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1974

A. I. M. E.

OPEN PIT DIVISION

SPRING MEETING

Inspiration Consolidated Copper Company

AERIAL VIEW
OF
INSPIRATION CONSOLIDATED COPPER COMPANY

THORNTON, LIVE OAK & RED HILL
OPEN PIT OPERATIONS

A I M E

ARIZONA SECTION

OPEN PIT DIVISION

SPRING MEETING
at
INSPIRATION CONSOLIDATED COPPER COMPANY

May 10, 1974

PROGRAM

8:00 - 9:00 A.M.	Registration - Miami High School
9:00 - 10:30 A.M.	Welcoming & Orientation - Miami High School Auditorium - Tom Anderson, Chairman Open Pit Division, H. D. Harper, General Superintendent.
	Inspiration History - Del Wisner, Assistant Leaching & Refining Superintendent.
	Inspiration Geology - Jack Eastlick, Chief Resident Geologist
	Inspiration's Ox Hide Mining and Leaching Operation - Bill Sorsen, General Foreman
	Inspiration's Open Pit Operations - Jim Lundy, Open Pit Superintendent
	Inspiration's Dump Leach Operations - Fred Rice, Chief Planning Engineer
10:30 - 12:00 Noon	Tour Ox Hide Operation
12:30 - 2:00 P.M.	Lunch - Elks Club, Miami
2:00 - 4:30 P.M.	Tour Inspiration Open Pit Operations
5:30 - 7:00 P.M.	Cocktails - Cobre Valley Country Club
7:00 P.M.	Dinner - Cobre Valley Country Club

INSPIRATION CONSOLIDATED COPPER COMPANY

INSPIRATION, ARIZONA

HISTORY

What is in a name?

Webster's dictionary defines Inspiration as:

1. An inspiring or animating action or influence
2. Something inspired, as a thought
3. Theology: A divine influence directly or immediately exerted in the mind or soul of a man

In Inspiration Consolidated Copper Company, the name itself is a mouthful of words, and to its employees and the other primary copper producers, an "Inspiration."

Inspiration, like many western mines, owes its discovery to the early prospector and his burro. Mineralization was recognized in the local area prior to 1900. The earliest exploratory working was the 1000 foot Woodson Tunnel driven into a local hill side in 1908. By then the local owners had consolidated claims and groups of claims into a single holding and induced outside capital to form the Inspiration Mining Company. Later mergers and aquisitions led to the formation of Inspiration Consolidated Copper Company in 1911.

From this time on the history of the company has been a series of "Inspirations." Dr. Louis Ricketts, William Boyce Thompson, Charles E. Mills paved the way to what is now one of the most complete metallurgical plants in the country.

The original concept was to build a plant to treat 7500 TPD by tabling. As work progressed it became apparent thata10,000 TPD plant would yield more profits. Meanwhile flotation work directed by J. M. Callow showed promising results.

The management at Inspiration Consolidated Copper Company had an "Inspiration." They cancelled the steel ordered for the tabling plant and re-designed the mill for Mr. Callow's flotation process, resulting in a 14,400 TPD plant on stream in June of 1915. It had been decided to use the unique mining method known as under cut or block caving. Ore would be crushed, and delivered to the Concentrator by train, where it was ground in 36 -(8' X 6') Marcy Mills. The ground slurry was floated with coal tar in a modified callow cell known as the Inspiration Air Cell. The sands, separated from the tail, were tabled for oxide recovery. Metallurgy for the first six months was as follows:

	% Total Copper	% Oxide Copper
Heads	1.702	0.226
Tails	0.373	0.180
Float Concentrate	37.63	
Table Concentrate	13.12	

At the end of the six months it was decided to again increase capacity to 16,000 TPD by adding four more ball mills.

At the end of the first operating year Inspiration estimated it had spent 20.5 million dollars to build the new metallurgical plant and mine. The net profit for this period was 20.6 million dollars. Within one and one-half years Inspiration had lived up to its name to become one of the largest copper producers and a major profit maker.

Because of Inspiration's unique ore body, containing approximately 50% oxide minerals, it was decided in 1918 to try to develop a metallurgy more amenable to this unusual ore body.

The first experiments on leaching the oxide minerals and then floating the sulfide minerals called "Dual Process Ore" were to continue until 1922. At this time

Dr. Ricketts engaged Mr. G. D. Van Arsdale for some small scale lab work on the ferric sulfate leach, using sulfuric acid leach for the oxide minerals and the ferric sulfate leach for the sulfide minerals. Recovery of the copper was accomplished through electrowinning and iron launder cementation.

From these results it was determined that an ore of -	1.19% total copper
	0.77% oxide
	0.42% sulfide
would yield a	0.182% total copper tail

In September, 1925 construction started on a Leaching Plant to treat 7500+ TPD. This was quickly scaled up to 9000 TPD and production started in October 1926.

