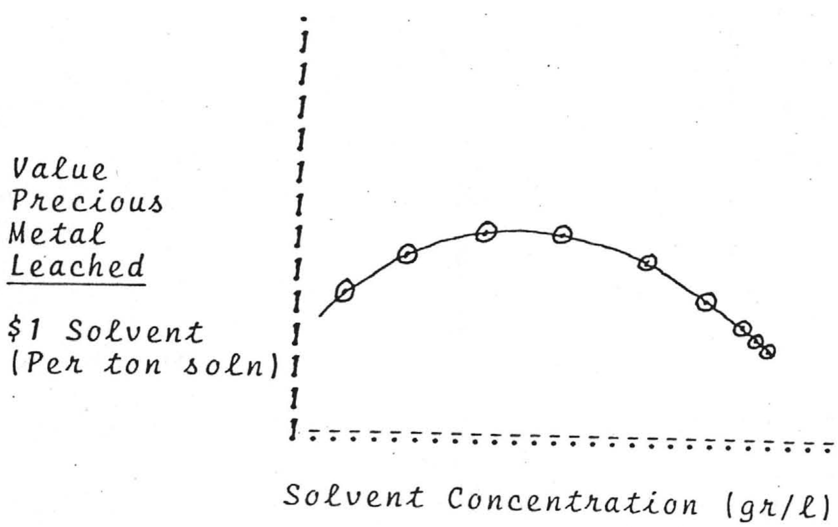
SOLVENT ECONOMIC ANALYSIS





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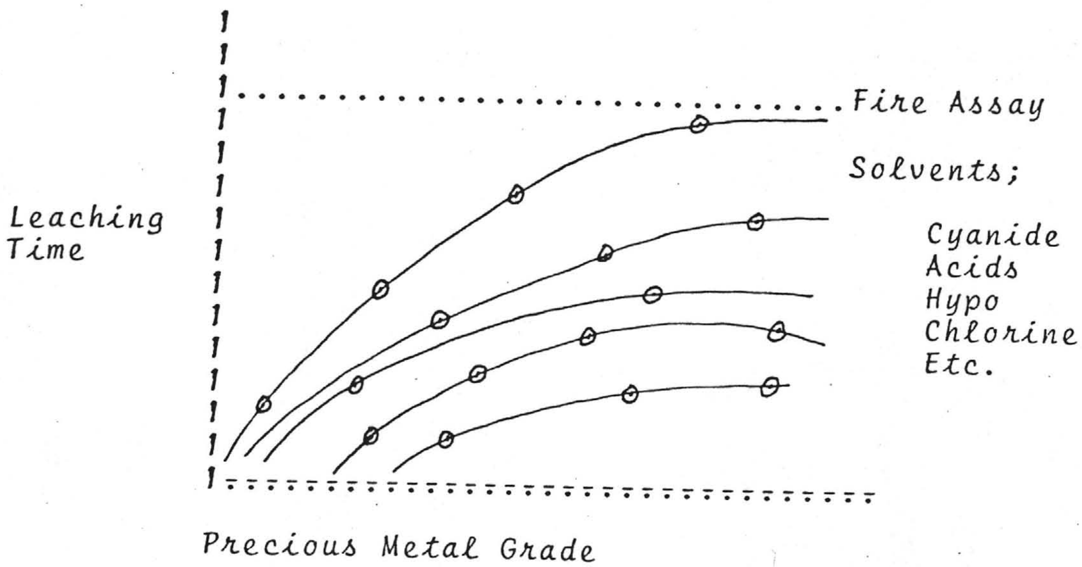
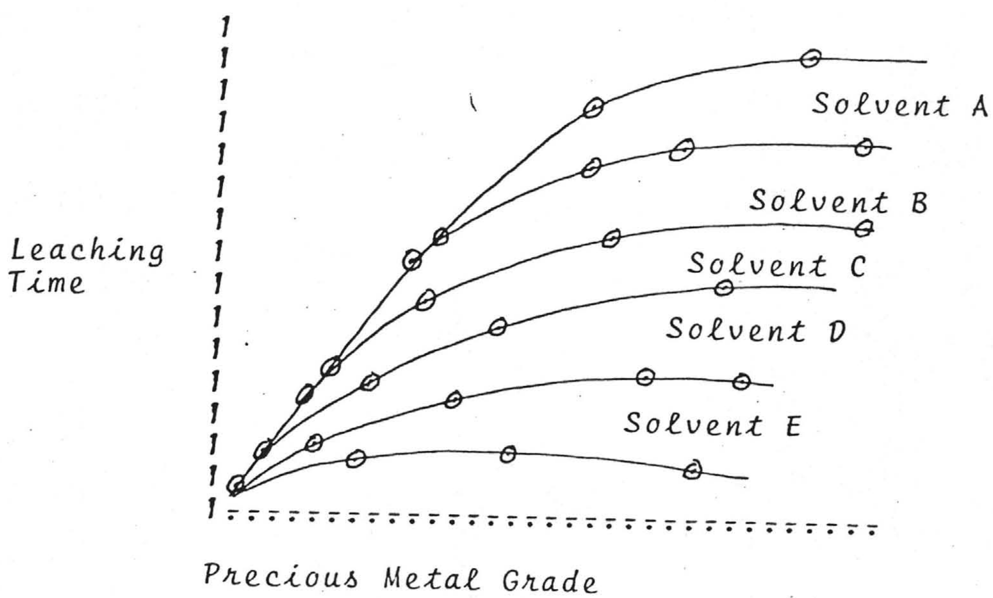
LAS VEGAS, NEVADA 89109

SOLVENT STATIC & DYNAMIC ANALYSIS





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Solvent & Reagent Costs

Solvent or Reagent	Supplier	Form	Price; 22 ton load	Unit Pri
Ferric Chloride	Sierra(R)	Liq.-42 Be-55 gal drums(625#)	$21/100wgt.	$ 0.21/
Sodium Chloride	"	Pellets- 50#/$2.88	625# drum-delivered	.16/
Sodium Chloride	Parsons(SP)	Cry.- 22 ton truck; $3/ton + $6/ton(GF)		$.0045/
Sodium Sulfide	Sirerra(R)	Flake-20 ton lots Del. WS		.195/
Lime	" (P)	Hydrated-22 ton lots-Del. WS $134.43/ton		.067/
Lime	" (P)	Processed CaO-$37/ton(P)+$5.12/200 miles		.021/
Caustic	"	Flake Na_2O-500# drum Del. WS		.185/
Zinc	"	Powd. Merrillite-$68.32/cwt Del. WS		.6832/
Sodium Cyanide	"	Pellets- Del. WS		.44/#
CaOCl(HTH) / Hydochlorite	"	Cry. 70%- 1000# lot WS		.70/#
Lead Acetate	"	Powd. 333# WS		$2.34/#
Sodium Thiosulfate	"	100# bags- 22 ton lot Del. WS		.1625/
Sodium Hypochlorite	"	Liq.- 14%(Cl^-) 55 gal drums Del. WS		.90/ga

