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James Doyle Sell Mining Collection

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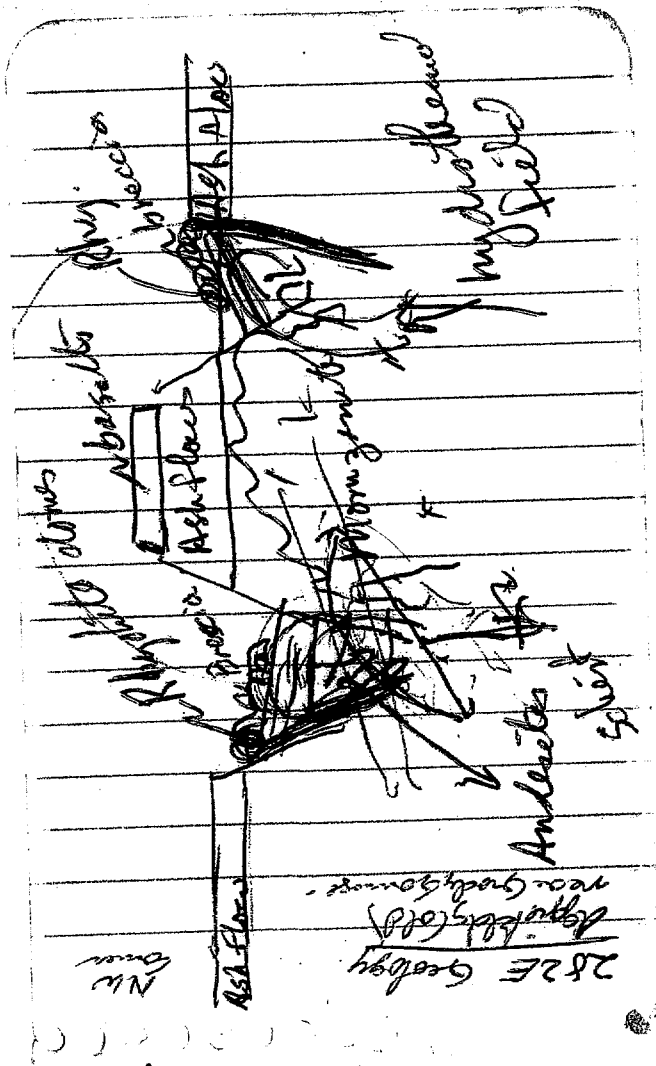
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282E Geology
 Dyer (old)
 near Godegoune
 Andesites
 quartz
 hydrothermal
 field



282E Geology
 Dyer (old)
 near Godegoune
 Andesites
 quartz
 hydrothermal
 field

1 PM - Monday Sheldon

Reg. in Soyen of Audition

Scot. Phyl. 118.

① 3 Samples per sq. mi.

RG Brown Thesis

asking of mesquite is answer,
not air-dried samples

Increased values late in season
in leaves, but not in branches

② PR Buck:

Spanning of top soil increases productivity

③ CF Kaye Jr.

age of my mole = Unknown.

④ RF Hendon. GH Lindsay

Oligocene hole w/ dog.

⑤ TP ~~Pro~~ Lewis

⑥ PS Lokalis

2 PM

SE Sample from #6

shaft area

2800 E 54 Dec MV.

(blue-yellow spots)

20' below the level

#9 Shaft

E 12/850

N 4750

500 Section cut in box about 1400

1st 9m Planispheric on straight

line to NE; then curving slightly to north

About 50% of Escalvosa is mineralogical

a certain % of residues. Remainder in

58.4 Superin. Hesperia

67.5 Summit Mine

70.1 Box- nat. type up

76.8 " " down

cc 2755 E-8 D

upper Escalona

cf 2935 E-8 E

Abes road

old lower Dev; upper Dev, & lower
Naco just above main shale
Drill holes unable to get into high
upper Naco bed.

3000 went to 109 P.S. &
all beds drilled from there. Dr. seems
to 3900 level. Drill holes show
continuous pyrite & min. below.

The upper extension may
be oxidized & do have highly
chalcocite in upper Esc - the only one
with veins. Pres thinks is supergene.
Drill holes show veins without any
copper - carbonate at no way.

Traverse from at 2200 in

main shale. Beautiful tunnel.

The 500' level w/ bit #9 @ 1200' below
surface.



From: "Russo, Jennifer (RCC)" <jennifer.russo@resolutioncopper.com>

Subject: Resolution Copper E-Alert

Date: Fri, 21 May 2004 23:16:02 +0000

Resolution Copper and Superior Junior/Senior High School Celebrate a Night at the Ballpark. Read the Release at <http://www.resolutioncopper.com/media/newsreleases.asp>.

[[Back](#)]

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Contact
Jennifer Russo, 602.956.0223, ext. 15
Corporate Communications Director



NEWS RELEASE

Resolution Copper Transitions to Managers of Resolution Project; Commencement Celebration Set for May 18

SUPERIOR, Ariz. — Resolution Copper announced today its official transition to manager of the Resolution project, a joint venture between Resolution Copper Company and BHP-Billiton. The company takes the helm after crossing the \$25 million mark.

"This project will have significant direct and indirect economic benefits for Superior throughout the operational life of the mine," said Bruno Hegner, vice president and general manager of Resolution Copper. "This transition will allow us to further our partnership with the residents of the Town of Superior and continue to identify mutually beneficial ways that we can work together on issues of concern."

Resolution Copper will continue further environmental and geotechnical evaluations of the property. During the remainder of 2004, the company will undertake two voluntary remediation projects at an investment of nearly \$2million dollars. One of those projects will involve closing adits, tunnels and other workings that remain from previous mining operations. The second initiative will focus on improvement of housekeeping and stormwater retention capabilities on the West Plant Site near town.

To commemorate the transition to manager of the Resolution project, the company will host an ice cream social on Tuesday, May 18, from 4:30 –6:30 p.m. to dedicate their new office at the West Plant Site. Guests will enjoy live entertainment from local favorite Sipie and His Big Band Sound. Treats will include delicious ice cream, plus face painting and balloon sculpting for the kids. There will be a special ribbon cutting ceremony at 5 p.m. The West Plant Site office is located at 102 Magma Heights, just east of town. There is not cost to attend this event.

- # # # -

Publication: East Valley Tribune; Date:Wednesday, MAR 24, 2004; Section:Business; Page 41



Magma
air quality
maintenance
systems.



Our goal... cleaner air.

Magma Copper Company and its parent company, Newmont Mining Corporation, are committed to the control of smelter emissions to whatever degree may be necessary to protect the health and welfare of residents in the area influenced by the San Manuel smelter.

Magma's air quality control systems have been designed and built to insure compliance with the ambient air quality standards established by the State and Federal governments.

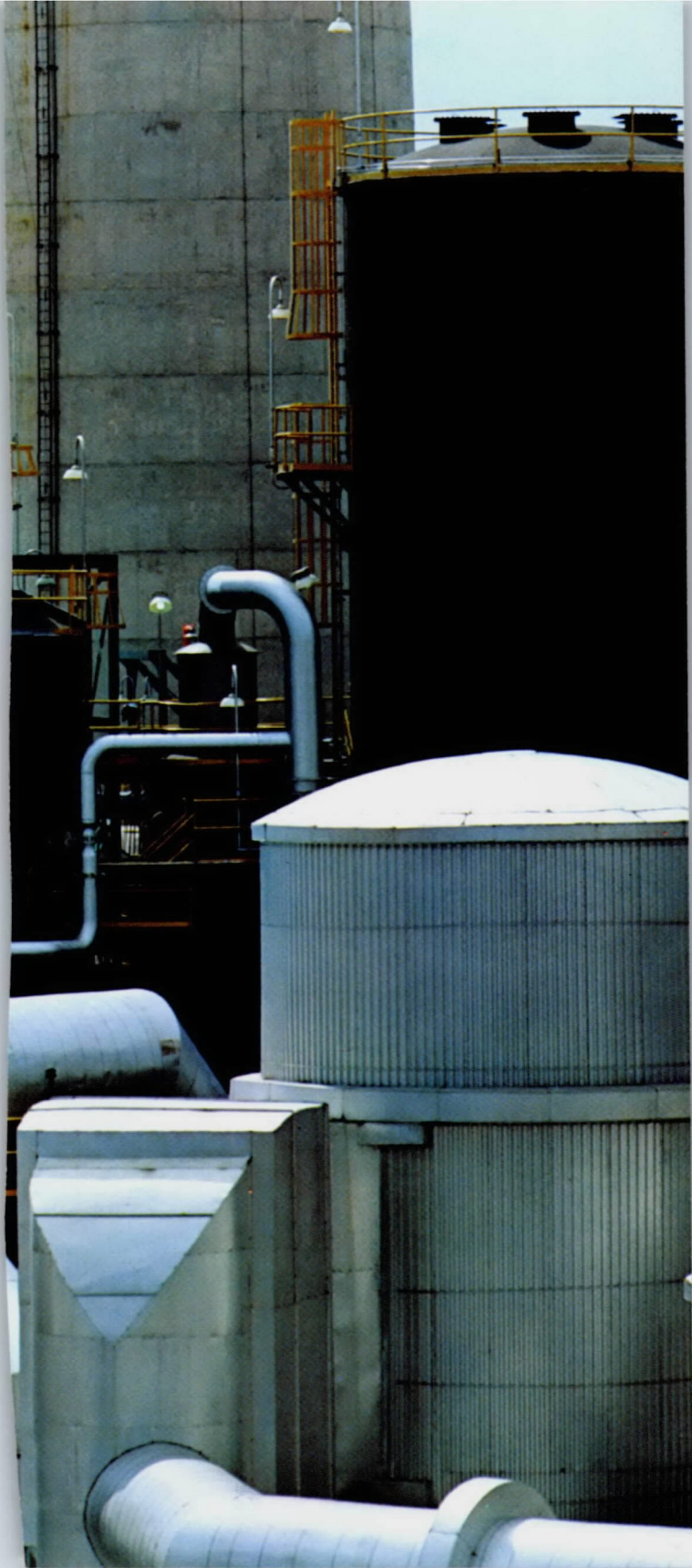
By 1975, Magma had taken these actions, which resulted in cleaner air:

- Installed the sulfuric acid plant at San Manuel to control up to 96% of the sulfur dioxide in smelter converter emissions.
- Installed electrostatic precipitators at the smelter and dust collection systems throughout the plant during original construction and later expansions (1954—1965—1971).
- Closed the Superior Division smelter in 1971 to consolidate smelting operations at San Manuel.
- Established comprehensive air monitoring in the area of influence of the smelter, collecting primary data on actual ambient air quality.
- Gave financial support to University of Arizona Atmospheric Analysis Laboratory.
- Cooperated with the U. S. Bureau of Mines in research and investigation of the citrate process to convert sulfur dioxide to elemental sulfur at a pilot plant in San Manuel.

- Participated in a second pilot plant project at San Manuel with other mining companies to study and evaluate the feasibility of scrubbing the weak gases from reverberatory furnaces.
- Conducted independent research programs through Newmont Mining Corporation's Research Laboratories, including study and evaluation of alternative smelting methods.
- Completed steps to utilize or dispose of acid product to avoid further environmental problems.
- Cooperated fully with and contributed information and experience to State and Federal agencies in the promulgation and administration of air quality standards.

Capital outlays between 1971 and 1975 for Magma's air quality control system approach \$40,000,000. In addition to initial construction costs, future operating and maintenance costs will be significant.

Copper Converter at Magma Copper Company's San Manuel, Arizona, smelter.



The contact sulfuric acid process.

The San Manuel sulfuric acid plant uses the contact process in a two-train or modular system. All of the converter gases are cleaned and cooled in a common system, and then split into two separate conversion and absorption systems.

Upon leaving the high velocity flues, the sulfur laden gases, principally sulfur dioxide, are pulled through a large electrostatic precipitator to remove dust and particulate matter, then through cooling and humidifying towers, and finally through a bank of eight electrostatic mist precipitators to remove all remaining solids and acid mist.

The resulting clean sulfur dioxide gas is split into two trains, or processing modules, where it is compressed and passed through beds of a catalyst, vanadium pentoxide, where it is converted into sulfur trioxide, SO_3 . Several passes over the catalyst are necessary.

The sulfur trioxide passes to absorption towers where it is absorbed into circulating sulfuric acid. The resulting saturated acid can be concentrated to any specified grade, usually the commercial grade of 93 percent.

Controlling the elusive sulfur.

Copper sulfide mineral concentrates produced at the San Manuel and Superior Divisions of Magma Copper Company contain approximately 28% copper, 30% iron and 32% sulfur. They also contain



minor amounts of other important minerals including molybdenum, gold, silver, rhenium and selenium.

In the smelting process, the iron is oxidized and combined with silica fluxes to form slag. The final slag is an inert material which is discarded near the smelter.

Sulfur is released by oxidization in both the reverberatory furnaces and converters. The major oxidization, which produces sulfur dioxide, occurs in the converting process, while only weak gases are released from the reverberatory furnaces.

There is no feasible technology available for processing the weak (less than 2% by volume) sulfur oxide gases from the reverberatory furnaces. However, the converters are capable of producing a richer (3% to 7% by volume) sulfur gas which is manageable with the contact sulfuric acid process.

Even for this purpose, the sulfur dioxide is frequently marginal in strength and tight hoods and gas collection systems are placed on the converters to keep air from diluting the gas. The hoods are high quality steel but do not have the advantage of refractory surfaces, so they must be water-cooled to survive the hot gases evolved in the converting phase of the smelting process.

The gas stream feeding the acid plant must have reasonably continuous flows of relatively strong sulfur dioxide. Converter operations must be coordinated and scheduled to maximize the sulfur dioxide content of continuous gas feed.

The feed gas stream is drawn through specially designed systems of high velocity flues and into electrostatic precipitators for first stage cleaning and cooling.





Temperatures and strengths of the acid systems circulating within the plant are critical to its operation and must be maintained within strict limits. This is accomplished by an elaborate system of automated controls to maintain efficient operations.

The San Manuel plant has a designed production capacity of up to 2,000 tons per day of sulfuric acid.

The reverberatory stack plume.

The visibility of a white plume from the reverberatory furnace stack is largely the result of moisture which is present in the mineral concentrates and also is produced as a product of combustion. About 500 tons of moisture per day are released from the three reverberatory furnaces of the San Manuel smelter.

A new electrostatic precipitator at the reverberatory stack is highly efficient and is designed to remove in excess of 98% of particulate matter in the reverberatory plume.

With all air quality control systems operating normally, components of the single white plume from the San Manuel smelter will be approximately 15% water vapor, less than 2% sulfur dioxide, and 83% inert natural air components.

MAGMA

A SUBSIDIARY OF HEWLETT PACKARD CORPORATION

UTLX 12995

CAPX 200000

LT WT 56600

VZU 12-71

From waste . . . useful products.

Sulfuric acid is a common chemical used widely in industry, mining and agriculture. Large quantities are produced and used in industrialized regions.

Southwestern markets are limited but Magma has taken steps to develop regional outlets for as much of its sulfuric acid production as possible.

Mining—Arizona has large quantities of the silicate and oxide ores whose copper can be extracted by leaching with sulfuric acid. The acid is also used in the processing of uranium, tungsten and other minerals.

Agriculture—Fertilizer production uses large quantities of sulfuric acid which also may be applied directly to irrigation water to help neutralize soil alkalinity.

Industry—Limited amounts of Magma acid will enter national markets for use in oil refining and consumer products, such as automobile batteries.

To transport the acid, Magma operates a fleet of railroad tank cars. In addition, a significant amount of acid is shipped by truck.

Storage is provided at the San Manuel shipping terminal for up to 20,000 tons of acid.

Neutralization . . . a standby necessity.

As important as the production of the acid itself is the necessity for providing for its disposal in the event that production exceeds the amount which can be disposed of beneficially through use or sale. In addition, the plant generates small amounts of weak acid waste which must be discarded.

To avoid possible land and water contamination, Magma's acid neutralization system has the capacity to process the full production of the San Manuel acid plant, if necessary.

The process involves neutralization of acid with finely ground limestone to form an inert and insoluble gypsum slurry, which can be discarded with the concentrator tailings. Approximately one ton of limestone and one ton of water are required to neutralize one ton of sulfuric acid.

To obtain this limestone, a quarry was located seven miles south of San Manuel and several small limestone hills must be excavated. A road was built for haulage and additional water wells were developed.

The limestone is crushed and prepared through existing concentrator circuits so that an ample supply can be made available as needed.

The cost of neutralizing the acid approximates the cost of its production.





Air monitoring and intermittent controls.

Under clean air regulations, the San Manuel smelter is required to maintain positive control over approximately 60% of the sulfur dioxide generated by the smelting process.

The acid plant is capable of controlling 96% of the SO_2 from the converters; but, since it does not treat reverberatory furnace gases, the overall emission control of total smelter gases is approximately 70%, well within State and Federal requirements for positive control.

For the reverberatory furnace, a new, large, high efficiency electrostatic precipitator is designed to remove in excess of 98% of the particulate matter, as required by regulations.

As an added precaution that ambient air standards will not be violated during adverse weather conditions, an extensive air monitoring system continuously measures sulfur dioxide concentrations and weather conditions throughout the area influenced by the smelter.

Seven permanent monitoring stations and one mobile station are equipped with continuous weather and sulfur dioxide monitoring instruments and radios which transmit data to a computer in San Manuel every three minutes.

Special computer programs produce guidance information about possible adverse weather conditions and potential air pollution episodes. This information is continuously displayed for management review. If necessary, timely action can be taken to reduce or curtail smelting operations to maintain ambient air quality standards.

The air monitoring system is supervised by meteorologists. Their continuing studies of the regional weather and characteristics of smelter emissions add substance to the body of scientific knowledge about air quality in Arizona.

Air Monitoring Station, one of eight, continuously measures air quality near San Manuel smelter.

Producing Arizona copper since 1910.

Magma Copper Company is a highly integrated producer of primary copper, controlling the entire process from underground ore bodies through refining and having a production capacity of 200,000 tons of metal per year.

Magma was founded in 1910 by William Boyce Thompson who purchased the Silver Queen mine near Superior and then began to explore and develop its high-grade copper veins. This extraordinarily rich mine has developed and expanded, and today produces 3,000 tons per day of ore with an average grade of 4.5% copper.

In 1944, Magma acquired the San Manuel group of claims and, with Federal assistance, launched the program of exploration and development which resulted in the present day San Manuel mine, community, concentrator, smelter and refinery. First production from the San Manuel plant was in 1956.

The San Manuel mine contains an estimated one billion tons of copper ore averaging 0.7% copper. Its production is 60,000 tons of ore per day, which is all processed daily through the concentrator and smelter. Concentrates from Superior are shipped to San Manuel for smelting and refining.

In 1969, Magma became a wholly owned subsidiary of Newmont Mining Corporation, an international firm specializing in the development and production of diversified mineral resources.

Continuous cast $\frac{5}{16}$ inch copper rod of the highest purity is produced at San Manuel for the wire and cable industry.