The mill continued to treat a portion of the high sulfide ores. In 1929 it was found that desliming the ore prior to leaching improved overall recovery, lowering the tail from 0.198 to 0.127% copper. The slimes treatment plant was designed and put into service in 1930. The slime slurry was pumped to the mill, floated for sulfide recovery and then leached and washed in four counter current decantation thickeners, with copper being recovered from the leach solutions in iron launder cementation.

When the price of copper fell to 5.5¢ per pound Inspiration shut down in May of 1932 and it did not resume operations until September, 1935.

Upon resumption of operations the ore was primarily oxides and the plant was converted to the faster acid leach sulfide float, Dual-Process method. When the market sagged again in 1937 the process reverted to the cheaper and slower ferric sulfate leach, where it was to remain with one exception until 1957.

In 1942 Inspiration was asked to produce more copper for the war effort. A unique metallurgical process resulted. Mixed ores were ground while acid was added, the copper leaching solution passed over scrap iron, and then floated to recover cement copper and the sulfide minerals.

In 1944 the Tank House burned to the ground. Again the plant switched to the Dual-Process recovery while the Tank House was rebuilt with copper being recovered in the iron launders.

The rapid development of modern earth moving equipment, and rising costs made Inspiration look at its "hole card." In 1947 the decision was made to begin open pit mining. Stripping for the new open pit began in 1947, the first ore was mined in 1948. The last of the underground ore was mined in 1954.

The phasing out of the underground operation and the building of large waste dumps led Inspiration into the dump and underground leaching. Iron launders were expanded at the Leaching Plant and still more copper was produced.

Meanwhile, the oxide content of Inspiration ore was decreasing, affecting the electrowinning, and it became necessary to re-dissolve cement copper produced at the Leaching Plant and add this copper sulfate to the leaching-electrowon circuit. This decrease in oxides was accompanied by an increase in chalcopyrite. Chalcopyrite is not soluble in ferric sulfate. It was now time for another change in the metallurgical process.

The old mill was revamped and the latest mill equipment added. When the plants switched from ferric sulfate leach to Dual-Process in 1957 the plant capacity was increased to 15,000 TPD and again to 17,500 TPD within the year. The Concentrator was now offered the opportunity to recover molybdenum as a by product. The moly circuit was added in 1958.

The change from ferric sulfate to Dual-Process reduced the number of electrowinning cells required in the Tank House and these were converted to electrorefining cells.

The development of the Christmas mine resulted in a 4000 TPD mill for treating ores from the underground mine. Poor ground conditions kept tonnages below design. Abundant oxide minerals on the surface were not amenable to leaching because of their high lime content. Inspiration metallurgists devised a circuit to recover the oxide minerals and a small open pit operation was started to supply additional tonnages. In 1966 the underground operations ceased and the operation was converted to surface mining.

The International Smelter was purchased in 1960 and the Tank House was expanded by 40%. Inspiration now had the capacity to treat, smelt and refine all of its production. Refinery capacity was further increased by adding a rectifier to the New Tank House.

A unique method of upgrading cement copper through floation was developed in 1962 to produce what we call "Cu Pels", a cement copper of 97+% copper with annual sales of 3.5 million pounds per year.

In 1964 it was decided an increase in plant capacity to 20,000 TPD was needed to offset rising costs and dropping grade. A 6300 foot conveyor was constructed to haul leached ore from the vats to the Concentrator. To speed up the excavation of the vats a new bucket-wheel excavator was built to feed the overland conveyor system.

Early in 1966 the new excavator collapsed and a modified ore treatment program was called for. The old clam-shell excavator was again used to load trains to convey the leached ore to the Concentrator at 15,500 TPD. A bypass belt system was added from the crusher to the new overland belt, thereby bypassing the leaching vats allowing a high sulfide ore to be fed directly to the mill. This change completely altered all previous mining plans and the mine was now producing a Dual-Process ore and Direct Mill Feed ore.

To treat the additional concentrates from the 20,000 TPD mill, the Smelter added a suspended arch reverbatory furnace, and started phasing the old Great Falls converters out in favor of new Pierce-Smith converters.

About the same time someone thought the mine had it entirely too easy and decided, "let's go to three ore products."

1. Dual Process Ore - now approximately 0.7% total copper
   0.35% oxide
   0.35% sulfide

2. Direct Mill Feed - 0.6% total copper
   0.15% oxide

3. Discard Ore - 0.6% total copper
   0.2% sulfide

By leaching the discard ore and using the old excavator to load 40 ton haulage trucks to carry tailings to the dump, the mill could then receive an equal amount of Direct Mill Feed ore. This, along with changes in the primary ore storage for three ore types, belt conveyors in place of train haulage from the primary to secondary crushers, allowed Inspiration to aim at 25,000 TPD.

