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Abandoned Mine Land Reclamation Award Winners

1992 Awards (Presented in 1993)

Boonville Hospital RAMP Project, Indiana
★ Coppermine Abandoned Mine Project, Navajo Reservation
Gay Branch Gob Pile Project, Virginia
Lead and Zinc Mine Sites Reclamation Project, Illinois
Ocean Refuse Removal Project, Maryland
Pine Creek Mine Shafts Project, West Virginia
Pyramid Coal Company Reclamation Project, Illinois
Shiloh Reclamation Project, Arkansas
Veca Pit and Spoils Project, Wyoming
White Oak Four Reclamation Project, Ohio

2000 Awards

Regional Awards

Pleasant View Mine Project, Kentucky (Appalachian Region)
Midwestern Reclamation Project, Indiana (Mid-Continent Region)
★ Carrizo 1 Reclamation Project, Navajo Reservation, Arizona and New Mexico (Western Region)

National Award

Pleasant View Mine Project, Kentucky

People's Choice Award

Midwestern Reclamation Project, Indiana

1999 Awards

Regional Awards

Blackwater River Limestone Drum Station, West Virginia (Appalachian Region)
Oklahoma Partnership Approach to Reclamation of Abandoned Mine Land, Oklahoma (Mid-Continent Region)
Socorro West, New Mexico (Western Region)

National Award

★ Monument Valley 2 AML Reclamation Project, Navajo Reservation

MARDUN COCONINO COUNTY

Pat Patterson, Copper Mine Trading Post re White Mesa Copper deposit. It is idle and still in litigation - trial set for November. FTJ WR 10-16-70

White Mesa Copper Co. had an auction sale of their plant and equipment during the quarter with no forecast as to the future of the mine. FTJ QR 1-13-71

Called Copper Mine Trading Post regarding White Mesa Copper deposit. Patterson said no activity although several companies have examined it.....Navajo Tribal mining engineer said 3 areas will be up for prospecting bids soon, similar to White Mesa deposit and also a large area for potential uranium deposits. FTJ WR 5-17-71

It was learned that in the settlement of the law suit involving the White Mesa copper deposit, James Melfi has been appointed a trustee and has power to bind all the litigants in the law suit in entering into leases, options and sales. LP 1/4/72

His address is:

James Melfi, Sr.
523 Third Street, N.W.
Albuquerque, New Mexico 87101

At the Gap no one knew of any activity at the copper mine on White Mesa. GW WR 9/7/72

CJH WR 6/18/82: Phone call: Ramon Shannon made an inquiry about the White Mesa Copper deposit in Coconino County in which Shattuck Denn had an interest in 1942. He understook an Arizona State agency had done some work on the deposit which reportedly is an oxide copper in the Coconino sandstone and averages 0.52% Cu. I could find no information here so referred him to the Phoenix office and the Bureau of Geology and Mineral Technology.

Visited White Mesa Co., Inc. - Mardun mine. 4 men working settling pond trying to make it leak proof. No mining being done. Other work is planned and hopes are to begin operation in a month or six weeks. Chas. S. (Bill) Tornbom is the new supt.
FTJ WR 5-12-67

The White Mesa Co., Inc. has been operating two months, but have been having difficulty with slimes. Memo to follow. Went to examine pit and outcrop one-half mile southwest of present pit. FTJ WR 9-15-67

Active Mine List Nov. 1967 - 25 men

White Mesa Co., Mardun, is expected to have operated during the quarter. FTJ QR 66-67

White Mesa (Mardun) is said to have some operating difficulties but this could not be verified. FTJ QR 4-1967

Mineral Resources, Inc., Box 202, Fargo, North Dakota 58102. Corres. 7-5-67

Active Mine List April 1968 - 25 men

Visited White Mesa Co., Inc. They have not operated since December. Rumored that Aimes was trying to get some financing. For information in the future we can call General Communications in Flagstaff and ask for Copper Mine Trading Post and Mr. Patterson will have the answers. All the mining equipment, etc., are at the mine. FTJ WR 5-17-68

The copper leaching operation (Mardun) on White Mesa was shut down for the whole of the quarter. FTJ QR 7-1-68

Mine visit to the Mardun mine. Irregular oxide copper is in sandstone. No mining since Dec. 12, 1967 according to Coit Patterson, owner of Copper Mines Trading Post about 100 yards north of the open pit mine. The leaching plant has been badly treated by vandals. Mr. Patterson said there was a talk of Mr. Shotwell, former producer of pumice from north of Flagstaff for use as pozzolan in concrete for Glen Canyon dam, taking hold of the Mardun. FPK field trip notes 5-6-69

Visited White Mesa. No one at the mine. Company has suits against it, bad debts, etc.
FTJ WR 9-12-69

A Mr. Aimes of Minnesota, brother of Aimes of White Mesa, was loading a large gyratory crusher on a truck for transport to Minnesota. He said his brother is trying to straighten out the affair on White Mesa. (Mardun) FTJ WR 5-15-70

Active Mine List May 1970 - not active

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MARDUN COCINO COUNTY

Active Mine List Oct. 1963 - 22 men working

Visited Zontelli Bros. leaching operation at Copper Mine, Harho Saari, Supt., said they had had quite a little water trouble. At the time of the visit about 200 gpm were going on the dump. EGW WR 5-19-64

Visited Zontelli Bros. Copper Mine. They now have 200-250 gpm going thru the precipitating plant. A new well was started to increase the water supply, but at 350 ft. they lost their drill tools. At the time of the visit another drill rig was being moved in to start another hole. EGW WR 9-15-64

Visited Zontelli Western Plant at Copper mine, interviewed John Simmons and Harho Saari, Supt. They are still having water trouble, only 90 gpm going through the plant. EGW WR 5-14-65

Visited Zontelli Western - Revere Copper and Brass have dropped their option and Zontelli Western is in the process of reorganizing. 5 men, including supervision, employed leaching small but higher grade material. Water is a continuous problem. FTJ WR 9-17-65

Mardun - Zontelli Bros. - According to C. Kuzell, the sandstone copper ore carries "pitch copper". It is a hydrated copper oxide which looks like obsidian. It has chemically bonded H_2O. Mineral "has dry look-like flint." FPK 11-22-65

Visited the White Mesa Copper deposit which is now called White Mesa Co., Inc., P.O. Box 1565, Page, Arizona. Donald Aimes of Fargo, North Dakota is president. Harho Saari, Res. Supt. Their flow sheet has been designed by Denver Equipment. Mechanization is to be used as far as possible. Electric power is to be supplied by Arizona Public Service, replacing the diesel plant at the mine. An electric shovel is to be used in the mine, loading into a portable conveyor to the crushing unit. Ore will be crushed to 4 mesh then conveyed to two leach vats which are agitated. From the leach vats the solution and tails go to settling tanks. The tails are fed to a portable stacker and the pregnant solution is fed to vats, using tin cans for precipitation. Plant will have a capacity of 50 tph producing about 10,000 # of 79% Cu cement. The operation is to be continuous. 18 to 20 men will be employed. All equipment is new and operations are expected to begin sometime in June. Construction now taking place and the mine is being prepared. A short tunnel to the mine from plant to house the conveyor and make the plant accessible from the pit is near completion. FTJ WR 5-14-66

White Mesa Co. operating the Mardun (Zontelli Western) were expected to be in operation by mid-June. FTJ QR 7-8-66

Interview with Harho Saari, Res. Mgr., and Mr. Aimes, Pres., Arizona Copper Project Div., of White Mesa Co., Inc. (Mardun Mine). They were trying to start the leach operation that was scheduled to start in July, but held up waiting for power to be delivered by APS who were setting up at the time of visit. Temporary power is being supplied by 2 diesel plants. No mining was being done as there was enough ore broken to make a trial run. FTJ WR 9-16-66

MARDUN COCONINO COUNTY

Visit from Sam Thurmond, supt. for the Zontelli Bros. exploration project in the White Mesa sandstone copper area - Mardun, etc. - consulted our files and maps, and reported he had drilled some 500 to 600 holes and his people were evaluating the results with an expectation that a producing project might be justified. TPL WR 4-28-62

Mr. Collins said Zontelli Bros. have been drilling 1½ years and think they may find enough small deposits to make it go. They don't plan a big operation. Believe they can get enough tin cans from the Indians who use a lot of canned soft drinks and beer. FPK 8-30-62

Visited Zontelli Bros. heap leach at Coppermine in the White Mesa region. The mine is about halfway between the Gap and Page, 27 miles off Highway 89.

At present they have two stockpiles. One about 25,000 tons and one about 50,000. Bulldozers were just starting the third stockpile.

The leaching plant isn't complete just yet so only the small stockpile has solution on it. The pregnant solution goes to the leaching plant thru plastic tubing and thru the completed part of the leaching plant and is then pumped back on the small stockpile.

The water for the plant comes from a well eight miles away. Mr. Thurmond said they have plenty.

So far, plenty of tin cans have been supplied by the Indians.

It is expected the plant will be complete by the first of May.
EGW Memo 4-17-63

Zontelli Western Co. secured in April a SBA loan for $66,500. 10 men working - copper mining. from - G. Moore - 6-3-63 LP

Zontelli Western Mining has a $66,500 loan from the Small Business Administration to explore and develop a copper mining project in Coconino County. The Zontelli firm bases out of Ironton, Minn., where it has developed iron deposits over the past 2½ years. Two ore stockpiles have been prepared at the Arizona operation - one of 25,000 tons, the other of 50,000. Leaching operations have been started with water supplied from a well eight miles distant. E&MJ August 1963

MARDUN COCONINO COUNTY

Visited the mining area surrounding Copper Mines Trading Post in the White Mesa district (site of former Mardun and other past projects). Patterson, the trading post proprietor, discussed the current situation so far as he knew of it. Steinberger and Blakemore have tied up and are drilling intermittently a sizable block of ground which includes Thompson's unpatented claims (27) and leases on some adjoining Indian land. Results to date are not sufficiently conclusive to make a satisfactory appraisal of the project. The holdings of the Shattuck estate (9 patented claims) are now contracted to Vaughey and Vaughey of Denver, Colorado and Dallas, Texas as a result of assignments to them by others. The property is idle. A short time ago some milling equipment (kiln, crusher, screens, etc.) was sold and several to The McDonald Construction Co. operating the Golden Sands gold placer project in San Domingo wash near Morristown.

Visited Blakemore again at Cameron to discuss the drilling at White Mesa, also the Cameron U308 situation in general. While there I met a group of AEC engineers of the Grand Junction's Operations office. The group included Tom Young, Frank Bemis, Tom Pittman, and two others. Also Dan Maglby, a geologist of the AEC Flagstaff office, was in the party. TPL WR 5-20-60

In a conversation with Rudy Gracey on Jan. 23, at his laboratory in Flagstaff he informed me that Zontelli Bros. (address not available) had performed some exploratory drilling on property which was formerly a holding of the Mardun Co. in the Copper Mines area of the White Mesa region. Steinberger, a former partner of Blakemore, recently completed a drilling contract for Zontelli. Over 100 shallow holes were drilled and the results are now being evaluated. TPL Memo 2-2-61

Visited the office of Cameron Mining Co. A Mr. George Bastedo together with Donald P. Wilson (notable author) bought Steinberger's half interest in the company and they are continuing work with Page Blakemore, owner of the other half. TPL WR 4-15-61

Visited the drilling operations of Zontelli Bros. (iron operators of Ironton, Minn.). They have taken over the claims once worked by Mardun and recently drilled in small part by Blakemore and Steinberger. S. S. Thurmond is in charge assisted by M. Provost. Drilling is being done by a Steinberger's contract crew. TPL WR 5-13-61

Visited the Navajo Agency offices at Window Rock and discussed uranium and other Reservation mining activity with C. V. Collins, mining engineer for the Tribe, and his assistant Leo Denetsone. Learned that Steinberger is still drilling the sandstone copper area on White Mesa - Mardun area - for Zontelli Bros., also he is drilling coal deposits for the Peabody Coal people. TPL WR 8-5-61

Active Feb. 2, 1962 - Expl. - White Mesa properties, S. S. Thurmond, res. supt., Zontelli Bros., Ironton, Minn.

Visited the Copper mine on White Mesa, 22 miles southerly from Page. The property, formerly operated by the Mardun Co. and more recently by Able Mining Co., was idle.
TPL WR 5-20-58

Visited the Copper Mine Trading Post copper area which includes the Claude Thompson claims (28 unpatented) and the Shattuck claims (9 patented) and development on adjoining Indian lands formerly worked by Mardun. There is no present activity on these sandstone copper properties. Mr. Patterson, the proprietor of the trading post, said that a Canadian group, Transcontinental (?) had an option on the Thompson claims and was negotiating for other ground (Shattuck and Indian). Also, he reports that Steinberger of Steinberger Drilling Co. is negotiating with the intent of drilling one or more deep test holes. Also a Mr. Fairman of Texas is attempting to negotiate. TPL WR 5-19-59

Cameron Mining Co. doing some work re copper leaching and possible sale of crushed sandstone for "hydrofrac" use in oilfields.

Page Blakemore - Cameron Mining Co. - also has taken over management of Rare Metals uranium mines. Info. from Lee Hammons - 8-11-59

Inspected all independent active properties in Cameron area and some of the more important workings of Rare Metals Corp. in the company of Blakemore. Blakemore, in partnership with Steinberger as the Cameron Mining Co., conducts an engineering service and mining contract business. Blakemore does some mining for his own account, and Steinberger also conducts a contract drilling business for his own account. Checked the Dept.'s active mine list - Feb. 1958, with Blakemore and made deletions, changes and additions thereto, in accordance with information furnished by him. TPL WR 5-20-58

Visited the Copper Mine Trading Post in the White Mesa district of Coconino County. Interviewed Patterson, the proprietor of the post, also visited the Baptist Missionary. Looked over the area being drilled by Steinberger and Blakemore. These partners are conducting this exploratory work under an agreement with Claude Thompson, owner of 29 unpatented claims, also under an agreement with the Navajos. Some of this is the ground explored and worked for a time by Mardun about 15 years ago. TPL WR 9-19-59

MESA MINING INC.

(A Subsidiary of Carleton Resources Corp.)
7564 North Palm Circle
Tucson, Arizona 85704 U.S.A.
Phone: (520) 544-7872 Fax: (520) 544-9236

July 8, 1998

Mr. Nyal J. Niemuth
Department of Mines and Mineral Resources
1502 W. Washington
Phoenix, AZ 85007

Dear Nyal:

It is always a pleasure to visit with you.

Enclosed is a summary report by American Coppermine Resources Ltd. (a holding company previously affiliated with Mesa Mining) describing the White Mesa project, which as you know is a sediment-hosted copper deposit near Page, Arizona. This report was written prior to the last drilling program in 1995, and gives ore reserves based on the drilling to the date of the report. The ore reserves stated in this report vary with cutoff grade and method of calculation from about 30 to 50 million tons with grades from 0.27% to 0.40% Cu for the Trading Post deposit, which is the most explored of several on the property.