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In order to determine the optimum solvent economics, testing must be performed at a comparitive economic concentration, as:

Solvent	Quantitiy for $0.20/ton solution
Cyanide	0.23 gr/l
Sodium Chloride	22. gr/l
Sodium Hypochlorite	421. ml/l
Sodium Thiosulfate	.62 gr/l
Ferric Chloride	.48 gr/l
Calcium Hypochlorite	.14 gr/l

Leaching Tests

It was shown in a previous report(June 23, 1978) that the Tombstone ore treated showed the following results:

1. "Natural shooting" of the ore resulted in;
   - A. Proper fragmentation for good perculation
   - B. Maximum exposure of ore-minerals
2. Ore contained some silver sulfides, and they;
   - A. Leach slowly in NaCN
   - B. Will leach more completely with an acid pre-tre-tment
3. Leaching rate is good due to a large percentage od Horn Silver.

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Screen Analysis:

Screen Size	Leached Ag Value (t. oz.)/ton
+ 2½ inches	0.25 oz./ton ore
2 "	.80
1½ "	1.10
1 "	1.40
½ "	1.90
¼ "	2.55
1/8 "	3.50
- 1/8 "	6.30

Comparative Leaching Rate and Recovery Rates:

Time	Per Cent Leached		
	Reville	Candelaria	Tombstone
24 hrs.	31 %	83 %	24 %
48 "	65 %	94 %	32 %
72 "	85 %	99 %	43 %
96 "	91 %	100 %	58 %
120 "	98 %		74 %
144 "	99 %		82 %
168 "	100 %		99 %

BARREL TEST RESULTS

Cyanide leach

Test 1: open pit area

Date	Atom. Adsorp. Au	Ag
10/14	.004	
	.007	
	.010	
	.015	
	.025	
10/15	.032	
	.042	
	.103	
	.283	
10/18	.308	
	.337	
	.341	
10/19	.490	

Leaching Rate

Date	Au Leached/day
10/14	.025
10/15	.258
10/18	.058
10/19	.149

Test 2: open pit area

Date	Atom. Adsorp. Au	Ag
10/7	.007	
	.010	
	.036	
	.044	
10/8	.052	
	.067	
	.075	
10/9	.084	
	.095	
	.100	
10/10	.165	
	.174	
	.180	
10/11	.200	
	.207	
	.222	
10/12	.240	
	.270	
10/15	.301	
	.306	
	.355	
	.379	
	.392	
10/18	.427	
	.431	
	.500	

Leaching Rate

Date	Au Leached/day
10/7	.044
10/8	.031
10/9	.025
10/10	.080
10/11	.042
10/12	.050
10/15	.120
10/18	.108

LIME-CAUSTIC-SODA ASH

Protective Alkilinity

Into three large beakers 500 ml. H_2O was added. Then enough sulphuric acid was added to bring the pH to 2.5(2 ml. H_2SO_4).

Amount of Base Added	pH Lime	pH Caustic	pH Soda Ash
1/4 gr.	3	2.5	2.5
1/2 gr.	5	3.5	5.75
3/4 gr.	8.5	6	6.5
1 gr.	11	8.5	8.5
1 1/4 gr.		11	9.5
1 1/2 gr.			10.5
1 3/4 gr.			11

$$\#/\text{gal.} = \frac{1\ \text{gr. lime}}{500\ \text{ml.}} = \frac{2\ \text{gr. lime}}{\text{liter}}\left(\frac{3.7853\ \text{liter}}{\text{gal.}}\right)\left(\frac{\#}{453.6\ \text{gr.}}\right) = \frac{.017\ \#}{\text{gal.}}$$

$$\#\ \text{lime in south acid pond} = \frac{.017\ \#}{\text{gal}}(1{,}000{,}000\ \text{gal}) = 17{,}000\ \#$$

$$\#\ \text{lime/ton ore} = \frac{17{,}000\ \#\ \text{lime}}{24{,}000\ \text{tons ore}} = 0.7\ \#\ \text{lime/ton ore}$$

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TOMBSTONE
METALLURGICAL TESTING

SILVER-SODIUM THIOSULFATE

In order to quantify the effectiveness and economics of sodium thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) as a solvent for silver halides, samples of high-grade silver ore (+7 oz./ton) were collected and analyzed.

Procedure

1. Standard solutions were made with 1, 4, 10, 21, 30, 40, & 50 grams sodium thiosulfate per liter water
2. 50 ml of each standard solution was placed in a flask with 20 grams of -40 to +64 mesh ore
3. Each flask of "hypo" standard and ore was hand shaken for increments of ½ minute; shaking was uniform
4. After each period of agitation, the flask was allowed to settle for 1½ minutes. Then a Silver determination was made with the AA
5. The flask was then sealed and steps #3 and 4 were repeated until 12 readings were made; 6 minutes of agitation.

Results

1. Leaching rate
2. Silver recovery per gram "hypo"
3. Silver recovery per "hypo" cost
4. Value silver per $1 "hypo".

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METALLURGICAL TESTING

Results of Sodium Thiosulfate Leaching of Silver

****

TROY OUNCES AG LEACHED PER TON SOLUTION

Agitation Time (Minutes)	Grams Sodium Thiosulfate per liter						
	1	4	10	21	30	40	50
0.5	.14	.30	.47	.74	1.60	2.63	2.90
1.0	.20	.50	.86	1.37	2.87	3.80	4.30
1.5	.25	.68	1.29	2.04	3.15	4.06	4.60
2.0	.32	.87	1.62	2.44	3.85	4.90	5.58
2.5	.36	.99	1.93	2.83	3.97	4.73	5.53
3.0	.41	1.24	2.20	3.15	4.12	4.80	5.61
3.5	.46	1.33	2.58	3.35	4.18	4.80	5.70
4.0	.55	1.57	2.79	3.69	4.30	4.90	5.70
4.5	.57	1.65	2.95	3.99	4.40	4.82	5.60
5.0	.67	1.90	3.26	3.99	4.39	4.80	5.70
5.5	.69	1.95	3.60	4.14	4.44	4.95	5.80
6.0	.75	2.02	4.12	4.50	4.50	4.90	5.85

[illegible] ore, [illegible]