MAGMA

Magma Copper Company

A Subsidiary of Newmont Mining Corporation

P.O. Box M, San Manuel, Arizona 85631



MAGMA

Magma Copper Company

A Subsidiary of Newmont Mining Corporation

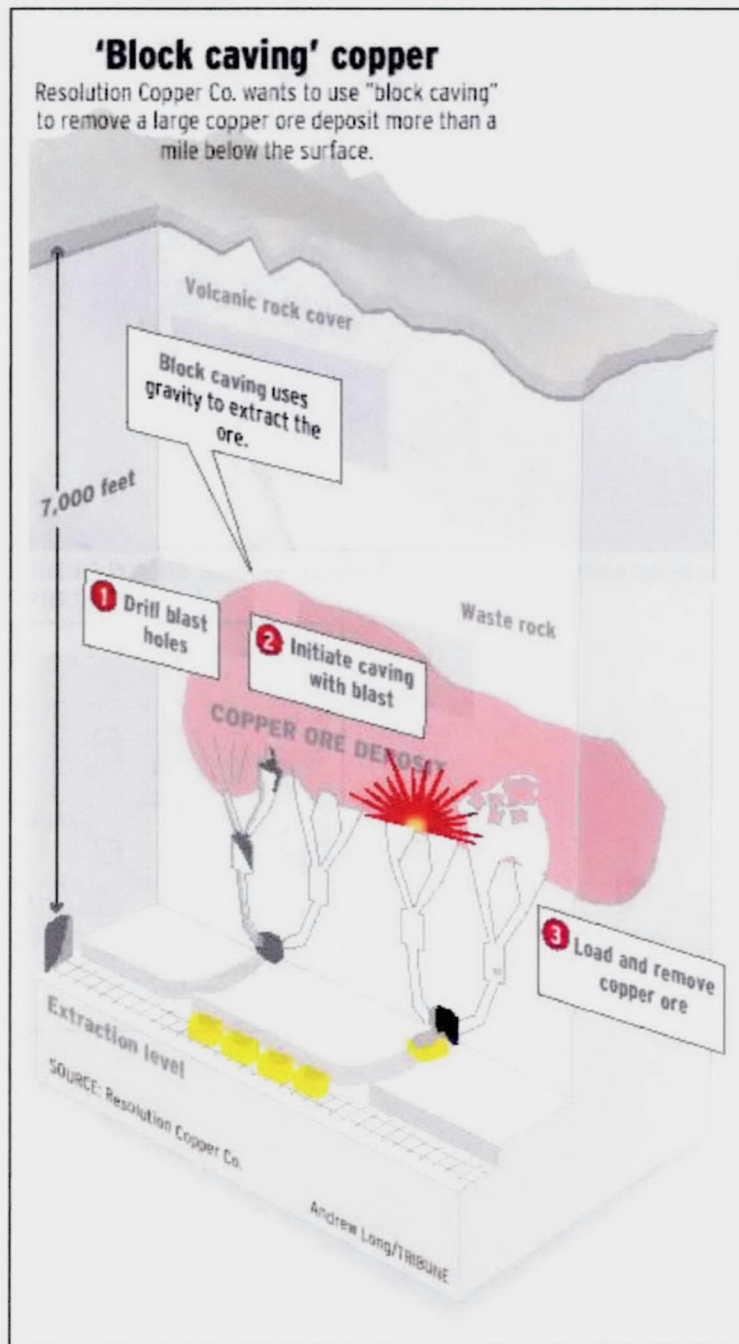
P.O. Box M, San Manuel, Arizona 85631

property in other ways.

Resolution's interest in the community was praised by Mayor Michael Hing, who said it contrasts v sometimes rocky relationships that existed between the town and mining interests in the past. Even exploration activities so far have had an impact, he said. "It has given us hope for the future."



MINING PLANS: Resolution Copper Co. wants to mine a copper ore deposit 7,000 feet below the surface at the Mine Shaft east of Superior. TIM HACKER, TRIBUNE







COPPER Discovery brings hope



From: Nyal Niemuth
To: James Sell
Date: 05/21/2001 10:58:46 AM
Subject: Magma Por. JV

> -----Original Message-----

> From: Perry, John JT
> Sent: Thursday, April 26, 2001 5:35 PM
> To: COPNASMN-MSG01 Mail Clients
> Subject: BHP COPPER SUPERIOR OPERATION-KENNECOTT EXPLORATION COMPANY
> JOINT VENTURE
> Importance: High

>
> As part of our ongoing process to evaluate all options for our facilities,
> I am pleased to announce we have signed an agreement with Kennecott
> Exploration Company regarding the Superior facility. I believe execution
> of the terms of this agreement is a great outcome for BHP shareholders,
> employees and the community. For additional information, please see the
> attached document which is the text that will be published in the Superior
> Sun newspaper next week.

>
> At BHP Copper, we recognize the strong mining legacy of which we are a
> part, and are proud of the contributions our industry has made to this
> region. As we move into the next century, we are constantly looking for
> ways to manage our mining resources, and ensure the well being of our
> employees and the community.

>
> On Tuesday, April 17, 2001, BHP Copper and Kennecott Exploration Company
> of Salt Lake City, Utah, entered into an agreement whereby Kennecott will
> conduct exploration drilling activities in an area where BHP Copper has
> the mineral claims near Superior. The exploration activities will be in
> and around the mineral resource known as the Magma Porphyry. Porphyry is a
> geologic term used to describe certain types of copper deposits. "We feel
> that the Magma Porphyry resource has the potential to yield significant
> copper reserves," said John Perry, President of BHP Copper North America.

>
>
> "Our arrangement with BHP Copper allows Kennecott Exploration Company an
> opportunity to expand upon previous exploration efforts in a prominent
> mining district," said Bruno Hegner, General Manager-Commercial, Kennecott
> Exploration Company.

>
> The terms of the agreement allow Kennecott Exploration Company to earn 55%
> of the project upon spending \$25 million over six years. Kennecott
> Exploration Company can withdraw from the project at any time prior to

- > earning in. As it has done in the past, BHP Copper will continue to keep
- > the community apprised of any changes or new arrangements that could lead
- > to further copper extraction in Superior.
- >
- > For more information, please call Mr. Charles Taylor, Director of
- > Environmental and External Affairs, BHP Copper, at (520) 498-4101, or Mr.
- > Bruno Hegner, General Manager-Commercial, Kennecott Exploration Company,
- > at (604) 669-9953.

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- > at (604) 669-9953.

**Memorandum**Growth and Technology
BHP Copper

7 May, 1998

TO: e-mail Distribution

CC:

FROM: Eric Seedorff

**PUBLIC INFORMATION ON THE MAGMA PORPHYRY DEPOSIT, SUPERIOR
DISTRICT, ARIZONA**

After several requests for information, I have compiled the public information available on the Magma Porphyry deposit at Superior, from the releases to the Quarterly Report on Exploration and Development, December 1997-February 1998, to the Australian Stock Exchange and the BHP Investor Relations Bulletin (8 April 1998). You may distribute this to anyone inside or outside of BHP.

Superior, Arizona, USA

Exploration drilling continued near BHP Copper's Superior mine, which was closed in June of 1996. A new porphyry copper deposit with high primary copper grades has been discovered south of historic underground workings in the district, deeply buried under post-mineral rocks. The mineral deposit, named the Magma Porphyry, now has been intersected by five holes that were drilled between October 1995 and January 1998. The first three were long holes that were inclined laterally and downward from underground mine workings. The latest two holes were deep, steeply inclined holes drilled from the surface. All five holes have significant intercepts of greater than 1% copper, and all five terminate in well mineralized rock. The longest intercept is from one of the surface holes; assays of drill core from the bottom 306 metres (1,004 feet) yielded arithmetic mean grades of 1.75% copper and 0.029% molybdenum, and the last 188.7 metres (619 feet) of that interval assayed 2.18% copper and 0.028% molybdenum.

The dimensions of the Magma Porphyry deposit are still incompletely defined, but it is at least 300 metres high, 700 metres long, and 200 meters wide. The top of the deposit is approximately 1.3 kilometres beneath the surface. The existing infrastructure at Superior is not suitable to exploit the new deposit, but the results of preliminary studies indicate that the deposit may be amenable to conventional bulk tonnage, underground mining methods and flotation processing. At the end of the quarter, exploration drilling had ceased; the mine remained on a care-and-maintenance basis; and BHP was evaluating options for future exploration.

Eric Seedorff

Vice President Mineral Resources

ADMMR Facsimile Cover Sheet

To: Jim Sell
Company:

From: Nyal J. Niemuth
Company: Arizona Dept. of Mines
and Mineral Resources

Phone:
Fax: 520-578-7196

Phone: 602-255-3795
Fax: 602 255-3777

Pages
including this
cover page: 3

Date:

Comments: BHP RELEASE RE: MAGMA PORPHYRY

YOUR BOOT PRINT PAPER NOTES MAGMA'S DRILLING
IN T23, H3E, SEC. 6.

Nyal:
Thanks a bunch for this
information.
Exploration is alive & well!
Jim

Forward copies to FTG & ECA

1-212-510-1855

FACSIMILE MESSAGE

DATE: 05-08-98

TO: Mr. F. T. Graybeal
Chief Geologist
ASARCO Incorporated

PHONE/FAX: 1-212-510-1855

SUBJECT: Magma Porphyry Deposit

NUMBER OF PAGES INCLUDING COVER 3

Hello Fred:

I received a copy of this release
and thought you might be interested

Events seem to continue to go
along.

Stop by and have a cup of
coffee when your this way.

Sincerely,
James D Seel

FACSIMILE MESSAGE

DATE: 10 July 98

TO: Keith Long

FROM: JW Sell

PHONE/FAX: _____

SUBJECT: Magma Porphyry release

NUMBER OF PAGES INCLUDING COVER 3

Here is the data.
Thanks for your info - hope
to get back to you one of these
days.



ASARCO

Exploration Department
Southwestern United States Division

February 3, 1982

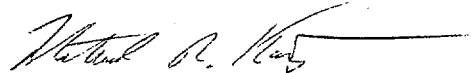
Mr. Frank Flores
General Manager
Magma Copper Co.
P.O. Box 37
Superior, AZ 85273

Dear Mr. Flores:

Steve Catlin, Barney Mason and myself would like to thank you for the excellent orientation on geology we received from Mr. Webster and his staff, and the excellent underground tour we received from Don Atkinson on January 22. Please extend our thanks to them.

We collected numerous specimens of ore and altered rock including the "conglomerate" which we have submitted for thin and polished sections. We will communicate any interesting findings on them directly to Mr. Webster within the next several months.

Very truly yours,



Fleetwood R. Koutz
Geologist

FRK:mek

SESSION 133, SEG--Economic Geology (Posters)

isolated small (2-20 micron) grains in the pyrite and chalcopyrite. The ore paragenesis has been divided into five distinct stages - (1) skarn-oxide (2) pyrite(3) base metals (4) carbonate, and (5) weathering. The skarn-oxide stage is dominated by the formation of the skarn silicate minerals as well as magnetite and ilmenite. The pyrite stage is dominantly coarse grained pyrite but contains minor gold and calaverite as inclusions. The base-metal stage is dominated by chalcopyrite but contains the greatest variety of minerals of any stage and the principal occurrences of gold. The carbonate stage is represented by calcite, dolomite, rhodochrosite and barite. The weathering stage consists of supergene copper sulfides and iron oxides. Fluid inclusion studies indicate that the ore forming fluids contained 2-4 wt percent NaCl equivalent and precipitated ores in the temperature range 430 to 150 C.

BTH 37 Johnson, K. E.

CHARACTERIZATION OF ZIRCONS FROM HEAVY MINERAL SANDS: IMPLICATIONS FOR PROVENANCE OF NORTH FLORIDA HEAVY MINERAL DEPOSITS

JOHNSON, K.E., Dept. of Geology and Geophysics, University of New Orleans, New Orleans, LA 70148; MCCLELLAN, G.H., Dept. of Geology, University of Florida, Gainesville, FL 32611

Cathodoluminescence (CL) and back-scattered (BSE) imaging techniques, combined with electron microprobe analysis, were used to characterize zircons from two heavy mineral sand deposits in north Florida. Zircons were examined from the Trail Ridge and Green Cove Springs localities, beach ridge deposits of Pleistocene age, to determine whether these heavy mineral sands have a common provenance. Three distinct morphological types of zircons in the Green Cove Springs deposit (prismatic, clear rounded, and cloudy rounded), and two in the Trail Ridge deposit (prismatic and cloudy rounded) have been identified.

The zoning patterns revealed by CL and BSE imaging provide a clear, though qualitative, assessment of variations in the growth history of these zircons. These imaging techniques and chemical analysis make it possible to discern zircons of metamorphic and igneous origins. Rounded metamorphic zircons have yellow or blue luminescence, and BSE imaging reveal textural relationships that indicate complex growth histories. Rounded igneous zircons typically luminesce grey to black with yellow rims. In contrast, the prismatic zircons from both localities display multiple growth stages that are distinctly igneous. An igneous origin is suggested by the exterior morphology, supported by chemical evidence. In CL the cores of these zircons are either green or dark grey to black, both colors being indicative of an igneous origin. Concentric or oscillatory zoning and the absence of resorbed internal structures are additional igneous characteristics. The Green Cove Springs prismatic zircons, however, display more growth stages than the Trail ridge prismatic type. Rare, blue metamorphic zircons also occur in this morphology type.

In BSE chemical differences are evident as shades from white to dark grey. The lighter growth bands apparent in BSE imaging correspond to the highest Y contents for zircons of both localities. Y (0.3-0.37 wt.%), U (0.3-0.29 wt.%), Ce (0.53-2.27 wt.%), and Hf (1.63-2.12 wt.%) display the greatest compositional variability. The Green Cove Springs igneous zircons have lower U, Th and Ce than in the Trail Ridge. The very high Ce observed in one case may correspond to the analysis of a phosphate inclusion.

The observed differences in the zoning patterns of prismatic zircons from both localities, as well as the distinct morphologies and chemical variations suggest that these deposits may not share a common provenance.

BTH 38 Pareja, Guillermo A.

CAN ISOTOPIC HALOS BE PRODUCED AROUND CARBONATE-HOSTED MANTO-TYPE ORE DEPOSITS? - EVIDENCE FROM THE SUPERIOR DISTRICT, ARIZONA

PAREJA, Guillermo A., and FRIEHAUF, Kurt C., Dept. Geological and Environmental Sciences, Stanford University, Stanford CA 94305-2115

The stratigraphically-selective carbonate-hosted massive sulfide/hematite replacement ores of the Superior district are analogous to those at Gilman and Leadville (CO), Bisbee (AZ), Tintic (UT), and Yauricocha (Peru). ^{13}C - ^{18}O isotope analysis of 23 carbonate rock samples (36 analyses) both adjacent to and distal to ore, but all within the stratigraphic horizons that preferentially host ore demonstrate significant differences in $\delta^{18}\text{O}$ and minor differences in $\delta^{13}\text{C}$ values between sedimentary-diagenetic carbonates ($\delta^{18}\text{O} = +20$ to $+26\text{‰}$ and $\delta^{13}\text{C} = -5$ to $+2\text{‰}$) and hydrothermal carbonates ($\delta^{18}\text{O} = +8$ to $+10\text{‰}$ and $\delta^{13}\text{C} = -2$ to -3‰). Samples of host-rock carbonate matrix within centimeters of carbonate veins, garnet skarn, and massive sulfide/specularite are isotopically indistinguishable from unaltered sedimentary-diagenetic carbonate in the same horizon. Similar results are reported at Leadville, Gilman, and Aspen, CO. Primary sedimentary-diagenetic variation between the carbonate beds (i.e. stratigraphic variation) is similar in magnitude to isotopic shifts produced by 10-15% hydrothermal carbonate contamination of bulk rock samples within a given bed.

The lack of isotopic variability in matrix carbonate within an ore-bearing stratigraphic horizon as a function of distance (1 cm to 1500 m) from mineralized bodies and dramatically contrasting values between hydrothermal veins and the matrix they cut suggest that most isotopic shifts are produced by direct precipitation of carbonate from the hydrothermal fluid rather than by diffusional re-equilibration between sedimentary carbonates and the hydrothermal fluid. For this reason, isotopic values of indiscriminate bulk carbonate samples are strongly affected by the occurrence of hydrothermal carbonate veins, intergranular void-filling cement, and/or primary stratigraphic isotopic variation and may define "false halos" and yield meaningless calculated fluid:rock ratios.

Any isotopic alteration study of carbonates should start with a detailed stratigraphic and characterization study of isotopic variation between strata. Focus then should be placed on well-defined key beds, analyzing veinlets and pods separately from host-rock matrix.

BTH 39 Yeats, Christopher J.

2.63 Ga LODE-GOLD STYLE MINERALIZATION OVERPRINTING A 2.93 Ga VHMS EVENT AT THE MOUNT GIBSON GOLD DEPOSITS, YILGARN CRATON, WESTERN AUSTRALIA

YEATS, Christopher J., Key Centre for Strategic Mineral Deposits, Department of Geology and Geophysics, University of Western Australia, Nedlands, WA, Australia, 6907. The Mount Gibson gold deposits are hosted in a ca. 3000 Ma greenstone sequence in the Murchison Province of the Archaean Yilgarn Craton, Western Australia. The host sequence to mineralization has been metamorphosed to middle amphibolite facies and comprises magnesian metabasalts, tholeiitic metabasalts and metadolerites, quartz-andesites, syn-volcanic quartz-feldspar porphyry intrusions and felsic metavolcanics.

Gold mineralization is contained within the Mount Gibson anastomosing ductile-shear network developed primarily within the mixed 'Mine Sequence'. Mineralization typically occurs as steeply dipping lenses of sulfide \pm quartz-bearing schist hosted predominantly within biotite \pm chlorite altered mafic rocks.

The Mount Gibson gold deposits are anomalous when compared with other Western Australian Archaean lode-gold deposits. The sulfide assemblage which accompanies mineralization is more varied than the norm and base-metal sulfides in places reach concentrations sufficient to give assays of several percent for Pb and Zn. The Ag to Au ratio is generally approximately 3:1, and fineness data for gold grains in primary mineralization averages 596, with the remainder silver. Unusual spessartine-gahnite and cordierite-muscovite bearing assemblages are also present, intimately associated with the gold mineralization.

The spessartine-gahnite bearing schists at Mount Gibson are intimately associated with base-metal sulfide mineralization and in places form a coherent stratiform horizon which immediately overlies the main gold ore zone. This horizon is interpreted as a metamorphosed, base-metal rich, hydrothermally altered, seafloor horizon (i.e. the upper portion of a VHMS system). Other evidence for VMS-style mineralization at Mt Gibson includes the unusually low Au:Ag ratios, and gold fineness values recorded for the deposit.

A more typical, syn-orogenic, shear-hosted lode-gold mineralizing event, represented by the quartz-biotite \pm chlorite alteration overprints the VHMS-style mineralization at Mount Gibson.

A combination of SHRIMP U-Pb geochronology in magmatic and hydrothermal zircons and Pb model ages of galenas from the two parageneses, suggest that VHMS-style mineralization developed at ca. 2.93 Ga and was overprinted by lode-gold style mineralization at ca. 2.63 Ga.

BTH 40 Chi, Guoxiang

BASINAL FLUID FLOW MECHANISMS RELATED TO CARBONATE-HOSTED Zn-Pb MINERALIZATION IN THE MARITIMES BASIN, NOVA SCOTIA, CANADA - AN OVERVIEW

CHI, Guoxiang, SAVARD, Martine M., ST-ANTOINE, Pierre and HÉROUX, Yvon, Quebec Geoscience Centre, 2700 Einstein, Sainte-Foy, Quebec, Canada G1V 4C7

Numerous Zn-Pb-Ba occurrences are hosted by carbonates of the basal Windsor Group along the southern margin of the Maritimes Basin which is characterized by horst-graben architecture. The basin was filled by a thick (up to 12 km in the central part) sequence of late Devonian to early Permian continental and marine sediments. The carbonates of the Windsor Group overlie the classic rocks of the Horton Group or the metamorphic basement, and are overlain by a thick sequence of evaporites.