In 1968 Inspiration decided to include a "CMCR" continuous melting casting rolling plant in its metallurgical line. Now cathodes from the refinery could be melted, cast, and rolled into 5/16" rod for direct sale, instead of costly shipment of cathodes back East for melting and refining into ingots. This was the first plant West of the Mississippi to do this and made Inspiration the most completely integrated plant of its kind, truly an "Inspiration."

During the same year the Smelter converted from log poling to natural gas refining of blister copper, one of the first major users of this new method. The mine started several new projects; stripping Red Hill for future ore development, Black Copper, a million + ton ore body of low grade oxide copper which was developed adjacent to the Leaching Plant. The Ox-Hide mine, a 12,000 TPD low grade oxide, pad leach, cementation operation was started just west of Inspiration. It was now time for the mine to upgrade its trucks, shovels and garage facilities for the larger haulage trucks now coming into service.

Due to the many diversifications of the company each plant generated and collected its own data; this was becoming an overwhelming avalanche of paper work, so a computer was added to receive and correlate much of the clerical activity.

The years 1966 to 1968 were busy ones for Inspiration, gearing the old facilities for increased production and expanding its workings to include many outlaying projects like Black Copper, Live Oak and Ox-Hide.

The years 1969 to 1972 were busy with the realization of 24,700 TPD in 1970. Taking place during this time was the development of the Sanchez property located near Safford, a large low grade oxide deposit, a preliminary look at the possible reworking of old mill tailings using LPF, and the use of liquid Ion Exchange (LIX) for leaching. Smelter capacity was increased by adding an air preheater and the realization that air pollution was becoming a serious problem led Inspiration to investigate many new pollution control plans. During this period all of the scattered assay labs and sampling rooms were consolidated into a new modern centralized Analytical Lab.

The old tertiary crusher built in 1926 for 750 TPH and now running at 1200 TPH is in advanced stages of old age. This coupled with subsidence in the old primary crusher area led to the design and construction of a new primary and tertiary crusher.

1973 saw the start of Willow Springs Leach Area and treatment facilities, and an expansion of the Ox-Hide mine. But most importantly, a commitment of 54 million dollars by Inspiration to meet the new State Air Pollution Laws was made.

Again Inspiration would commit itself to an "Inspirational" undertaking. A large new electric furnace, five Hoboken siphon converters and gas-collecting apparatus are teamed with a Lurgi double adsorption acid plant to treat 1500 TPD through the Smelter while reducing incoming sulfur content of the ores by 90%, thereby enabling Inspiration to meet the State and Federal Ambient Air Standards. Scheduled start up for the new reduction plant is midyear 1974.

1974 will bring the new reduction plant into operation, a new lime plant is under design and Willow Springs will start. Mining will begin on the Joe Bush Area, a joint venture with Cities Service to produce 49 million tons of ore for Inspiration.

All in all it looks like a busy future for Inspiration. The past 60 years have seen many changes in process and attitudes. Each change took courage and foresight. To remain competitive the Inspiration Consolidated Copper Company must remain an "Inspiration in Copper."

Del Wisner

GEOLOGY OF THE INSPIRATION-MIAMI DEPOSIT

by John T. Eastlick
May 3, 1974

INTRODUCTION

The Inspiration-Miami ore deposit has had a long productive history, and in terms of production, it ranks among the large orebodies of the world. As presently developed (including the OxHide and Bluebird Mines), it has a strike length of over 27,000 feet with widths ranging up to 4,000 feet and thicknesses up to 900 feet. Although severed by faults and mined as separate orebodies, it is essentially one zone of mineralization. This mineralized zone occurs along the contact between schist and porphyritic intrusive rocks, which trend generally to the east and to the southwest.

Tonnages of ore mined from the various mines within the mineralized zone up to January 1, 1974 totals in excess of 530,500,000 tons. To date, total copper produced from these operations amounts to more than 7,200,000,000 pounds including both concentrates from milling and cement copper from in-place and dump leaching.

ROCK DESCRIPTIONS

Rocks represented in the general area within and surrounding the orebody include only those of Precambrian and Tertiary ages. Paleozoic sediments are absent, but are exposed elsewhere in the district in association with other mineral deposits indicating that a thick section of covering material existed during the time of the intrusion of the granitic rocks and the formation of the ore deposit.

Descriptions of the rocks presently exposed in the general are are as follows:

Precambrian Rocks

Pinal Schist: The Pinal Schist of early Precambrian age consists of a metamorphosed sequence of sedimentary and volcanic rocks which are represented in the general area by coarse grained quartz muscovite schist, fine grained quartz serecite schist, and chloritic schist. The general schistosity strikes about N50°E and dips steeply to the southeast with some local variations. In general, the outlines of the orebodies and the trend of the intrusive porphyries appear to closely parallel the local schistosity.