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

Leaching Rate

INCREMENTAL TROY OUNCES AG LEACHED (PER TON SOLN.) PER ½ MINUTE INTERVAL

Grams Sodium Thiosulfate Per Liter	Agitation Time, Minutes											
	Initial ½	1	1½	2	2½	3	3½	4	4½	5	5½	6
1	0.14	0.06	0.05	0.07	0.04	0.05	0.05	0.09	0.02	0.10	0.02	0.06
4	0.30	.20	.18	.19	.12	.25	.09	.24	.08	.25	.05	.07
10	0.47	.39	.43	.33	.31	.27	.38	.21	.16	.31	.34	.52
21	0.74	.63	.67	.40	.39	.32	.20	.34	.30	.00	.15	.36
30	1.60	1.27	.28	.70	.12	.15	.06	.12	.10	.00	.04	.06
40	2.63	1.17	.26	.84	-.17	-.10	-.10	.00	-.08	.00	.15	-.05
50	2.90	1.40	0.30	0.98	-.05	0.03	0.09	0.00	-.10	0.00	0.10	0.05

The above results show the following:

A. Initial "hypo" contact with the silver minerals is the most effective

B. Additional silver is leached with each time increment at low "hypo" concentrations

C. Silver is precipitated out of solution at high "hypo" concentrations.

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

Silver Recovery Per Gram "Hypo"

The weight per test solution of water, hypo, and ore is computed:

Grams Hypo Per Liter	Wgt. Hypo & H_2O Per Liter	Wgt. 50 ml H_2O	Wgt. 50 ml Hypo
1	1001 gr.	49.95 gr	.05 gr
4	1004 "	49.80 "	.20 "
10	1010 "	49.50 "	.50 "
21	1021 "	48.97 "	1.03 "
30	1030 "	48.54 "	1.46 "
40	1040 "	48.08 "	1.92 "
50	1050 "	47.62 "	2.38 "

From these computations, the recovered Silver per gram Hypo per ton of solution is computed.

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

OUNCES AG PER TON SOLUTION RECOVERED PER GRAM HYPO

Gr Hypo per Liter	Agitation Time, Minutes											
	½	1	1½	2	2½	3	3½	4	4½	5	5½	6
1	.14	.20	.25	.32	.36	.41	.46	.55	.57	.67	.69	.75
4	.08	.13	.17	.22	.25	.31	.33	.39	.41	.48	.49	.51
10	.05	.09	.13	.16	.19	.22	.26	.28	.30	.33	.36	.41
21	.04	.07	.10	.12	.13	.15	.16	.18	.19	.19	.20	.21
30	.05	.10	.11	.13	.13	.14	.14	.14	.15	.15	.15	.15
40	.07	.10	.10	.12	.12	.12	.12	.12	.14	.12	.12	.12
50	.06	.09	.09	.11	.11	.11	.11	.11	.11	.11	.11	.12

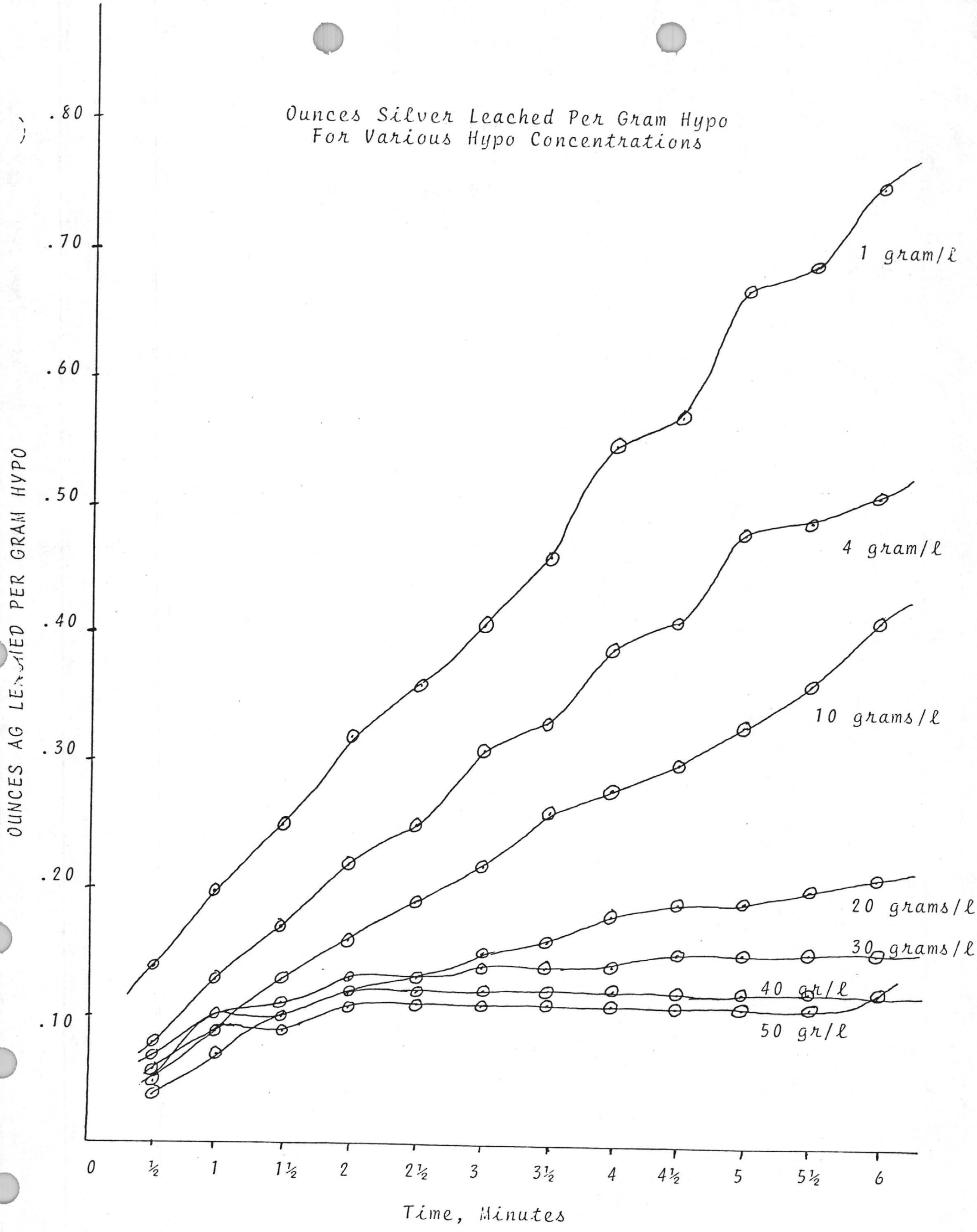
These results have been plotted on the graph on the following page.