Previous workers have proposed that sudden release of geopressured fluids in the Horton aquifer under the evaporite seal was the mechanism of fluid flow. The source of mineralizing fluids was thought to be the central part of the Maritimes Basin approximately 250 km away from the sites of mineralization. Tectonic events such as detachment faulting have also been proposed as the trigger of geopressured flow. Gravity-driven flow due to uneven topographic uplift has also been suggested as an alternative mechanism. These models are broadly compatible with the timing of mineralization as estimated at 300 Ma for the Gays River deposit.

Fluid inclusion studies in the Gays River and Jubilee deposits indicate two stages of fluid mixing. In the first stage, hot brines ($T_f = 200-230^\circ\text{C}$, salinity = 24-27 wt%) mixed with cooler burial background brines ($T_f = 53-161^\circ\text{C}$, salinity = 21-27 wt%). In the second stage, mainly post-ore, fluids of relatively low salinities (<14 wt%) and low temperatures ($<90^\circ\text{C}$) invaded the hydrothermal systems and mixed with the previous fluids. The succession of fluid types and their mixing likely reflect changes in the fluid flow regime. In the first stage, geopressured fluid flow of hot brines, probably provoked by faulting, may have dominated under the evaporite seal, while gravity-driven flow may have been operating above. With the fading of the geopressured system, the low-salinity low-temperature fluids in the upper system may have entered the lower system and mixed with fluids there.

Vitritine reflectance from a deep drill core of the Subacadian sub-basin indicates a geothermal gradient of at least $80^\circ\text{C}/\text{km}$. This result supports a previous suggestion that the Maritimes Basin was underplated by basaltic magmas at about 300 Ma, and implies that the central (deepest) part of the Maritimes Basin is not the only source region that could have provided the hot mineralizing fluids. High geothermal gradients, if not evenly distributed in the region, may have provided yet another possible driving force for basinal brine circulation.

BTH 41 Hagni, Richard D.

MINERALOGY AND MINOR ELEMENT CHARACTER OF EARLY BORNITE AND NICKEL-ARSENIC SULFIDE ORES IN THE VIBURNUM TREND, SOUTHEAST MISSOURI LEAD DISTRICT: RELATIONSHIP TO THE LEAD-ZINC ORES AND THEIR GENETIC SIGNIFICANCE.

HAGNI, Richard D., Geology and Geophysics Dept., 125 McNutt, University of Missouri-Rolla, Rolla, MO 65401.

The earliest ores deposited in the Viburnum Trend are bornite ores at the Fletcher, Sweetwater, Brushy Creek, and Casteel mines, and nickel-arsenic sulfide ores at the Magmont-West mine. Those two types of ores are similar in their mineralogy, trace element geochemistry, and paragenetic position.

The bornite ores consist primarily of bornite and chalcopyrite, but contain smaller amounts of gersdorffite, tennantite, enargite, fletcherite, nickeliferous carrollite, chalcocite, digenite, djurite, anilite, covellite, and blaubleibender covellite. The ores occur as small lenticular to pod-shaped bodies of very fine-grained massive replacements of Cambrian Bonnetterre Dolomite. They exhibit exsolution, replacement, colloform, and granular textures. The ores are characterized by high minor and trace element contents of As, Ni, Co, and Mo.

The nickel-arsenic sulfide ores at Magmont-West are characterized by abundant millerite, gersdorffite, polydymite, and chalcopyrite, but contain smaller



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Biographies



John Rickus is the President of Resolution Copper Company. He is responsible for managing the strategy and direction of Resolution Copper.

Mr Rickus has a Bachelor of Science degree in Geology from Liverpool University in England. He has worked in the mining industry for over 30 years. After a brief period evaluating china clay and bentonite deposits in Europe, Mr Rickus worked in various management positions in copper and gold open pit and underground mines in southern Africa. He then worked as a geological consultant before joining Rio Tinto in 1984.

With Rio Tinto, he has worked in Rio Tinto Technical Services in UK, Chile and Australia becoming Managing Director in 1994 with responsibility for Technical Services projects for Rio Tinto operations and projects worldwide. In 1999 he joined the Copper Group in Rio Tinto's London headquarters as Mining Executive. In this capacity he has served on the Board of Directors of many of the copper mines managed by Rio Tinto including Kennecott Utah Copper in Salt Lake City and the Palabora copper mine in South Africa, which is developing a block cave underground mine. He also has a significant role in looking after Rio Tinto's interests in joint ventures where Rio Tinto is not the manager including the Escondida copper mine in Chile and the Grasberg copper operations in Papua, Indonesia, the former being managed by BHP Billiton who are Rio Tinto's partners in Resolution Copper.

Bruno Hegner is Vice President and General Manager of Resolution Copper Company. He is responsible for the daily operations of Resolution.

Mr. Hegner has had a varied career as a logger, ski area employee, attorney and as a corporate manager. Mr. Hegner earned his Bachelor of Arts in Russian History from Fort Lewis College in Durango, Colorado, and a Juris Doctor (JD) from the University of Denver College of Law. He also attended the Colorado School of Mines through the University of Denver's collaborative program for graduate studies in mineral economics.

Mr. Hegner has held general management positions in the United States and abroad with Cyprus Minerals Company, Magma Copper Company and Rio Tinto, the parent company of Resolution Copper. Since joining Rio Tinto in 1995, Mr. Hegner has served as General Counsel of Kennecott Exploration Company in Salt Lake City, Utah, and General Manager, Commercial



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with Rio Tinto Exploration in Vancouver, Canada.

Mr. Hegner serves as Director of the Boyce Thompson Desert Arboretum.

Jennifer Russo is Corporate Communications Director for Resolution Copper Company. Her primary responsibilities include community outreach, corporate sponsorship, media relations and marketing. Jennifer's goal is to ensure the attention to those components of the Resolution project that affect the communities in which Resolution Copper operates.

Prior to joining Resolution Copper, Jennifer held positions at Giant Industries and American Golf Corporation where she led marketing, public relations and community affairs efforts.

In addition to her industry and business experience, Jennifer has worked closely with various community groups. Her volunteer experience includes Habitat for Humanity, St. Vincent De Paul food services program and St. Patrick's.

Jennifer holds a Bachelor of Arts in Journalism from Arizona State University with a minor in Spanish.

Contact Jennifer at
Jennifer.Russo@resolutioncopper.com.

Carl Hehnke is the Site Manager for Resolution Copper Company. He is responsible for coordinating environmental baseline surveys and managing the scheduled takeover of the Magma Mine property by Resolution Copper.

During the initial exploratory phase, Carl designed and implemented the geotechnical logging program at Resolution Copper as well as permitting and executing the drilling program. Prior to joining Resolution Copper, Carl worked for more than a decade as an exploration geologist with Kennecott Exploration Company. His responsibilities included designing, executing and managing exploration projects in Nevada, California, Washington, Idaho and Montana.

A graduate of California State University Sacramento, Carl holds a Bachelor of Science degree in Geology.

Susana Roque is Office Manager for Resolution Copper Company. She is responsible for managing daily administrative operations and upholding compliance with Rio Tinto's business policies and procedures.



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Frequently Asked Questions

Who is Resolution Copper Company?

Resolution Copper Company was created in 2002 and is a subsidiary of Rio Tinto, the largest diversified mining company in North America.

What is the Resolution project?

Located near the Magma Mine in Superior, Arizona, it is believed to host a large copper orebody.

What is the operating structure of Resolution Copper Company?

The Resolution Project's assets are held through an incorporated joint venture. The shares of the joint venture company are owned 55 percent by Resolution Copper Company and 45 percent by BHP Copper, Inc. As the manager of the project, Resolution Copper Company will supply management services and personnel to the joint venture. Resolution Copper Company is a wholly owned subsidiary of Rio Tinto America. BHP Copper, Inc. is a subsidiary of BHP Billiton. More information about Rio Tinto is available at www.riotinto.com. Additional information on BHP Billiton may be obtained from www.bhpbilliton.com.

Who is Kennecott?

Kennecott is a sister company to Resolution Copper Company. Kennecott Exploration is also a Rio Tinto company, responsible for discovering and acquiring mineral resources in North and Central America. Kennecott Exploration conducted the initial exploration phase of the Resolution project.

Is Resolution Copper still in the exploration phase?

Initial exploration was completed in February of 2003. We will be conducting evaluation and engineering programs for the next three years.

What do you know about the orebody?

It appears to be a world-class ore deposit. The orebody is situated over 7,000 feet below surface. Ambient temperatures hover at approximately 175 degrees.

What kind of mine will you construct?

The project will be completely underground with no open pits and limited waste rock piles. It will be a 21st century mine employing state-of-the art technology. It will be developed using the block caving technique.

What is block caving?

Block caving is a safe, efficient technique that uses

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gravity to extract the ore. At present, engineers would create a cave below the ore deposit, causing the ore to break away from the ceiling and fall to the bottom of the cave. Loaders would bring the ore to an underground crusher, and shafts would convey the ore for processing. We would continue this process until we extract all of the ore.

What are the benefits of an underground mine?

As an underground operation, there would be no large open pit and limited waste rock piles. We do not have plans for on-site smelting. Instead, any copper concentrate would be transported off-site for smelting and refining.

What is your time frame?

If evaluation and feasibility studies are successful, production will likely begin in the next decade.

What kind of revenue will the project generate?

This abundant copper production could deliver significant new wealth to the U.S. and Arizona through salaries and federal, state and local taxes.

What kind of jobs will the Resolution project create?

Technology will allow the mine to be largely automated. There will be few, if any, traditional mining jobs which expose people to "working at the face". The workforce will need high educational levels.

If the mine is developed, the Resolution project could produce nearly 1,000 construction jobs and about 400 permanent, high-quality technical jobs at the mine site. We calculate that for every full-time person hired at the mine, the economy will grow by three additional service jobs. That's a net gain of more than 1,500 new, permanent jobs in Superior and the rest of the Copper Triangle once the operations begin.

How will Resolution Copper work with the local community to get their input on the project?

We have formed advisory committees in Superior and surrounding towns. We are working together with these committees to determine how we can best support the local communities and enhance the quality of life. Resolution Copper is working with local communities by seeking mutual commitment and reciprocity based on trust and openness to reach agreed objectives and shared involvement.

How will Resolution Copper support the local community?

Resolution Copper will help anchor the resurgence of Superior. Our company will closely align its community involvement with programs that support needs identified by local residents. We currently award college scholarships to high school students from Superior and nearby towns and sponsor an after-school educational program held at the Boyce Thompson Arboretum.

How will you address environmental concerns?

Resolution Copper recognizes that by its nature, mining disturbs the land. We are committed to ensuring high environmental standards in everything we do, including in particular the development and implementation of full closure and rehabilitation plans.

Additionally, we are working with recreational and other user groups to address their needs and provide them with other opportunities to enjoy the outdoors.

What is sustainable development?

Sustainable development means that we are

committed to balancing economic success with environmental care and social responsibility. We understand that every local community is different. We will work to understand and interact constructively with local communities and user groups, to understand what the the issue are and how they may be solved over time. The concept of sustainable development provides a sound framework for understanding how these social, economic and environmental factors combine in their net influence on the future of the earth.

Who can I contact if I have further questions?

To learn more, e-mail info@resolutioncopper.com. You can expect a response from the Resolution team within 72 hours.

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The Resolution Copper newsletter will be making its debut shortly! To receive the newsletter by e-mail, submit your information here. Please be sure to note whether you would like to receive the newsletter via e-mail or post.

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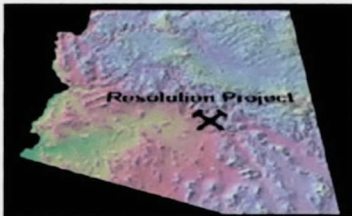
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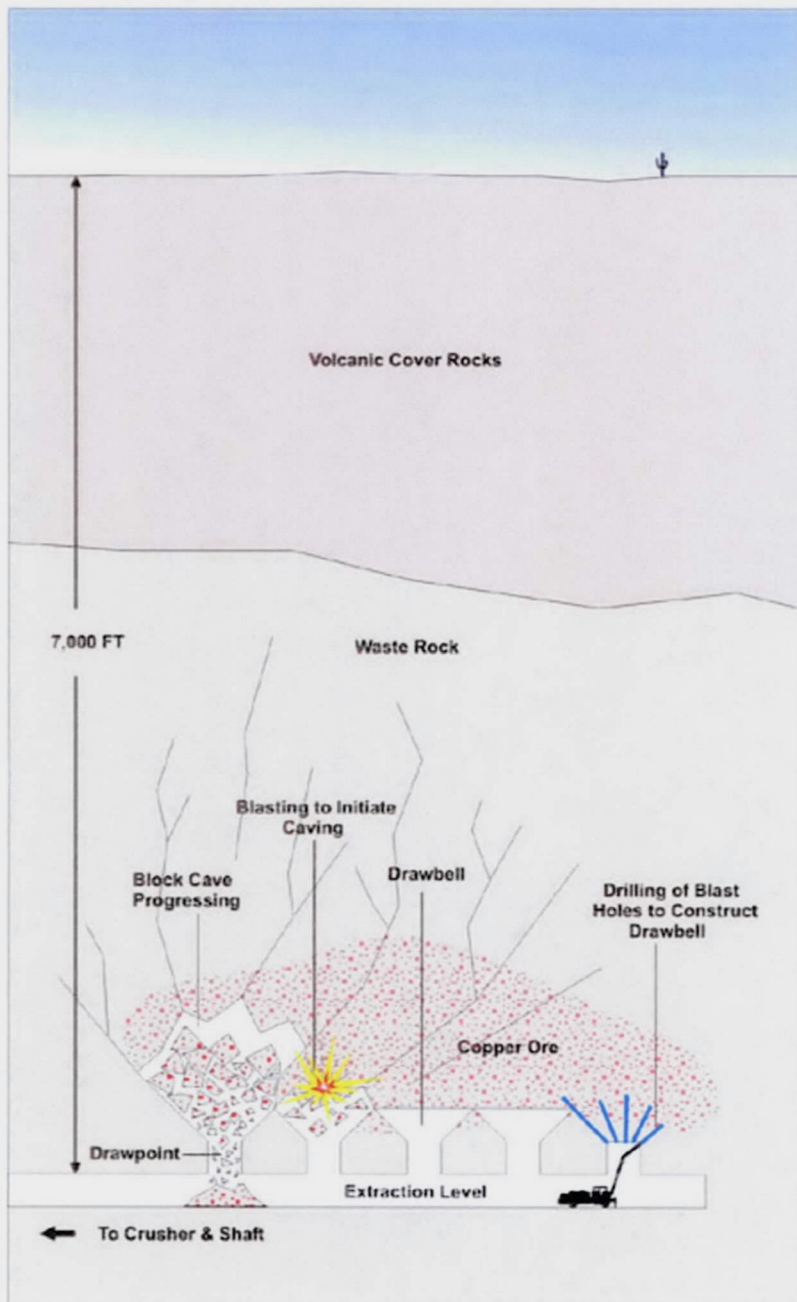
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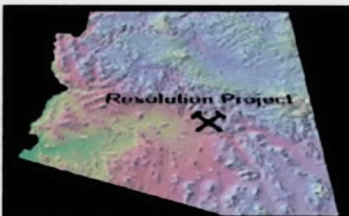
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Project Overview

The Resolution Project is in the historic Pioneer Mining District just three miles east of Superior, Arizona. Exploration conducted in 2001-2003 indicates a large copper orebody more than 7,000 feet below surface.

If developed, the project will be a completely underground mine. There will be no open pits and limited waste rock piles. The currently preferred mining technique is called **block caving**, which uses gravity to extract the ore. Resolution Copper is not planning on-site smelting. Instead, any copper concentrates will be transported off-site for smelting and refining.

The project is in the early stages of evaluation. To view an estimated project timeline, [click here](#). If it proceeds to production, the orebody could produce significant tonnages of copper each year during an expected life span of at least 25 years. This abundant copper production will deliver billions of dollars of new wealth to the U.S. and Arizona economies through federal, state and local taxes.

The mine will be a 21st century operation. Technology will remove much of the risk associated with traditional mining jobs. If Resolution Copper decides to proceed, the project could produce nearly 1,000 construction jobs and about 400 permanent, high-quality technical positions. Resolution Copper calculates that for every full-time person hired at the mine, the economy will grow by three to four additional service jobs. Resolution Copper will work with state and local entities to implement vocational training so the company can hire as many qualified people as possible from Superior and surrounding towns.

Resolution Copper believes its success depends on protecting the environment, and the health and safety of its employees and neighbors. Though Resolution Copper is part of a global family of companies, it wants to be a local partner. Resolution Copper is looking forward to a long-term, active relationship with Superior and its neighboring towns.

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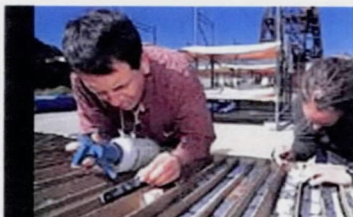
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Resolution Copper & the Community

Resolution Copper recognizes that good relations with our neighbors are key to long-term success. Our goal is to prosper together and bring positive change to Superior. Resolution Copper is already an active partner with many local organizations. We offer partnerships and support on issues that affect the quality of life for Superior residents.



Current Initiatives

- ✦ Award scholarships to graduating high school seniors pursuing a higher education in science, engineering and business at Arizona universities
- ✦ Sponsor an after-school educational program for primary school students at the Boyce Thompson Arboretum
- ✦ Environmental Partner of BirdLife International, a global organization dedicated to improving the quality of bird life and avian habitats
- ✦ Formation of advisory committees that are helping Resolution Copper decide how to best support the local communities
- ✦ Provide vocational training as new positions are created to develop a qualified workforce

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Charitable Giving

Implementing a community policy is not easy. Partnership building is a highly complex process that relies on trust, consultation, common objectives and the active involvement of local people. At Resolution Copper we believe in supporting the surrounding community in ways that improve the long-term quality of life. We believe our company can not only do well by doing good, but also feel that it is important to support causes that directly tie to Resolution Copper's mission. We do this through financial contributions, matching gifts, in-kind donations and volunteerism.



Our philosophy of sustainable development means we want to help create healthy, economically strong communities. To be successful, we must also have effective educational and vocational training programs that develop a qualified workforce and invite cultural amenities and new business. Our goal is to be a guide in Superior and surrounding communities, help forge partnerships among organizations, and be the catalyst for positive change.

Our charitable giving focus is in five areas: civic, education, environment, health and human services, and arts and culture. Our corporate sponsorship committee will review all requests for support on a quarterly basis, unless we determine that timing is a significant factor. Responses will be granted in written form.

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Sustainable Development

We know that being a responsible company means supporting development of a more sustainable society. Resolution Copper has accordingly embraced a commitment to sustainable development, which means balancing economic success with social and environmental responsibility.

Our goal at Resolution Copper is to meet the needs of the present without compromising the ability of future generations to provide for their own needs. We intend to give practical meaning to the concept of sustainable development through our actions - which we hope will demonstrate the mutual benefit of our commitment to people, occupational health and safety, and environmental excellence. In particular, we are already seeking to implement sustainable development principles at Resolution Copper by:

- ✦ Engaging our host communities and key stakeholders throughout each phase of the project and working together in ways that exemplify mutual respect, active partnership and long-term commitment.
- ✦ Ensuring high environmental, social and community standards in everything we do, including in particular the development and implementation of full closure and rehabilitation plans.
- ✦ Ensuring that sustainable development considerations are an integral part of the way we plan our business and make decisions.