Also enclosed is a description of the project which I prepared for a presentation to some Navajo authorities. It gives an overview of how Mesa was planning to develop the Trading Post deposit if it had ever got its financing done.

The 1995 drilling program was done by reverse circulation, mostly wet. The geologist noted that blue water flowed from a number of holes, but did nothing about it. I believe that the chrysocolla, which fills the spaces between the sand grains, was partially washed out of the cuttings. In any case, the results of the 1995 drilling were disappointing. Ross Glanville (a consultant who does valuations for the VSE) used the 1995 and previous data to prepare report for the VSE. He calculated minable reserves as about 19 million tons at 0.28% Cu with a 0.15% cutoff. We planned a 50 core hole program for 1997 to twin some of the 1995 holes to show that the RC drilling understated the grade, and to cut the ore off at several points around the periphery of the deposit. This was never done for lack of funds.

We believe that there are at least 30 million tons at at least 0.30% Cu in the Trading Post deposit. In addition, copper mineralization is widespread within the lease area. Mesa Mining did a resistivity survey covering essentially all of the lease. The theory was that areas of higher chrysocolla content would be more conductive due to the water of hydration. The survey

confirmed the theory and indicated that about 25% of the 10,000 acre lease is prospective. More work is needed to determine if other significant deposits exist.

The Trading Post deposit has the potential to be a low-cost mine. The ore is relatively soft and leaches extremely well with very low acid consumption. Excellent leach pad, waste dump and plant sites are located adjacent to the orebody. The ore outcrops on top of a mesa, giving a low stripping ratio. I believe that a run-of-mine leach with a low (~0.10% Cu) cutoff is feasible even at low copper prices.

I have included a list of available relevant information which I can copy for anyone with serious interest. They'd have to sign a confidentiality agreement to get any of this additional information.

I would appreciate anything you can do to bring this property to the attention of parties who might be interested.

Sincerely,

Fred B. Brost, P.E.
Project Manager

Encl. American Coppermine report
Project description
Data list

SUMMARY OF RELEVANT INFORMATION AVAILABLE
MESA MINING WHITE MEAS PROJECT

1943 and 1992 drilling program assay data. 44 holes in 1943, 30 holes in 1992. 30 pages.

1993 drill hole assay data. 34 holes. 80 pages.

1995 survey data and assay results. 92 pages.

1996 Montgomery hydrogeology report on potential source of water for the project.

1992 N.A. Dagerstrom metallurgical report. 100 pages.

1995 Ross Glanville valuation report. 90 pages.

1995 American Coppermine Resources report. Good overview. 30 pages.

Drill hole map, 3/14/96, Trading Post Area

Drill hole map, 3/14/92, Trading Post Area

Cross Sections, 15' bench composites, 48,200N through 51,400N (200' intervals), 11/28/95

IP Survey Lines 51,600N, 51,000E, 54,800E

Resistivity Survey maps: 92329-1, -2, -3, -4, -5, 5A, -6, -7, -9A

NOTE: There is much more data available, but some is in raw form (assay sheets, hole logs, geophysical data, assay sheets, etc.) which is probably not useful for a first look. All this data will be made available if there is serious interest.

Number of pages given above is approximate

JULY, 1998

MESA MINING INC.

(A Subsidiary of Carleton Resources Corp.)
7564 North Palm Circle
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Phone: (520) 544-7872 Fax: (520) 544-9236
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The Company

Mesa Mining is a subsidiary of Carleton Resources Corporation. It was formed in 1991 by Mr. Dick Moores, Mr. Wayne Livingstone and others to develop the White Mesa copper deposit. Mr. Fred Brost, a registered professional mining engineer, is the Project Manager . Mesa Mining has offices in Tucson, Arizona and Vancouver, B.C. Canada.

The White Mesa Copper Deposit

The deposit is a medium-sized copper oxide deposit which lies under the mesa north of the Coppermine Chapter House. The deposit is low grade, averaging about 0.3% copper (six pounds of copper per ton). Because the mineral is copper oxide, the ore can only be economically processed using modern hydrometallurgical techniques.

Mesa Mining has drilled approximately 200 holes to define the deposit. It has also done extensive testing to develop the metallurgical process and has completed conceptual engineering for the mine and facilities.

Legal Status of the Deposit

In 1992, Mesa Mining negotiated an operating agreement with the Navajo Nation covering a portion of the deposit and the surrounding area. Mesa Mining also purchased nine patented mining claims (180 acres) covering the rest of the deposit from non-Navajo owners. These claims existed before the area was included in the reservation, and included both mineral rights and surface rights. Mesa Mining donated the surface rights to the Navajo Nation, but continues to own the mineral rights within these claims.

Plans for Development

Mesa Mining plans to develop an open-pit mine on the mesa and build processing facilities on the plain north of the mesa. It plans to mine about 10,000 tons of ore per day to produce 30 tons of copper per day.

Permitting. The mine and facilities will cover about 400 acres, and will be developed in accordance with strict permit standards of Navajo Nation and US government agencies, including the Navajo EPA and US EPA. Prior to development, Mesa Mining will have to obtain more than ten Navajo Nation and federal permits and approvals, including approval of an Environmental Impact Statement (EIS). Community members will have the opportunity to express their concerns about the project during the EIS process. Public concerns and potential hazards must be evaluated and mitigated before the EIS will be approved.

The rights of local residents and land users will be respected during the development and operation of the project. If project activities affect the homes, property or grazing rights of community members, the Company will pay fair compensation.

Mining and processing. Mesa Mining will remove and stockpile the top layer of soil for use in reclamation before any area is disturbed. The leach pad and solution ponds will be developed using state-of-the-art composite liners, and will include leak detection and/or collection systems and monitor wells.

The mine will be developed using normal open-

pit mining techniques, including drilling, blasting, loading and truck hauling. Rock containing no copper will be placed in mined-out areas of the pit when possible, otherwise in a rock dump. The proposed the mine and processing facilities during operation are shown in Figure 1.

Blasting will be done once a day, during the early afternoon. Charge sizes will be limited to minimize noise. Water sprays and road watering will be used to minimize dust from loading and hauling.

The ore will be placed on the lined leach pad. A solution containing water and a small amount of sulfuric acid will be dripped onto the ore using drip emitters. The solution leaches (dissolves) the copper from the ore and is collected in a solution pond. The copper-bearing solution will be pumped to the solvent extraction plant, where the copper is removed from the leach solution and transferred to a concentrated, pure electrolyte solution. The electrolyte is then either electrowon to produce pure copper sheets or crystallized to produce copper sulfate crystals. Mesa Mining is studying the two alternative products, and will decide which to produce in the next few months. Typical processing facilities are shown in Figures 2 and 3.

All process solutions are recirculated. Make-up water is needed only to replace water lost to evaporation, initial ore wetting and dust control.

Reclamation. The life of the mine will be about 10 years, unless more ore is found. At the end of the life of the mine, the area will be reclaimed to meet or exceed government standards. Reclamation will include: removal of all buildings and equipment, except for buildings requested to be left by the chapter; rinsing of the leach pad and evaporation of excess water; flattening the slopes on the rock dump and leach pad to enhance revegetation; removing pond liners, filling and levelling pond areas; covering of the rock dump, leach pad, ponds, plant area and road surfaces with stockpiled soil; revegetating disturbed areas with native plant species; and fencing the top of the open-pit slopes. Following reclamation, vegetation would be monitored and tended as needed for several years to ensure survival. Most of the reclaimed area would be available for grazing after the vegetation has been reestablished.

A portion of the open pit will be left open as allowed by current mining laws. Mesa Mining will work with Coppermine Chapter to minimize the impact and/or to develop a beneficial use for this portion of the pit. Proposed reclamation is shown in Figure 4.

Employment. The project will employ about 200 persons for construction and 100 persons for mining and processing. Construction jobs will include the usual construction trades.

Production jobs will include: mine engineer, geologist, metallurgist, mine foreman, plant foreman, engineering technician, surveyor, driller, blaster, powderman, loader operator, truck driver, plant operator, mechanic, electrician, laborer, laboratory technician, purchasing agent, environmental and safety supervisor, environmental technician, warehouseman, clerk, and receptionist. Mesa Mining is committed to local and Navajo preference in employment and training, and will train Navajos for operating and supervisory positions.

Schedule

If permits and approvals can be obtained, construction will start in about one year. Mining would then commence about October, 1999.

Contacts

If you have questions, please call:

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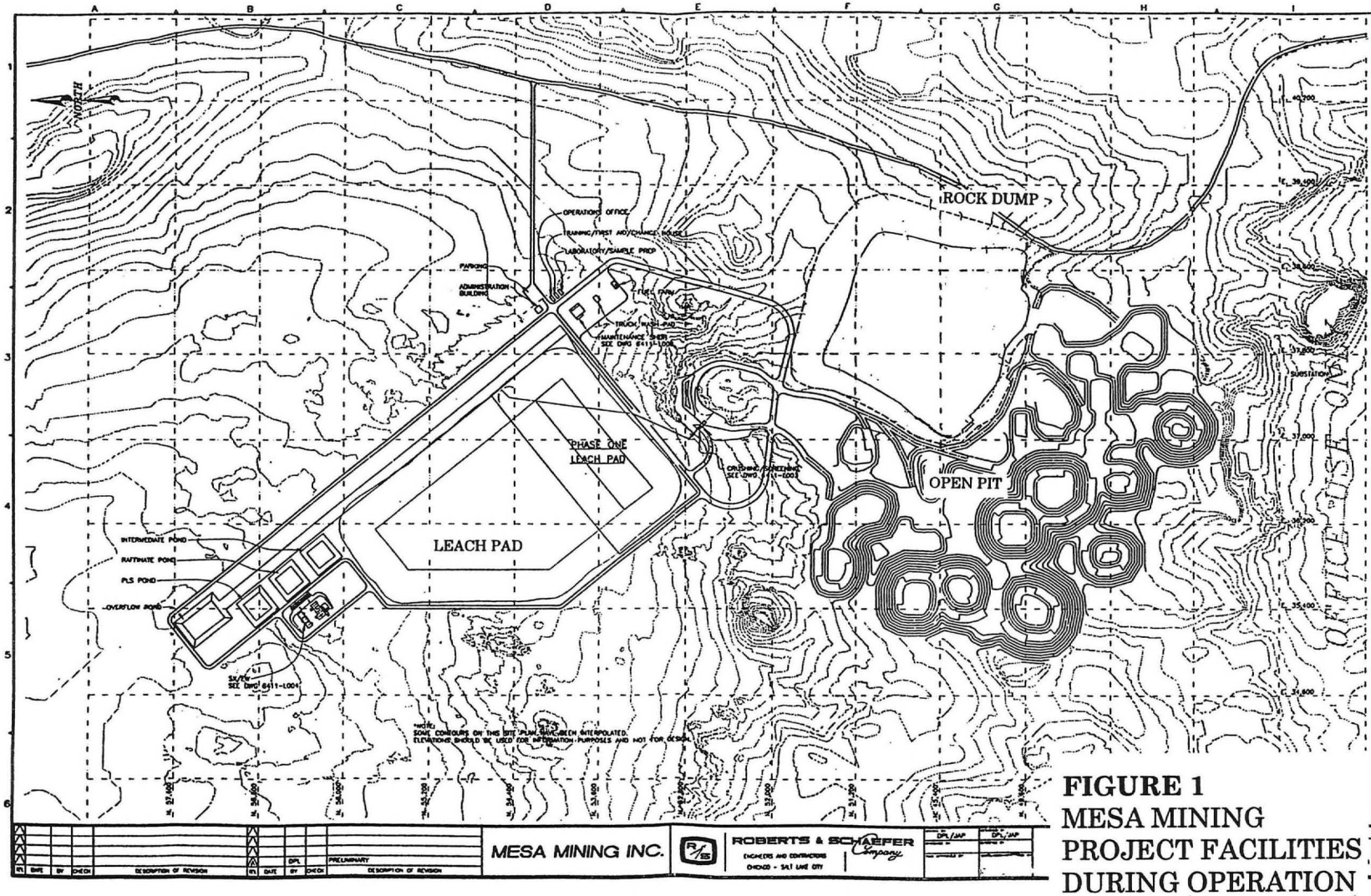

FIGURE 1
MESA MINING
PROJECT FACILITIES
DURING OPERATION

PAUL L. RUSSELL, P.E.
CONSULTING MINING ENGINEER

6050 W. Yale Avenue
Denver, Colorado 80227
Phone: (303) 986-6363

April 6, 1994

Mr. H. Mason Coggin, Director,
State of Arizona,
Department of Mines & Mineral Resources,
1502 West Washington Street,
Phoenix, Arizona 85007.

Re: Coconino Copper & Chemical Co. - 1940.

Dear Mr. Coggin:

Thank you for your interest in the 1940 data on the Coconino Copper & Chemcial Company. Enclosed, as promised, are the pictures and some notes of what went on while I was there.

The need to preserve data and pictures of early events of all types for future reference is essential if we are to have a useable record of our early history. I became acutely aware of this in the 1970's when I wrote "The History of Western Oil Shale" (now out of print), and again in the late 1980's when I wrote "Oil Shales of the World, Their Origin, Occurrence & Exploitation (flier enclosed). Needless to say I did a lot of searching for data and pictures.

I regret to report that I can offer no additional records regarding early operation of Arizona mines. For the most part my mining career was spent in other areas. However, I am a Registered Mining Engineer in Arizona, Certificate # 1356.

My Interest in the Indian area of Arizona is a natural one since I was born at Keams Canyon and grew up in Flagstaff.

I would appreciate notice of receipt of this information.

If I can be of further assistance please advise.

Sincerely,

Paul L Russell

Paul L. Russell

NOTES ON THE OPERATION OF THE COCONINO COPPER & CHEMICAL COMPANY IN 1940

By Paul L. Russell, 6050 West Yale Ave., Denver, Colorado 80227

While an engineering student at the University of Arizona, I was employed during the summer of 1940 by the Coconino Copper & Chemical Company as assayer and general operator.

The plant and mine was located north-east of The Gap, Arizona, on patented mining claims (Calumet & Hecla, I believe) that pre-dated the establishment of the Navajo Indian Reservation.

I do not have an overall history of these claims, but the records at the Arizona Department of Mines & Mineral Resources show that they were mined for copper during World War I. The hand-sorted high grade sandstone (Red Bed) copper ore was hauled to the highway at The Gap using "bull wheel" steam tractors pulling iron wheeled ore wagons. I do not remember where the ore was finally processed.

During the 1940's the hand-sorted high-grade copper ore was trucked by the Company to the Kennecott Copper Co. near Salt Lake City, Utah. Here it was traded for sulfuric acid which was used in the Coconino Copper & Chemical Co., leaching process.

This Red Bed copper deposit contained very few impurities and a high grade copper sulfate was produced.

The major production problem was the lack of sufficient water and poor roads. A deep well had been drilled but could only be pumped a few hours before going dry. As I recall only a few tons of water could be produced per day (see Photo # 12).

I do not remember what the production was, but it was quite limited.