The following graph makes the following conclusions obvious:

A. Lowest concentrations of "hypo" are the most efficent

B. Lowest concentrations of "hypo" do not load-up with Ag

C. High concentrations of "hypo" are in-efficient, due to induced chemical precipitation and the possible chemical de-composition of the "hypo".


Ounces Silver Leached Per Gram Hypo
For Various Hypo Concentrations
OUNCES AG LEACHED PER GRAM HYPO
.80
.70
.60
.50
.40
.30
.20
.10
0
½
1
1½
2
2½
3
3½
4
4½
5
5½
6
Time, Minutes
1 gram/l
4 gram/l
10 grams/l
20 grams/l
30 grams/l
40 gr/l
50 gr/l

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METALLURGICAL TESTING

Silver-Sodium Thiosulfate

Economics

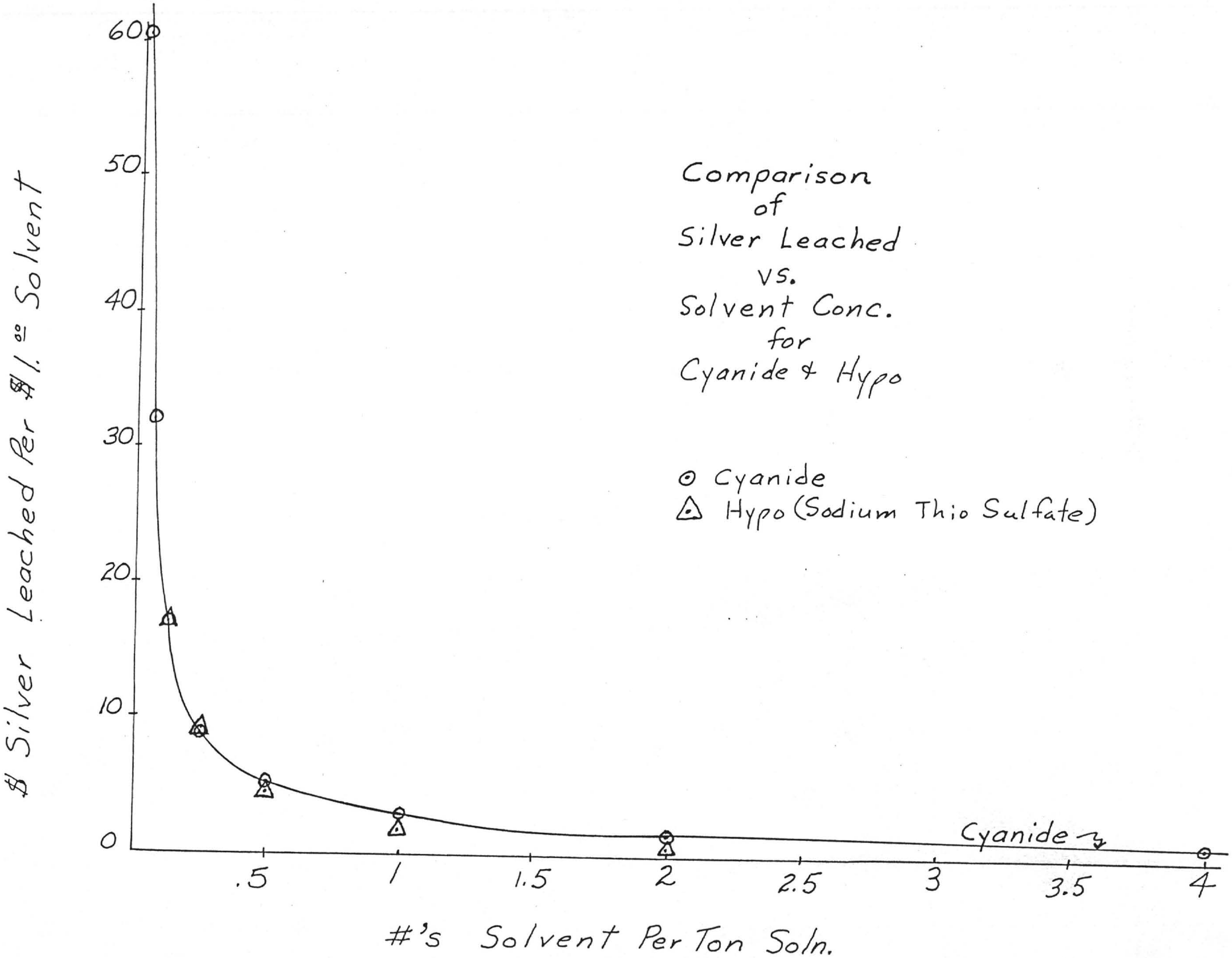
The value of the silver recovered is computed from;

$$\text{Ounces Ag Per 50 ml Solution} = \frac{\text{Ounces Ag}}{\text{Ton Soln.}} \times \frac{\text{Tons Soln.}}{\text{Gr } H_2O\text{/ton}} \times \frac{\text{Gr } H_2O}{\text{50 ml}}$$

$$\text{Where; Gr } H_2O\text{/ton } H_2O = \frac{\text{240 gal}}{\text{ton}} \times \frac{8.331\ \#}{\text{Gal } H_2O} \times \frac{\text{453.6 gr}}{\#}$$

VALUE OF LEACHED SILVER AND PER $1 HYPO

Gr Hypo / l H_2O	T. Oz. Ag / 50 ml soln.	Value Ag @ $5.00	Cost Hypo @ 18¢/#	Ag Recovery / $ 1 Hypo
1	.0000413	$.0002065	$.00002	$10.33
4	.0001109	.0005544	.0000794	6.98
10	.0002248	.001124	.0001984	5.67
21	.0002429	.0012145	.0004087	2.97
30	.0002408	.0012039	.0005794	2.08
40	.0002597	.0012985	.0007619	1.70
50	.0003071	.0015354	.0009444	1.63


Comparison
of
Silver Leached
vs.
Solvent Conc.
for
Cyanide & Hypo
Cyanide
Hypo (Sodium Thio Sulfate)
$ Silver Leached Per $1.00 Solvent
60
50
40
30
20
10
0
.5
1
1.5
2
2.5
3
3.5
4
Cyanide
#'s Solvent Per Ton Soln.