We think sustainable development provides the best framework for understanding how social, economic and environmental factors influence the future of our planet and our neighborhoods. Resolution Copper is committed to doing good work and as such is working with ecological, environmental and community groups to help build sustainable communities in Superior and its neighboring towns. All of our efforts are based on:

Mutual Respect - This is key to forming lasting, beneficial relationships between Resolution Copper Company and the local communities. This requires ongoing communications and realistic expectations on both sides.

Active Partnership - This is how Resolution Copper

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works with local communities, user groups and governments. We seek mutual commitment based on trust and openness to reach objectives that will benefit everyone.

Long-Term Commitment - We hope to build a long-term, active relationship with Superior and its neighboring communities. We want to maintain the friendly, small-town atmosphere while working together to further enhance the quality of life for Superior residents.

Through development of the Resolution deposit in a manner that is guided by our commitment to sustainable development, we believe we can make an important and lasting contribution to the economic prosperity and social well-being of the town of Superior, Pinal County and the State of Arizona, as well as the stewardship of our environment.

For more information on Rio Tinto's approach to sustainable development, please visit the [Rio Tinto Social and Environmental Web site](#).

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Scholarship Program

Since 2002, Resolution Copper has awarded scholarships to graduating high school seniors in Superior, Globe, Miami and Florence. We are committed to helping deserving students who wish to pursue a higher education in science, business and engineering at an Arizona university. The recipients may also work at Resolution Copper Company during the summer months.



We want to encourage the area's brightest minds to continue their studies and evolve into tomorrow's leaders. They may be the key to making Superior and its neighbors the vital, thriving communities of the future. And they may also be the skilled, adaptable minds that help Resolution Copper succeed in its goals of sustainable development and economic success.

Graduating seniors from Superior, Globe, Miami and Florence high schools are eligible for Resolution Copper scholarships. The application process begins in March. Applications may be obtained by sending an e-mail to info@resolutioncopper.com with the word scholarship application in the subject line. Please be sure and include the name of your school.

[Click here](#) to read about our current scholarship recipients.

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**Boyce Thompson Arboretum**

A mining engineer, financier, patriot and extraordinary philanthropist, Boyce Thompson was a self-made millionaire who used his money to accomplish great things. The proof is in the sprawling nature sanctuary that bears his name.

He established the Boyce Thompson Arboretum to study desert plants and to help educate the public. Today, the Arboretum's collection includes samples from arid climates around the world. Resolution Copper Company ranks the Arboretum and its staff among our best resources for acting as responsible stewards to the land. Experts from the arboretum will help us restore lands disturbed by the mining process to their original, unspoiled condition.

Resolution Copper also sponsors a program that allows 3,000 students to visit the Boyce Thompson Arboretum each year. Students study desert ecology and enjoy guided tours while learning the value of protecting the environment in a safe, fun setting. It is our hope that these young people will someday be an integral part of our operational compliance, closure and rehabilitation programs.

To learn more about the Arboretum, visit www.ag.arizona.edu/BTA/index.html on the Internet.

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Copper pipes are the preferred method of carrying drinking water because it inhibits the growth of bacteria.

Superior Happeni

March 20-
Welcome
Back
Buzzards
at the Boy
Thompson
Arboretum



Birdwatching Program

For nearly five years, companies in the Rio Tinto family have hosted BirdLife events at their project sites. During the 43 events worldwide, participants recorded more than 1,000 species of birds.

These events are about more than just watching birds. They're about protecting some of the world's most important and beautiful species and their habitats. Rio Tinto boasts more than 100 BirdLife partners worldwide that have joined together in promoting interest and awareness of bird conservation. The annual birdwatch at each operation is not only fun, but allows the local bird population to serve as a biodiversity indicator that helps us better understand our impact on the environment.

The events are generally between June and October and are held everywhere from the Arctic tundra to steamy tropical rainforests. Each location helps us celebrate and safeguard the world's diverse bird species and the habitats in which they thrive. For more information on Birdlife International, visit their Web site at www.birdlife.com.

Come celebrate INTERNATIONAL MIGRATORY BIRD DAY at the oldest and most spectacularly situated arboretum and botanical garden in the American Southwest- Boyce Thompson Arboretum.

Join us as we celebrate and support migratory bird conservation. Guests will enjoy a fun-filled afternoon including a guided bird walk, avian photography class, bird watching 101, and fun activities for kids of all ages.

Event hours are from 7 a.m. - Noon, with a special one-hour early opening time. Regular Arboretum prices apply. Just \$6 for adults and \$3 for children. Children under 5 years old may enter free of charge. Exclusive event posters and calendars will be available for purchase at the event.

This event is brought to you by Partners in Flight, Arizona Game and Fish, Boyce Thompson Arboretum and Resolution Copper. For more information about International Migratory Bird Day, please visit www.birdday.org/imbd.htm.

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<http://www.resolutioncopper.com/community/birdwatching.asp>

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Superior History

Superior is a town rich in culture and history that was originally mined for gold and silver, but bases its history on copper mining. The town was named Superior when in 1902, a Michigan company named The Lake Superior & Arizona Mining Company took over several claims near Silver Queen for the purpose of mining copper.



In 1912, William Boyce Thompson purchased the Silver Queen Mine and established the Magma Copper Company. A copper magnate, Thompson is credited for establishing Superior as a prolific copper producer. While many organizations worked claims around the Superior area, Magma became the largest operation in the area, running from 1911 to 1996. The company was the community's largest employer and made many significant contributions. By 1920, Superior's Main Street was lined with over two dozen businesses and featured theatres, hotels, cafes and various businesses.

During this same period Thompson, recognized worldwide as an American financier and operator of silver and copper mines in Montana and Arizona, had a home constructed two miles west of Superior. He had a genuine concern for the destruction of the desert plants in the Superior area. Having already established the Boyce Thompson Institute for plant research in Yonkers, N.Y., he made a decision to do the same in the desert. In 1929, a 1700-acre site devoted to studying, growing and preserving plants of arid regions was officially dedicated as the Boyce Thompson Southwestern Arboretum. The home that Thompson built stands today and overlooks his arboretum.

Superior has changed with the times. A reduction in copper prices negatively impacted the town and its mining operations, causing the eventual shutdown of the mine, and the decrease in population in Superior. The core of the community, however, has held fast in its commitment to its history.

The town is rich with historical landmarks and is a cinematic treasure for Hollywood filmmakers. Superior's film appearances include *How The West Was Won*, *The Prophecy*, *U-Turn* and *The Fugitive*, while television commercials include Gucci, Harley-Davidson, General Motors and Samsonite. Many families now residing in Superior trace their roots back

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to three generations of native Superior residents. Many who leave Superior are hard pressed to find anyplace that offers the friendly, comfortable atmosphere of their hometown, and often return to raise their families there. Today Superior serves as a welcoming community for those commuting to work in the Valley, as well as devoted winter visitors.

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A typical luxury car contains 1,500 copper wires that, if laid end-to-end, would stretch a mile.

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Resolution Copper & the Environment

Resolution Copper Company is guided by its commitment to sustainable development. This means we are committed to balancing our economic progress with our social and environmental responsibility. Whereever possible, we prevent or otherwise minimize, mitigate and remediate the harmful effects of our operations on the environment.



We have been conducting environmental investigations on the Resolution Study Site and in the surrounding area for about two years. We are currently collecting general background environmental data across a broad geographical area and for all environmental media, including air, land, water, plants and animals.

The types of activities that have been done on the Resolution Study Site include: conducting wildlife and vegetation surveys, collecting surface water samples, conducting recreation and land use studies, collecting data on air quality and meteorology, and conducting cultural resources surveys. In areas surrounding the Resolution Study Site (such as Devils Canyon, Queen Creek, and Arnett Creek), additional monitoring of washes and springs has been performed, and these studies are ongoing. For more information on our water studies, [click here](#). Additionally, air quality and meteorological stations have been installed at three locations in and around the Resolution Study Site. For more information on air and weather studies, [click here](#).

Our company is committed to the conservation of species, their environment and their habitats. Wildlife studies on the Resolution Study Site are numerous and include such activities as locating and identifying birds, monitoring ponds and pools for reptiles and amphibians, and recording information about sensitive species and their habitats. [click here](#) to read about what we've learned so far.

Additionally, the vegetation communities present on the Resolution Study Site have been carefully mapped, and the types of plants and where they occur on the Study Site have been recorded. A thorough investigation of all of the historic and prehistoric sites has been completed on the Resolution Study Site and both historic and prehistoric sites were recorded. We have additional plans to install several monitoring wells in 2004 in order to collect background information about groundwater in the area of the Resolution Study Site.

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Our company plans to continue environmental studies for several years during the feasibility study for the project and beyond if the mine is feasible.

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Case Studies

Resolution Copper is fortunate to have the support of Rio Tinto - the largest diversified mining company in North America. The company has made a firm commitment to the principles of sustainable development. Rio Tinto, however, does more than just talk about doing good works. The case studies below show how various business units within Rio Tinto have put sustainable development into action and are realizing the mutual benefit of a commitment to people, health, safety and environmental excellence.

Click on the links below to see more examples of Rio Tinto's environmental rehabilitation work across the world.

[Ridgeway Mining Company \(Ridgeway, South Carolina\)](#)

[Flambeau Mine \(Ladysmith, Wisconsin\)](#) *1 page*

[Bingham Canyon Mine \(Oquirrh Mountains, Utah\)](#) *1 page*

[Antelope Coal Mine \(Wyoming\)](#)

[Labrador City Mine \(Wabush Lake, Labrador, Canada\)](#)

[Dry Creek Mine \(Cumberland Plateau, Tennessee\)](#)

[Borax \(Boron, California\)](#) *1 page*

[Azemuth Mine \(Germany\)](#)

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Building construction is the most common use for copper, accounting for more than 45 percent of all copper produced.

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Flambeau Mine

In Ladysmith, Wis., the Flambeau mine began operations against a background of skeptical community opinion. But the company engaged the community, kept faith with all of its environmental promises and restored the site to a place of natural beauty and recreational uses.

The open-pit mine yielded 181,000 tons of copper, 334,000 ounces of gold, and 3.3 million ounces of silver in just four years. The mine closed in 1997 and reclamation work was completed in 2000. This was followed by extensive revegetation of the site.

In addition to backfilling the pit, 90 percent of the mine site was replanted as grassland and trees along the wetland area. Site monitoring will continue for up to five years and groundwater quality will be monitored for the next 40 years.

Flambeau's administration, laboratory building and railspur were leased to the local Ladysmith Industrial Development Corporation and continue to provide benefits to the community.



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Bingham Canyon Mine

Kennecott's Bingham Canyon Mine is the largest open pit copper mine in the world. Kennecott Utah Copper owns or controls approximately 110,000 acres along the northern Oquirrh Mountains, west of Salt Lake City. About 10% of that contains its active operations, which includes the mine, concentrator, smelter, refinery and the tailings impoundment.



The rest — the non-operational area — is now home to abundant wildlife, such as deer, cougar, hawks, and a variety of other species. Kennecott's property also boasts one of Utah's largest elk herds — over 350 strong by the last count, January 2003.

At the southern end of Kennecott's property near the Bingham Canyon Mine, Kennecott Utah Copper removed material containing high levels of lead and arsenic, deposited clean soil where needed, and recontoured and reseeded more than 1,000 acres of land. Kennecott Utah Copper has received three prestigious Earth Day Reclamation Awards and several national and international awards for these successful projects.

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U.S. Borax - Boron Mine

For over 130 years, U.S. Borax has mined for refined borates — minerals with a wide variety of uses: from treating lumber to prevent termites, to plant nutrients that increase crop yield and quality. Continued mining and expansion plans make environmental stewardship and mine site reclamation a critical component of its operating strategy. Borax, however, also sees it as an opportunity to support workforce development in the community.



For ten years, U.S. Borax's operation in Boron, California (near Death Valley), embarked on a revegetation project. With only limited success to show for its efforts, Borax elected to partner with Victor Valley College, a nearby community college. The three-year partnership commits \$10,000 per year toward a student internship program combining academic and practical approaches to sustainable development challenges. As a result of the partnership with Victor Valley College, mortality rates for transplants are dropping and the transplant rate is expected to rise from 100 plants to 500 annually in 2004. Student interns learn nursery cultivation and reclamation site challenges, along with regulatory and permitting requirements first-hand by participating in Borax-related reclamation activities.

Following Borax's lead, two other High-Desert mining companies have entered into partnerships with Victor Valley College in nursery development and site reclamation. Mitsubishi Cement Corporation and Specialty Minerals Corporation, both of nearby Lucerne Valley, have enlisted the help of the college to find reclamation solutions in ongoing programs.

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Superior Happeni

Phoenix B
April 23-2
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Rock Climbing

During the next three to five years, Resolution will continue exploring and evaluating the project site. If we proceed with construction of the mine, certain areas will be impacted.

Access to the Oak Flat Campground and nearby climbing and bouldering areas may be affected. Resolution is conducting ongoing discussions with Superior town officials and user groups to help consider alternate recreation sites if they are needed.



Though any changes are still several years away, Resolution wants to ensure that campers, rock climbers and other outdoor enthusiasts will have uninterrupted enjoyment of the outdoors in the future. That's why we have started discussions with user groups at this early stage of the project.

Resolution welcomes your suggestions and comments. Please contact us via e-mail at info@resolutioncopper.com

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A mid-sized car contains about 50 pounds of copper.

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News Releases

Celebrate International Migratory Bird Day with a special event - May 8, 2004

Florence High School Student Earns Resolution Project Scholarship - June 16, 2003

Miami High School Student Earns Resolution Project Scholarship - May 15, 2003

Superior High School Students Earn Resolution Project Scholarships - May 13, 2003

In the News

- ✓ **Arizona town digs deep for boom (USA Today, 3/28/04)** *2 pages*
- ✓ **Copper dreams alive, well near Superior (East Valley Tribune 3/24/04)** *4 pages*
- ✓ **High-grade ore found beneath closed mine tantalizes area residents (Arizona Republic 3/21/04)** *4 pages*
- Resolution Copper Company Planning a new mine in area (Arizona Silver Belt 3/17/04)**
- ✓ **Copper's comeback benefits Arizona (East Valley Tribune 2/26/04)** *2 pages*
- ✓ **Exploration Phase Ends for Resolution Copper Company (The Superior Sun 2/25/04)** *4 pages*
- ✓ **Cobre Valley Institute of Technology (The Superior Sun 1/14/04)** *1 page*
- Superior Food Bank (The Superior Sun 12/3/03)**

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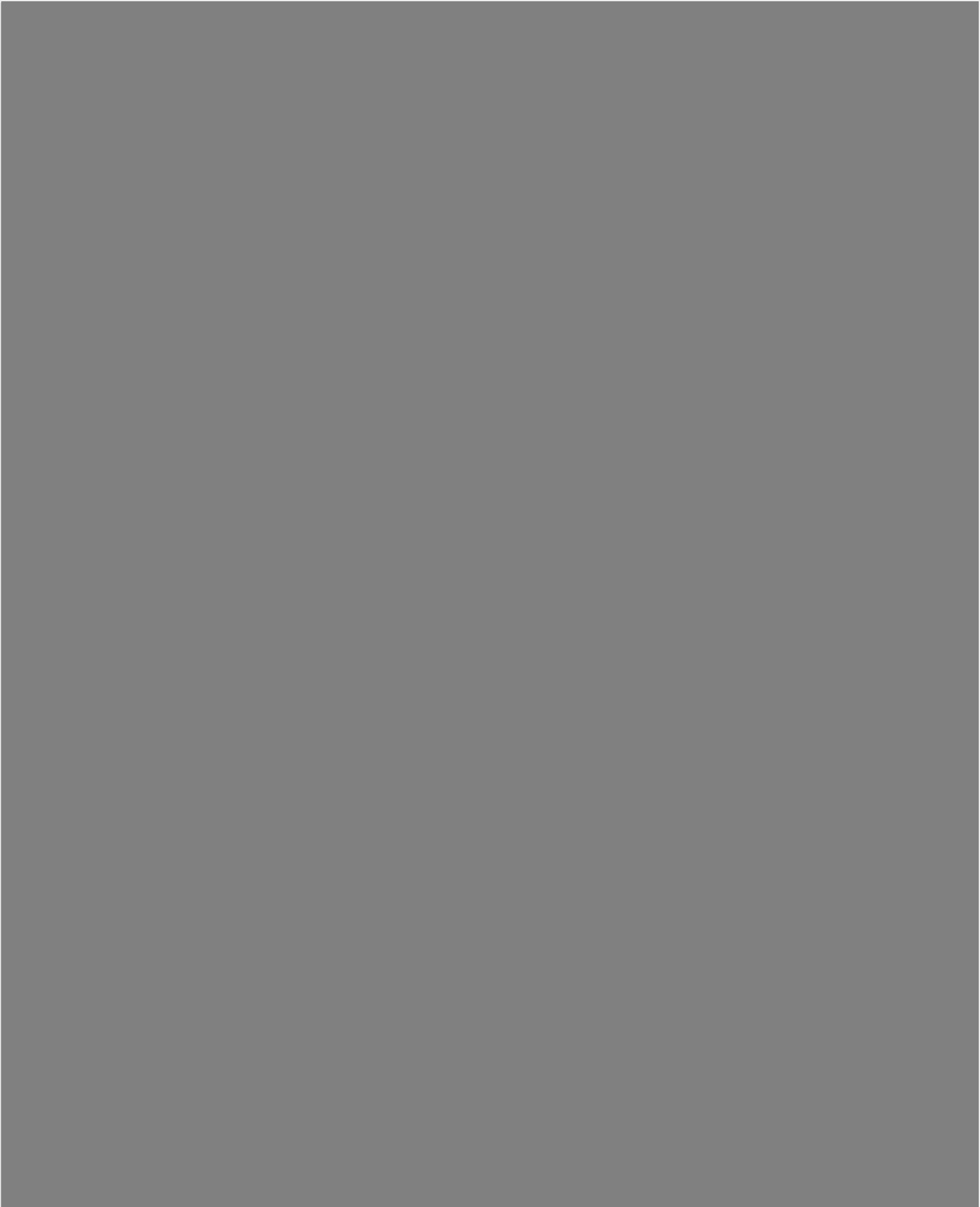
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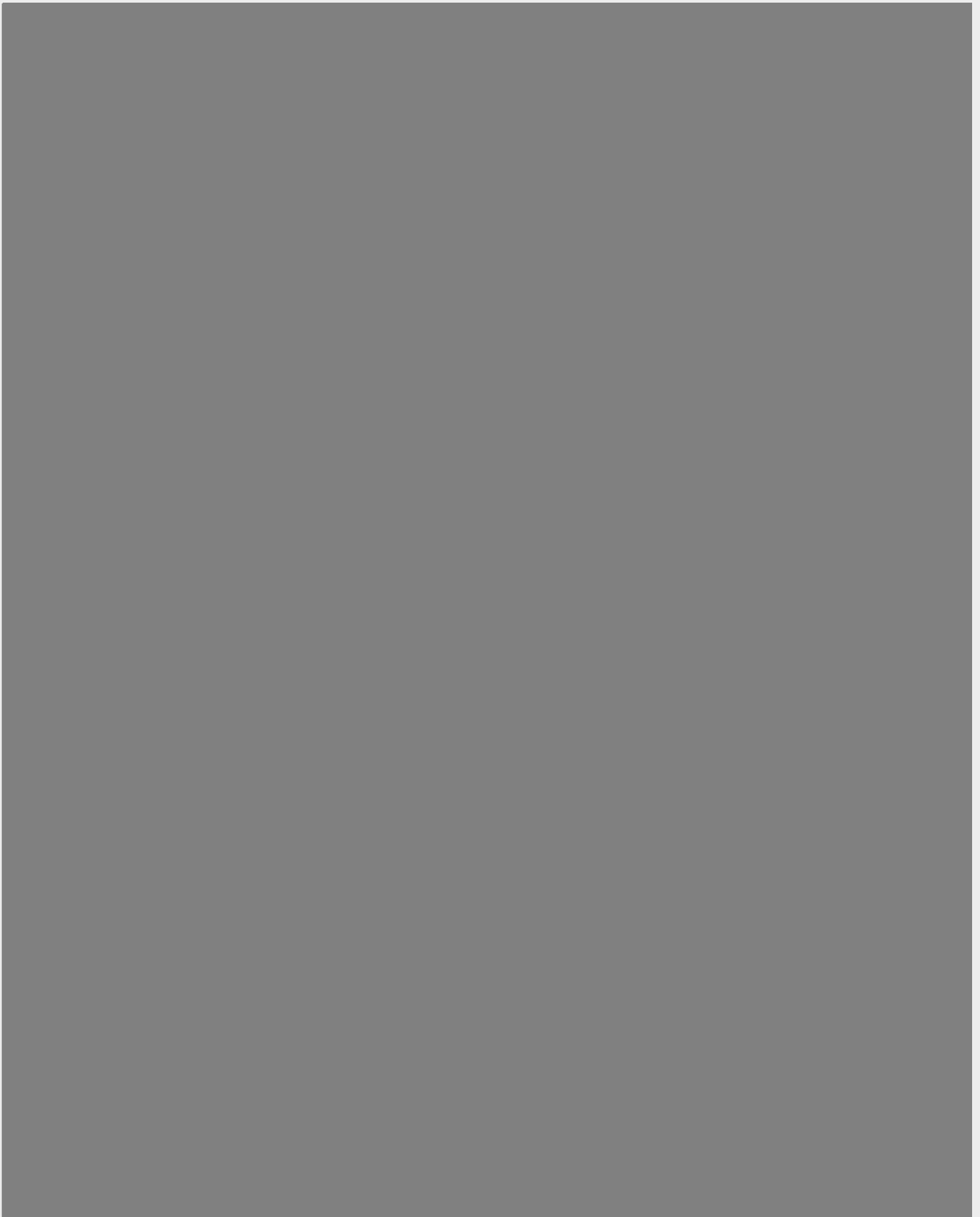


http://www.usatoday.com/money/economy/2004-03-28-coppertown_x.htm

☐ Check the box to include the list of links referenced in the article.