Mining and ore treatment was relatively simple. The ore was mined from an open cut or pit. Blast holes were churn drilled by hand using long steel drill rods, Photo # 1. The ore was hand sorted into mill feed and high grade. The high grade was traded for sulfuric acid in Utah. The mill feed was trucked to the crushing section of the leaching plant, Photo # 2. The crushed ore was placed in large tanks, Photo # 3, & 4, at the leaching plant. Photo # 5 is of sulfuric acid drums near the leaching plant. A coal-fired boiler, Photo # 6, supplied heat to provide a hot solution of dilute sulfuric acid which was added to the crushed ore in the leaching tanks. (The author had just finished rolling the tubes in this boiler when this picture was taken). This combination of heat and acid produced a saturated solution of copper sulfate that precipitated out when cooled in shallow recovery vats, Photo # 7. The precipitated copper sulfate was removed by hand shoveling, Photo # 8 & # 9. The copper sulfate was dried, crushed, and sacked in a preparation building located near the precipitation vats, Photo # 10 & # 11. As I remember, the copper sulfate was marketed under the MEDFORD brand.

The crushed leached material was hand shoveled from the three leaching tanks and disposed of on the waste dump. The cycle was then repeated.

Photo # 12 shows the pumphouse about mid-way between the mill and the leaching vats. The water tank is to the left of the mill, assay office to the right and the tailing dump is right-center. The market for the product was quite good. In fact the Company hired a salesman who in his first or second call received an order that would have required the next 20-odd years to produce. The salesman resigned.

OTHER TRIVIA:

Since the mine and plant were surrounded by the Navajo Indian Reservation, most of the operating crew was Navajo.

The Copper Mine Trading Post, Photo # 13, was operated by Babbitt Brothers of Flagstaff. What apparently had been a storage-warehouse building near the Trading Post was used as a bunkhouse by the Company, Photo # 14.

From the mill-assay area, I was able to see over 30 rugs being woven at one time.

The acid-resistant chrome shovels used to remove the copper sulfate from the precipitation vats were "borrowed" between uses by the Navajos and had to be rounded up each time they were needed again. They were always found.

One Navajo who worked at the mill was a genius in anticipating break-downs and was always gone when needed. He had recently married a young squaw. I asked him how much he had paid for his bride. He replied about as follows "I gave some sheep, a horse, a concho belt (etc.) "She did not know how to weave-I had to teach her. She had no sheep-I had to buy her some. She did not cook well-I had to teach her." A couple of other problems were mentioned also. He then said "You know I think I got cheated."

An interesting experience!

Paul L. Russell.

ANTILLES RESOURCES LTD.
N. 10220 Nevada Street, Suite 70
Spokane, Washington 99218
(509) 467-5200 FAX (509) 467-5045

21 February 1995

VSE SYMBOL: ARY.
12g3-2(b) Exemption Number 82-2874

ARIZONA COPPER OXIDE DEPOSIT TO BE ACQUIRED

ANTILLES RESOURCES LTD. announces that it has agreed to amalgamate with American Coppermine Resources Ltd. (ACRL), a private British Columbia company, in order to participate in the development of ACRL's White Mesa copper oxide deposit located in Northern Arizona. Ross Glanville and Associates Ltd. have calculated the value of this deposit, based on the net present value of the projected cash flows, to be approximately US$22,000,000.

The White Mesa property comprises 10,000 acres of Navajo Reservation lands and 188 acres of patented claims. The property has excellent infrastructure, with good road access, several power lines crossing the property, ideal processing sites and available labor nearby.

The mineable proven and probable ore reserves utilized by Glanville were approximately 21 million tons grading 0.36% copper. With additional drilling, the possible reserves are expected to be upgraded to probable reserves. Furthermore, the widespread copper mineralization over the whole property and the geophysical anomalies suggest that the ultimate reserves could be much greater than the 35 million tons of calculated proven, probable and possible reserves.

Copper mineralization on the White Mesa deposit consists almost entirely of copper oxide minerals. The deposit is easily leachable (99% recovery within a few weeks based on column leach tests) and appears ideal for development using low cost heap leaching and modern SX/EW copper extraction methods. The plan is to carry out open-pit mining at a production rate of 12,000 tons per day of ore (4.2 million tons per year). The capital cost is estimated to be US$24 million. These figures may be subject to revision upwards depending upon the results of a $1.5 million feasibility study planned to commence as soon as possible.

Approximately 90 drill holes have been completed on the property, of which 65 were drilled in the main deposit area. Other studies including hydrological, environmental, biological, and archeological, have also been undertaken. Total expenditures by ACRL have been approximately US$1.5 million to date.

Antilles and ACRL have agreed, subject to shareholder and Vancouver Stock Exchange approval, to amalgamate and continue as one company under the name of AMALCO. Under the terms of the agreement three Antilles common shares will be exchanged for one new share of AMALCO and one ACRL share (anticipated to be subject to a voluntary pooling agreement) will be exchanged for 1.0776 new shares of AMALCO.

At the date of the amalgamation, Antilles shareholders will receive approximately 4,200,000 shares of the amalgamated company (5.9 million fully diluted). ACRL shareholders will receive approximately 8,340,000 shares (8.9 million fully diluted) of the amalgamated company; of which 4,000,000 will be issued free of all restrictions and 4,340,000 shares will be held in escrow. The escrowed shares will be released subject to completion of a $2,000,000 work program or an ore reserve report acceptable to the Vancouver Stock Exchange.

The 10,000 acre property is governed by an operating agreement between the Navajo Nation and Mesa Mining Inc., a subsidiary of ACRL, whereby Mesa Mining can acquire 100% of the property (subject to a back-in purchase option by the Navajo nation for 49% subject to negotiation/arbitration) in return for annual payments of US$55,000 plus a royalty on gross proceeds, which varies according to the price of copper (6% with copper under US$1.00 per pound and 8% with copper between US$1.00 and US$1.25 per pound).

The patented claims are owned outright by Mesa Mining, with no royalties. Since approximately two thirds (2/3) of the copper production from the proposed mining operation will come from the lands leased from the Navajo Nation and one third (1/3) from the 100% owned patented claims, the effective royalty rates on the full production will be about two thirds (2/3) of the stated royalty.

A finders fee is payable to the Barrington Communication Group for its services.

ON BEHALF OF THE BOARD

"John B. Hite" (signed)

John B. Hite
President

THE VANCOUVER STOCK EXCHANGE HAS NEITHER APPROVED NOR DISAPPROVED THE INFORMATION CONTAINED HEREIN

For further information contact Mark Bradbury at the Barrington Communications Group at (800) 663-0321

DEPARTMENT OF MINERAL RESOURCES

REPORT TO OPA ON ACTIVE MINING PROJECT

Date 7/24/45

Name of Mine Madden

Owner or Operator Earl F Hastings

Address 337 Clarendon Phx

Mine Location Navajo Indian Reservation

File System

File No.

This chart to be used for gallons of gasoline required per month.

PRESENT OPERATIONS: (check X)

Production ✓; Development ; Financing ; Sale of mine ;

Experimental (sampling) ; Owner's occasional trip ;

Other (specify)

PRODUCTION: Past and Future.

	Tons
Approx. tons last 3 months	
Approx. present rate per 3 months	
Anticipated rate next 3 months	
If in distant future check (X) here	

EQUIPMENT OPERATED:

Special

Type	Quantity or Horse Power	Miles or Hours ~~Per Month~~	Gallons Required Per Month
Personal Cars	36 Olds	600	
Light or Service Trucks			
Ore Hauling Trucks			
Compressors			
Other Mine or Mill Eqpt.			

PRODUCT PRODUCED OR CONTEMPLATED: Name metals or minerals.

Copper

REMARKS:

Mr Hastings, a Special Employee of this dept has previously made examination of this property and has been called by this Company for reexamine in regard of recent developments

ARIZONA DEPARTMENT OF MINERAL RESOURCES

By George Ballen

ARIZONA DEPARTMENT OF MINERAL RESOURCES
Mineral Building, Fairgrounds
Phoenix, Arizona

1. Information from: Donald Weisenberger - Bus. Manager

   Address: P.O. Box 1565, Page Arizona

2. Mine: Copper Mine(Mardun)White Mesa 3. No. of Claims - Patented 23 (Thompson)
   Unpatented 8

4. Location: unsurveyed - Kaibito Plateau - 26 miles NE of The Gap.

5. Sec - Tp 37 N Range 9-10 E 6. Mining District

7. Owner: Thompson estate of New York - reported owner of patented claims.

8. Address: not known by Mr. Weisenberger.

9. Operating Co.: White Mesa Co.

10. Address: Box 1565, Page, Arizona

11. President: Donald Aimes 12. Gen. Mgr.: Donald Aimes

13. Principal Metals: Copper 14. No. Employed: 25

15. Mill, Type & Capacity: Continuous leaching by agitated vats. Capacity uncertain.

16. Present Operations: (a) Down ☐ (b) Assessment work ☐ (c) Exploration ☐
    (d) Production ☒ (e) Rate 658 tpd.

17. New Work Planned: Some additions to mill planned to lessen slimes in preg. solution.

18. Miscl. Notes: Copper mineralization principally chrysocolla and other silicates, some malachite & black oxides. These have replaced in part the clayey matrix of the sandstone. A great amount of stripping will be necessary to recover some of the ore in pit. Walls are too high (75+ feet) and incompetent at the top - northside. South side of pit has less overburden, but pit design is difficult. An outcrop south of present pit (1/2 mile +) may offer good ~~chance~~ for new development.

Date: Sept. 13, 1967

F. T. Johnson
(Signature) F.T. Johnson (Field Engineer)

A ONA DEPARTMENT OF MINE RESOURCES
Mineral Building, Fairgrounds
Phoenix, Arizona

Mayo report says almost due N. Fig. 10 indicates that the 26 mi is by road. Copper mine Trading Post is in the copper district.

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   Address: P.O. Box 1565, Page Arizona
2. Mine: Copper Mine(Mardun)White Mesa 3. No. of Claims - Patented 23 (Thompson)
   Unpatented 8
4. Location: unsurveyed - Kaibito Plateau - 26 miles NE of The Gap. Best route is up from The Gap. Road list is Page is just a trail.
5. Sec - Tp 37 N Range 9-10 E 6. Mining District
7. Owner: Thompson estate of New York - reported owner of patented claims.
8. Address: not known by Mr. Weisenberger.
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Date: Sept. 13, 1967

F. T. Johnson
(Signature) F.T. Johnson (Field Engineer)

DEPARTMENT OF MINERAL RESOURCES

STATE OF ARIZONA

FIELD ENGINEERS REPORT

Mine	Zontelli Western	Date	October 2, 1963
District	White Mesa	Engineer	E.G. Williams
Subject:	Visit		

Quite a number of changes have taken place since the writers last visit April 10, 1963. One leach dump now has about 140,000 tons, another about 40,000 tons. At the time of the visit, equipment was filling in the space between the 2 dumps. When complete the dump will be about 225,000 tons.

The precipitating plant is now complete and consists of 13 cells a decant pond and a concrete drying slab. At the time of the visit 40 gpm was going thru the plant. They expected 500 gpm by October 1.

A complete change has been made in the personnel. Harho Saari, Supt., John J. Simmons, Mgr., and E. Coyle, plant foreman.

R E P O R T

MARDUN COMPANY
White Mesa Mining District
Coconino County, Arizona

April 30, 1945

Purpose

Pursuant to instructions of C. H. Dunning, director, Department of Mineral Resources, a visit was made to the above property for the purpose of correcting, amplifying and/or extending the data compiled in the report of G. A. Ballam, Department of Mineral Resources, dated November 17, 1942. The holdings and records of the Mardun Mining Company were examined on April 7, 8 and 9, 1945, in company with G. A. Ballam and O. F. Marvin, a partner in, and manager of, the enterprise.

Conclusion

The essential facts of the Ballam report were in agreement with the conditions noted except those changes which would necessarily follow the development and production accomplished since that report. Such changes accrue to the benefit of the property and in no case have they been found to detract from the merit as previously reported.

There now appears to be inferred tonnage for an operating period of 5-1/2 years at the rate of 60,000 tons per month. Such operation should yield a minimum of 1,728,000 pounds of copper per month at a direct cost of approximately $0.0629 per pound of recovered copper on the present smelting schedule and return $0.07 per pound without premium, or $0.215 per pound with premium.

This enterprise in its completed proposed schedule appears to be one having the advantages over other major copper producers of:

1. Less initial capital expenditure per unit of production.

2. Less manpower required per unit of production.

3. Less critical material needed per unit of production.

As such it is deserving of early exploitation for war purposes and through investigation for post-war production possibilities.

Conditions have been altered since the initial report in the respects hereinafter discussed.

Property

In addition to the original lands leased from the Indian Service the company has acquired leases on mineral claims formerly held by the Shattuck-Denn Mining Company, thereby enlarging their holdings to approximately 1,155 acres.

Reports

In August 1943 a United States Geological Survey party, under Charles B.

Read, examined the area and estimated ore reserves. This report has not been published but a copy is at hand.

In March 1945 the Supervising Engineers of the Salt Lake City office and the Tucson office of the U. S. Bureau of Mines visited the property, making special study of the beneficiation of the ore as practiced by the Mardun Company. Such report has not been published and will possibly be withheld pending additional laboratory experimentation.

Mining

Mining and development are quite closely associated as most of the ore extracted was for the purpose of proving either lateral or vertical extensions of the known bodies. Thus the extraction was scattered over wide areas, the more concentrated part being on the Dutchman claim 1-1/8 miles south of the mill and the Copper World adjacent to the mill site. Smaller quantities were taken from throughout the general area.

The grade and nature of deposition were found to be comparable between deposits as was the ratio in quantity of shipping to milling ore.

Between October 1943 and March 1945 ore as follows was extracted:

2,140 tons of shipping ore averaging 6.56% cu.

3,282 tons of milling ore averaging 1.3% cu.

5,422 tons of wasted material averaging 0.8% cu.

10,844 tons of all grades averaging 2.16% cu.

This average grade of ore is definitely higher than was indicated by the drilling previously accomplished, plotted and reported. Previous estimates of the grade of ore in other areas must likewise be revised upwards proportionately.

Mining costs are extremely low as the deposit lends itself to surface extraction. Drilling is accomplished by jackhammers with holes spaced at 25 foot intervals. Holes are drilled to a depth of 25 feet on the angle, or about 20 feet in vertical penetration, to cut the strata. Black powder is used for blasting, 12-1/2 pounds per 25 foot hole, and 1160 tons of ore is broken per hole.

Hand loading into trucks for removal to the mill, stockpile or shipping pile follows hand sorting for grade.

Ore Reserves

The nature of the deposit is such that wide variance in estimates of ore reserves would be obtained from individual engineers. The generally satisfactory results of development and exploration so far experienced leans favorably toward potentialities in extensions of present known exposures.