Gold Dissolution Rates
(Milligrams Gold Dissolved Per Hour

Equal quantities of gold foil were weighed and allowed to dissolve in various solvents to determine the dissolution rates. After the time to dissolve was observed, the quantity of gold dissolved was checked by titration. Therefore, the rate of dissolution was computed (milligrams Au/Hour), and the dissolution rate cost (milligrams Au/$1 Solvent Cost per ton solution). These results are presented to illustrate:

1. The dissolution rate of cyanide is very slow compared to other halide solvent systems.
2. The relative cost of cyanide compared to halide systems is much higher (for cyanide).
3. Halide system solvents are economic for pre-treatment applications to carbonaceous ores.

Basic to the above is the concept that aurous chloride is insoluble in water but is soluble in sodium chloride. This is based on the following:

A. The initial reaction between chlorine and gold is;

$$2\ Au + Cl_2 = 2\ AuCl$$

B. The rate of solution of the gold is controlled by the rate at which the insoluble aurous chloride film is removed from the surface by the following;

$$AuCl + Cl_2 + Cl^- = AuCl_4$$

and

$$AuCl + Cl^- = AuCl_2^-$$

C. The aurous chloride ion is later oxidized to the auric state, but in dilute chlorine solutions this is not the rate-controlling reaction.

Sodium Cyanide

This standard leach solvent produces the following dissolution rates:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
5	2.4
1	3.0
.2	.36

Sodium Chloride-Chlorine System

A standard-brine-solution was prepared using 58.86 pounds of salt (NaCl) per ton solution. This provides an excess chlorine ion. Into this standard brine solution were added various amounts of liquid chlorine. Following are the Au dissolution rates:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
.118	.18
.236	7.2
2.36	108.

Additional tests were made with brine solutions and liquid chlorine because of the application of chlorine to make hypochlorite for carbonaceous ores. An equal amount of gold foil was dissolved in various combinations of concentrations of chlorine and salt. The time to dissolve the gold was divided by the cost of the solvent (per ton solution) to yield a time-of-dissolution vs. cost relationship that allows direct comparison because of the standardization of all of the variables. The plot of these data are presented in the following illustration.

Sodium–Chloride-Chlorine-H_2SO_4 System

The same standard-brine-solution was used with 58.86 pounds of salt (NaCl) per ton of solution. Into this solution were added various amounts of liquid chlorine and sulphuric acid. Following are the Au dissolution rates:

Solvent Concentrations; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	H_2SO_4	
.118	5.	7.8
.118	14.	8.4
.236	5.	16.2
2.36	14.	108.6

Chlorine Solution

Two different liquid chlorine solutions were prepared with the following results:

Solvent Concentration; # / ton solution	Milligrams Au Dissolved Per Hour
.874	3.6
4.0	20.4

Chlorine-H_2SO_4 System

Various sulphuric acid concentrations were added to chlorine solutions, with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	H_2SO_4	
.874	1.6	9.
.874	16.	21.8
.874	20.	37.2

Chlorine Solutions

Various solvents were mixed with chlorine solutions, with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Cl_2	Other	
4.	1. Br_2	19.2
4.	4. $CaCl_2$	40.8
4.	16. HCl	225.6
4.	40. Na_2SO_4	19.8
4.	40. NaF	21.

Bromine Solutions

Various solvents were dissolved in bromine solutions with the following results:

Solvent Concentration; # / ton solution		Milligrams Au Dissolved Per Hour
Br_2	Other	
1.	4. Cl_2	19.2
60.	-	110.4
60.	40. NaCl	960.
60.	50. KBr	2220.

Analysis of Various Gold Solvents

Rank	Solvent Concentration; #/ton soln. Reagent A		Reagent B		Reagent C		Dissolution: Rate; Mg. Au/Hr.	Dissolution: Mg. Au Per $1 Solvent(s)
1	60.	Br_2	50.	KBr			2220.	94.9
2	4.	Cl_2	16.	HCl			225.6	74.2
3	60.	Br_2	40.	NaCl			960.	60.
4	4.	Cl_2	4.	$CaCl_2$			40.8	60.
5	4.	Cl_2					20.4	51.
6	2.36	Cl_2	58.86	NaCl			108.	41.7
7	.874	Cl_2					3.6	40.
8	4.	Cl_2	1.	Br_2			19.2	30.
9	.874	Cl_2	1.	H_2SO_4			9.	22.5
10	2.36	Cl_2	14.	H_2SO_4	58.86	NaCl	108.6	15.7
11	60.	Br_2					110.4	7.7
12	.874	Cl_2	16.	H_2SO_4			31.8	6.3
13	.874	Cl_2	20.	H_2SO_4			37.2	6.3
14	1.	NaCN					3.	4.8
15	.236	Cl_2	5.	H_2SO_4	58.86	NaCl	16.2	4.1
16	4.	Cl_2	40.	NaF			21.	2.8
17	.118	Cl_2	5.	H_2SO_4	58.86	NaCl	7.8	2.0
18	5.	NaCN					2.4	1.9
19	4.	Cl_2	40.	Na_2SO_4			19.8	1.5
20	.118	Cl_2	14.	H_2SO_4	58.86	NaCl	8.4	1.3
21	.2	NaCN					.36	1.3
22	.118	Cl_2	58.86	NaCl			.18	.1

Ionac SR-3 Resin for Noble Metals and Mercury Recovery

Ionac SR-3 is a macroporous chelating resin which is highly selective for precious metals such as gold and others of the platinum group as well as for mercury and methyl-mercury compounds.

Other base metals such as iron, copper, lead, etc. do not react at all with this resin and do not interfere with the selective process. The noble metals are very strongly attached to the resin, yet their recovery presents no difficulty.

Applications

Precious metals are completely removed from solutions containing them (from very high to extremely low concentrations) on passing the solutions through a column of Ionac SR-3.

Use of Ionac SR-3 is recommended for noble metal extraction from ores and wastes, the separation of noble from base metals, the recovery of spent catalysts, the concentration of very dilute solutions containing noble metals and the refining of noble metals.

In addition, Ionac SR-3 is applicable to the removal of mercury(and methyl-mercury) compounds in pollution control.

Example

One microgram of gold dissolved in one liter of slightly acidified water was completely recovered with the aid of Ionac SR-3. Furthermore, even after adding hundreds of milligrams of nickel and copper to the solution, precious metal recovery was complete to the exclusion of the other metals.

Ionac SR-3 also quantitatively collects methyl mercury and inorganic mercury compounds. Both forms are collected from solutions of pH 1-9.

Typical Characteristics

Physical Form: White, macroporous beads
Supplied: Regenerated
Nominal Mesh Range: -16 + 55
Moisture Content: 45% - 55%
Shipping Weight: 750-850 g/l

Capacities

Gold: 150 g/l
Platinum: 65 g/l
Palladium: 58 g/l
Iridium: 25 g/l
Mercury: 150 g/l

General Instructions for Use

1. The pH of the solution coming into contact with the resin should prefereably be adjusted to between 0.5 and 2.5.

2. Adsorption of noble metals or of mercury is carried out at room temperature using conventional ion exchange column techniques. Minimum bed depth should be 750 mm and the flow rate about 10-20 bed volumes per hour.