Business Update

Copper's comeback benefits Arizona



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about 50 pounds of
copper.

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Industry Links

[Rio Tinto](#) *2 pages.*[Sustainable Development](#)[Kennecott Exploration](#) *1 page*[Kennecott Utah Copper](#)[Global Mining Initiative](#)[The Institute of Materials, Minerals & Mining](#)[Women in Mining](#)[Boyce Thompson Arboretum](#)

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Investor information

Register for electronic communications:

Rio Tinto plc

Rio Tinto Limited

Shareprice information

£PLC	12.37	- 16
A\$LTD	32.53	0.52
\$ADR PLC	89.6	-0.21
\$ADR LTD	98.25	-2.15

Latest price (20 min delay)

Shareprice graphs



Shareprice calculator

Enter number of shares

Value: GB£

Past performance cannot be relied on as a guide to future performance

LATEST MEDIA RELEASES

Results of voting at 2004 annual general meetings of Rio Tinto plc and Rio Tinto Limited

22 Apr 2004

The Annual General Meetings of Rio Tinto plc and of Rio Tinto Limited were held on 7 April 2004 and 22 April 2004 respectively. All resolutions were passed by poll. The results are as set out below. Under Rio Tinto's dual listed companies structure e...

First quarter operations review

21 Apr 2004

New iron ore agreement strengthens Rio Tinto's China relationship

21 Apr 2004

Palabora first quarter 2004 operational review

21 Apr 2004

More media releases

IN FOCUS

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Rio Tinto provides access to HIV/AIDS treatment

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TINTO**

Kennecott Exploration is a leader in mineral exploration and evaluation in North America. It is part of the Rio Tinto group and has proven expertise in all aspects of the mineral exploration business.

Rio Tinto Sustainable Deveopment Award
(PDF 756 KB) from London Mining Journal, December 05, 2003

QWIKSEARCH

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**RIO
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ADNET INC.
and Kennecott Exploration

file: Magma Mine

1974 Spring Field Meeting of the Arizona Section

PROGRAM

8:30 A.M.	Meet at No. 9 Shaft for Underground Tour of Replacement Ore.
9:00 A.M.	Load Cage.
9:15 A.M.	Leave Collar.
9:25 A.M.	Arrive 3600 Level.
11:00 A.M.	Hoist
11:30 A.M.	Leave #9 Shaft.
12:00 P.M.	Arrive Outcrop.
12:30 P.M.	Leave Outcrop.
1:00 P.M.	Luncheon - St. Mary's Center, Sunset Drive, Superior, Arizona
2:00 P.M.	General Geology of the Area & Discussion

Outcrop

RR

Guard House ☐

Magma Office ☐

Parking

Hospital

RF

No 9 shaft →

US HWY 60-70

AME

Mike Lane - Superior Geol - speaker
Ben Green

Green - secondary dol - alt of colls is - dol. alt in volun 12% less volume
producing porosity necessary for intercal of subs and spec

Frank Forrest "Mining Methods"

Mining Methods, Art. m. Eng. May or June 1973

Rock temp on 3200 140° (3° per 100')
A BRIEF HISTORY OF THE PIONEER MINING DISTRICT
AND THE MAGMA MINE

Presented at the Spring Meeting Geological Section,
Arizona Chapter of the AIME, in Superior, May 11, 1974

12 bl ft per ton ore - at 250 per 1000
Bruce Johnson
Magma Mine Ventilation Engineer

1000 per ton to ore pass (not incl develop)

The advent of the Civil War had necessitated the withdrawal of most US army troops from Arizona, leaving the Southern part of the territory to the dominance of the Apaches, with only a few isolated towns where Whites could live safely. After the war, the Army started to move its troops back to Arizona with the aim of subduing hostile Indians. The Military Department of Arizona was created under the command of Colonel George Stoneman.

In 1870, Stoneman ordered the construction of a road to connect the garrisons in the Southeast with those in the central and northern part. A camp was established near Hutton Peak under the name of Camp Pinal, at which is now the Craig ranch. In May 1871 this camp was moved several miles westward to near the base of an unnamed butte, which was a volcanic neck. This butte suggested to the soldiers the corner towers, or picket posts, of cavalry forts; hence the name Picket Post, by which the mountain has been known to this day.

It had been suspected for some time that there was an Apache camp somewhere in the dacite cliffs of the rugged fault escarpment to the East of Picket Post, as an occasional Apache could be seen here. But a trail up the escarpment could never be located. Finally after a particularly vicious Apache raid at a ranch near Florence, the army determined to once and for all locate the camp. One night a detachment consisting mostly of Pimas under the command of Captain Walker found the trail up the cliffs and raided the Apache camp at dawn. Seeing the hopelessness of their situation, the fifty remaining Apache braves flung themselves to their deaths off the side, giving the name Apache Leap to the cliffs.

From this camp at Picket Post, construction was commenced on a mule road which headed Northeast. This road came to be known as the Stoneman Grade.

One of the soldiers employed on the construction, named Sullivan, when returning to camp one evening, sat down to rest near camp and began picking up loose fragments of rock. In the rock he noticed some black lumps which didn't break off when struck, but instead flattened out.

94% andesite porphyry - or dacitic intrusion
found in hangwall of magmatic vein - Ser alt - silicification

Though knowing nothing of minerals, Sullivan figured he must have found something unusual. He kept the rocks and returned to camp without saying anything about his find to any of the other soldiers.

Sullivan was shortly after discharged from the army. He rode down to the ranch of Charles Mason near Florence where he obtained employment. Often during his months on Mason's ranch Sullivan would show his rock samples to Mason without ever saying exactly where he had obtained them.

Mason assumed that Sullivan would eventually propose that they form a partnership and locate a claim on Sullivan's discovery. But one day Sullivan mysteriously disappeared, and it was thought that he had wandered off into the desert and fallen victim to the elements or to the Apaches.

In 1874, Mason and several other ranchers decided to organize an expedition and search for Sullivan's discovery. They located one promising outcrop and called it the Silver Queen, but did not file claim on it immediately. It was recognized that this was not Sullivan's find. They also located another deposit higher in the Pinals which they called the Globe. This prospect they did begin to develop.

In March 1875 another expedition by the same men was organized to bring ore on mules out of the Globe. But as they were returning to Florence they were attacked by Apaches and one of the men was killed. The remaining men buried the victim in a stone baking oven in an old temporary military camp near the summit of Stoneman Grade.

After the burial, the four remaining members of the party started the descent toward Florence. The story is that Issac Copeland was chasing a mule which had gotten away when he spotted the same type of black lumps projecting from rocks on a hill as Sullivan had shown to Mason. Sullivan's discovery had at last been relocated.

On March 22, the Silver King was staked out, and on March 29, the previous discovery, the Silver Queen, was also staked. There were two claims comprising the Silver Queen, the Irene and the Hub.

The original Silver King high grade assayed from \$8,000 to \$20,000 per ton. Mason and his fellow ranchers immediately began mining the deposit, but did little work on the nearby Silver Queen.

In 1876 the owners entered into partnership with some Nevada silver miners, and a stamp mill was erected on Queen Creek southwest of the mine. This mill was completed in July 1876. Two camps were established to service the mine, that at the mine itself which was also called Silver

King and that at the mill which was first called Picket Post, but later came to be known as Pinal.

As is always the case with bonanza discoveries, a rush to the area around the mine followed, and the district, which had then come to be known as the Pioneer district, was soon dotted with claims.

In June of 1876, two of the original four partners had sold their interest in the Silver King to Mason and Benjamin Reagan. In December of the same year Mason sold his interest to a Yuma merchant named James Barney.

By May 1877 the Silver King Mining Company had been organized in San Francisco by Comstock interests with a capitalization of ten million dollars. At this time Reagan, the last of the original discoverers, sold out his interest.

By the end of 1878, the main Silver King shaft had reached 110 feet in depth and the mine was booming. Mule drivers who carried the ore from the mine to the mill had worked out a high grading scheme in which they would fling chunks of high grade at recalcitrant mules. The high grade was later retrieved by cohorts.

In 1881, Sullivan, the soldier who had made the discovery originally, walked into the mill in Pinal and claimed ownership. It turned out that he had gone to California after leaving Mason's ranch with the idea of raising enough money to return and start his own operation, but had been unsuccessful, and had returned when he heard of the mine operating. Of course he had no legal claim, but the company did feel duty bound to give Sullivan a job. He left shortly thereafter and was never heard from again.

By 1883 the main shaft was down 830 feet with seven mining levels. The formation here was a stockwork, apparently a compact plexus of veinlets enclosed in a comparatively unfissured porphyry, about 130 feet maximum diameter, with a general dip of 70° West. The most abundant hypogene base minerals were sphalerite, chalcopyrite, tetrahedrite, galena, and bornite. The valuable constituents were supergene stromeyerite and native silver.

Mason and his associates had sold their Silver Queen claims in 1876 to the group who had organized the Silver King company, and the Silver Queen company was organized at the same time. But the owners were more interested in the King and did little work on the Queen, and sold out in 1880 to Philip Swain and associates in New York. The second Silver Queen company was thus organized in New York in 1880. This second company did more work on the Queen than had the first, and by 1882 had sunk the Queen Shaft, or No. 1, four hundred feet deep.

Another town grew up at the mouth of Queen Creek Canyon to service this mine, as both Silver King and Pinal were too far for the Silver Queen miners to travel each day. The post office here was established as Queen on April 28, 1881, but was discontinued in September of the same year. The town was then renamed Hastings after an early miner.

Originally, concentrates for smelting were hauled by wagon from Pinal to Yuma, where they were loaded on steamers which sailed down the Gulf of California and up the coast to San Francisco. But in May of 1879, the Southern Pacific had established a line to Casa Grande from the California coast, and concentrates henceforth had only to be hauled by wagon as far as Casa Grande.

As was the case of many high grade mines in the West, the Silver King ore was immensely rich but of very limited depth. In 1887 the ore was probably of too low a grade to be profitably mined and the mine began to go in the red, although there is some speculation that a lot of high grade was purposely left untouched with the idea of forcing a close down so that most of the stockholders, who by this time had become numerous, would sell out and a few insiders would be able to take over and reopen the mine. Another problem was labor, as the company was only paying the miners every six months, and there had been several strikes. The mine shut down in January 1891, was reopened in September of the same year and continued into 1892.

The stamp mill had been previously moved up to Silver King from Pinal in 1888 with the idea of saving on transportation of ore, and in 1891, where once it had boasted a population of 12,000, only ten people remained in Pinal. Today only traces of the foundations of a few of the buildings can be seen.

The Silver King was again closed in 1893, reopened briefly in 1895, and closed in 1896. The mine flooded. In the early 1900's a company built a modern mill at the mine site but never did any mining, just reworked some of the old tailings. The mine was reopened for the last time in 1918, and closed in 1920. It has been closed ever since.

The panic of 1893 had also forced closure of the Silver Queen, and the town of Hastings was fast dying.

In 1902, a group of Michigan capitalists acquired the old Golden Eagle mine, which had been one of the numerous smaller properties in the Pioneer district in 1885. This property had been only briefly worked before 1885 by the Gem Mining Company, but had contained little silver, although fairly rich in copper. Copper in the 1880's could not be profitably mined in such an isolated area as the Pioneer district. The Golden Eagle was located at the

mouth of Queen Creek Canyon, at the contact between Precambrian quartzite and Devonian Martin limestone. But the Michigan capitalists saw the possibilities in mining copper here, and formed the Lake Superior and Arizona Mining Company to mine the deposit.

In 1904, the Vivian shaft was sunk 279 feet, and three tunnels, the Anderson, Carlton, and Holt were driven 200 feet into the mountainside. The Lake Superior and Arizona remained in operation until around the First World War.

A resurgence of interest in the area caused Hastings to prosper, and in 1902 a veteran of the Silver King named George Lobb laid out a legal townsite at Hastings, and a Post Office was established. The town took its name from the mine - Superior. The town of Superior has never incorporated.

In 1906 a mining engineer from Globe examined the old Silver Queen, which had been dormant from 1893, and reported favorably on it as a copper prospect. Globe interests formed the Queen Copper Mining Company which leased the mine. A steam hoist was installed at the shaft collar, and development was undertaken, but the 1907 depression forced closure after less than a year of operations. Only 212 tons of chalcocite ore assaying 23% copper had been shipped.

In 1909, Colonel Boyce Thompson, who owned the Inspiration and various other Western mining interests in partnership with George Gunn, sent two engineers to look over the dump of the Silver Queen mine. The two engineers, Fred Flindt and Jim Cole could not agree, so Henry Krumb was sent to give a third opinion. Krumb reported favorably, and in June 1910 Magma Copper Company was organized. On August 1, Magma leased the Silver Queen claims, still only consisting of the Irene and Hub, and shortly thereafter purchased them. At the same time, contiguous claims were purchased. Initial capitalization of Magma Copper Company was \$1,500,000.

The Queen shaft at the time of acquisition was 400 feet deep. By February 1911, it had been sunk to 650 feet at which level crosscuts were driven. The main vein proved to be eight feet wide assaying \$800 to \$1000 per ton of both copper and silver.

In 1911, the 200 level adit was driven to intersect No. 1 so that the ore could be hoisted to this level. At that time ore was loaded onto "B" cars and trammed to the cage for hoisting.

Supplies were brought from Florence to Superior with five teams of six horses each, and ore hauled down on

the return trip. At Florence it was loaded on the railroad to an El Paso smelter. This early ore mined was all direct smelting.

In 1912, the mine had bottomed on the 800 level, over sixty men were employed, and 100 to 150 tons of ore averaging 26% copper mostly as bornite and covellite, went to the smelter each month. A compressed air powered hoist had been installed at 200 level at the shaft, and an office building, bunkhouse, mess hall, and change house had been built.

By May 1913 diamond drilling had proven ore to the 1400 level, and further investment was obviously justified. A power line was run from Roosevelt Dam via inspiration to Superior, and a 150 ton mill was built. This mill was supplied ore from the mine via an aerial tramway which loaded from trestle bins near the mine entrance. The mill was in operation by April 1914, shipping concentrates to the newly completed AS&R smelter at Hayden via team to Florence, then rail to Hayden.

In 1914, the cost of shipping concentrates by this method had become too high, and a narrow guage railroad was constructed by Magma to carry concentrates from Superior to a junction of the Arizona Eastern near Florence. This railroad was completed in 1915.

Also in 1914, sinking was begun on No. 2 shaft, as No. 1 was in poor condition due to mining which had been carried on too close to it. No. 2 was an extension of a two compartment winze which had been sunk from the 800 to 1000 level for exploration.

On May 27, 1915, the first stockholders report was issued. By this time, the mine had reached the 1000 level. Number 3 shaft was sunk in 1917, as No. 1 was by this time no longer serviceable, and at the end of 1919, both 2 and 3 shafts had been sunk to below 2000. Mechanical ventilation was installed in 1917, and No. 4 shaft was sunk in 1919 as an exhaust shaft.

The method of handling ore by loading it on small cars and hoisting it directly to the surface on the cage was becoming too costly. Hence in 1919 a tunnel was driven on 500 to connect the shafts with the mill level. Pockets were installed on 2000 level at shafts 2 and 3, with dumps on 500 and 200. This system was initiated in 1922. Direct smelting ore was hauled to the 500 level dump, milling ore to the 200 #3 dump where it transferred to the aerial tram, and waste was taken to above 500 at No. 2, where it was dumped into a waste raise system for backfill.

The mine shut down production for about a year in 1920 and 1921 due to a low copper price and increased smelting costs, although some development work was carried on. It was

decided to build a smelter and to change the railroad to a standard guage at this time.

Copper production was resumed in 1922. A waste glory hole which tied into the waste raise system was completed at this time, as development did not provide sufficient backfill material for stopes.

In 1923 smelter construction was finished, the railroad had been changed to standard guage, and the mill expanded to 600 TPD.

During the 1920's, production was from between the 1600 and 2550 levels. Because of the Westward plunge of the orebody, No. 5 shaft was sunk West of No. 3 for better ventilation. In 1926, the aerial tram had been completely replaced by haulage of ore across 500 level to the mill. Development of an Eastern ore shoot necessitated the sinking of No. 6 shaft to the East in 1928, and No. 7 was sunk in 1929 to ventilate the newly discovered West ore body.

Exploration was carried out as deep as 4000 level in 1935. The high rock temperatures encountered at this depth proved the need for a cooling system, and two 140 ton carrier units were purchased and put into operation in 1937. No. 8 shaft was also sunk at this time as an exhaust shaft, as the workings to the West of No. 3 were too deep and far away to effectively employ No. 4.

The mining method employed at this time was a system of square set timbered rill stopes, backfilled with waste.

The mine continued mining deeper ore during subsequent years, with production coming from the main vein, and West ore bodies. In 1938, stoping had begun in the Eastern copper zone above 3000, and in a copper-zinc containing part of the vein above the 2000 level 1400 feet East of No. 3 shaft. Also in 1938 the 400 HP Prescott dewatering pumps were installed at No. 8 shaft. These pumps move 600 GPM 3200 feet in ore lift.