As of August of 1943 the U.S.G.S. report tabulated ore reserves in a total amount of 16,260,000 tons, of which 2,260,000 tons was indicated and 14,000,000 tons was inferred. Of the indicated ore 260,000 tons graded from 1% to 4% copper and the balance from 0.3% to 1% copper. This estimate was attributed to the entire district and not limited to the Mardun Company's holdings, although most of the

areas are now under the control of that company. Ore grades were predicated upon the combined data of the Shattuck-Denn, Coronado and Mardun Companies. Sampling experience has shown loss of value through handling samples in the conventional way which accounts for actual copper content in extraction exceeding anticipated grade. Much of the then inferred tonnage can now be tabulated as indicated ore following the mining and development heretofore described.

The major areas within the Mardun Company's holdings, in the present state of development, are as follows:

1. Dutchman Claim

There are four general areas, all connected, within the confines of this claim. Of the 4, 3 have been subjected to extensive exploration. The area has been thoroughly drilled to a depth of 25 feet and the cuttings assayed. Numerous pits have been sunk to a depth of 15 to 25 feet and the bottoms drilled to an additional 25 foot depth. These pits account for much of the ore milled, shipped, and stockpiled as previously described.

The surface area covered is 430,000 square feet. The topography and drilling from the pit bottoms indicate ore extensions below the lowest visible horizon, but for the purpose of this calculation only the top 25 feet are being considered as indicated ore. As such there are 860,000 tons of ore reasonably expected to be gained from this claim. Based upon the extraction record such ore should average 2%+ in copper content.

2. Copper World Claim

The exposure here actually extends over a part of 4 claims, 3 of which are a part of the Mardun Company's holdings. An area 1200 x 1200 feet has been drilled on 25 foot centers to a depth of 25 feet, and several long cuts expose the same character of ore to a local depth of 50 feet. Drill holes in the bottom of these cuts indicate ore to an additional 25 feet in depth. Some ore has been mined from these cuts and a mill grade of 1.0%+ copper is probable from the area. Rough sorting to a 2.0% copper mill head could be accomplished mechanically by wasting overburden and the impoverished sections within the main zone as mining progressed.

The indicated tonnage within the Mardun claim limits is 2,875,000 tons of 1%(+) ore, or proportionately less as the grade is increased. The inferred tonnage vertically is 3 or more times as great as indicated, and horizontal extension is apparent easterly and probably northerly. For purposes of calculation an estimated 1,500,000 tons of 1.5% ore will be applied to the area.

3. Copper Hill (Indian lease)

This body stands out above the surrounding plateau level prominently.. Some of the earlier production was obtained from this area and considerable drilling and benching exposed ore below an 8 to 16 foot overburden. The area is approximately 600 x 900 feet on the surface with a visible depth of 100 feet and can be expected to yield 3,375,000 tons of ore below the overburden to the mesa level. The general average value and sorting possibilities found on the Copper World, immediately adjacent to the north, should be applicable here. Thus 1,750,000 tons of mill ore of an approximate grade of 1.5% is probable.

4. Other smaller, or at least less exposed areas, are in evidence over the entire locality but no attempt is made in this report to estimate their potential productive value. Such areas should be subjected to more detailed study and exploration at some future time.

5. Indicated ore reserves, on the basis of current exposures and experience, can be recapitulated as follows:

Location	Est. % Cu.	Est. tonnage	Cu. content
Dutchman Claim	2.0	860,000	17,200 tons
Copper World	1.5	1,500,000	22,500 "
Copper Hill	1.5	1,750,000	26,250 "
TOTAL	1.6%	4,110,000	65,950 tons

Milling

The mill has been increased to a capacity of 5 tons per hour and has been in operation at irregular intervals. Between September 1944 and February 1945 approximately 3,282 tons of ore from which the high grade had been removed were milled showing an average grade of 1.3% copper. A concentration ratio of 10:1 was maintained and a copper recovery of 85% was averaged.

Concentrate shipments totalling 324 tons were made to Clarkdale and Hayden. Shipments to Clarkdale averaged 12% copper and those to Hayden approximately 9% copper. This difference is explained in the shipping schedule to Hayden in which demurrage on rail cars rendered it expedient to lower the grade of shipments to take the greatest advantage of the time element.

Shipments to Clarkdale were made by truck at a cost of $6.00 per ton. Shipments to Hayden were trucked to Flagstaff at a cost of $5.00 per ton and thence to the smelter by rail at a cost of $3.73 per ton.

The concentrate is very desirable due to the silica content (71.0%) and low alumina (4.2%). Verbal reports indicate that it was used as furnace lining at the Clarkdale smelter.

A premium by Metals Reserve Company of 15¢ per pound is in effect which aggregates $0.2139 net return per pound of copper when added to the base price. Income on a 12% copper concentrate as previously shipped is as follows:

12% = 240 pounds - 16.8 pounds = 223.2 pounds 223.2 pounds x (11.775¢ - 2.5¢) =		$20.70
$20.70 - $15.00 = $5.70 $3.50 base + 10% of $5.70 =	$4.07	
SiO_2 70.9% - (10 x 4.2% Al_2O_3 = 42) = 28.9% 28.9% @ 1¢ per unit = credit	0.29	3.78
		$16.92
Sampling charge		0.50
Smelter net return		$16.42

Premium: 97% of 240 pounds = 232.8 pounds
232.8 pounds @ 15¢ per pound = $34.92

Net value of concentrates $51.34

In milling mine run ore, without having removed the shipping ore, a higher grade mill head will be maintained. The estimated average copper content of the inferred ore is 1.6% of which 90% plus is recoverable with mill improvements to be described. Thus, assuming no improvement in ratio of concentration, the following smelter settlement would result:

1.6% cu. heads @ 90% recovery = 28.8 pounds copper
10:1 ratio of concentrates = 288 pounds copper in concentrates

288 - 20.2 = 267.8 pounds
267.8 pounds x (11.775¢ - 2.5¢) = $24.84

$24.84 - $15.00 = $9.84
$3.50 base + 10% of $9.84 $4.48
SiO_2 70.9% - (10 x 4.2% Al_2O_3 = 42) = 28.9%
28.9% @ 1¢ per unit = credit 0.29 4.19

$20.65

Sampling charge 0.50

Smelter net return $20.15

Premium: 97% of 288 pounds = 279.3 pounds
279.3 pounds @ 15¢ per pound = 41.89

Net value of concentrates $62.04

Operational Program

In view of the novel deposition habit of these bodies and the unique beneficiation system developed through the ingenuity of O. F. Marvin of the Mardun Company, operations cannot be evaluated by the usual criteria. If conventional operation practices need be applied, no profit possibilities would exist, and those examiners who have predicated operations upon conventional methods have of necessity rendered adverse reports.

The milling system now in use has been proven economically and metallurgically sound and further improvements are possible. The U. S. Bureau of Mines has already investigated the plant in operation and are reported to have duplicated results in their Salt Lake City laboratory. It has been found that copper recovery can be increased without damage to the concentration ratio by additional disintegrators and collectors in the circuit. This has been demonstrated by rerunning tailings at the mill and in the Bureau's laboratory.

Further cost improvement is probable through leaching of concentrates. The concentrates are amenable to ammonia leaching and tests along this channel are now in process in the Bureau of Mines laboratory. The process now under investigation would yield copper oxide having a value in excess of the market price

of the metal itself. Thus, not only would the shipping and smelting costs and losses be reduced or eliminated, but the net income per pound of recovered copper would be greatly increased. While such leaching would be desirable, in that the present marketing cost is greater than the mining and milling costs combined, it is not an absolute necessity in the economical operation of the property.

Exclusive of this leaching feature the program currently planned is adapted to the peculiar conditions and characteristics found. Considerable loss of value by dusting is experienced in handling the ore; the recovery by milling being in fact a dust recovery system. It is therefore expedient to transfer the ore as little as possible. Handling can be limited to a single step by arranging a moveable mill at the pit face with delivery of the ore to the mill feed hopper by a power shovel. Tailings and pit waste would be removed by a tractor and carryall, or by mine cars trammed to a conveyor disposal system. The mill would follow the ore in the manner of a dredge.

A mill having a capacity of 20 tons per hour weighs, including diesel electric power, 22 tons and can be mounted on a structural steel platform 19' x 30' square. The entire structure could be moved forward on tracks or tractor treads along the pit floor as the face progresses. Such moves would be limited as the shovel has a 25 foot swing radius and a cut 100 feet in width can be maintained.

A tentative design of the portable mill includes the necessary additional units for improved recovery and an extraction of 90% to 95% can be anticipated. Also included is a pre-drying arrangement which will greatly augment capacity and ease of operations.

Operating costs with this arrangement would approximate:

Mining (480 tons per day):

1 - 1/2 yd. power shovel at $100.00 per day	$0.204	
1 - Cat. & carryall at $45.00 per day	0.169	
Drilling & Blasting at $15.00 per day	0.031	
Total		$0.404

Milling:

Labor (3 operators, 1 utility man, 1 assayer)	$0.10	
Power (150 h.p. diesel)	0.04	
Fuel (Dryers)	0.05	
Repairs & replacements	0.05	
Total		$0.240

Shovel and caterpillar costs are estimated on a rental basis. An overall reduction in per ton costs could be effected by purchasing those items. The shovel, having some 5 times the mill capacity, would serve to eliminate any obvious low grade material as that material is easily detected. The caterpillar would

remove such mine waste and mill tailings from the pit and be available for stripping and exploratory work. Drilling would be accomplished with a wagon drill operating on one shift only. Holes would be drilled in the pit floor behind the mill advance to determine depth and value of ore below to be extracted on the next "cut". With the use of a wagon drill exploratory drilling can be attained at considerable more depth than is currently possible with a jackhammer.

The estimated cost of a portable mill having a capacity of 480 tons per day is $16,000.00. For the first unit the greater part of the equipment is at hand and the cost should not exceed $7,500.00. A portable mill having a capacity of 960 tons per day would cost approximately $23,000.00. Both the Copper World and Copper Hill deposits could efficiently supply a mill of the latter capacity with a marked downward revision of production costs. Mining equipment capacity is identical with the requirements of the smaller mill, and a 40% reduction in extraction cost is indicated with the larger mill capacity.

With each milling unit installed, subsequent to the first, additional camp installation, water development, hauling equipment, etc. will be required. The extent of necessary expenditure for these items is contingent upon several factors which are pending; these include the leaching experiments, an access road application to improve the 26 miles of desert road to the paved highway, and other variables. In any event such capital outlay is not exorbitant in the light of commercial tonnage calculated.

Expenses in the operation of the 3 major exposures on the basis of two 960 ton units and one 480 ton unit would approximate:

Mining	$0.296 per ton
Milling	0.200
Hauling	0.600
Royalty	0.201
Supervisory & Gen. Acct.	0.250
Total Direct Costs	$1.547

Net value per ton of raw ore after concentration on the smelter schedule is $2.01 at 12-cent copper and $6.20 with benefit of premium. There appears ample differential to cover capital return and profit within a relatively short period of operation. Inferred ore is sufficient to operate the above 3 units for a period of 5-1/2 years. Additional ore proven within this period should provide for a much longer productive life since no limiting deposition factors have been discovered to date.

In spite of the unusual characteristics of the property it has sufficient merit that it can be considered one of Arizona's major potential copper producers.

Earl F. Hastings
Projects Engineer
Arizona Department of Mineral Resources

COPPER DEPOSITS OF WHITE MESA MINING DISTRICT

Coconino County, Arizona.

By Charles B. Read
R. D. Sample
H. H. Sullwold, Jr.

United States Geological Survey - August, 1943.

CONTENTS:

Illustration

Sec 3
6
map file

COPPER DEPOSITS OF THE WHITE MESA MINING DISTRICT

Coconino County, Arizona.

Summary: The White Mesa Mining District is an area of approximately 10.5 square miles near the western margin of the Kaibito Plateau in unsurveyed Township 37 N, Ranges 9 and 10 East, Coconino County, Arizona. It is 112 miles northeast of Flagstaff, the nearest rail head from which it is accessible by paved and secondary road, and is at an elevation of about 6400'. Inadequate water supply and isolation from supply centers and smelters are factors which have inhibited development and which may be expected to handicap mining operations.

Sporadic attempts to develop reserves of the district have been unsuccessful, and production has been minor. At present, three companies are interested in development, and engaged in, or have recently attempted, prospecting.

The copper deposits occur in the upper portion of the nearly horizontal, highly cross-bedded, gray Navajo sandstone (Jurassic?). Occasional large tabular bodies and numerous small pods of copper ore occur through an interval of at least 150 feet in the upper part of the formation. The deposits are disseminations of malachite, copper silicates, and minor quantities of copper pitch and sulphides in sandstone, the copper minerals ~~occuring~~ OCCURING as cementing and grain-coating materials. Grade varies up to 15%, but it is doubtful if many of the deposits will average much higher than 1%. The larger bodies, some of which contain several thousands of tons, may be expected to average less than 1%. The deposits show a well defined fissure control. Origin may have been telethermal or meteoric, but there is no decisive evidence bearing on this point.

The mineralization is too sporadic to permit accurate estimation of ore reserves in the absence of extensive underground exploration or mining operations. The following preliminary figures are therefore only indicative of the general magnitude of the deposit. Approximately 2,250,000 tons of ore, averaging about 1% copper are indicated in the ore bodies that are exposed or penetrated by drill holes. Only a few thousand tons of this total can be classed as "measured ore" on the basis of available data, but 615,000 tons are reasonably assured. The remaining 1,650.000 tons probably exist in extensions, indicated by geologic evidence, of the known ore bodies. In addition, 14,000,000 is the inferred magnitude of an aggregate tonnage of mineralized sandstone that may exist in "blind" ore bodies concealed in undissected uplands.

Consideration of the average grade and size of the known deposits suggests that large-scale development of these reserves under present conditions will be a marginal enterprise, even under favorable operating conditions. The additional problem imposed by inadequate transportation facilities and water supply enforce a pessimistic outlook. The relatively large inferred reserves of concealed ore cannot be regarded as a mitigating factor, because it is problematic whether concealed ore bodies can be discovered and developed at reasonable costs.

It is recommended that further attempts to prospect or to develop copper reserves of the district be prefaced by a careful analysis of mining and concentration costs based on minimum tonnage estimates. Only in the event that such a survey indicates economic feasibility, should additional steps in development be undertaken.

INTRODUCTION.

The sandstone copper deposits here described are near the northwest margin of the Kaibito Plateau in the Western Navajo Reservation, Coconino County, Arizona. The area, known as the White Mesa Mining District, is in unsurveyed Township 37 North, Ranges 9 and 10 East. It consists of 9 patented and 28 unpatented* claims, 2 mining and prospecting leases, an abandoned millsite lease and a campsite lease.* Sporadic attempts to mine the small deposits of high grade ore in the district have been futile. Recently, comprehensive prospecting by three companies has been initiated in a determined effort to ascertain the feasibility of developing, on a large scale, the low grade copper reserves in the district.

The area, approximately 10.5 square miles, which encompasses the claims and leases, is about 112 miles northeast of Flagstaff, Arizona, from which it is accessible by U. S. Highway 89 to Gap Trading Post, and from there by dirt road 26 miles to the Copper Mine Trading Post in the northwest portion of the district. The mean altitude is about 6400 feet and the local relief approximately 420 feet.