3. The recovery of the noble metals from the resin is possible in two ways:

   a. Ignition -- Slowly roasting the exhausted resin in air at 900 - 1000° C. leaves the metal in a very pure metallic form.

   b. Elution -- Eluting immediately after adsorption with a 5% aqueous solution of thiourea to which 5 ml/liter of HCl has been added yields a solution from which the metal can be recovered by reduction. When elution is applied, the resin can be reused for many cycles.

4. The elution of the mercury can be also accomplished by treating the resin with 4% sodium sulfide at a level of 200 g Na_2S per liter of resin.

   Following the elution, it is necessary to regenerate the resin by treatment with 10% hydrochloricc acid at a level of 100 g HCl per liter of resin.

TOMBSTONE
Process Chemistry

Activity		Solvent	Reagent	Recovery Method Ag	Au
A.	Spray Side Slopes	(1) $Na_2S_2O_3$ (2) NaCN	None Lime	Powd. Zn Na_2S	Na_2S Resin
B.	Crush & Leach No. Ramp	(1) $Na_2S_2O_3$ (2) CN	None Lime	Powd. Zn Na_2S	Na_2S Resin
C.	Crush & Leach Heap (Low-Mn)	(1) NaCl (2) CN	NaOCl Lime	Na_2S Na_2S	Resin Resin
D.	Crush & Leach Heap (High-Mn)	(1) NaCl (2) $Na_2S_2O_3$ (3) CN	NaOCl - Lime	Na_2S Powd. Zn Na_2S	Resin Na_2S Resin
E.	Leach heap In Situ	(1) H_2SO_4 (2) NaCl (3) NaOCl (4) NaCN	None " " Lime	Powd. Zn Na_2S	Resin Resin

TOMBSTONE HEAP

Following are recent samples taken from the heap, grouped by screen size and mineral:

Ore Type	Troy Oz./Ton Au	Troy Oz./Ton Ag	Value* Au	Value* Ag	Total Value
Clay	.041	.26	$10.25	$1.95	$12.20
Fines	.086	.29	21.38	2.18	23.56
Large	.038	.53	9.38	3.94	13.32
Manganese	.155	1.44	38.75	10.80	49.55

The above were weighted by their respective weight percent age (15%,25%,40% & 20%) and the average value ($250 Au & $7.50 Ag*) is $22.95. Assuming a 65% recovery, the resulting ore value would be $15.00. The operating costs will be under $5.00 per ton ore, yielding a net operating profit before taxes of $10.00 per ton ore.

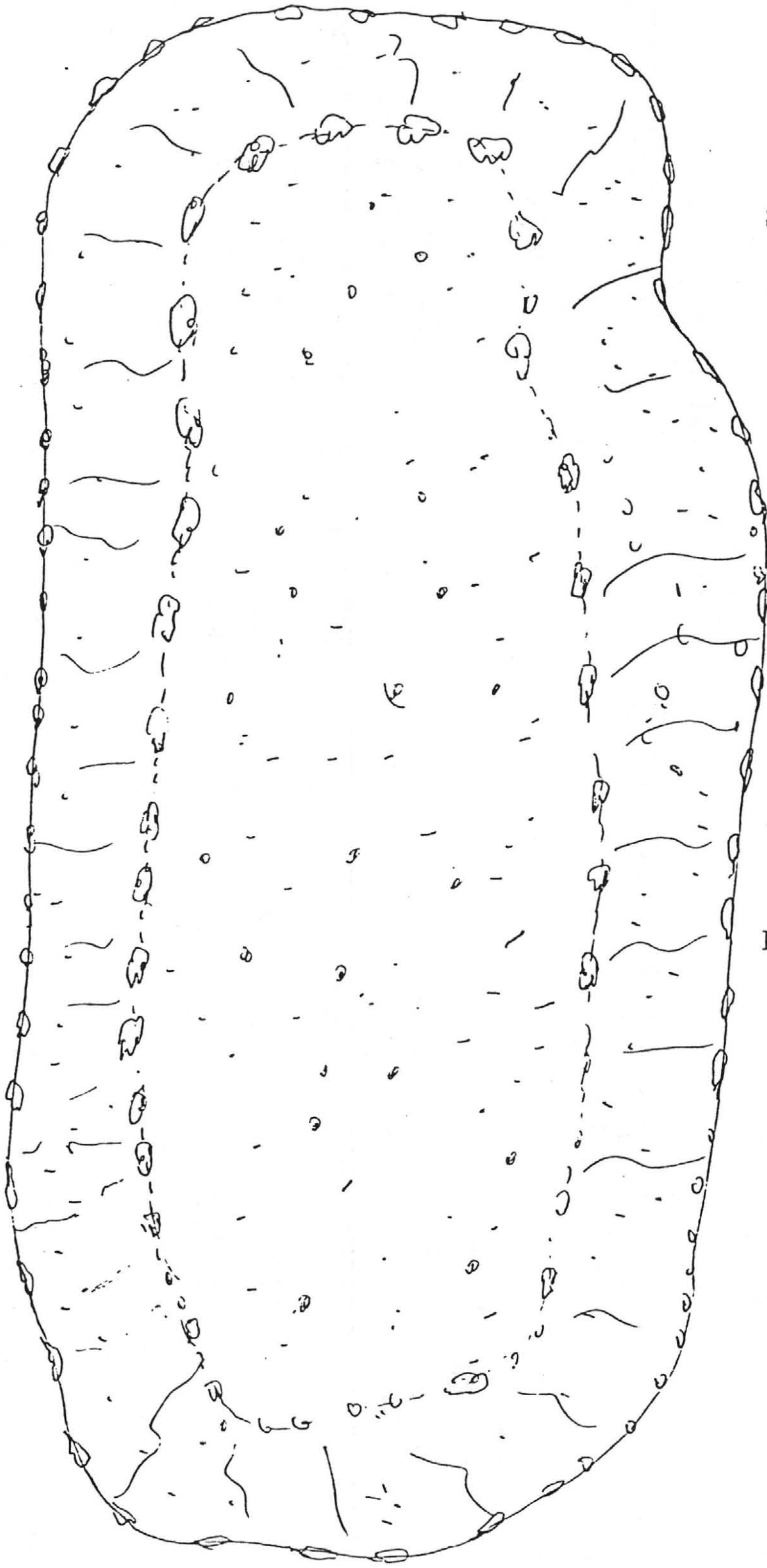
Top of heap
Aqua regia, 25%, 3:1

SOUTHEAST CLAY .021 Au/.12 Ag

SOUTHWEST CLAY .060 Au/.36 Ag

SOUTH FINES .120 Au/.42 Ag

SOUTH LARGE .042 Au/.57 Ag



SOUTH MANGANESE

.150 Au/1.89 Ag

TOMBSTONE "HEAP"
****
Assays of ore types and sizes..........