By 1940, stoping had begun between 3600 and 4000 in the central zone, and had reached 4400 by 1943. In 1940, diamond drilling had encountered a parallel striking East - West vein South of No. 3 shaft between the 3400 and 4000 levels. This was named the Koerner vein after the manager at the time of the discovery, who died in 1940.

By 1945, all ore above 3600 on the West side of the mine had been removed, and mining of zinc above 2250 was discontinued.

In 1947, the mine development was downward below 3600 and Westward. With increasing depth additional cooling

was necessary, and a cooling tower was built near No. 5 shaft for this purpose the same year. By 1948 refrigeration equipment was being moved to the East to exploit the ore in this area below 3000. The mine began to exploit more of the ore in the Eastern zone at this time.

In 1950 mining of the copper - zinc ore above 2250 was resumed. A zinc flotation section had been installed when the new mill was built in 1950. Ore was discovered in a replacement bed in the Martin limestone this same year.

By 1952 the zinc price had fallen and zinc mining was discontinued. Mining in the Koerner vein commenced in earnest this year. Main vein mining was above 4600 West of No. 3. The bedded deposits were being developed at this time.

In 1953 production from the East bedded deposits commenced. In 1955 ore was discovered West of the North-South fault which had previously appeared to be the West limit of the bedded deposit, and above the 2550 level. The Koerner vein was gradually being mined out, and mining in the main vein was commenced above the 4800 level on the West side. Ore in the vein East of No. 3 had pretty well played out.

By 1957, No. 6 shaft had been deepened to hoist ore from the operations in the bedded deposits to 2550, where it was transferred to trains for haulage to No. 3 and 5 shafts. The Koerner vein was depleted and was shut down.

The No. 5 shaft was deepened to 4900 to service the bottom of the main ore body, but production from here was costly. Production in the main vein area west of No. 5 ceased in 1961, although ore was encountered on 4600 East of No. 3 in 1962.

The increasing thickness of the ore and decreasing competence of the hanging wall in the East beds necessitated a modification of mining methods, and accordingly a hydraulic backfill system, with mining proceeding up dip was initiated in 1963. Timbering was still usually by square set.

By 1965, all of the production was from the replacement deposits in the Martin limestone. It had been discovered that the vein in the area of the beds had split and the branches had been faulted about 1100 feet North along the strike of the North - South fault. Mineralization extended roughly 100 feet North and South of the strike of both these faults in a horizon dipping 30° East and about 30 feet in thickness. Hence the mining in the beds was divided into two areas, the North, or Main Vein area so called because it was the faulted portion of the original vein, and the South area, which was from the South branch of the vein. All stoping in the West part of

the mine was shut down in 1965 due to unprofitable mining and no indication of more ore in the area.

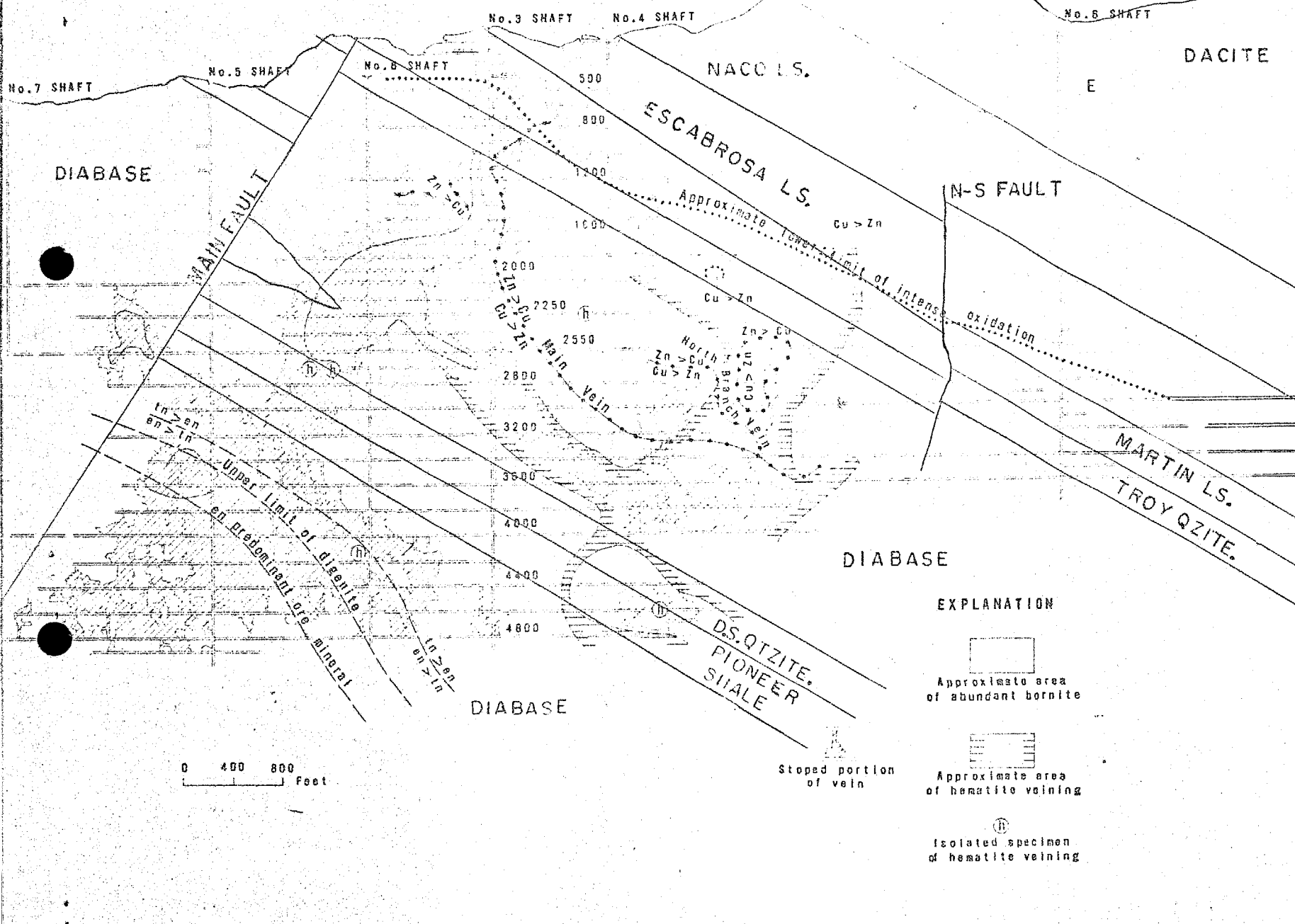
It was during 1965 that diamond drilling to the East indicated ore in the Mississippian Escabrosa and Permian Naco beds overlying the Martin, in the same general North - South area.

Futher study showed this to be a major ore body consisting, with a second horizon in the Martin limestone, of four parallel horizons. A fifth minor one has since been discovered.

The mine was barely profitable as it was, with mining operations a mile removed from the hoisting facilities, and with low tonnage skips and small mandecks which took a long time to lower the shift. It was therefore decided to sink a large circular shaft and install modern hoisting facilities and a new cooling system. It was also necessary to convert from 25 cycle to 60 cycle power.

A better mining method was also being developed at this time, using an undercut and fill system with air operated load and carry machines.

Construction of the new shaft, No. 9, and attendant facilities, as well as a mill expansion, was begun in 1969 and the facilities put into use in the summer of 1973, boosting production to 3000 TPD.



AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 28, 1970

J. H. C.
DEC 30 1970

TO: W. E. Saegart

FROM: J. D. Sell

Re: Production and Operating Costs
Magma Copper Company
Pinal County, Arizona

Attached are excerpts from a May 5, 1969 report to the Newmont Mining Corporation stockholders giving the five year (1964-1968) production and cost figures for the San Manuel and Superior operations of Magma Copper Company.

James D. Sell
James D. Sell

JDS:mw

Att.

cc: J. H. Courtright ✓

W. L. Kurtz

BUSINESS AND PROPERTIES OF MAGMA

Magma Copper Company was incorporated in Maine in 1910. It has been engaged in the business of producing copper from its Magma mine near Superior, Arizona, since 1911 and from its San Manuel mine near San Manuel, Arizona, since 1956.

The Company's subsidiaries are the San Manuel Arizona Railroad Company, which serves the San Manuel Division, and the Magma Arizona Railroad Company, which serves the Superior Division. Both railroads provide the Company with rail transportation to the lines of the Southern Pacific Railroad.

Total copper production of the two mines for 1966, the last full year of uninterrupted operation, was approximately 242,041,000 pounds, which is the current rated annual capacity and on the basis of which the Company ranked as the fourth largest copper producer in the United States.

The industry-wide labor strike, which shut down all Magma's operations from July 15, 1967 to March 15, 1968, greatly reduced production in both those years. Total copper production for 1967 was approximately 127,027,000 pounds, and for 1968 was 173,561,000 pounds. In 1967, the Company sold 155,863,000 pounds, the excess over production coming from inventories. Sales in 1968 were 23,081,000 pounds less than production as the depleted inventories were restored to normal levels.

Gold and silver are recovered as by-products of the copper production at both mines, and molybdenum concentrates also are recovered at San Manuel.

Blister copper produced at Superior is sold f.o.b. the Superior smelter to a single buyer under a long-term contract, which provides for payment on the basis of market or agreed-upon prices for the copper, gold and silver content less freight, refining and marketing allowances. San Manuel's copper is custom refined and marketed by an independent sales agent. The molybdenum concentrates are sold under a contract extending through 1971 at prices based on market quotations.

A Statement of Income of the Company and its subsidiaries for the past five years appears on page 15, while its other financial statements are set forth on pages 55 through 59 hereof.

The earnings for 1967 and 1968, as shown by the summary, were adversely affected by the long labor strike. Fluctuations in copper prices have an important impact on Magma's net income. For example, a 1¢ increase or decrease in average annual price would increase or decrease at present capacity Magma's annual earnings by approximately \$0.55 per share (presently outstanding) before income taxes.

Domestic refinery copper prices over the last ten years ranged from a high of 42.22¢ in 1968 to a low of 28.00¢ per pound in 1961, and the averages of such prices for each such year were as follows:

	<u>1968</u>	<u>1967</u>	<u>1966</u>	<u>1965</u>	<u>1964</u>	<u>1963</u>	<u>1962</u>	<u>1961</u>	<u>1960</u>	<u>1959</u>
Average Copper Price, ¢ per lb.....	41.85	38.23	36.17	35.02	31.96	30.60	30.60	29.92	32.05	31.18

On March 20, 1969, the domestic refinery copper price was 44.44 cents per pound.

The new labor agreements with the United Steelworkers of America and other unions made at the settlement of the strike in March 1968, extend to July 1, 1971, and provide for an average total wage increase of 55.3 cents per hour over the 39½ months of the contract, of which approximately 14.5 cents became effective at once, with subsequent increases becoming effective January 1, 1969, November 1, 1969 and September 1, 1970. Monthly pensions were increased by the agreements from \$2.50 to \$5.00 times years of service, with some increases for employees already retired and with new pension benefits to widows of employees who die after age 55. Vacations, health and welfare, unemployment, death and disability, and other benefits also were increased.

The federal income tax returns filed by Magma Copper Company and its subsidiaries have been examined by and settled with the Internal Revenue Service through 1962. In subsequent years, the operating results of Magma have been included in the consolidated federal income tax returns filed by Newmont Mining Corporation. Newmont's returns for the years 1963, 1964 and 1965 are currently being examined.

The Company's long-term debt at December 31, 1968 was \$36,000,000, consisting of the \$15,000,000 bank debt referred to below, and the \$21,000,000 balance of ~~5~~^{5½}% unsecured note payable to The Prudential Insurance Company of America which is due in semi-annual installments of \$1,500,000 from June 1, 1972 to December 1, 1978, with certain rights of prepayment available to the Company. The note agreement requires that the Company maintain at least \$10,000,000 of consolidated working capital and also contains certain restrictions on dividend payments. At December 31, 1968, approximately \$37,140,000 of retained earnings were unrestricted as to the payment of dividends.

In March 1968, in connection with the purchase of the Kalamazoo property hereinafter mentioned, the Company borrowed a total of \$15,000,000 in equal amounts from two New York banks. The loans mature in March 1970. The Company anticipates that these loans will be paid from cash flow from operations or will be refinanced, possibly when financing is arranged for the Magma expansion program hereinafter described.

Two legal actions against the Company have been pending since 1959 and 1960. The first is a patent infringement suit involving smelter converter practices at San Manuel, in which the federal court has held the patent valid and infringed, and in March, 1969 found the amount of damages due for the infringement to be approximately \$983,000, plus interest, attorneys fees and costs. The interest to date plus attorneys fees and costs aggregate approximately \$453,000. In the second action, which claims compensation for use of the same invention prior to the issuance of the patent in 1959, a jury verdict for \$400,000 against the Company in the Arizona state court was set aside on appeal by the Company, and a new trial was held in February, 1969, resulting in a jury verdict of \$165,000 plus interest and costs. The interest to date and costs in this case amount to approximately \$106,000. The Company is taking further action in both cases preliminary to possible appeals.

San Manuel Division

The San Manuel mine and plant is currently producing and treating approximately 40,000 tons of ore per day.

The mine is a large underground mine worked by block caving methods. The major part of the orebody, from which production has been obtained, is sulphide ore. There is in addition an area of oxide ore overlying a portion of the sulphide ore which may be leached in place or mined and leached or otherwise treated at some future time. A small part of the orebody lies in State lands held under long-term mineral leases, and another small part is held under a long-term lease and option from The Anaconda Company. The latter requires future payment of rent or royalty in the total sum of \$4,350,000 in annual installments through 1988 and, if the purchase option is exercised, an additional payment of \$1,500,000.

The surface plant consists of a mill, power plant, smelter, transportation and other facilities required for the current rate of operations. Townsite housing and facilities for San Manuel employees are owned and maintained by San Manuel Townsite Division of the Company, and a fully-equipped hospital is owned and maintained by the Company at San Manuel. The lands occupied by these facilities and ranch and other lands in the area are owned or held under lease by the Company.

Mine production to date has been obtained from the first and second levels. The first level was about 1,400 feet below the surface, and mining there has been completed. The second level, about 2,000 feet below surface, is now being mined. A third level about 600 feet below the second and an intermediate level half way between, will be prepared for start of production about mid-1974. Mining from the second and third levels will be accelerated to 60,000 tons of ore per day when the expansion program described below is completed, and while development work is done on the adjacent Kalamazoo orebody to prepare

it for future production. The Company has spent approximately \$5,487,000 annually for the past five years in mine development expenditures. These expenses, together with costs capitalized in prior years with respect to shaft sinkings and attendant installations for the San Manuel orebody, are being charged to operating costs ratably as copper is produced from the ore developed and mined.

Sulphide ore reserves of the San Manuel mine as of December 31, 1968 are estimated, using an average 0.50% sulphide copper cut-off, to be 496,800,000 tons of 0.728% net sulphide copper, before dilution, of which 228,500,000 tons of 0.71% sulphide copper are above and can be mined from the second level. In addition, the estimated oxide ore reserves are 130,000,000 tons of 0.70% total copper (0.47% oxide copper), before dilution, all lying above the second level.

In March 1968, the Company purchased from Quintana Minerals, Ltd., under an agreement with that company and Newmont Mining Corporation, the Kalamazoo copper property adjoining the San Manuel mine in Arizona for \$27,000,000 in cash and stock equivalent. Quintana received from Magma \$15,000,000 in cash and 42,478 shares of Magma common stock, and from Newmont 78,208 shares of Newmont common stock and \$4,800,000 in cash, and Newmont received from Magma 169,912 shares of Magma common stock. The Kalamazoo property is estimated to contain 565,000,000 tons of sulphide ore averaging 0.72% net sulphide copper, before dilution. This orebody is believed to be similar to the San Manuel orebody though lying at a considerably greater depth with the top of the orebody approximately 2,500 feet below the surface of the ground.

San Manuel's production and costs for the past five years have been as follows:

	<u>1968</u>	<u>1967</u>	<u>1966</u>	<u>1965</u>	<u>1964</u>
Ore mined:					
Tons	11,367,640	7,891,854	14,391,355	13,504,024	12,442,752
% Sulphide copper.....	0.701	0.758	0.772	0.773	0.828
Payable metal content:					
Copper (tons)	72,074	53,963	101,390	93,767	92,589
Molybdenum sulphide (tons)	2,298	2,001	3,544	2,863	2,486
Silver (ounces)	245,316	166,893	311,699	273,610	282,334
Gold (ounces)	14,303	10,534	22,396	21,550	20,746
Gross value per ton ore mined.....	\$ 5.97	\$ 6.18	\$ 6.47	\$ 5.66	\$ 5.46
Operating costs ⁽¹⁾ per ton ore mined	\$ 3.72	\$ 4.03	\$ 3.33	\$ 3.42	\$ 3.39
All other costs ⁽²⁾ per ton ore mined	\$.85	\$ 1.08	\$ 1.26	\$.83	\$.69

(1) Including all operating costs, all Arizona taxes, federal social security taxes, and amortization of deferred development, but excluding depreciation, depletion and interest. Includes effect of strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion, interest and federal income taxes.

The above results for the years 1967 and 1968 reflect the adverse effect of the prolonged labor strike already mentioned.

Superior Division

The Magma mine at Superior is an underground mine having replacement or bedded-type orebodies. It is provided with access, transportation and aircooling facilities required for current operations. The surface plant includes a concentrator, smelter and related auxiliary facilities.

Production and costs at the Magma mine for the past five years have been as follows.

	<u>1968</u>	<u>1967</u>	<u>1966</u>	<u>1965</u>	<u>1964</u>
Ore mined:					
Tons	333,607	219,510	431,913	439,911	377,575
% Copper	4.63	4.77	4.70	4.65	4.78
Payable metal content:					
Copper (tons).....	14,706	9,551	19,631	19,452	17,064
Silver (ounces).....	347,119	197,419	466,334	408,366	306,269
Gold (ounces).....	7,263	4,970	12,802	12,748	11,078
Gross value per ton ore mined.....	\$42.38	\$45.37	\$44.02	\$38.48	\$31.51
Operating cost, ⁽¹⁾ per ton ore mined	\$45.47	\$54.01	\$40.34	\$35.50	\$37.58
Other costs, ⁽²⁾ per ton ore mined..	\$ 0.43	\$ 0.93	\$ 0.48	\$ 0.18	\$ 0.18

(1) Including all operating costs, all Arizona taxes and federal social security taxes, but excluding depreciation and depletion. Includes strike expenses in 1968 and 1967.

(2) Includes depreciation, depletion and federal income taxes.

Operating costs have been high principally due to extensive timbering required to support the underground workings, high temperatures and humidity underground requiring expensive cooling facilities, long distances underground from existing shafts to the working areas, and to the obsolescence of much of the surface and underground facilities, and also in 1967 and 1968 costs were adversely affected by the eight months labor strike.

Extensive diamond drilling has developed additional replacement orebodies in beds lying stratigraphically above the areas presently being mined, and has increased the ore reserves to the highest tonnage in this mine's long history. As of December 31, 1968, total reserves at Superior were estimated at 10,100,000 tons of ore averaging 5.88% copper, before dilution.

The increased ore reserves have made feasible the commencement of an expansion program at Superior as described below.

Expansion Programs

As a result of the Kalamazoo acquisition, the Company has commenced a program to increase capacity at the San Manuel mine and plant from 40,000 to 60,000 tons of ore per day. This will require additional shaft sinking, mine development and plant expansion. Completion of the program is planned for 1971.