Annual precipitation is less than 10 inches, and surface and ground water are scarce in and adjacent to the district. The deficiency of water, isolation from supply centers, and lack of adequate transportation routes are important factors which have inhibited development of the reserves of the district.

(* In the southwest part of the area, maps show two additional claims, the corners of which are not found in the field.)

Only one report bearing on the geology of the White Mesa Mining District has been published, a brief and general account by J. M. Hill ("Copper Deposits of the White Mesa Mining District"; United States Geological Survey Bulletin 540, pages 159-163, 1914). However, a number of confidential reports have been prepared by geologists and engineers employed by companies interested in the area, and several of these have been examined during the course of the recent Geological Survey investigations. Company prospecting data have likewise been consulted freely, and grateful acknowledgment of the courtesies of the Shattuck-Denn, Coronado and Mardun organizations in making these available is here expressed.

Field work of the Geological Survey was begun late in March and was completed early in July, 1943. The investigation was part of a program designed to determine the status of marginal copper deposits, and was undertaken by the Geological Survey at the request of the War Production Board. C. B. Read was in charge of the White Mesa project, and was assisted by H. H. Sullwold during the entire period of study. R. D. Sample joined the party May 23d, and aided in the later stages of the work.

DEVELOPMENT AND PRODUCTION

Many operations in the White Mesa District were first attempted by Mormon settlers, who, in the latter part of the last century, located the mining claims and opened many of the known ore bodies. An unknown but relatively small tonnage of high grade ore was recovered during the early period of discovery and initial development.

In 1917, operations on the Little Dick and Copper World claims were attempted by the Navajo Copper Company. Two open cuts were developed, and 290,000 pounds of copper, as well as a small quantity of silver are reported to have been recovered. The operations were not profitable, and were discontinued in 1918.

The Coconino Copper and Chemical Company began operations in the western part of the district in 1939 and suspended them in 1940. Their activities were mainly on the Copper World and Dutchman claims. Complete records of production are not available. However, in 1940 they treated 4,584 tons of 3.13% ore from which 797,878 pounds of copper sulphate were produced and shipped.

The Mardun Company, which was formed in 1941, milled 3000 to 3500 tons of ore which yielded about 150 tons of concentrates estimated to contain 15 to 20% copper. This Company operated on a mining lease obtained from the Navajo Indian Service. In 1943 an option on the Mardun lease was acquired by the Coronado Copper & Zinc Company. An intensive prospecting program, begun by the Mardun organization, has been continued in an effort to locate large low-grade ore bodies on the property. It is reported that the Mardun Company drilled 17,000 feet of test holes with an average depth of 24 feet or less. Records of a number of these have been examined, but others are lost. Known locations are shown on map, Plate II-B.

The recent activities of the Coronado Company suggest that the assay logs of these tests show unduly high copper content. In order to avoid confusion the data are therefore withheld until the matter is clarified by shaft-sinking and drilling now in progress. At present the engineers of the organization are pessimistic regarding the possibilities of discovering large ore bodies on the lease.

In 1926 the Shattuck-Denn Mining Corporation acquired tax title on 9 patented claims in the White Mesa District. More recently they acquired options on the unpatented claims, and in 1942 undertook a drilling and prospecting program in the Old Fort Hill area. About 4700 feet of core holes were drilled and assayed. Locations of these holes and summaries of mineralized sandstone encountered are shown on the map; Plate II.

GEOLOGY.

Most of the Kaibito Plateau, in the area studied, is surfaced by nearly horizontal, highly cross-bedded gray Navajo sandstone of Jarassic (?) age. About 1525 feet of clastic sediments assigned to this unit were measured in an incomplete section at Echo Cliffs immediately west of the district where the Navajo is underlain by Triassic clastic sediments and Permian limestones. To the east, red clastic sediments assigned to the Carmel formation rest on the Navajo.

The major structural feature of the western Kaibito Plateau is Echo Cliffs monocline which trends north-northwest to north along the margin of the tableland. The steep dips of this flexure flatten gradually eastward into the plateau, but regional dip continues east to southeast. Oblique normal faults locally complicate the Echo Cliffs monocline and extend north-eastward into the plateau, where they are difficult to trace because of the homogenous nature of the Navajo sandstone which forms both walls at the surface.

GEOLOGIC FEATURES OF THE WHITE MESA DISTRICT.

The White Mesa Mining District occupies an area some 10 miles East of the Echo Cliffs monocline. Nearly horizontal Navajo sandstone, overlain by a

veneer of dune sand, is the surface rock throughout the district. Approximately 420 feet of the unit, constituting the upper portion of the formation, are exposed in the area.

The fracture pattern of the White Mesa District is shown in Plates I and II. Fault fissures trend north-northwest and south-southeast in the western part of the district. Most of these show a slip down to the west and northwest. Sheeted zones, traversed by parallel to sub-parallel faults and joints, are marginal to the major fissures. A set of master joints, trending northeast, intersects these fractures, forming a complex system. In the central and eastern portions of the district, northeast trending master joints constitute the dominant fissures. Reefs of silicified breccia and gouge characterize the faults. Veinlets of chalcedony and, more rarely, calcite occur in the fault zones and walls. The major joints also commonly show extensive silicification.

MINERAL DEPOSITS.

The copper deposits of the White Mesa Mining District vary from large, low-grade, tabular bodies to small irregular pods and veins of higher grade ore. Most of the well-exposed bodies are along or near zones of south, southeast, or northeast trending joint or fault fissures which constitute the dominant structural control of ore deposition. The deposits have a very limited vertical extent, and few show thicknesses which exceed 50 feet. The majority are similarly limited horizontally. Grade varies widely but is predominately low, and for the district as a whole will not exceed 1%/ Inferred reserves of the low-grade ore are large, but the cost of exploring the deposits will probably be high, due to the large area which must be prospected.

MINERALOGY.

Malachite is the most important copper mineral in the district and is usually associated with chrysacolla. (The exact composition of the copper silicates has not been determined. Clays, which are the common cementing minerals in the Navajo sandstone, have been combined with soluble copper compounds, forming copper carbonates disseminated in clay, silicates, and oxides; cf. Clark, F.W. - The Data of Geochemistry; United States Geological Survey Bulletin 770, pages 670-680, 1934.) These two minerals are disseminated through the sandstone in which they partially fill pore spaces, form coatings on grains, and occasionally occur as veinlets.

Copper pitch occurs in the wall rock of fissures, where it frequently forms a halo around disseminations of chalcocite or bornite. The small quantities of both oxides and sulphides make their economic consideration negligible.

Gangue, in addition to sand grains comprising the sandstone, is mainly chalcedony which occurs in anastomosing stringers associated with the higher grades of ore. Veinlets of calcite are rare. Limonite is commonly disseminated in the sandstone as variable but rarely extensive halos around the copper bodies.

DISTRIBUTION.

Large low-grade copper deposits are mainly restricted to the northwest portion of the district in the area between the Ida M. Smyth and Eastern Star faults. The most notable of these are the Little Dick and its possible Grand Pacific Extension, the Copper World, and the California deposits. Series of closely spaced small bodies occur on the Dutchman claim, and in the area of the

Coronado lease on and near Copper Hill and Old Fort Hill. A rather large, but very low-grade, body is exposed on the Queen claim, and smaller ones occur on the Sunset and Ray claims.

Throughout the district there are numerous small copper bodies. The distribution of the various exposed deposits and of their indicated or inferred extensions is shown on the map - Plate I.

FORM AND CHARACTER.

The copper deposits are very irregular and pockety. As indicated above, the larger, low-grade, tabular deposits are exemplified by the Little Dick, Grand Pacific, Copper World, and California bodies, where weak mineralization occurs in large areas of sandstone. Drillhole records show that these may exceed 80 feet in thickness. Such bodies are traversed by numerous joint fissures, the walls of which frequently show stronger mineralization than does the intervening sandstone. The smaller, higher-grade ore bodies often occur as disseminations in the walls of fissures, and are usually vein or pod-like in character. Few have been observed to extend as continuous deposits for a greater horizontal distance than 50 feet. It is probable that their maximum vertical dimensions are approximately the same as those of the tabular bodies.

CONTROL.

The majority of the copper deposits examined are associated with joints, but relatively few are adjacent to fault fissures. In the western part of the district, fissuring is dominantly south to southeast, although locally it trends nearly east. Farther east, most of the fissures associated with

copper deposits are northeastly trending. Copper mineralization is commonly although not invariably strongest in the walls of the joint fissures, but continues, with decreasing intensity, for a variable distance away from the apparent feeders. Joints which are strongly silicified appear to have constituted partial barriers to copper-bearing solutions and to have caused the waters to spread widely along bedding planes.

The White Mesa copper deposits are epigenetic and are products of precipitation from dilute copper-bearing solutions which entered the Navajo sandstone along fissures and spread along permeable laminae away from these fractures. It is not clear, however, whether the solutions were meteoric or telethermal.

There has been some modification of the original form and composition of the copper deposits. Downward-moving surface waters have undoubtedly resulted in the oxidation of copper sulphides which were probably important primary minerals in the deposits. Such waters have caused rather wide dissemination of originally more restricted deposits as a result of leaching and re-precipitation. "Sweating" of the sandstone has apparently resulted in concentration of soluble copper minerals near the present topographic surfaces.

RESERVES.

The status of mining development in the White Mesa Mining District does not permit highly accurate estimates of copper reserves. The ensuing discussion is an attempt to indicate the general magnitude of these reserves and their approximate range in grade as determined in the course of the surface mapping.

Drilling and assay data are available only in the western part of the district and have been frequently been used to supplement outcrop data.

In terms of the classification of ore reserves recently adopted by the Geological Survey and Bureau of Mines (Engineering & Mining Journal, Volume 144, No. 6, Page 94 - June, 1943) reserves of ore in known ore bodies of the White Mesa District are herein classified as indicated ore, and possible reserves that may exist in concealed ore bodies are classed as inferred ore. A significant portion of indicated ore, in parts of ore bodies bounded by very moderate extensions from observed faces of ore in open cuts, shallow shafts, or short adits, is reasonably assured. The remainder of the ore in this class, although regarded with less assurance, is believed to exist in farther extensions of the ore bodies. Outlines of these blocks (Plates I and II) are based on geologic evidence with little or no prospecting control. If further refinements in classification were justified, a small fraction of the indicated ore might be regarded as measured, and a similarly small fraction around the fringe of the assumed outlines might be regarded as inferred ore. In this report, however, inferred ore includes only those possible reserves which may be present, although not exposed, in undissected mesas and buttes. Estimates of this class of reserves has been calculated by applying the ratio of volumes of sediments to the volume of ore as measured in adjacent outcrops. They are not in any sense accurate estimates, but they do provide a reasonable indication of the general order of magnitude of completely hidden (and still undiscovered) reserves.

TABULATION OF ORE RESERVES

White Mesa Mining District

INDICATED ORE

	Reasonably Assured	In Probable Extensions	Total
Grading 1% to 4% (in scattered small bodies)	80,000 tons	180,000 tons	260,000 tons
Grading 0.3% to 1% copper (in a few large and many small bodies)	535,000 tons	1,465,000 tons	2,000,000 tons
	615,000 tons	1,645,000 tons	2,260,000 tons

INFERRED ORE

In Concealed Ore Bodies

In area west of Eastern Star fault	7,250,000 tons
" " east " " " "	6,750,000 tons
Total	14,000,000 tons

Total Indicated Reserves	2,260,000 tons
" Inferred Reserves	14,000,000 tons
Grand Total	16,260,000 tons

Variations in grades of ore are further illustrated in the following take of typical average assays from various parts of the district:

	Samples	Oz. Au.	Oz. Ag.	Cu. %	Remarks
Little Dick Claim					
In and along walls of open cut	16	.001	.32	1.23	
40ft, northeast and northeast of north end of open cut	2	.001	.18	1.15	25 channel samples
South central part of claim	3		.15	.70	1.12% Cu.
West central part	1		.14	.59	
Northwest corner of claim	3		.20	1.05	
Grand Pacific Claim					
West central part of claim	6		.23	1.02	12 channel
Central part	3		.18	..82	samples
South central part	3		1.21	.84	.82% Cu.
California Claim					
Central part	8		.14	.98	18 samples
Western part	10		.13	.69	.82%
Nannie E. Claim					
North end	6		.18	.54	
Copper World Claim					
Northern part open cut	10	.001	.44	.69	16 channel samples
Southern part	6	.001	.26	.74	.71%
Ida M. Smyth Claim					
Northwest corner	4	.001	.22	.55	
Southeast corner	1	.001	.14	1.57	
Northeast corner	1	.001	.16	1.02	
Eli Claim					
North central part	4	.001	.32	.80	
Gopher Claim					
Southwest central part	1	.001	.20	1.35	

av 0.91
Weighted av. 71 samples 0.9%

The area west of the Eastern Star fault contains most of the larger ore bodies and is believed to offer the best chance for mining development. Most of the large, low-grade copper deposits occur in this part of the district, where they lie north of the Ida M. Smyth fault. The Little Dick, Grand Pacific, California, and Copper World bodies together account for 323,000 tons of measurable or indicated ore, and 1,130,000 tons of inferred low-grade ore in the estimates given. The Copper Hill area on the Mardun lease affords some promise, as does the Dutchman claim. It is considered possible that about 10% of the uplands in this part of the district are mineralized to an average depth of 50 feet, giving 7,250,000 tons implied ore which probably cannot be found economically.

Numerous small pods of high-grade ore occur in the eastern part of the district. There are a few large bodies, however. Approximately 1% of the uplands east of the Eastern Star fault are believed to be mineralized, through an observed interval of 150 feet. The resultant 6,750,000 tons of implied ore will be costly to find and probably cannot be recovered economically.

OUTLOOK.

Possibilities for large copper-mining operation in the White Mesa Mining district are not high in the immediate future. The summation of the reserves indicates a large probable and possible tonnage of ore, which at first glance might be considered attractive to mining companies. The grade, however, is low and will average less than 1% copper. There is little to suggest that numerous large deposits of the low-grade material will be found, and abundant reason to believe that most of the bodies will contain not more than a few

thousand tons. Deposits such as the Little Dick, Copper World and California are clearly in the minority. ~~Estimates of~~ Exploration for reserves in the area will be costly because of the large areas which must be drilled on close centers in order to block out known ore.bodies or to find inferred ones. Open pit mining operations require the removal of large tonnages of barren or very low-grade sandstone in order to search out and recover ore-pods which may characterize the supposed large tabular deposits. Furthermore, such operations cannot long be restricted to a narrowly circumscribed portion of the district. Costs of constructing roads, trucking ore to mills, and moving mining machinery from one location to another will therefore be considerable.

The White Mesa Mining District is 112 miles from rail head at Flagstaff and approximately 175 miles to the nearest smelter at Clarkdale, Arizona.

Beneficiation will be necessary to obtain, in sufficient tonnages, a product which can be profitably shipped. The White Mesa ore will leach well, but the present water supply of the district is inadequate for such an operation, and conditions are unfavorable for any large increase by additional drilling. Although it would be physically possible to obtain surface water from the Colorado at Lee's Ferry or Navaho Creek, about 20 miles north or northeast of the district, and at far lower elevation, costs of installing and maintaining a pumping system would probably be prohibitive.