Pioneer Formation: This unit comprises the lower part of the younger Precambrian Apache Series. The upper portions of this formation are fine grained, thin-bedded sandstones, whereas the basal part is a pebbly arkose 15 to 20 feet thick. In places, the lower part grades into hard, fine grained, reddish-brown sandstones, and in some localities interfingers with fine grained gray sandstones and arenaceous shales. Pre-Whitetail erosion has removed much of the Pioneer Formation from the area containing the mineralized deposit, but it is mineralized where found within the limits of the orebody.

Diabase: The age of the diabase has been the subject of some controversy, but it is believed by the author to be of Late Precambrian age. It clearly intrudes the Pinal Schist and younger Precambrian Apache Series, but contacts with the later Precambrian Troy Quartzite and the Paleozoic sediments are generally fault contacts.

In the mine vicinity, this basic intrusive ranges from fine grained to coarse grained varities with the composition grading from a hornblende to an augite diabase. Larger bodies of diabase occur near and in the

Warrior and Geneva workings, but only narrow dikes are found within the Thornton and Live Oak Mine areas. Apparently this rock was very receptive, both from hypogene and supergene sources, as a precipitant for mineralizing solutions.

Tertiary Rocks

Schultze Granite: The Schultze granite occurs as a large irregular stock, forming a noteable part of the Pinal Mountains to the south and west of Inspiration. Generally the rock has a characteristic granitic texture, consisting of a coarse grained matrix of quartz, oligoclase, and biotite which often encloses phenocrysts of sodium-rich orthoclase from one to four inches long. Chemically the rock is a sodium-rich granite, but mineralogically it is a quartz monzonite.[4] Age determinations by Creasay and Kistler[1] indicate the Schultze granite to have an age of about 62,000,000 years which would date it as early Tertiary.

The relationship of the Schultze granite to the Inspiration-Miami orebody is obscure, but it generally believed to be part of the parent magma from which the porphyritic intrusives and associated hypogene mineralization were derived. Although both the Bluebird and OxHide deposits rest on Schultze granite, both are fault contacts and only very weak pyrite disseminations are noted in the immediate footwall at these mines.

Biotite Granite and Granite Porphyry: Intrusive rock types within the mine area are classified into two types. Along the north and northeast sides of Live Oak Gulch, the most prevailing rock is designated as granite prophyry in conformance with local rock nomenclature. Specifically this rock is a quartz monzonite porphyry composed of medium sized phenocrysts of orthoclase and plagioclase, together with varying amounts of quartz and biotite set in a phaneritic matrix.

Outcrops to the south and southwest of Live Oak Gulch, extending towards the Bluebird Mine, consist of both granite porphyry as above and a somewhat coarser grained igneous rock, which is designated as a biotite granite. Mineralogically this so-called biotite granite is also a quartz monzonite. In many places the boundaries between the porphyry and the biotite granite appear to be graduational and the exact contact is poorly defined; in other places, however, these are well-defined contacts which may indicate a later intrusive phase. Age determinations by Creasey and Kistler[1] date the granite porphyry to about 58,000,000 years which would favor the latter.

Actually, the two rock types are rather uniformly altered, being light gray in color, intensely silicified with numerous quartz veinlets, and moderately sericitized. Both contain abundant secondary biotite, and veinlets and replacements by K-feldspar. Near the contact zone in the Inspiration area, the granite porphyry is usually intensely altered, with quartz "eyes" and sericite forming the predominant minerals.

Generally these rocks are regarded as separate marginal or younger intrusive phases of the Schultze granite. These rocks are particularly significant in that roughly one-third of the orebody in the Inspiration area extends into the granite porphyry and ore occurs in the Bluebird and OxHide deposits in both granite porphyry and biotite granite.

Breccias: Several separate breccia structures are exposed within the granite porphyry mass along Live Oak Gulch to the south of the Open Pit office, being composed mainly of angular to subangular fragments of granite porphyry and quartz, together with a few fragments of schist. These have been recemented by later quartz which fills the spaces between the individual breccia fragments. Generally these zones contain more quartz fragments near their centers with granite porphyry fragments becoming more abundant towards the outer edges. Sizing of the individual pieces of breccia commonly range from one to two inches in diameter, but some fragments range up to 12 inches in size. At their perpheries the breccias grade outward to fractured and shattered granite porphyry with a stockwork of intersecting quartz veinlets.