At Superior an expansion program also is underway to double the ore production there from 1,500 to 3,000 tons per day. The program includes an additional 4,800 foot mine ore shaft, a 9,100 foot tunnel on the 500 foot level, and modernization and expansion of the mine, mill and related facilities. The Superior smelter, however, will be abandoned, and the mill concentrates shipped to the expanded San Manuel smelter for smelting. Completion of the Superior expansion is scheduled for late 1972 with the production increase being gradual and fully accomplished two years after the program is completed.

Contracts for certain phases of the expansion programs at both mines have been negotiated. The cost of the two programs is expected to be in excess of \$100,000,000. The amount and nature of such

J. H. C.

MAY 5 1969

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 5, 1969

MR. WES
READ AND RETURN _____
PREPARE ANSWERS _____HANDLE _____
FILE ✓ INITIALS _____

TO: J.H. Courtright

FROM: J.R. Wojcik

W.E.S.

MAY 5 1969

AIME Underground Mining Section
Magma Copper Co., Field Trip

On May 3, Jim Sell and I attended the annual AIME Underground Mining Section Field Trip at the Magma Copper Company's mine at Superior, Arizona. A tour was conducted underground, where we visited the 2550, 2800 and 3200 levels.

On the 2550 level we saw a demonstration of their experimental Load and Carry mining system using trackless machines made by Atlas Copco and Eimco. This system allows a three man crew to advance two headings from the same cross cut simultaneously thus more fully utilizing the machinery.

On the 3200 level, we saw some of the air conditioning equipment which is used to cool the air in the deep levels of the mine.

On the 2800 level we saw the Security Model 480 Raise Drill. It was set up on a 45° angle hole and had completed a 9 7/8" hole to the level below, about 200'. We learned later in the day that, at Superior, the raise drill can penetrate quartzite with a 9 7/8" hole at about 8 ft/hr. Reaming the hole to 60" in quartzite takes about 48 min/ft. Drilling in limestone progresses at about 20 ft/hr., and reaming takes about 3 1/2 minutes/ft. No data on costs were offered, but a range from \$80.00 per foot for a 200' hole to \$65.00 per foot for a 450' hole were inferred. Station preparation and moving amounted to 54% of the total cost of the hole. This data has been developed over the experience of 6 holes drilled over the past 6 months.

It is apparent that raise drilling in hard rock is feasible and can compete favorably with conventional methods.

J.R. Wojcik
J.R. Wojcik

JRW:lzb

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 5, 1969

J.H.C.

MAY 20 1969

FILE MEMORANDUM

MR. ~~SEBASTIAN~~ ~~ADK~~ ~~SRD~~

READ AND RETURN ☒

PREPARE ANSWERS ☐ HANDLE ☐

FILE ☐ INITIALS ☐

Superior Division
Magma Copper Company
Superior (Pinal County), Arizona

The Underground Division of the Arizona Section, AIME, held the Spring meeting at Superior on May 2, 1969. It was attended by J R Wojcik and J D Sell as well as others from the smelter and mining departments.

The mornings activity was taken up with a tour of the presently mining limestone replacement deposit. Stopes and equipment being used in the trackless mining-cemented sandfill areas were visited. These studies are in anticipation for mining the new "Escabrosa" reserves. The raise drill was also inspected as well as several of the 5 foot diameter holes which have been drilled. Following the underground tour the automated surface sand-fill plant was toured. Following lunch a technical session was presented with three papers read: 1) Sand-fill by B. Johnson, 2) Load-and-carry machines by F. Flores, and 3) The Security raise-drill by J. Murry. Attached is the data sheet on the Sandplant--the only paper distributed.

In regard to the Superior Division, Magma Copper released the following statement (Notice to Stockholders, March 28, 1969, p. 38):

"Extensive diamond drilling has developed additional replacement orebodies in beds lying stratigraphically above the areas presently being mined, and has increased the ore reserves to the highest tonnage in this mine's long history. As of December 31, 1968, total reserves at Superior were estimated at 10,100,000 tons of ore averaging 5.88% copper, before dilution."

They further announced an expansion program to double the production rate from 1500 to 3,000 tons per day. A new shaft (No. 9) is to be put down from the Oak Flat area to a depth of 4,800 feet and will be connected with the mill by a new 9,100 foot haulage tunnel on the 500-foot level. The smelter is to be closed and all concentrates shipped by rail to the expanded San Manuel smelter. Completion date for all phases is 1972.

The pioneer road into the new shaft area is completed and bids for the shaft (22-foot diameter) will be asked this week. The tunnel borer, with laser-beam guidance, for the haulage tunnel is scheduled for delivery in September and will drive a 12 $\frac{1}{2}$ -foot tunnel. The portal area is being prepared and the first 200 feet will be driven by conventional means.

Figure 1, USGS 7 $\frac{1}{2}$ quad., shows the approximate location of the proposed shaft and haulage tunnel as well as the general outline of the replacement ore-bodies mined to date. The new replacement tonnage given in the announcement is largely from deposits in the Escabrosa Limestone but commercial mineralization has been found in various parts of the Mescal, Martin, Escabrosa, and Naco Limestones. Most of the new reserves lie above and easterly from the "old" Devonian beds as shown. The main sulfide Escabrosa ore-body apparently apexes about the 3000 level and above this the former mineralization has been destroyed by intense oxidation. Native copper and secondary chalcocite is found at the interface. (See various sections in the paper by Hammer and Peterson, 1968: Geology of the Magma Mine Area, Arizona, p-1282-1310 in Ore Deposits in the United States 1933-1967, volume 2, AIME).

Table I lists the production from the Magma Mine (Superior), from Hammer's paper and annual reports, and indicates that the newly announced tonnage reserves, developed in the last three years, is equal to about two-third of the total tons mined to date! Mining within the vein systems essentially terminated in late 1963 and thus the later grade figures reflect those of the old Devonian replacement beds. Thus it would appear that the new reserves at 5.88% copper are going to be somewhat higher than has been mined in the past (dependent upon the amount of dilution). The reserves are still open ended.

Table I

Tonnage and Production-Magma Copper Co., Superior.

Year	Ore (tons)	Copper (lbs)	Silver (oz)	Gold (oz)	Ave. Grade		
					Cu%	Ag oz	Au oz
1911-1964	13,695,822	1,460,400,223	25,118,086	435,716	5.69	1.93	0.031
1965	439,911	38,904,231	408,366	12,748	4.65	0.99	0.031
1966	431,913	39,262,051	466,334	12,802	4.70	1.13	0.032
1967	219,510	19,100,841	197,419	4,970	4.77	1.01	0.026
1968	333,607	29,412,000	347,119	7,262	4.4*	1.04*	0.022*
Grand Total	15,120,763	1,587,079,346	26,537,324	473,498			

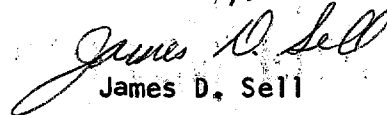
*Calculated from tonnage-production figures.

Figure 2, from Hammer and Peterson, shows the distribution of the old replacement outlines and a cross-section through the deposits. Note that the individual ore bodies are quite continuous down dip and the outlines generally follow the easterly trend of the major mineralized veins.

Drilling for the new replacement horizons was essentially by very long drill holes fanned out from drill positions along the 3200 level east drift which terminated at E 109 position or 3700 feet east of No. 6 shaft (see figure 1). The limestones at this position still maintained their 30 degree eastward dip as is shown on Hammer's sections in the AIME volume.

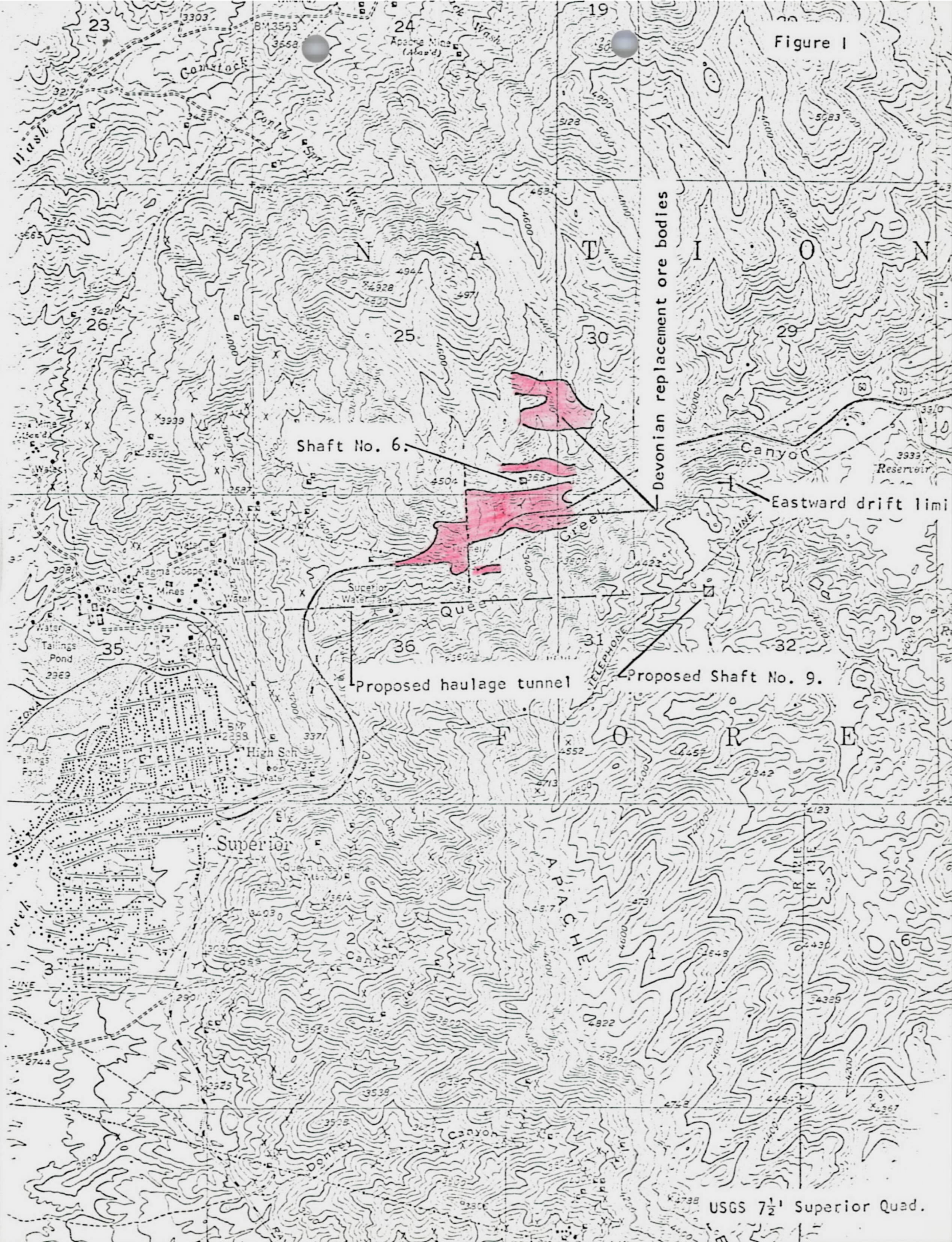
Sand-fill is the major factor in being able to maintain production in the present mining areas (data presented at the meeting is included as Attachment A). Sand-fill placement since the start up in March 1963, through April 1969, was 650,000 tons of sand-fill. Present rate of production is 11,000 tons of dry sand per month.

The AIME tour did not include any look at the new reserve areas but a geologic tour of the Magma limestone workings for ASARCO personnel can be set up by contacting Mr. Russell Webster, Chief Geologist at the Magma (Superior) Division. Also attached separately is a copy of my thesis on a portion of the Devonian replacement ore body.


James D. Sell

cc: JRWojcik
WES

Figure 1



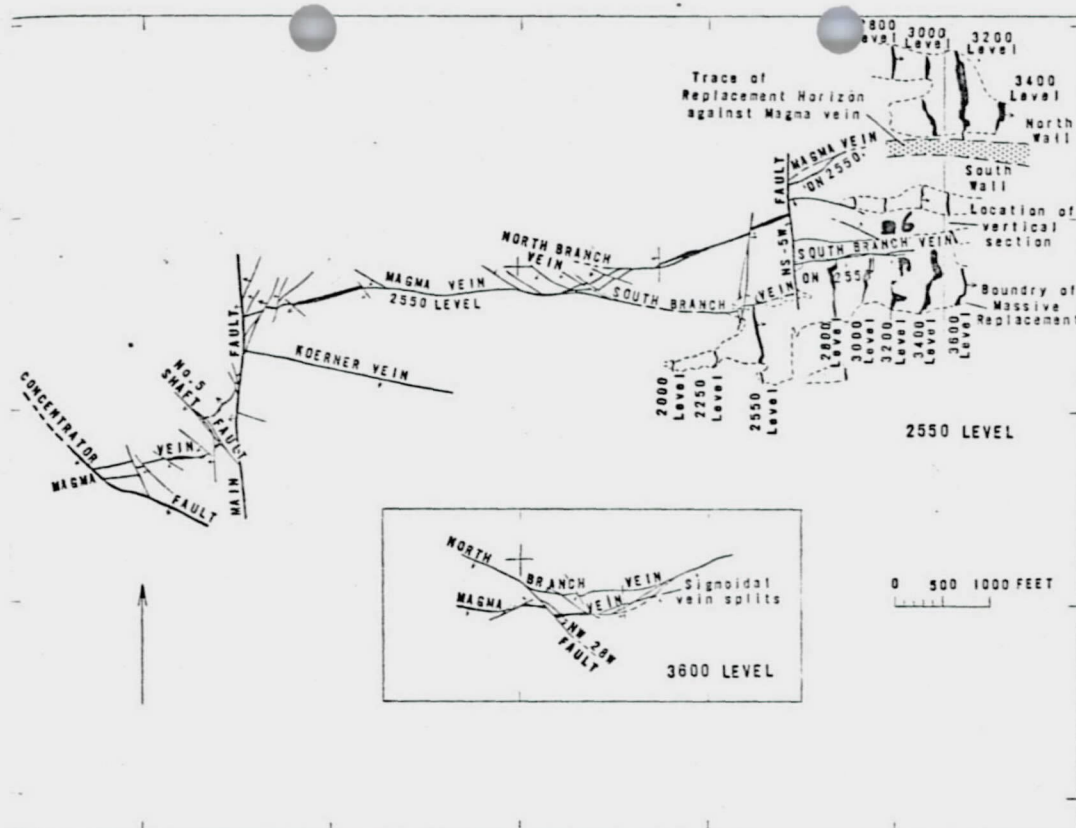


Fig. 4. Structural Map of the 2550 Level of the Magma Mine. The map shows the Magma vein, its major branches, significant subsidiary fractures, offsets by major faults of the north-striking set, and the Koerner vein. The outline of the east-dipping limestone-replacement ore bodies is projected to the diagram. The inset shows a structural map of part of the 3600 level of the mine.

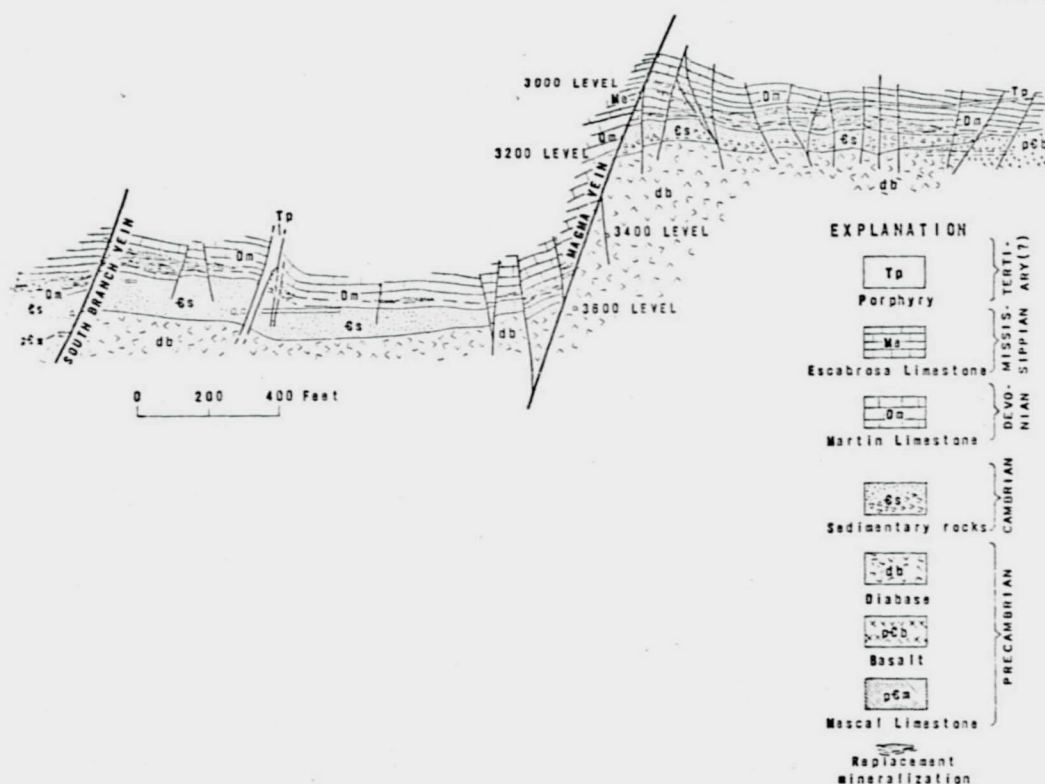


Fig. 7. Vertical North-Trending Section through the Limestone-Replacement Deposit, Magma Mine (looking west). Some ore shoots show direct connection with veins, but others are isolated. See Figure 8 for location of section).

SANDPLANT DATA

A. Sand Production

1. 470 tpd of low-pyrite, partially deslimed sand produced by mill for sandfill.
2. 130 tpd produced by reclaiming of tailings for sandfill, a total of 600 tpd available.

B. Sand Storage

1. Two 100 ton wooden storage tanks at mill.
2. One 500 ton tank at sandplant.
3. Three Hydroseal pumps to move sand from mill tanks to sandplant.

C. Cement Storage and Feed System

1. 80 ton storage bin, pneumatically loaded from delivery trucks.
2. 4 ton cement surge bin.
3. 44 foot screw conveyor, to transfer cement from storage bin to surge bin.
4. Prater Rotary Vane Prefeeder, controlled by Vari-Speed drive motor.
5. Auto-Weigh belt feeder-weigher.
6. Honeywell continuous circular chart recorder of cement feed in tons per hour, combined with cement weight totalizer.

D. Sand-Cement Mixing System

1. 8.5 ton mixing tank.
2. Honeywell mixing tank level control, pneumatically actuated.

3. Accu-Ray gamma ray density meter, combined with continuous circular chart recorder, in control loop with pneumatically actuated dilution water control valve.
4. Fisher Porter magnetic flowmeter.
5. Honeywell dry tons per hour integrator, which utilizes data from the density meter and flowmeter.