NORTH MANGANESE

East .177 Au/1.98 Ag

West .138 Au/.45 Ag

NORTH CLAY .042 Au/.30 Ag

NORTH FINES .051 Au/.15 Ag

NORTH LARGE .033 Au/.48 Ag

TOMBSTONE

Sampling Summary
March 12, 1979

Location	Ore Type	Troy Oz./ton ore		Gross Value
		Gold	Silver	($250/$7.5)
Heap	Coarse	.038	.53	$ 13.48
"	Clay	.041	.26	12.20
"	Fines	.086	.29	23.56
"	Manganese	.155	1.44	49.55
North Ramp	Contention	.138	1.31	44.33
Emerald Dump	Fines/coarse	.127	2.72	52.15
Contention	Tailings	.050	.63	17.23
Sh-t	Carbonaceous	.234	1.56	70.20
Contention Dike-Cave Open-Pit Area	Altered Dike/ Limestone- No Manganese	.158	1.94	36.00

[illegible]

TOMBSTONE

North Ramp Sampling:
(Tom Schloss et. al.)

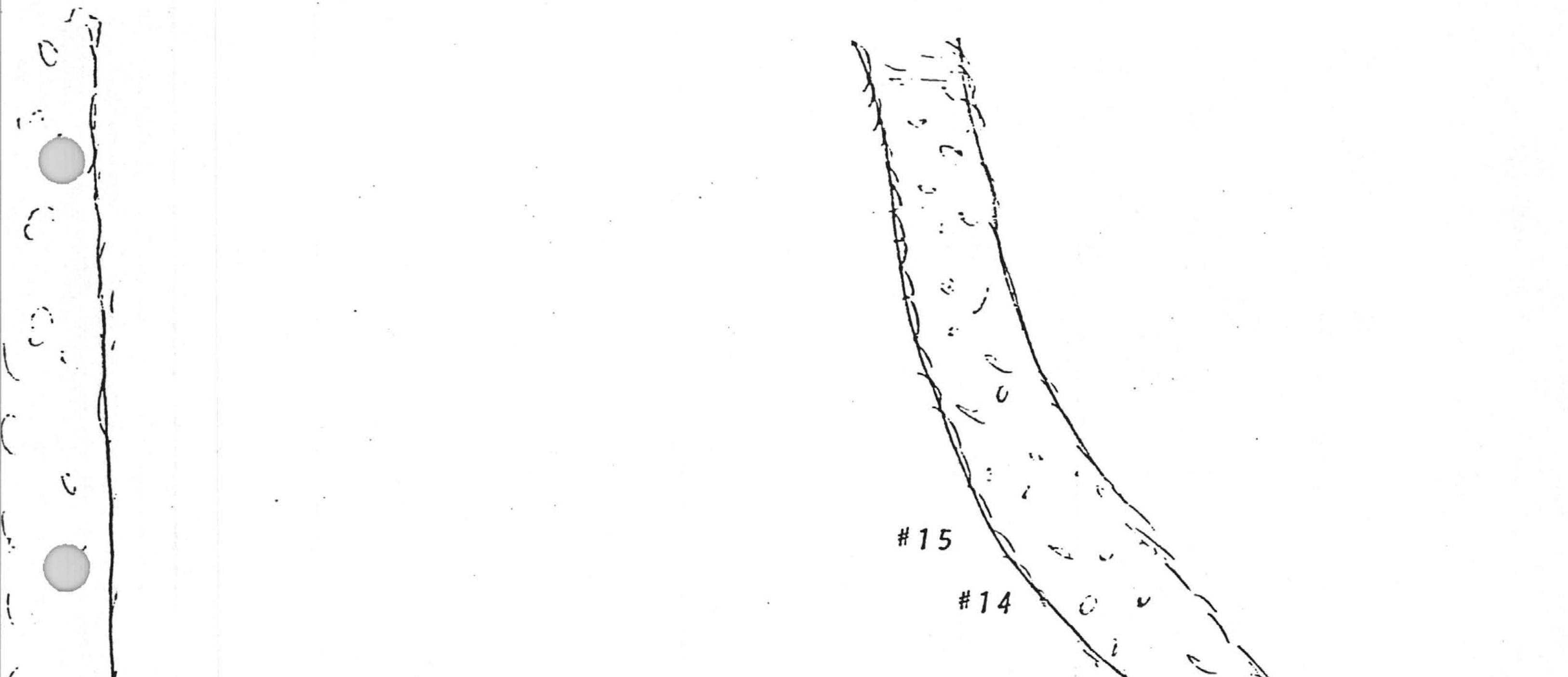
(C. Escapule AA Lab Results);

Sample Number	Troy Oz./ton soln.		Troy Oz./ton ore	
	Gold	Silver	Gold	Silver
NR- 1	.043	.31	.129	.93
NR- 2	.040	.38	.120	1.14
NR- 3	.063	1.80	.189	5.40
NR- 4	.039	.24	.117	.72
NR- 5	.043	.41	.129	1.23
NR- 6	.104	.58	.312	1.74
NR- 7	.037	.29	.111	.87
NR- 9	.039	.41	.117	1.23
NR-10	.034	.20	.102	.60
NR-11	.034	.29	.102	.87
NR-12	.040	.29	.120	.87
NR-13	.052	.46	.156	1.38
NR-14	.039	.20	.117	.60
NR-15	.037	.25	.111	.75
		Ave.	.138	1.31

aqua regia solvent [illegible]

TOMBSTONE

North Ramp Sample Map:



NORTH !