Intruded into the breccia structures and numerous small dikelets of later intrusive material, ranging from a few inches to two feet in width. These intrusives are very irregular, in places cutting steeply through the breccia and in other places intruding the breccia in flatly dipping sinuous patterns. In contrast to the granite porphyry this later intrusive material is finer grained and darker colored, containing more inherent biotite and small to medium sized phenocrysts of feldspar and quartz set in an aphanitic groundmass. Locally small breccia fragments appear within this finer grained igneous material, possibly indicating a later stage of microbrecciation.

The significance of these breccias and later intrusives to the mineralizing cycle is not clear, but the pipe-like structures evidently served in part as principal conduits for the large amounts of quartz, which flood the general area. Evidence of primary mineralization is meager, but scattered psuedomorphs of hematite after pyrite indicate some sulfides were present.

The age of the breccia and associated igneous material is clearly post-porphyry and pre-mineral.

Whitetail Conglomerate: Thin Conglomerate beds, regulated to this unit, are noted on the northwest corner of the property near the Warrior and Geneva workings, and are found overlying the 550, the South Barney, and Montezuma ore zones. This conglomerate also covered parts of the Live Oak, and Red Hill pits before these areas were excavated. Generally this detrital material overlies the older rocks along an erosion surface that existed prior to the eruption of dacite, and it probably post dates the period during which the major part of supergene enrichment occured. However, some exotic copper enriched material due to those processes is present in certain areas.

Dacite: Eroded remnants of dacite in many places overlie the Whitetail conglomerate, but in others the basal portions of the dacite rest directly on the older rocks. The dacite is composed generally of plagioclase, sanidine, quartz, and biotite in a glassey aphanitic groundmass, together with occassional fragments of older rocks. Commonly, these dacitic flows are underlain by a bed of water-lain tuff from 10 to 100 feet in thickness which grades upward into a layer of black vitrophyre. The lower part, including the tuff and vitrophyre layer is regarded by Peterson[4] as an earlier volcanic eruption, and the dacite as part of later volcanic activity being dated at about 20,000,000 years in age.[1]

Quaternary Rocks: Thick sections of Gila Conglomerate cover the mineralized zone to the west of the Barney Fault and to the east and southeast along the hanging wall side of the Miami Fault. Within these areas, fragments of schist and the various intrusive rocks are the prevailing rock constituents with schist being predominant towards the bottom. Cementing material consists generally of clay minerals and calcareous material.

These conglomerates generally overlie a post-dacite erosion surface with the bedding trending northwest-southeast and dipping 30-55 degrees southwest.

STRUCTURE

Pre-porphyry and pre-mineral controls within the area are to some extent related to the schistosity of the Precambrian schist which trends to the southwest, and to other fault structures and fault veins which strike east-west to northeast-southwest, generally paralleling the schist-porphyry contact. Structures of this type include the Warrior, Sulphide, Southwestern, and other paralleling faults and fault veins located further to the south. All of these have had some post-mineral movement, but apparently these trends had some expression before the emplacement of the porphyry and the formation of the ore deposit.

The breccias, as previously mentioned, provided some control, for the extensive quartz that is exposed throughout the area. These breccias outcrop at the surface generally as oval, pipe-like bodies with their long exes oriented approximately N60°W. Although none are fully exposed, the largest is approximately 800 feet long on its major axis and 300 feet wide across the minor axis.

Several systems of pre-mineral and post-breccia fractures and shears are in evidence. One system, striking N25°-60°E and dipping 20-55 degrees southeast, is abundantly represented throughout the mine area. Another set trends with a north direction dipping steeply to the east, and another system strikes about N60°E, dipping to the northwest. These pre-mineral systems of fractures and shears, many of which are quart filled and sulfide enriched, cut both the schist and igneous rocks, including the breccias.

Some controversy exists as to the age of other fault systems exposed within the area. While there is some agreement that these faults may have followed along pre-mineral zones of weakness, evidence points strongly to the fact that the major part of their movements postdate the formation of the chalcocite blanket and probably followed the deposition of the greater part of the Gila conglomerate.

Post-mineral faulting throughout the area is reflected by two main systems. One of these of which the Pinto, Williamson and Schulze faults are a part, trends to the northwest and dips from 35 to 55 degrees northeast. The other system appears as north-northeast trending faults which dip flatly to the east and southeast. Faults of this system include the Barney, Porphyry, Number Five, Keystone, Bulldog, and Miami Faults. Both of these fault systems cut and displace the enriched chalcocite zone, the Whitetail conglomerate, and the dacite; and several, including the Miami, Barney, and Williamson Faults, also offset thick sections of Gila Conglomerate. These faults generally have broad crush zones with strong development of clay along several fault strands. Movements are normal, with the various blocks being downdropped to the east.

Another strong fault, the Joe Bush, strikes approximately parallel to the Pinto Fault, but dips steeply to the southwest. As exposed, this fault apparently displaces the schist-porphyry contact and ore zone about 1,000 feet northwest.