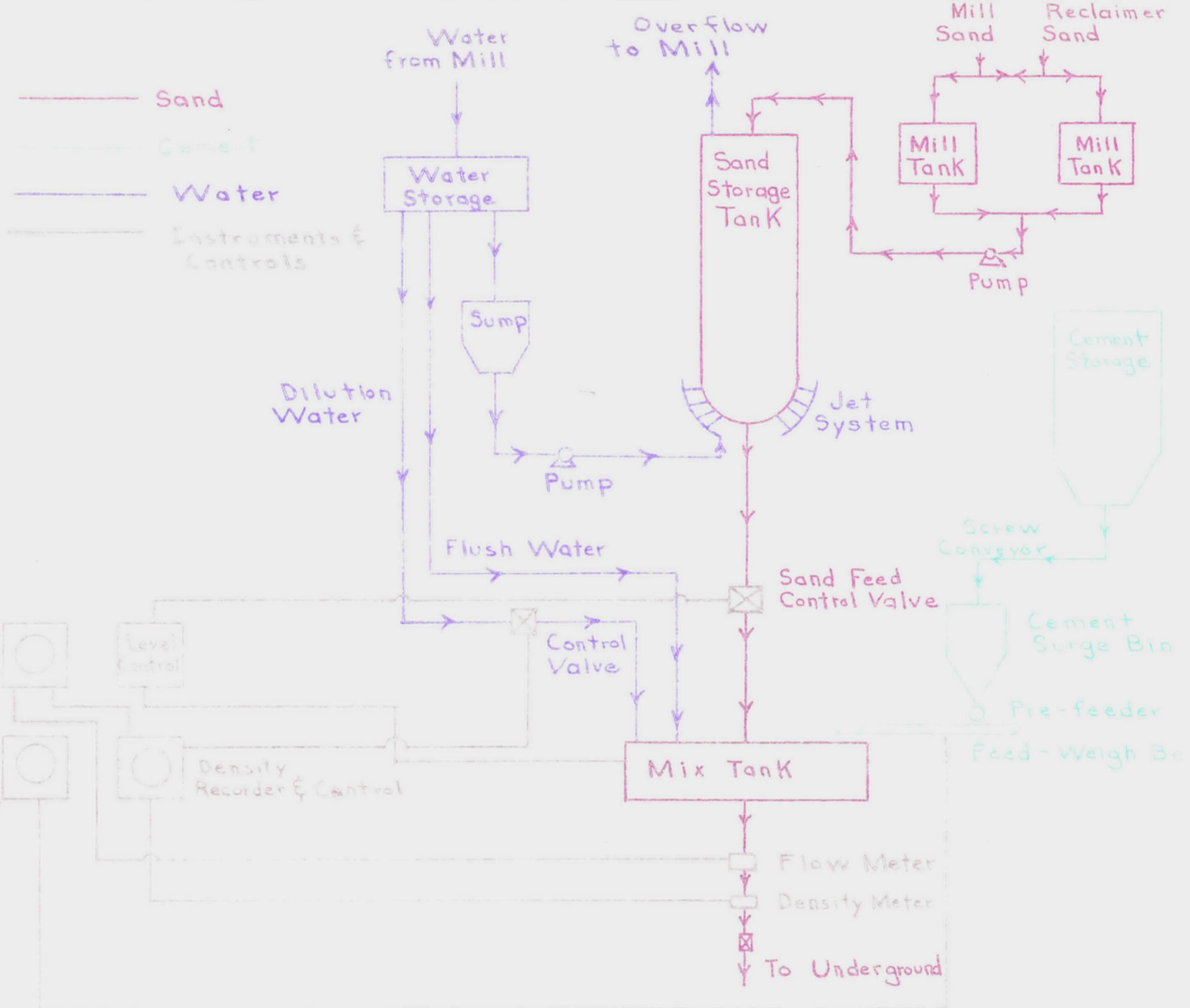
D. Water Supply System

1. Worthington DPO pump, which supplies water at 250 gpm and 200 feet of head to sandplant water storage tank.
2. 20,000 gallon water storage tank.
3. 400 gallon water sump for sand tank jet system.
4. Gould No. 3196 pump, which supplies water at 160 gpm and 240 feet of head to sand tank jet system.
5. Jet system on sand storage tank, consisting of fifty-six 1/8 inch nozzles delivering 2.8 gpm each at 240 feet of head.
6. Two inch line from water storage tank to mix tank for dilution water.
7. Three inch line from water storage tank to mix tank for flush water.
8. Main water supply water used for auxiliary purposes.

PROCEDURE OF OPERATION

1. Cleanup of mix tank and cement feed system.
2. Test water and air sent underground, to assure line is open.
3. Packed sand at bottom of sand storage tank broken with high pressure water.
4. Sand turned into mix tank and sent underground.
5. Cement feed rate set by adjusting RPM rate of Prater prefeeder.

6. Dilution control set on automatic.
7. Sand-cement product is sent underground to the stope being filled as required by the operational sand fill crew. The sand-cement ratio for each stope is designated by the Sandfill Foreman or Assistant General Mine Foreman.
8. When flush is called for, cement and sand feed into mix tank is stopped, flush water is turned into the mix tank, and after twenty minutes of flushing with water, the sandline underground is blown out with air.
9. An average of 600 tpd of cemented sand is sent underground, 11,500 tons monthly. Most of this cemented sand is a 20 to 1 sand-cement ratio by weight.



JHC

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 3, 1954

FILE MEMORANDUM

MAGMA MINE
Superior
Pinal County, Arizona

A meeting of the Mining Geology Division of the A. I. M. E. was held at Superior on April 23. Visitors were taken on a tour of the 4600 level, including two active stopes above the level. Copies of the two geological papers given and a longitudinal section are attached herewith. The section, based on one which appeared in an Arizona publication, contains essential features of up-to-date information presented at the meeting. Below is a brief summary of features of interest in the papers and of general information gathered in conversation with members of the staff.

The Magma vein, striking east-west and dipping south at about 80 degrees, is developed over two miles on strike and to almost a mile in depth. The mine is currently producing 1400 tons per day of 6-7% copper ore. Vein widths average about six feet. Production to date probably totals nearly 10 million tons.

In 1948 replacement-type ore was discovered near the base of the Martin limestone at about the 2600 level. This discovery was the result of drill exploration done in search of the easterly continuation of the Magma vein beyond an off-setting cross fault. The ore bed runs 7.0% copper, averages 12 feet thick, 300 feet strike length and extends down-dip at least 1600 feet — the present depth of exploration. One large east-west vein and several small ones which are present are considered to be the "feeders" which mineralized the bed.

The Magma vein has one major split and numerous small offsets on cross-faults. The hanging wall of the fault which the vein occupies has a horizontal displacement of 400 to 500 feet and down-dip 200 feet or more. It cuts all local Paleozoic and Pre-Cambrian formations, including the Pinal schist. Small dikes of monzonite porphyry parallel the vein and are younger than the diabase sills. A substantial portion of the vein has no surface expression, being concealed by post-mineral dacite flow rocks. Chalcopyrite, bornite and chalcocite (primary) are the principal ore minerals. Enargite is found only on the lower levels. The vein (as seen on the 4600) is composed of alternating bands of sulphides, quartz and altered rock gangue.

Two faults of large displacement cut the vein on the west. Ore has been mined west of the Main fault, but nothing is known of the ground west of the Concentrator fault — attempts to drive through this structure have so far been unsuccessful due to the excessively heavy nature of the ground.

The attached section shows a block of Troy quartzite down-dropped more than 1,000 feet in the hanging wall of the Main fault, but no displacement of certain lower members of the Apache series such as the Dripping Springs quartzite, Barnes conglomerate, Pioneer shale, etc. Mr. Steele, Chief Geologist, stated that they

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File Memorandum

had no satisfactory explanation for this embarrassing situation. He mentioned rotation of the block west of the fault and the intrusive dike as possible factors.

Square set and fill (from the surface) is used in mining the veins. Much of the ground is heavy and maintenance of haulage levels is costly. Ten-inch timber is used in the stopes and 12-inch timber in the haulage drifts. On the 4600 level each set was angle-braced under the cap and under the rails with 12-inch timber. In some places double post and caps were necessary.

Ore from the bed, which dips 30 degrees east, is extracted with slushers, using timber and roof bolt support. Stoping is laid out on a "retreat" pattern which allows the hanging wall to cave soon after the ore is removed.

Rock temperatures have become increasingly high with depth and mine ventilation is a major problem. The average wet bulb temperature of the air was reported by a ventilation engineer to be 82 degrees on the 4600 and about 90 in a stope six sets above. (After spending 15 minutes in this stope, it seemed quite likely that reported temperatures were theoretical, rather than actual). The average rock temperature on the 4600 is 157° and 161° on the 4800. Five large Carrier refrigeration units are operated underground. Ventilation and refrigeration costs amount to about 80¢ per ton of ore mined.

The mine makes surprisingly little water — 400 gpm. It was stated that the flow varied somewhat but during the history of the mine had never been much higher.

Including the total pay roll the mine produces less than 2 tons per man shift; underground, less than 3 tons. The average per miner in the stopes is 7 tons per shift. This average includes time spent in timbering and filling.

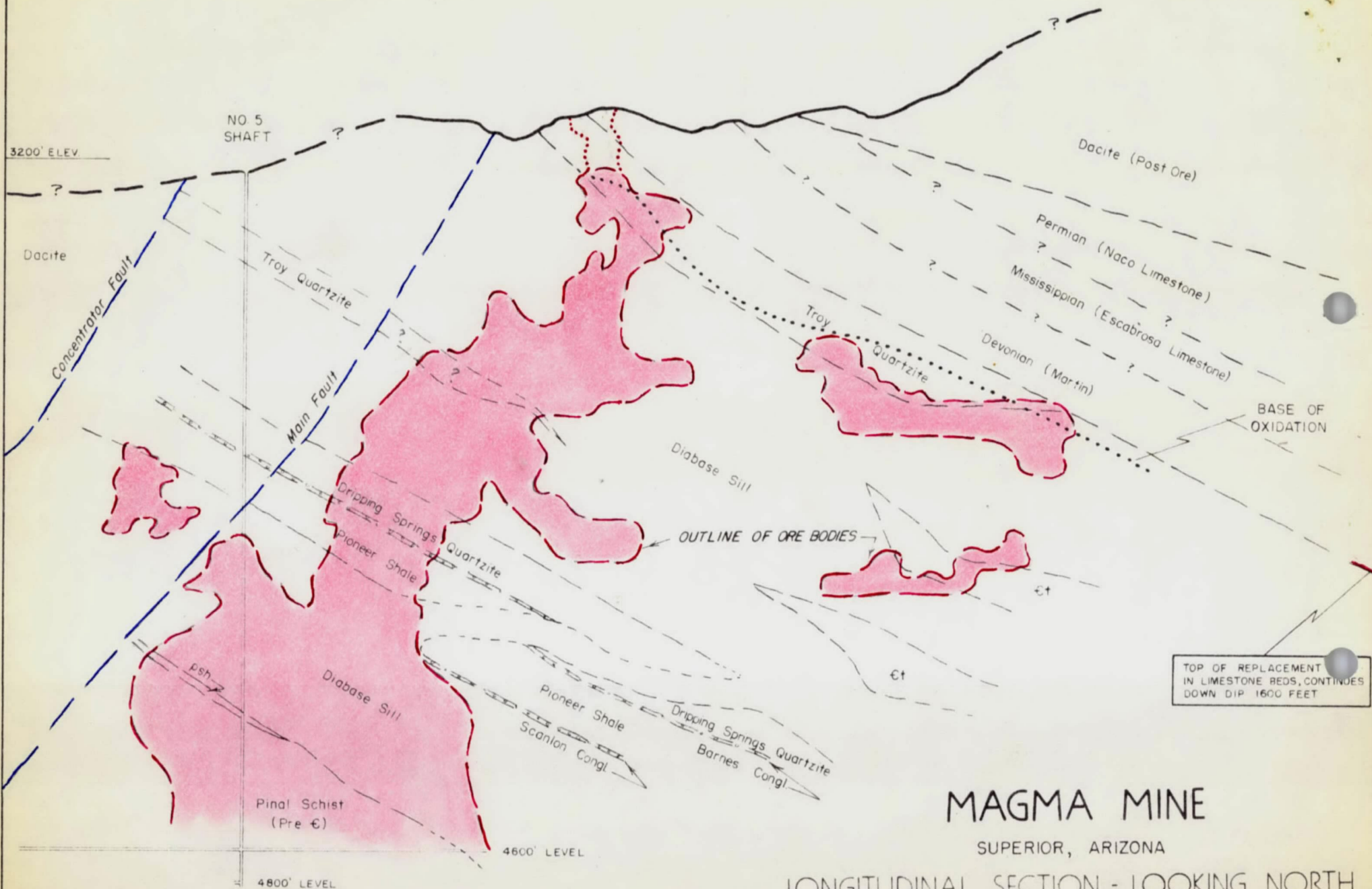
Miners are paid \$16.00 per shift plus a bonus which is figured on a basis of 7 cents per cu. ft. less \$5.00 per shift worked. This covers breaking, timbering and any mucking that might be necessary. Most of the ore falls directly onto inclined floors laid over the fill and continues down to draw points by gravity.

As may be noted on the attached section, the vein ore body has a disproportionately small outcrop — something like an elephant's tail in size contrast.

Eldred Wilson expressed the opinion that the replacement ore near the base of the Martin limestone at Magma was in the equivalent of the O'Carroll bed which is the ore-bearing horizon at the old London-Arizona Mine west of the Christmas. Some mineralization was found in the bed up-dip from the 2600 level at Magma but none was of appreciable extent, or of commercial grade. The down-dip extent of the recently discovered ore chute has not been determined. This is also true of the vein ore. Exploration possibilities appear almost unlimited, so, ventilation and refrigeration problems will probably be the principal factors which determine the ultimate "bottom" of the mine.

JHC:ar
cc: WRLandwehr


J. H. Courtright



MAGMA MINE

SUPERIOR, ARIZONA

LONGITUDINAL SECTION - LOOKING NORTH

SCALE 1" = 800'

From Arizona Bureau of Mines Bulletin 151, with some revisions shown at A.I.M.E. meeting April 23, 1954
J.H.C.

EXPLORATION EXTENDS MAGMA'S FUTURE

by RUSSELL WEBSTER

Magma Copper Co.'s east replacement orebody has a potential little dreamed of a short time ago. If the exploration and development problems can be solved, Magma's productivity may be extended for many more years.



Rock Types Associated With the East Replacement Orebody

• The Troy quartzite is of Middle Cambrian age with an average thickness of 400 ft and may be quite heavily mineralized when cut by the vein system.

• Overlying the Troy quartzite is the Upper Devonian Martin limestone, 350 to 425 ft thick. Underground, the Martin limestone is a dark gray fine grain thin-bedded rock but on the surface it is lighter in color and tends to form debris-covered sloped between the white Escabrosa and the cliff forming Troy quartzite. The lower dolomitic part of the Martin is important economically as a favorable horizon for replacement mineralization in the vicinity of vein cross breaks. It is in this horizon that Magma's east replacement orebody is located.

• The Escabrosa limestone is of lower Mississippian age and averages about 420 ft in thickness. It is white to light gray in color. On the surface this limestone has been known to have replacement mineralization, but as yet no ore content has been found underground, although the Escabrosa is considered an area for exploration.

• Of lower Pennsylvania age, Naco limestone is a thin bedded white, light gray, or light pink limestone of over 1200-ft thickness. Limited exploration for replacement mineralization has been carried on in this limestone.

• Intrusive as sills in the Troy quartzite, the diabase has a total thickness of 3100 ft in the Magma mine. The age of the intrusion is considered to be Post-Devonian.

• A number of dikes of light-colored quartz monzonite porphyry cut the diabase, Troy quartzite and the limestones. So far no age relationship between the dikes and replacement mineralization has been established.

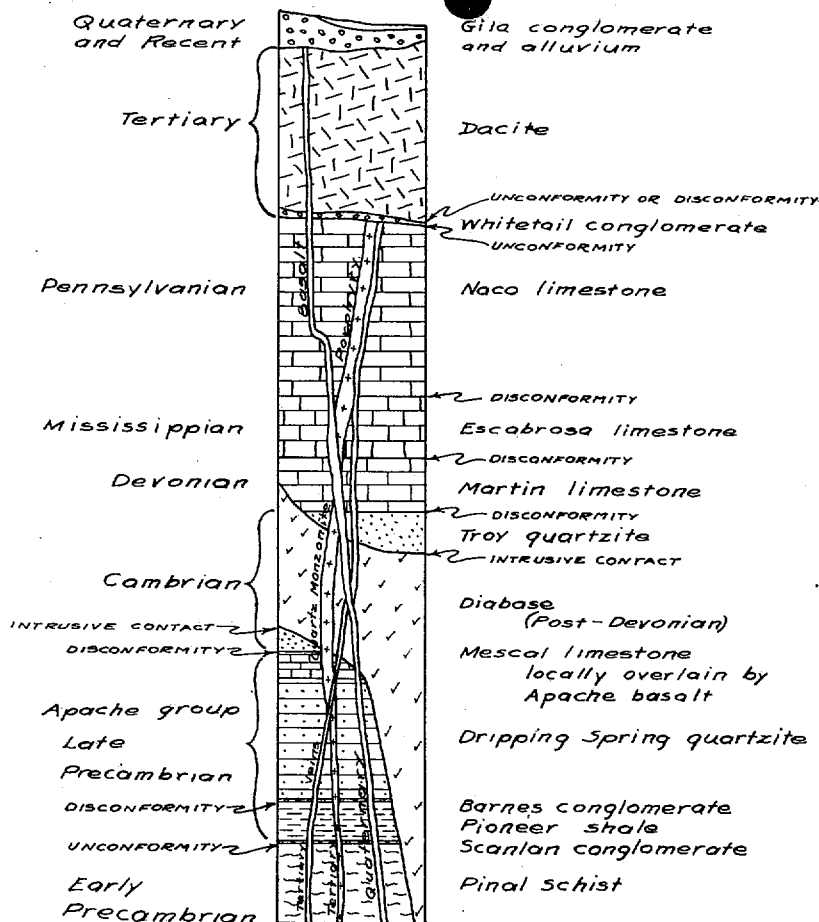


Fig. 1. Generalized geologic column in Magma vicinity. Because of a regional dip of about 30° to the east, the complete stratigraphic column cut by the vein is exposed at the surface near Superior. See Fig. 2.

altered. The hanging wall limestone has less bleaching but has been noted to contain many calcite-filled fractures. More intensive study of this phenomenon may clarify interpretation of data gained from diamond drilling into unknown areas.

Present State of Development: Exploration and development have proved that the beds south of the vein in the replacement orebody are more extensively mineralized than those to the north. Exploration and mining have progressed more than 750 ft south from the vein and about 200 ft north of it. Diamond drilling indicates that down dip the strike length of mineralization in the north bed may be increasing, with a corresponding decrease in the south bed.

The replacement horizon continues below the 3600 level, with mineralization like that in the upper levels. Similar mineralization extends above the 2550 level west of the north-south fault.

Exploration and Mining Methods: Exploration of the replacement bed must be very closely coordinated with mining operations. Owing to an abnormally high rock temperature (125°F) and difficult waste disposal, crosscuts and drifts out of the ore are held to a minimum. Because of this, diamond drilling in fringe areas outside the known ore zone is limited.

From the vein on the footwall of the replacement bed, contour drifts are driven north and south to the ore boundary. From these drifts inclined raises are driven up the footwall of the replacement bed

to the ore cut-off or to the next level, a vertical distance of 100 ft. Active stoping of ore starts at the ore cut-off and proceeds down dip at an angle toward the vein. Modified square set timbering in the stopes aids mining and temporarily supports the hanging wall. Because of heavy ground, stopes cave and fill soon after the ore has been removed. To protect unmined blocks of ore, a series of cribs are placed to control this caving.

Ore is slushed from stopes to sublevels, slushed down inclined raises and then goes via ore passes to haulage drifts. Rail haulage takes it to the main hoisting shafts in the central section of the mine.

Located about 2000 ft east of the vein deposits in the central portion of the mine, the east replacement bed can be considered a separate mining unit, with exploration, development, and mining problems peculiar to this area alone. If these problems can be solved, the east replacement orebody will give new life to the long productive Magma mine.

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