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ASARCO

Southwestern Exploration Division

May 20, 1977

TO: F. T. Graybeal

FROM: J. D. Sell

In-Place Leaching
Oxy-Min Project - Miami
Gila County, Arizona

In conversation with C. Caviness he stated that in their in-place leaching test the initial hydrofract pressure was 1600 psi which then dropped rapidly as circulation was established between the two bore holes (70 feet apart). — 1000' deep

They are using a straight acid-water leach at a pressure of 600 psi to force sufficient fluid into the hydrofract ground.

Solution of chrysocolla, malachite, and azurite is excellent. Except for several barrels of "high grade liquor" (to be sent to their research department to make "first production" trinkets) the production solution of up to 6000 gallons per test is being given to ICC which operates a new solvent extraction plant nearby (after they take out control samples).

Oxy-Min originally hydrofracted the basal portion of the 1000-foot drill holes and they are now planning on moving up the hole in increments and repeating the hydrofract and leaching tests.

Caviness says the technique is relatively easy and productive, with the maintenance of pumps, valves, etc. the largest bottleneck to date.

James D. Sell

James D. Sell

JDS:Lb

cc: JHCourtright ✓

+ 100 M Tons — .55% Cu — 80% oxide (2/3 mal, azurite)
(1/3 chrys. mainly in por)
Rock — 10% por — 90% schist (20% cc — minor native cup.)
Leaching test: 72% of total Cu
Geometry: tilted blanket 100–600' thick — 1200–1600' deep.
← S.E.
Suggested mining — block cave 20% — (to top of ore)
then in situ leach.

AMERICAN SMELTING AND REFINING COMPANY
TUCSON ARIZONA

September 21, 1973

CONFIDENTIAL

FILE MEMORANDUM

Occidental
Miami East

The following information was obtained from Occidental Minerals:

Size -- +100 million tons 200 million (mostly within the 100-million ton area)

Grade -- 0.55% Cu 0.4% Cu

Rock -- 10% porphyry; 90% schist

Mineralogy -- 75-80% oxide (2/3 malachite, azurite
1/3 chrysocolla - mainly in porphyry)
20-25% chalcocite, little native copper, cuprite, etc.

Leaching -- Test on core recovered 72% of total copper.

Geometry -- Tilted blanket 100-600' thick, average about 300'; 1200 to 1600' beneath surface -- tilts SE.

Suggested Mining -- excavate 15 to 20% to allow caving (just to top of ore) then leaching in place.

Property -- 1) Van Dyke mineral ground -- 5% NSR until total price $3 million paid.
2) 20 acres city lots -- $20,000 x 80 ≈ $1,600,000
3) Surface options 40-50 @ $30,000 ≈ $1,500,000

Purchased 1 sq. mile near Copper Hills for $300 A; that could be subdivided.

AMAX is turning property back to Occidental on November 29, 1973.

wlk
W. L. Kurtz

WLK:lb

SOCIETY OF MINING ENGINEERS

P.O. BOX 625002, LITTLETON, COLORADO 80162-5002

PREPRINT NUMBER

88-66

CASE HISTORY: VAN DYKE ISL COPPER PROJECT

R. V. Huff

S. G. Axen

D. R. Baughman

Ray V. Huff & Associates, Incorporated
Golden, Colorado

For presentation at the SME Annual Meeting
Phoenix, Arizona - January 25-28, 1988

Abstract: An in-situ leaching technology was developed for copper oxide minerals at the Van Dyke deposit at Miami, Arizona. This paper discusses the process developed and the activities that occurred. Specifically, the activities of well installation, deposit data acquisition, leach testing and equipment development are reviewed. Installation and operation of the test facility are described.

Introduction

In January, 1976, a mining company embarked on the development of an ISL process for copper oxides at the Van Dyke deposit. In Phase I, the technical feasibility of the process was established. Phase II of the development was initiated in October, 1977, and established the potential economic viability of the process. Phase III, which would have been operated in a fashion similar to a commercial operation, was designed to demonstrate the commercial application of the process.

Process Review

An ISL facility is composed of five segments. They are:

1. Solution preparation plant
2. Injection equipment
3. Wellfield
4. Production equipment
5. Copper extraction plant

Solution preparation facilities and the copper extraction plant with a few exceptions are little different than that used for conventional leaching operations. Copper extraction can be accomplished with SX-EW. However, certain minerals that can precipitated from the leaching fluid may be deleterious to the process. These can be controlled by addition of chemicals at the solution preparation plant and special circuits in the extraction plant.