TOMBSTONE

Open Pit Samples
Contention Dike

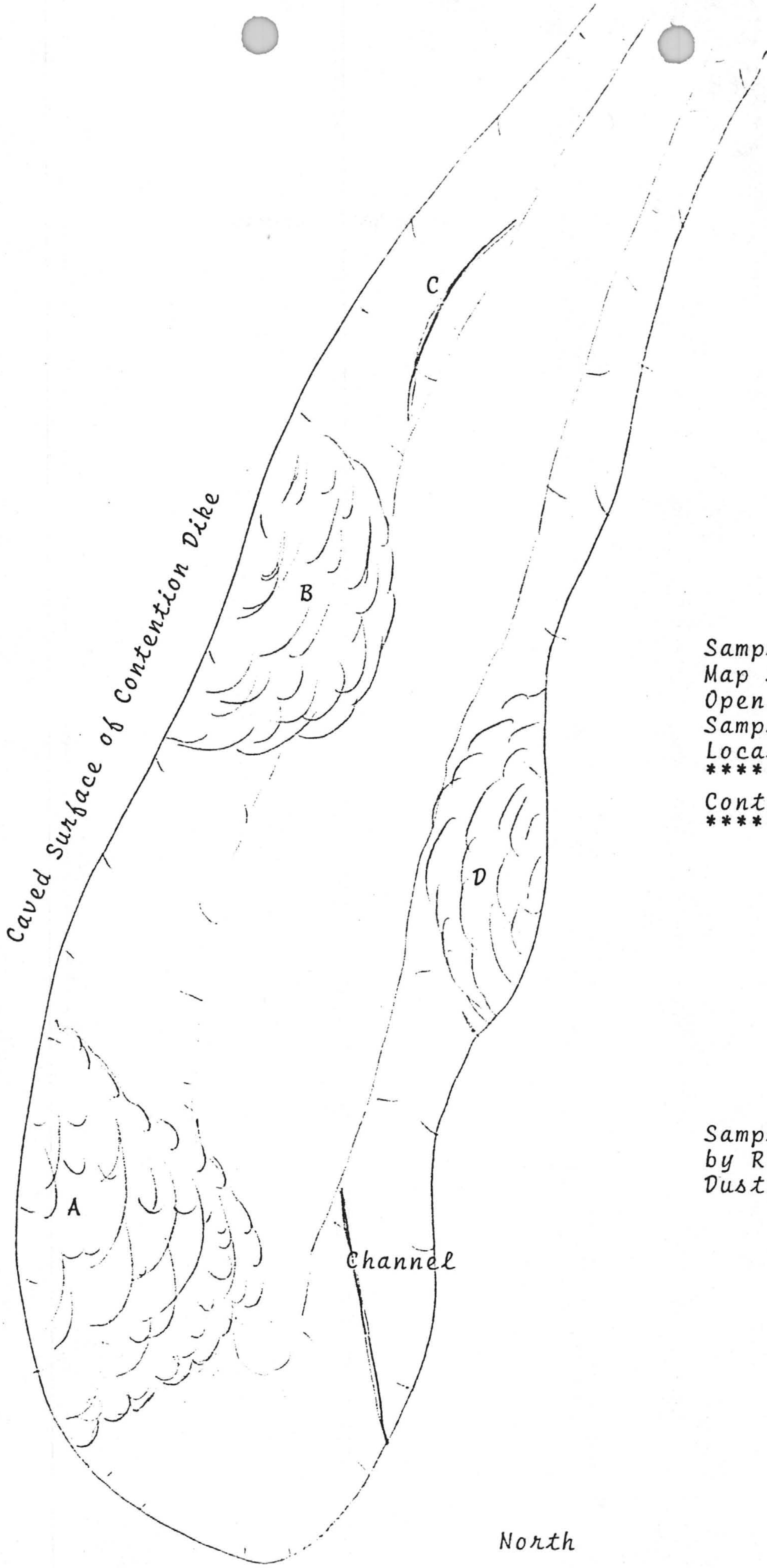
Summary of Contention Dike Open-Pit Samples:

Sample Identification	T.Oz./ton ore		Gross Value/ton ore
	Gold	Silver	($250/$7.50)
Channel Coarse	.126	.39	$ 34.43
A-Fines/coarse/mixed	.130	1.32	42.40
B-Fines/coarse/mixed	.135	2.88	55.35
C-Coarse	.105	.48	29.85
D-Fines/Coarse	.158	1.94	54.05
Ave.	.158	1.94	$ 36.00 ....

TOMBSTONE

Open Pit Samples
Contention Dike

Sample Identification	T.Oz./ton soln.		T.Oz./ton ore		Gross Value Ton Ore ($250/$7.5)
	Gold	Silver	Gold	Silver	
Channel Sample along Contention Dike	.042	.13	.126	.39	$ 34.43
A- Fines	.060	.70	.180	2.10	60.75
A- Mixed(mine run)	.035	.25	.105	.75	31.88
A- Coarse	.035	.37	.105	1.11	34.58
B- Fines	.055	2.03	.165	6.09	86.93
B- Mixed(mine run)	.040	.35	.120	1.05	37.88
B- Coarse	.040	.50	.120	1.50	41.25
C- Coarse(Channel)	.035	.16	.105	.48	29.85
D- Fines	.050	.96	.150	2.88	59.10
D- Coarse	.055	.33	.165	.99	48.68



Sample Location
Map Showing
Open-Pit
Sample
Locations
****

Contention Dike
****

Sampled March 11, 1979
by RF Hewlett and
Dusty Escapule........

TOMBSTONE

Special Samples:
(Tom Schloss et. al.)

(C. Escapule Lab Results);

Sample Number	Troy Oz./ton soln.		Troy Oz./ton ore	
	Gold	Silver	Gold	Silver
Emerald Dump;				
Fines	.037	2.14	.111	6.42
Coarse	.060	.38	.180	1.14
High Ag	.026	.70	.078	2.10
Hot H	.046	.40	.138	1.20
			.127	2.72
Contention Tailings;				
East	.010	.21	.030	.63
Middle	.017	.28	.051	.84
West	.023	.14	.069	.42
			.050	.63
Sh-t	.078	.52	.234	1.56

TOMBSTONE

Special Samples

CYANIDE vs. ACID LEACH:

To estimate the effectiveness of cyanide as a leaching solvent without pre-treatment, samples taken from the same location were leached with cyanide and aqua regia to determine the relative recoveries. It is known that aqua regia will dissolve all of the gold and some of the silver, making aqua regia a good estimator of total value(heads). For gold, aqua regia is more precise than fire assays, and with the use of an atomic absorption machine, is much faster. Following are the results:

	CYANIDE		AQUA REGIA		PerCent CYANIDE RECOVERY
	T.Oz./ton soln.		T.Oz./ton soln.		
Ore Type	Gold	Silver	Gold	Silver	Gold
Sh-t	.020	.27	.070	.42	29 %
Emerald Fines	.005	.24	.045	.21	11 %
Contention Tails	.020	.21	.047	.08	43 %
North Ramp-6-	.025	2.85	.082	.52	30 %

The above cyanide-aqua regia comparison confirms Ralph VanArsdale's statement concerning the recovery of only 10% of the values from the manganifeous ore left in the Emerald dump and what was hauled to the heap and leached.