A dry-milling process, which is reported to yield a 20% concentrate with a rather high efficiency, has been developed by the Mardun Company. As the process is still in the experimental stages, however, there are no data on costs and recovery in larger milling operation. It is possible that the process may offer a solution to concentrating problems in the district.

It is suggested that any large-scale attempt to develop copper reserves in the district be prefaced by a careful analysis of mining and concentration costs based on the mining of many small bodies which will average not higher and probably less than 1% copper. Efforts to block out ore should be initiated only in the event that such an economic survey points to the possibility of development based on minimum rather than maximum tonnage expectation.

(Signed) C. B. READ.

R. D. SAMPLE

H. H. SULLWOLD, Jr.

REPORT ON MARDUN COMPANY LEASE

BY

GEORGE A. BALLAM
FIELD ENGINEER
ARIZONA DEPARTMENT OF MINERAL RESOURCES

NOVEMBER 17, 1942

PURPOSE: Two years ago the lessees of the property described herein approached the Reconstruction Finance Corporation in San Francisco relative to a mining loan for the purpose of mining and milling low grade copper ore by means of a new process. At that time this process was in the experimental stages, and they were informed that further development was recommended in order to qualify for government aid. The process has since been developed to a practical working operation, under the direction of a competent metallurgist, at an expenditure of some $40,000. The applicants feel that they are now prepared to submit their plans for reconsideration by the Reconstruction Finance Corporation. To this end they contacted the Department of Mineral Resources for aid in presenting these data. The following report embraces a survey by a department field engineer to ascertain the extent to which the department may be justified in sponsoring their request for reconsideration of the project.

At the outset, it must be stated that the project -- both property and process -- is unique and apparently without precedent in the history of the various types of copper mining and milling practice. The novel features involved may tend to militate against due consideration of its merits and its potentialities as a substantial producer of copper. However, every phase of the operation has been carefully worked out by a competent metallurgist and the results attained, now applied to a commercial operation, are embodied in this report.

GEOGRAPHICAL: The property is located on White Mesa Mining District, sometimes called Keams, in District No. 1 of the Navajo Indian Reservation in Coconino County, Arizona. The district in general is not included within a government survey, but the area in question was surveyed by Amherst Baker in 1900, which survey was subsequently approved by the General Land Office. The applicants hold a mining lease to 595 acres of tribal Indian lands from the Department of the Interior on a 10% royalty basis. A copy of this lease is appended.(Exhibit___)

The Mardun lease is situated 26 miles north of the Gap, an Indian trading post some 30 miles north of Cameron on U. S. Highway 89. (Exhibit___) Leaving the highway at the Gap, a fair road ascends the White Mesa and traverses a rolling and sandy country to the mine. For a distance of about 10 miles, crossing a bowl-like depression, considerable clay is admixed with the sand and the road is good throughout most of the year. The entire distance of 26 miles can readily be improved by means of grader with the use of a bulldozer in places at a cost not to exceed $500 per mile. Application for road improvement and maintenance is being made through the Indian Service under supervisions of the mine access road program.

Elevation of the mine is 6220 feet. Precipitation does not exceed 2 inches annually as reported by a station of the U. S. Weather Bureau located at Copper Mine Trading Post adjoining the property. This record covers the last five

years. Climate is invigorating and permits year round operation. The region is sparsely wooded with cedar and juniper, sufficient for domestic purposes. There is little water developed in the area. However, a well has been drilled 1200 feet deep about 1500 feet from the Mardun mill and half that distance from their end line. Permission has been obtained through the Indian Service to use this water. The well makes about 2000 gallons per day which is ample for domestic and cooling purposes.

GEOLOGY AND MINERALOGY: The surface rocks of White Mesa are light-colored sandstones, probably of the Navajo series. Outcropping nearly everywhere, in places covered with a few feet of loose sand, these sandstones vary in color from a cream-white through light browns and varying shades of blue and green. The beds dip generally toward the east at about 30 degrees, but are strongly cross-bedded and very uniformly stratified, the strata ranging from 0.1 inch to 2 inches in thickness. The strata are separated by what appear to be thin layers of altered lime. The sandstone is very friable throughout its depth and as evidenced by the well already mentioned, continues uniformly to a depth of 1200 feet. (Drillings from this well were sampled and examined by applicant.) No other rocks are found in the area traversed by writer, roughly about 10 square miles, and the applicant asserts that the same formation exists over an area of 5 by 7 miles which he has tested by pits and drilling (Exhibit____).

At frequent intervals, as indicated by attached photographs (Exhibit___), mesas rise abruptly from the surrounding plain to a height of 200 to 250 feet, and from 10 to 20 acres in extent. These buttes are severely eroded and carry little overburden. As nearly as can be determined, they consist of identically the same type of sandstone as is encountered elsewhere.

The grains of sand are uniform in size and cemented together by a calcareous material which has been replaced by varying amounts of copper and iron minerals giving rise to the vari-colored strata. Even the white sandstone contains appreciable copper, about 0.2%, and some of the darker green stone runs well over 20% copper. In general, the lighter shades of blue and green indicate values of from 2% to 5% copper, but some of the brown colored rocks run equally high. No copper-free sandstone has been found in this area by the applicant.

Black spots and stains occur at frequent intervals throughout the sandstone layers. These were found to be extremely small crystals of a silver compound, probably halide or oxide, although only the silver yielded a positive test. The applicant states that the tests have shown as much as 4 ounces of silver in his concentrates. Along the planes of movement, especially where copper minerals have been concentrated to a greater extent, considerable amounts of cuprite are encountered, undoubtedly a result of conversion of malachite by frictional heat. At these points, of which a score or more were examined, high grade copper has been extracted during the past fifty years. Shipments of high grade malachite and cuprite are still being made from time to time by the Indians in the district. Although it has been reported that chrysocolla constitutes the main copper mineral in the district, in the area examined the writer found malachite predominating, and this is supported by analyses of the concentrates already shipped which have been shown to be chiefly the carbonate of copper. All of the sandstone carries about 0.01 ounce of gold, but so far no attempt has been made to recover it.

HISTORY: The first mining operation of record was carried on by the Navajo Copper Company in 1916-17. This company shipped high grade ore and although there is no record of the amount shipped, several thousand tons of ore were extracted and some 2000 feet of open cuts and tunnels made. This operation was immediately adjacent to the northern boundary of the Mardun lease.

The next activity occurred in 1937-38 when the Coconino Copper and Chemical Company attempted to leach ore to make a sulfate product. A 50-ton leaching plant was installed on the present site of the Mardun mill. Water was hauled a distance of 30 miles, acid being brought in from Salt Lake City. This company is no longer in operation.

On March 6, 1941, the Mardun Company was formed as a co-partnership consisting of C. L. Duncan and O. F. Marvin. The former is owner of the C. L. Duncan Company, with offices in San Francisco and Los Angeles. The latter, for the past twenty-two years, has been engaged exclusively in the fields of mining, metallurgy and chemistry. Much of his work has been in relation to the treatment of ores.

Prior to formation of this company, the applicant had spent considerable time in the development of a process for the dry separation of copper minerals from the Navajo sandstone of this area. Research was conducted in the laboratories of the Marvin Metals Inc. in California on this ore, for a period of seven months. From that time on, experimental and development work has progressed and at the present time the company is operating a 75-ton pilot plant on the Mardun lease. Between 2500 and 3000 tons of ore have been milled successfully, some 150 tons of concentrates containing 50,000 pounds of copper have been shipped to the Phelps Dodge Smelter at Clarkdale (Exhibit____). Meanwhile, extensive drilling and other test work has been conducted in the immediate vicinity of the Mardun property.

MINING DEVELOPMENT: The area examined by the applicant, prior to seeking a lease, comprised about 35 square miles of the White Mesa district, roughly five miles east and west by seven north and south. This area was found to be mineralized throughout. More intensive investigation was conducted in the area now constituting the Mardun Lease together with a strip about one mile wide adjoining the western boundary thereof. In this area numerous test holes were sunk by drilling and digging, some 17,000 feet of drilling having been done, all of which was in copper bearing sandstone. Of the drilling, 8000 feet averaged a copper content in excess of 1.5%. The remainder or 9000 feet averaged from 0.4 to 0.5% copper, the upper 5 feet being of lowest grade, consisting largely of leached and weathered overburden.

The dug holes and open cuts referred to were made for the purpose of checking against the drill holes, and were found to run about 30% higher in copper content than the drill holes. This discrepancy is only apparent and is readily accounted for by the fact that this sandstone disintegrates very easily, making it difficult to draw cores. The extremely fine and friable copper mineral, mainly malachite, was lost to a considerable extent, especially under conditions of dry drilling necessitated by this type of rock.

In addition to test work done on this ground by the applicant, further information was obtained from former work done in the locality. An 800 foot cut made by Navajo Copper Company some 20 feet deep, (Exhibit____) another 1000 foot

cut with tunnels made by the same company, (Exhibit___) the 1200-foot well already mentioned, were sampled and assayed. Scores of smaller holes and cuts are to be found, the work of high graders in the past. The writer examined about one hundred openings, all of which revealed practically identical conditions of structure and mineralization. More recently, during the past few months, the Shattuck Denn Corporation has been drilling land immediately surrounding the Mardun lease. In 40 holes, ranging in depth from 80 feet to 150 feet, and sampled every 4 feet, copper mineral showed in every case, with a minimum copper content of 0.1% and a maximum of about 7.0%. The approximate average was 0.7%.

Acting upon information obtained, the applicant proceeded to systematically block ore within an area now known as Copper Hill and Old Fort Hill, lying near the southwest corner of the lease (Exhibit___). To this end, the surface of the entire mesa was drilled to a depth of 25 feet with 100 foot centers. Then, at the north end of Copper Hill, which here is quite precipitous, benches were blasted out at about 25 foot vertical intervals. These likewise were drilled at an angle of 10 degrees toward the face and 25 feet in depth. This was continued to the base of the hill. In all, 50 holes showed an average of 1.8% copper, disregarding overburden of 8 to 16 feet, which, nevertheless, largely constitutes ore amenable to the process used. (Exhibit___).

As shown on the map (Exhibit___), the dimensions of Copper Hill are approximately 770 feet by 680 feet. Old Fort Hill comprises an area of 400 feet by 250 feet. On the basis of a depth of 150 feet for the former and 50 feet for the latter, it indicates an ore body of 6,400,000 tons. Of this amount 33-1/3% runs 1.5% Cu, 50% averages 0.9% Cu, while the remaining sixth is approximately 0.2% Cu. Thus it will be apparent that the entire 6½ million tons averages about 1% Cu and contains about 120,000,000 pounds of the metal. This grade of ore constitutes an excellent mill head for the process.

On November 14 the writer took a 60 foot channel sample down the north face of Copper Hill. One half of this cut was in the original face and badly weathered and leached. Assay showed 0.54% copper (Exhibit___). On the west face a channel sample was taken over 6 feet exposed of a 16 foot bed which assayed 2.9% copper (Exhibit___).

Although no complete blocking of ore has been carried out in other sectors of the lease, the entire area has been examined, and in four other places, as indicated on the map (Exhibit___) blocking of ore has been partially completed. In formation, extent and values, these were found to be almost identical with Sector 4 described above. In fact, it is the opinion of the applicant that the entire area of the lease is uniform throughout. This belief appears to be logical when it is remembered that the entire area is in Navajo sandstone exclusively, of similar formation, bedding, and mineralogical structure.

MILLING PROCESS: In order to get a clear picture of the milling procedure, it is first necessary to review the tests carried out on the mineral, the essential phases of which were confirmed by the writer. In the first place, the process is a segregation, rather than a concentration in the ordinary sense of the word. No constituent of the copper-bearing mineral itself has to be dropped, chemically or otherwise, Malachite has been concentrated already by nature and it is only necessary to separate it from the sand. The sand grains are extremely resistant

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to fracture, well rounded, and of uniform size. 75% of the particles pass over a 30-mesh, and are retained on a 40-mesh screen. Less than 0.1% are plus 30-mesh while only 3% pass 150-mesh. The copper mineral, malachite, on the other hand, is extremely light and friable, consequently the sandstone disintegrates readily, malachite segregating from sand particles as a fine dust, all minus 200-mesh, under the proper conditions of treatment. This finely-divided malachite dust weighs 80 pounds to the cubic foot or occupies 25 cubic feet to the ton. As an illustration of its character, it must be transported to the smelter in a light metal box which fits within the body of a truck, being loaded from the baghouse through a valve and unloaded at the smelter by suction equipment.

To separate the copper carbonate matrix from the sand grains embedded in it, a beater type of disintegrating machine is employed of 22 inch by 16 inch dimensions. On account of the abrasive property of this sand, the disintegrator blades are faced with pure cast tungsten carbide of 30-mesh size. (The process for production of this material is carried out under patents granted Mr. Marvin in 1929. This treatment increased the life of the blade in comparison with a manganese blade over one hundred times.)

The ore, now partially disintegrated, and all minus one-half inch, passes to a direct-fired rotary dryer where it is dried to a point at which copper mineral will not adhere to the gangue. Dust liberated in the dryer is sucked into a baghouse. This dust has always exceeded 20% in copper content. From the dryer, the ore passes under controlled suction to a second disintegrator of similar type from which it is drawn into a set of Impax air separators. This operation is based on the principle of a sudden decrease in velocity by increase in cross section causing the larger and heavier particles (sand) to drop while the finely-divided mineral remains in suspension. Tailings from these separators pass to another disintegrator of higher velocity for a final scouring, thence to a final bank of separators. All copper mineral is sucked to the baghouse where it settles on a sampling floor.

The following are typical results of mill operation in October, 1942: (Exhibit___).

Head	Tails	Conc.	Recovery	Conc. Ratio
0.41%	0.087%	13.97%	80%	34.0
0.60%	0.094%	15.73%	84%	25.8
0.82%	0.11%	16.93%	87%	20.6
1.90%	0.34%	21.7%	82%	11.4

During this examination by the writer, samples of the run of November 12, 1942, were taken and assayed by him as follows (Exhibit___):

1.92%	0.27%	20.7%	86%	10.8

The foregoing operation has been developed into a continuous and automatic process. Only two men are employed to operate this mill at its capacity of 75 tons per day. Electric power is generated for the mill and camp nearby. A chemical and testing laboratory is maintained in addition to a machine shop with electric and acetylene equipment (Exhibit___).

PROPOSED OPERATION: The operation proposed by applicant will be on the basis of 1000 tons every 24 hours, which with an assured mill head of from 0.75% to 1.0%

copper will produce 15,000 pounds of copper daily (Exhibit___).

Quarrying will be accomplished by blasting from benches in the face of the hill, using holes of 25 foot center and depth charged with black powder. Material thus broken down will be moved by 3/4 yard power shovel into loading bin of cable tramway and conveyed 1200 feet to a 500 ton mill bin. From the bin, it will be fed by a pay type reciprocating feeder into a four-foot hammer type rock breaker, thence passing into a 6x60 foot direct fired rotary dryer from which it will be fed into a four-foot disintegrator. Next it will br drawn into a bank of two Impax air separators from which the tailings pass for further scouring to another disintegrator and thence to a similar bank of air separators from which they will be discharged to tailings dump.