The heart of the process is associated with the injection of the solvent into the deposit, dissolution of the desired metal values, and production of the metal-laden liquor to the surface. With suitable information about the geological properties of the deposit, the wellfield and the solvent can be designed and selected, respectively.

Because copper is soluble in either acidic or ammoniacal aqueous fluids, a choice between the two solvents may be made. This choice is dictated by the consumption of the active agents in the solvent by gangue. If the gangue is a high acid consumer, an ammonia solution may be chosen. On the other hand, ion exchange minerals may tie up the ammonium or cupric ammonium ion and render the ammoniacal fluid less suitable.

The process utilized on the Van Dyke deposit can be outlined as follows:

* A dilute (2-4%) H_2SO_4 aqueous lixiviant was prepared.
* Solvent was pumped at high pressure into injection wells.
* Solvent exited injection wells through induced horizontal hydraulic fractures.

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CONTROL OF MINERALIZATION BY MESOZOIC AND CENOZOIC LOW-ANGLE STRUCTURES IN WEST-CENTRAL ARIZONA

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Tucson, Arizona

For presentation at the SME Annual Meeting
Phoenix, Arizona - January 25-28, 1988

CONTROL OF MINERALIZATION BY MESOZOIC AND CENOZOIC LOW-ANGLE STRUCTURES IN WEST-CENTRAL ARIZONA

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ABSTRACT

Mesozoic and Tertiary mineral deposits in west-central Arizona are commonly associated with Mesozoic thrust faults and Tertiary detachment faults, respectively. Quartz-kyanite rocks and pyritic quartz-sericite schists with local anomalous gold are the product of probable Jurassic argillic alteration of Jurassic volcanic, sedimentary, and plutonic rocks followed by Cretaceous thrust burial and associated metamorphism. Slivers and sheets of Paleozoic carbonates along Mesozoic thrust faults were locally sites of syn- and post-thrust mineralization. Widespread brecciation along Tertiary detachment faults resulted in increased permeability along fault zones. Elevated thermal gradients also resulted from detachment faulting and apparently caused convective aqueous-fluid circulation along detachment faults and associated Fe+Cu±Au mineralization.

INTRODUCTION

Quartz-kyanite-pyrophyllite mineral assemblages with locally occurring pyrite and anomalous gold have recently been recognized within Mesozoic metasedimentary and metavolcanic rocks of west-central Arizona and southeasternmost California. These deposits are most common in the wall rocks of Jurassic plutons and below thrust sheets of crystalline rocks (Reynolds et al., in press). Thrust faulting and tectonic burial are not considered to be responsible for the genesis of the deposits, but are thought to be responsible for their preservation and, in part, their metamorphism. Major gold deposits are associated with similar aluminous mineral deposits in the southern Appalachian Mountains, raising the possibility that significant gold deposits of similar origin are present in the Southwest as well.

Detachment-fault-related mineral deposits of mid-Tertiary age are numerous in west-central Arizona and southeastern California. Virtually all of these deposits have the same mineral assemblage: massive or fracture-filling specular hematite with younger, fracture-filling chrysocolla and malachite or brochantite. Some deposits contain early-formed copper and iron sulfides that are now largely oxidized. The larger deposits form replacements in upper-plate rocks directly above the detachment fault. Numerous smaller replacement and fracture-filling deposits are present along detachment faults or are within a few tens to perhaps a hundred meters above or below the faults. Consistent mineralogy, structural style, and association with Tertiary detachment faults indicate that these deposits are genetically related to faults (Reynolds, 1980; Wilkins and Heidrick, 1982; Spencer and Welty, 1986). Copper has been the primary commodity produced from these deposits, with additional production of minor gold, silver, lead, and zinc.