Other paralleling smaller faults, known as the Colorado Fault system, occur as splits in the hanging wall of the Bulldog Fault. Some of these have displacements of as much as 100 feet offsetting the secondary-enriched zone with movements down to the northeast.

At least, one reverse fault or overthrust is represented and others may be present in the Barney-Number Five Fault block and in the fault block to the west of the Barney Fault. This overthrust apparently trends about east-west and dips about 40 degrees to the south with the hanging wall side displaced upward between 500 to 600 feet, over-riding the enriched chalcocite zone, Whitetail conglomerate, dacite, and Gila Conglomerate on the footwall side.

Indications are that the general area remained relatively undisturbed during the erosional period preceding the deposition of the Whitetail Conglomerate and probably remained stable throughout the period of volcanic activity that followed. Regional tilting to the southwest possibly began during the erosion cycle following the volcanic activity and culminated during or after the deposition of the Gila Conglomerate with the development of the major fault trends that strike north to northwest. This is evidenced by the drilling to the west of the Barney Fault which shows, the enriched chalcocite blanket and overlying Whitetail and dacite to plunge sharply to the southwest, being covered on the west end by as much as 1,500 feet of Gila Conglomerate. It is also suggested to the east of the Miami Fault where the dacite, Whitetail, and underlying enriched zone is covered with thick sections of Gila Conglomerate up to 4,000 feet in thickness.

MINERALIZATION

In general, the better mineralization in the Inspiration orebody is confined to a belt on either side of the schist-porphyry contact, but further to the east in the Miami Copper workings and in the blocks to the east of the Miami Fault the orebody appears to extend into the schist some distance from the porphyry contact. Some porphyry in the form of dikes and irregular bodies, however, is present in these areas intruding into the schist.

Hypogene alteration effects are shown by the intense silicification and moderate to strong sericitization throughout the general mine area. Secondary biotite is evident within the breccias and surrounding igneous rocks, occuring as thin bands parallel to the trend of quartz veining and locally as irregular masses and filling along fractures. Pervasive and veinlet replacement by K-feldspar occurs within the igneous mass.

Although the original modular expression of the Inspiration-Miami deposit is now obscured by rotation and erosion, and by later enrichment and faulting, it probably was roughly cylindrical in shape consisting of an inner zone of potassic alteration (quartz-biotite-sericite-K-feldspar) outward through a phyllic zone (quartz-sericite-pyrite), an argillic zone (quartz-kaolin-montmorillonite), and a porphylitic zone (chlorite-epidote-calcite-magnetite). Over this same interval sulfide assemblages apparently varied from a weak pyrite-chalcopyrite-molybdenite inner zone outward through various other sulfide mineral assemblages to sphalerite-galena with minor gold and silver on the outer margins. These zonal arrangements are well represented to the northwest of the Miami Fault, but are cut off to the south by the Miami-Williamson Fault complex.

Primary mineralization is not strong; although below some of the thicker portions of the chalcocite enriched zones, diamond drill cores contain veinlets of chalcopyrite up to one-quarter of an inch thick, sometimes accompanied by blebs of bornite. Within the schist, the stronger mineralization generally occurs in granular beds in which the schistose structure is either poorly developed or destroyed. Quartz, pyrite and chalcopyrite occur as veinlets and pyrite and chalcopyrite is disseminated throughout the schist. Mineralization in the porphyry is similar, with quartz, pyrite and chalcopyrite filling fractures to form veinlets, and with pyrite and chalcopyrite occuring as disseminations, replacing biotite in many instances.

Quartz appears to be early, occuring in several successive stages. Pyrite is later followed by chalcopyrite and bornite, and molybdenite and glassy quartz were introduced at a still later stage.

Most of the ore mined today at Inspiration was formed by supergene enrichment. Supergene chalcocite was deposited, mainly on pyrite, forming a blanket-like enriched zone of varying thickness. Sometimes the chalcocite replaces the pyrite completely or occurs as thin films on the surface of the pyrite. Above the chalcocite enriched zone, chrysocolla occurs as the principal oxidized mineral with later malachite and azurite cementing and filling fractures. Brochantite, atacamite, lindgrenite, libethenite, and minor metatorbernite are found locally, and some native copper and cuprite occur within and near the faulted zones.

The rocks capping the ore zone are generally moderately iron-stained at the surface and locally contain some varying amounts of copper oxides. The thickness of this capping is quite variable due to the tilting of the ore zone and subsequent erosion, but it apparently averaged about 400 feet in thickness. The usual limonitic colors are well-developed, and there are abundant crusts of transported limonite. The silic boxworks, although not in abundance, are characteristic of that resulting from a mixture of sulfides that contained a high pyrite content.