There are three points from which concentrates will be drawn off. These are the dryer and the two banks of air separators. This dust-laden air containing the concentrates will be passed through dust-collecting equipment consisting of a Multiclone and baghouse from which they will be discharged to storage bins.

Labor requirements will be two men per shift for the mill. For quarrying operations three men per shift will be required on equipment, maintenance man, powder man, driller, and two or three common laborers will complete the labor needs. Other requirements will consist of the operator, a bookkeeper and chemist. It is anticipated that the product will be transported to smelter under contract. The labor situation is not very acute in this area. Navajo Indians can be utilized to some extent as they have not been impressed into agriculture as is the case with other Indians in the State.

Power will be generated by 360 H.P. Fairbanks Morse diesel engine directly connected to 250 KVA 3-phase 60 cycle alternator. All fuel oil will be purchased in Flagstaff at tank car prices and transported to the mine by back haul.

COSTS: Complete installation of 1000-ton mill, quarrying equipment, together with additional camp facilities will cost $80,000. Operating capital to carry on until first returns are available amounts to $20,000, making a total cost of $100,000 which is the estimated minimum amount adequate for this project (Exhibit___).

Operating costs as outlined (Exhibit___) total $1,000 per day.

On this basis with a production of 15,000 pounds of copper daily, the cost per pound will not be in excess of 6-3/4 cents.

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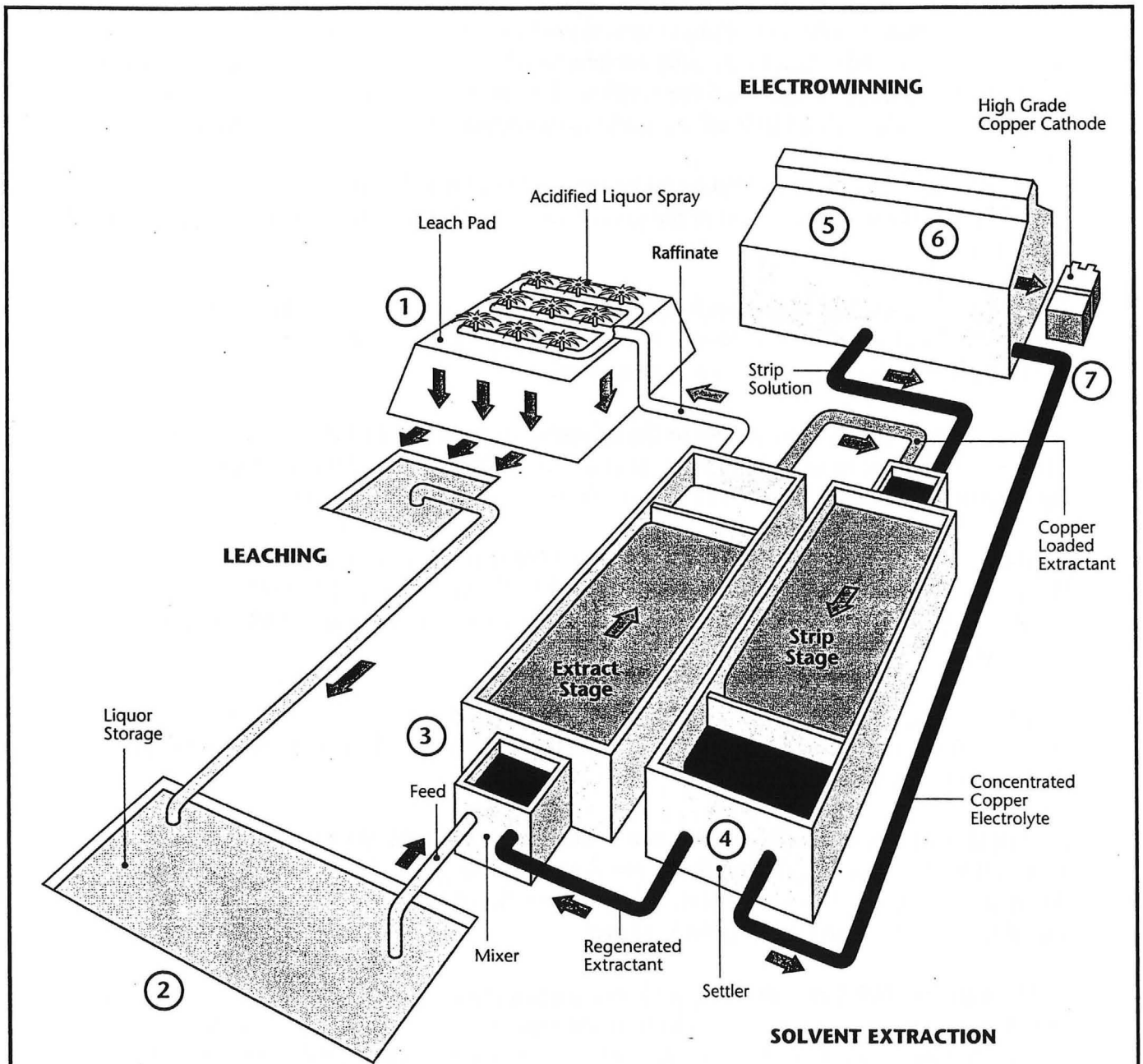


(SEE FOLLOWING PAGE FOR EXPLANATION)

Recovery of Copper By Solvent Extraction

FIGURE 2
MESA MINING
TYPICAL COPPER
RECOVERY PROCESS

COPPER RECOVERY PROCESS (NUMBERS REFER TO FIGURE 2)

Copper is recovered by a hydrometallurgical process in which the metal is extracted entirely by the use of circulating solutions. Pure copper is produced at the mine site, with no smelting or refining required. All solutions are fully contained and recirculated. Water is required only to make up for evaporation and initial ore wetting. This process was developed in Arizona, and is now used to produce about 25% of the worlds new copper. The process is as follows:

1. After mining, the ore is stacked on an impermeable pad liner in 10'-12' layers. Over time, additional layers are added on top of the previously leached layers, eventually reaching a height of about 150 feet.

2. Each layer is leached with a weak solution of sulfuric acid in water, yielding a pregnant (copper-bearing) solution. This solution is collected in perforated pipes laid on top of the liner and flows to a collection pond and a storage pond.

3. The pregnant solution is pumped to the solvent extraction plant where it is mixed with kerosene containing an extractant in the extract stage. The extractant removes the copper from the pregnant solution and reacidifies the now barren leach solution (called raffinate).

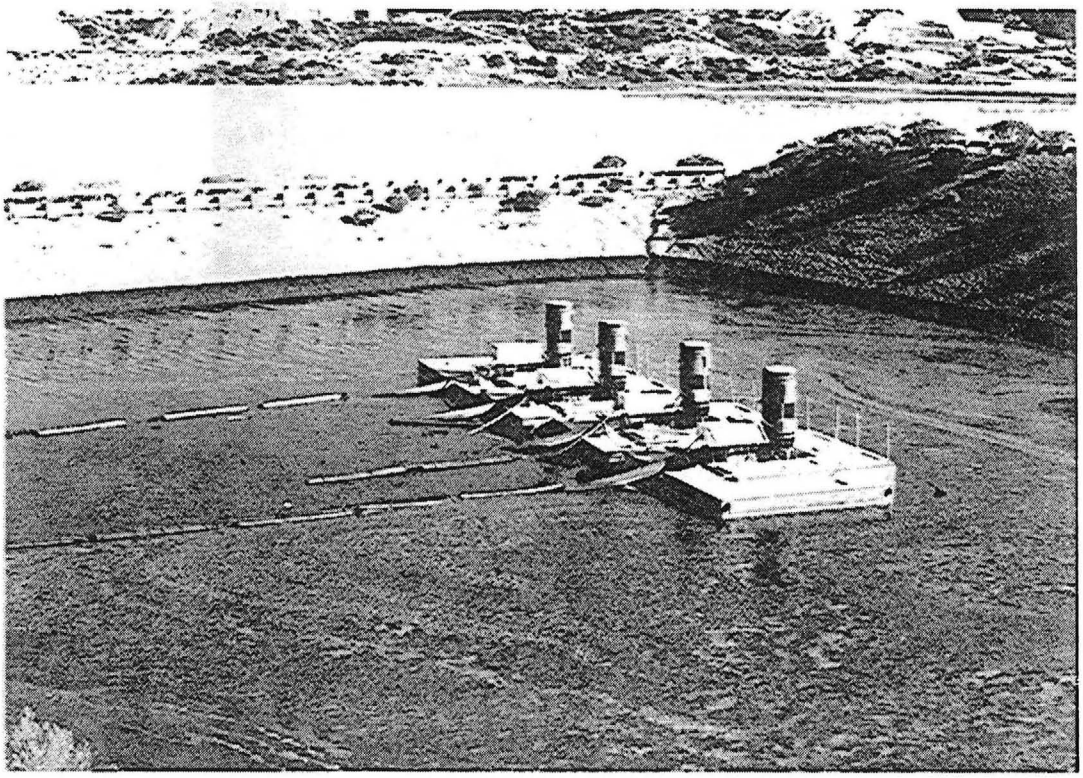
4. The kerosene (now containing the copper) and the raffinate separate in large swimming-pool like tank. The reacidified raffinate is pumped back to the leach pad to leach more copper. The kerosene is pumped to the strip stage where it is mixed with a more acidic solution, called electrolyte.

5. The electrolyte strips the copper from the kerosene. The barren kerosene is recirculated back to be mixed with the incoming pregnant solution (step 3, above). The electrolyte is pumped to the electrowinning tankhouse.

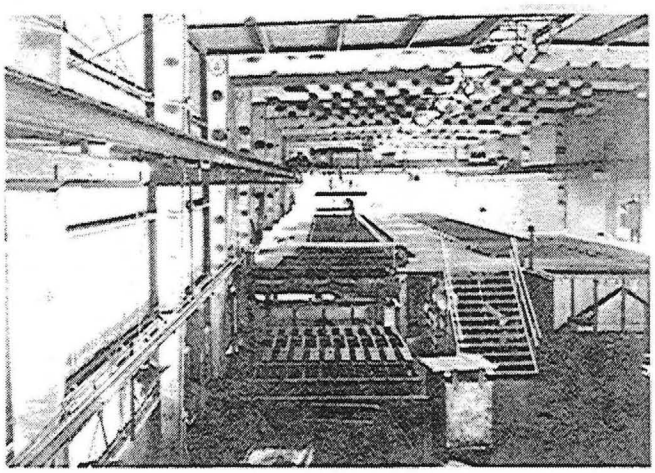
6. The electrowinning tankhouse contains a number of large electrowinning cells through which the electrolyte is circulated. Electric current is passed through the cells, causing the copper to be plated on to thin, stainless-steel plates. The depleted electrolyte (strip solution) flows back to the strip stage to strip more copper (step 5, above).

7. The pure (99.999% copper) copper sheets stripped from the stainless steel on a weekly basis. The plates are then returned to the cells to receive more copper. The copper sheets are bound into bundles and shipped directly to end users. No smelting or refining of the copper is required.

Mesa Mining is considering production of copper sulfate crystals instead of copper metal. The process is identical except that in steps 6 and 7, copper sulfate crystals are produced from the electrolyte by crystallization.

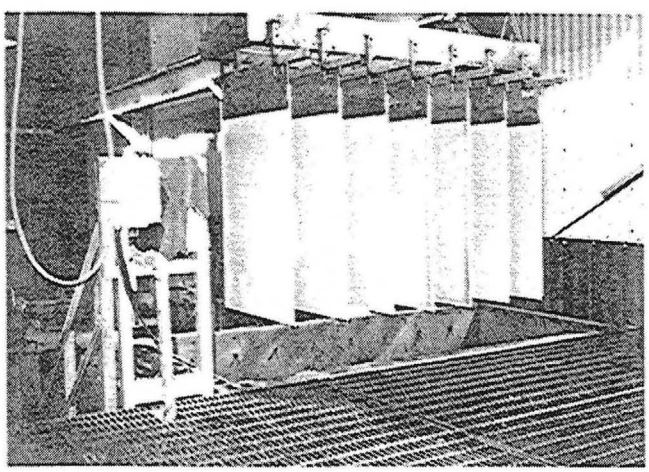


Copper bearing solution from the heap is collected in pregnant leach solution ponds.



Copper cathodes are grown in an electrowinning facility.

FIGURE 3
MESA MINING
TYPICAL COPPER
RECOVERY FACILITIES



150 lb. copper cathodes are harvested once a week.