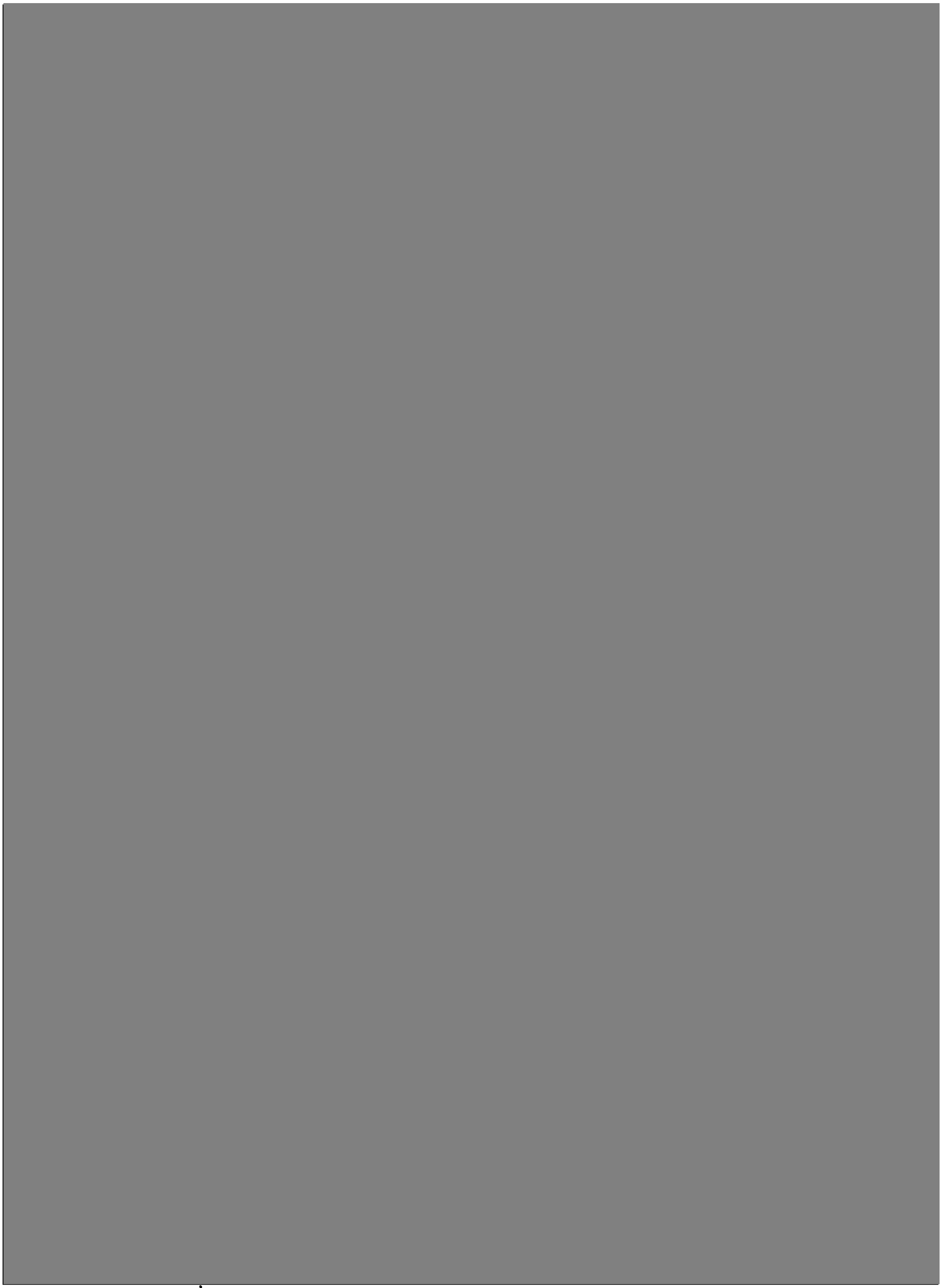
MESOZOIC ALUMINOUS METASOMATIC DEPOSITS

Mesozoic metavolcanic, metasedimentary, and plutonic rocks in west-central Arizona and southeasternmost California host aluminous metasomatic rocks that are locally associated with anomalous gold. The most striking of the aluminous metasomatic rocks are those composed almost entirely of quartz and kyanite; other common combinations are quartz-muscovite and quartz-pyrophyllite. Minor associated minerals are andalusite, sillimanite, pyrite, tourmaline, rutile, ilmenite, biotite, lazulite (hydrous Mg-Fe aluminophosphate), apatite, dumortierite, staurolite, K-feldspar, and magnetite. The most common assemblage comprises quartz, an aluminosilicate, a Ti-bearing mineral, and a P-bearing mineral (Reynolds et al., in press).

Aluminous metasomatic rocks are most common in schistose metavolcanic and metasedimentary rocks, especially near Mesozoic thrust faults (Granite Wash Mountains) or near the intrusive margins of Jurassic plutons (Dome Rock Mountains). They have also been recognized as pods within granitic rocks (Fig. 1). Schistose fabrics and evidence of greenschist-grade metamorphism are common in host rocks, especially near thrust faults and plutons. Virtually all of the Mesozoic supracrustal rocks in west-central Arizona and southeasternmost California underwent Cretaceous thrust burial and associated prograde metamorphism and fabric development. The coarse aluminous minerals in the aluminous metaburial and metamorphism. In the Dome Rock Mountains, it is inferred that wall

Arizona and in the Whipple Mountains of southeastern California juxtaposes a wide

[redacted]



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2 copy Occi (Oxymin) article with file - 1) occidental 2) in place leaching - JHC WKK EIG BJD JHC

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