ORE GENESIS-CONSLUSIONS

The ore deposits in the Inspiration-Miami area show the inter-relationship of intrusive activity, hydrothermal alteration, metallization, and supergene enrichment. Hydrothermal alteration and ore deposition are late in the intrusive sequence, occuring after the formation of the breccias and intrusion of the finer grained igneous material.

The characteristics of the ore deposit are suggestive of a typical porphyry copper system, consisting of disseminated and stockwork veinlet sulfide mineralization emplaced in schist and intrusive rocks that are hydrothermally altered into roughly concentric zonal patterns. The configuration of these alteration zones and subsequent mineralization is apparently not related in detail to the distribution of the quartz monzonite porphyry bodies, but these processes were influenced to some extent by the porphyry trends.

References

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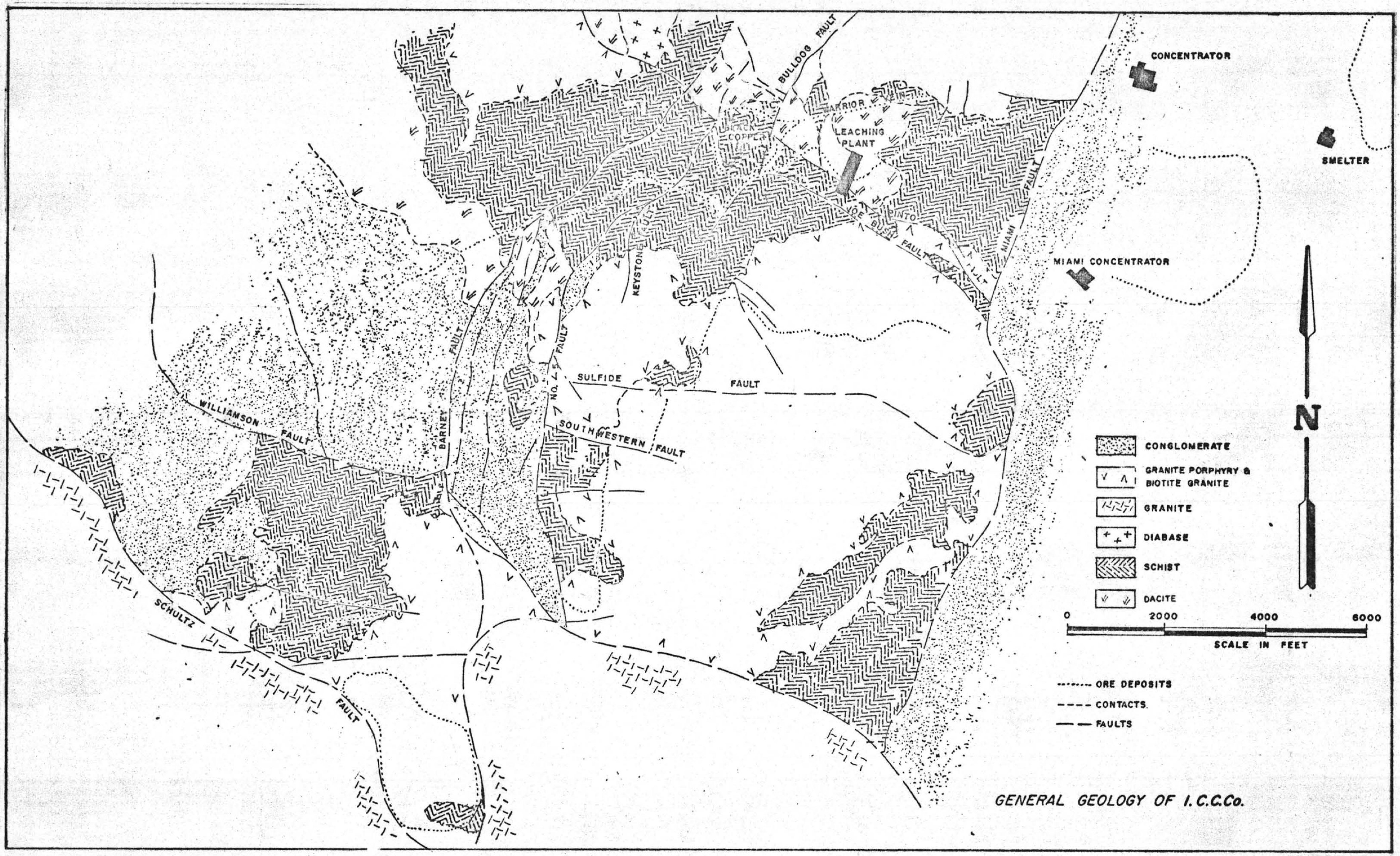

GENERAL GEOLOGY OF I.C.C.Co.