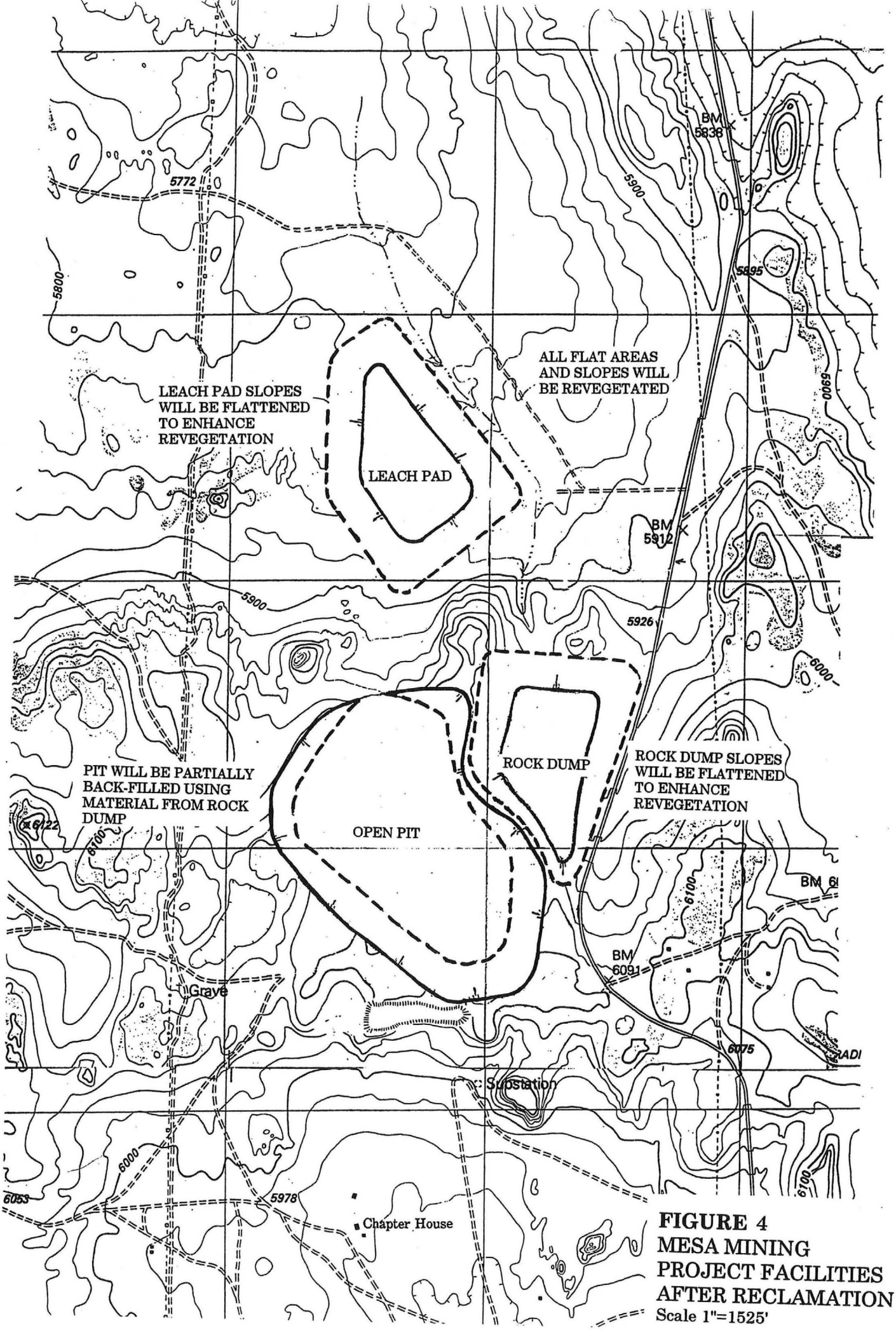
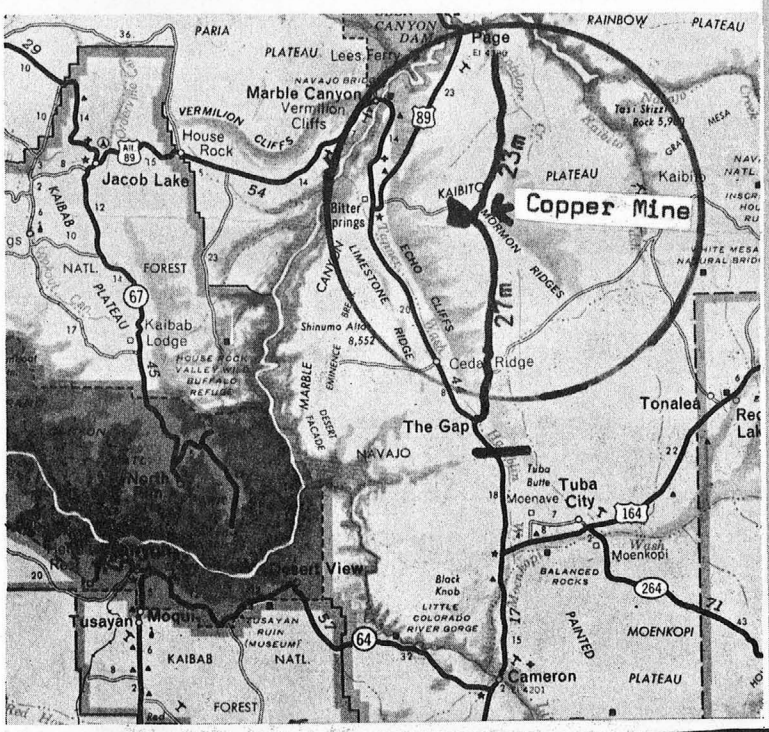


FIGURE 4
MESA MINING PROJECT FACILITIES AFTER RECLAMATION
Scale 1"=1525'

PUBLIC AUCTION

Mining AND Crushing EQUIPMENT



TUESDAY

NOV. 24

11:00 A.M. M.S.T.

WHITE MESA MINING COMPANY

SALE ON THE PREMISES

AT

COPPER MINE, ARIZONA

DIRECTIONS TO SALE SITE

FROM PAGE: Go left one block south of 1st Baptist Church. Follow Copper Mine Trading Post and Auction Signs to Sale Site at Copper Mine, Arizona.

FROM FLAGSTAFF: Go North on Highway 89 to The Gap. Turn Right and Go 27 Miles to Sale Site at Copper Mine, Arizona.

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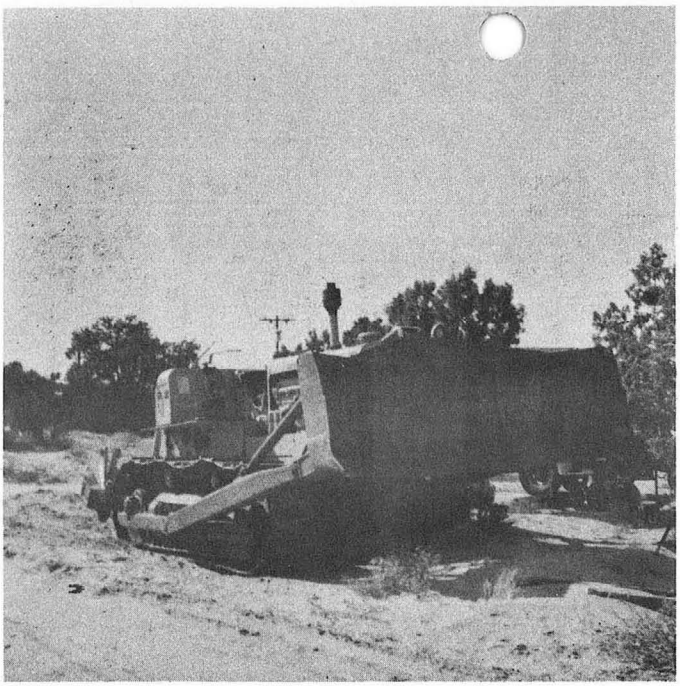
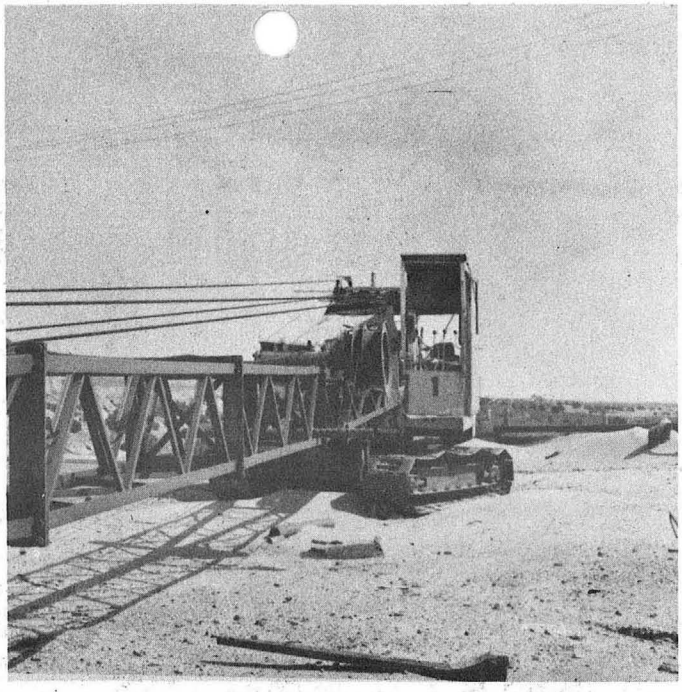


D8 CAT - 14A W/DOZER & RIPPER



LORAIN CRAWLER CRANE - 40' BOOM

CRAWLERS – CRANE – DRILL

- D8 CAT 14A SERIES W/HYDRAULIC DOZER AND RIPPER
- D-8 CAT 2 U SERIES W/CABLE DOZER
- LORAIN CRAWLER CRANE W/40' BOOM & DRAGLINE BUCKET
- FAILLING DRILL - ROTARY TYPE ON TRUCK
- PORTABLE INGERSOLL RAND COMPRESSOR MODEL P 1411195
- SPERRY SEARCHLITE POWER PLANT
- KEISLER CLAM SHELL BUCKET
- LETOURNEAU SCRAPER
- P & H ELECTRIC CRANE
- GRACE WHEEL PACKER
- DENVER GARDNER AIR COMPRESSOR (Diesel)

CRUSHERS & SCREENING PLANT

- CEDAR RAPIDS DOUBLE IMPELLER IMPACT BREAKER S/N #14390 WITH 2 BARBER GREEN 160-FT. BELT CONVEYORS POWERED BY TWIN DIESELS
- PETTIBONE UNIVERSAL SCREEN (Like New)
- SAND CLASSIFIER W/TANKS AND COMPRESSOR

PUBLIC AUCTION

MINING AND CRUSHING EQUIPMENT

OF

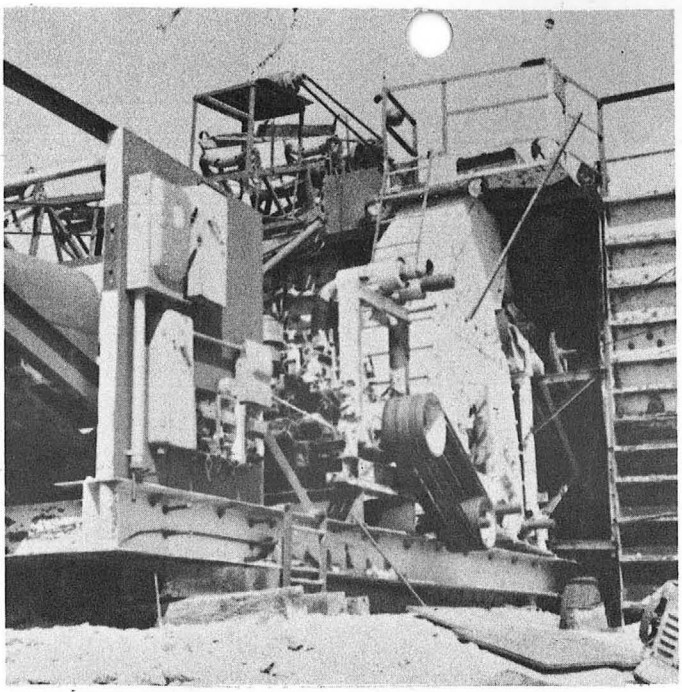
THE WHITE MESA MINING COMPANY

LOCATED AT

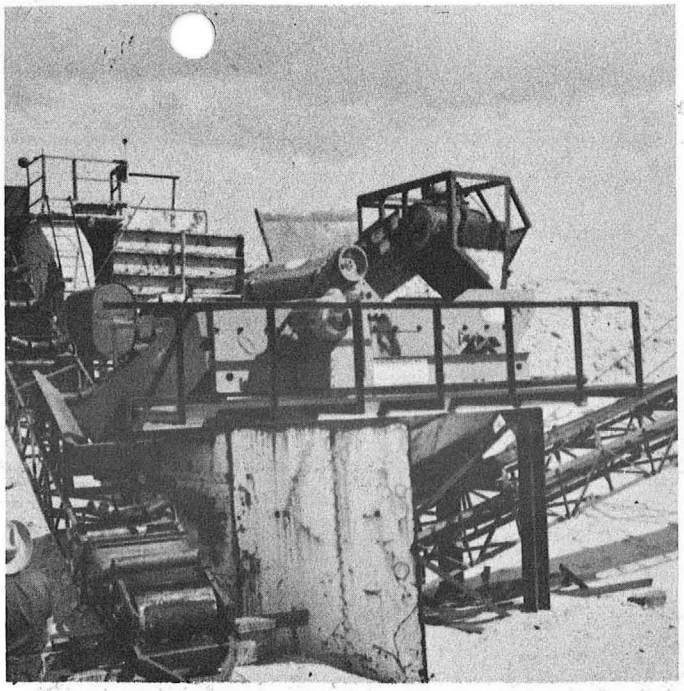
COPPER MINE, ARIZONA

TUESDAY, NOVEMBER 24

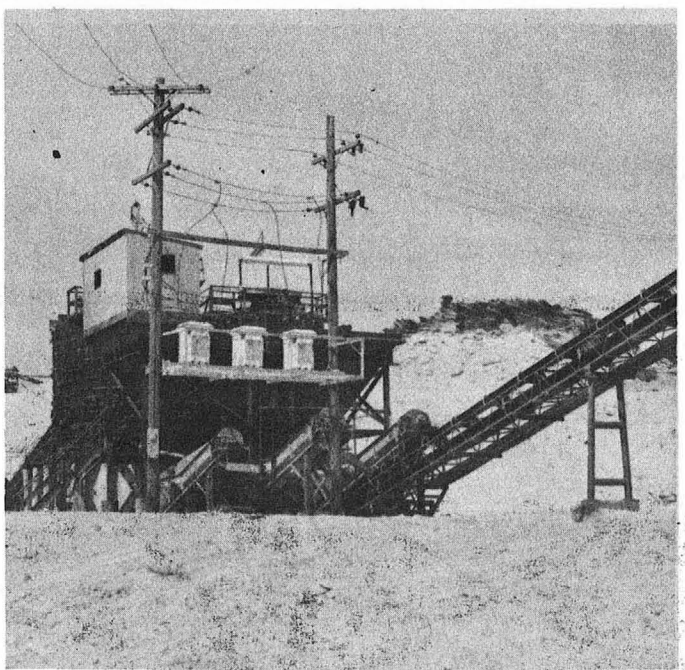
11:00 A.M. — M.S.T.



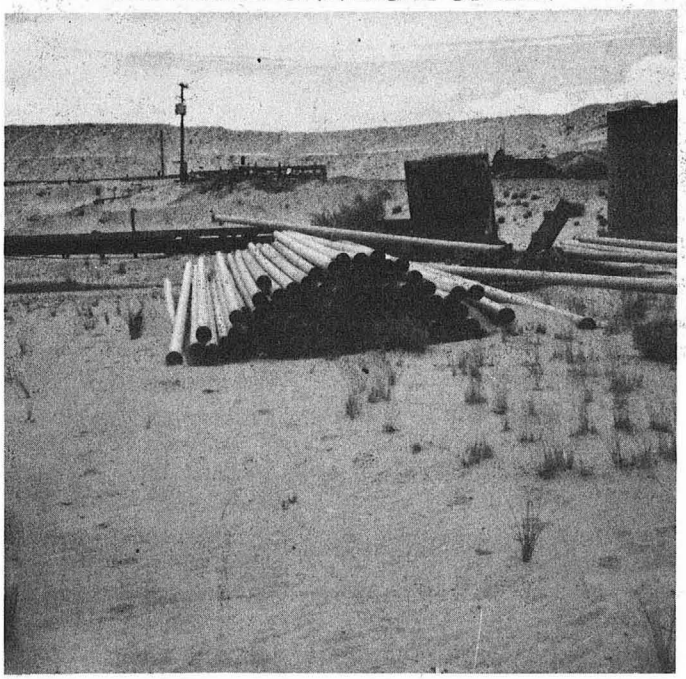
CEDAR RAPIDS IMPACT CRUSHER



PETTIBONE UNIVERSAL SCREEN



SAND CLASSIFIERS



PARTIAL VIEW OF PIPE

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- **20" MAGNET**

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Tuesday–11:00 A.M. M.S.T.

NOVEMBER 24th

★ ★ ★

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AND

CRUSHING

EQUIPMENT

OF

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