MINERALOGY OF THE INSPIRATION MINE AREA

by David W. Johnson

In discussing the mineral assemblage of the Inspiration Mine area the first major division would logically be that of rock type minerals and ore and ore associated minerals.

The rock type minerals and their alteration products comprise a very large and complex group of primary, hydrothermal and supergene minerals. In addition to the alteration products of argillization, serictization, and silicification, there exists alteration products of biotization, orthoclazation, epidotization and surface oxidation and leaching. It is sufficient to say that the list of minerals covered in this group is large and non-economic in nature.

The ore and ore associated minerals present in the Inspiration Mine area, that is those minerals with some economic conotation, should be divided into three main divisions: hypogene minerals, which are minerals formed by generally ascending solutions; supergene minerals, which are minerals that have been formed by generally decending solutions; and oxidation products. At Inspiration the original hypogene mineralization of the porphyry and schist was of low tenor and the ore zones as we know them today were dependent upon supergene enrichment.

In the hypogene mineral classification we have chalcopyrite (which is considered to be the most important hypogene copper mineral), minor bornite, minor chalcocite, molybdenite, magnetite, traces of gold and silver, very minor galena and sphalerite, and pyrite is here included because of its role in the enrichment cycle. The molybdenite, it should be noted, is present in molybdenum-quartz veins and veinlets which cut all other mineralization and it is therefore considered to be the last phase of the hypogene metallogenetic phase.

The supergene minerals would include chalcocite (the most abundant copper sulfide mineral), covellite, chalcopyrite, minor amounts of bornite and native copper. Chalcopyrite has been included here because of its rather consistant occurrences of thin films on pyrite beneath the chalcocite blanket. Bornite was included because it is a product which will readily result from copper sulfate solutions in contact with chalcopyrite under the proper conditions.

The oxidation products consist of chrysocolla (the most important oxide copper mineral), malchite, azurite, and minor copper pitch, cuprite, chalcotrichite, brochantite, pseudomalachite, libethenite, lindgrenite, ferrimolybdite, hematite, goethite and limonite. Chalcanthite, a product of mine water seapage, is found in the underground mine workings and on many of the undercut faces which are exposed in the Thornton Pit and Live Oak Pit. It is interesting to note the more important recent discoveries in the area such as the OxHide, Blue Bird, and Montezuma ore zones seem to represent a former chalcocite blanket which has been oxidized in place.

By: William W. Sorsen

INSPIRATION'S OXHIDE MINING AND LEACHING OPERATION

INTRODUCTION

The OxHide Mine, formerly known as the Shulze Copper Deposit, is located on the lower slope of the Pinal Mountains at an elevation of 4,000 feet. The property adjoins U. S. Highway 70, about three miles Southeast of Miami, Arizona.

HISTORY

The first claims of record were located by the Shulze family in 1894 and ownership has been sustained by them to the present. No record of production is available but undoubtedly selected ore was shipped from some of the shallow workings scattered over the property. During the period from 1923 to 1962, several mining companies leased the Shulze property and drilled a total of 58 exploration holes. This drilling indicated the presence of two separate mineralized bodies.

In 1964, Inspiration Consolidated Copper Company obtained a lease and option from the Shulze family. Inspiration drilled 21 diamond drill holes and 55 churn drill holes to further delineate the mineralized zones.

GEOLOGY

The OxHide Mine is along the North contact of the main intrusive stock of Shulze granite and granite porphyry which extends Southwestward from the Miami-Inspiration area.

Copper mineralization is confined chiefly to the block of ground which lies to the East of a strongly faulted zone, known locally as the Shulze fault. This fault strikes almost due South where it crosses U. S. Highway 70 and trends roughly N85°W along the upper reaches of Needle Creek. The dip varies from 20° to 35° to the Northeast.

The Upper OxHide deposit is adjacent to the quartz porphyry contact in highly fractured and altered Pinal schist.

The Lower OxHide orebody is all in shattered quartz porphyry. These two rock types form the hanging wall of the Shulze fault, overlying barren Shulze granite in the footwall.

Surface exposures of both the schist and quartz porphyry show evidence of having been weakly mineralized by primary sulphides. In general, the schist orebody has a higher copper content than the porphyry orebody. The copper mineralization in the porphyry, however, is more widespread both in lateral and vertical extent.

MINERALOGY

In both of the mineralized bodies, the rocks are stained by copper and iron oxides and the numerous fractures are coated with copper silicates and copper carbonates. The principal supergene minerals are chrysocolla, malachite, and azurite. Melaconite, tenorite and cuprite are found as minor incrustations along fractures, and occurrences of native copper are noticeable along the more intensely crushed zones.

Hypogene mineralization has been intersected in the deeper diamond drill holes. Pyrite is the most abundant sulphide followed by Chalcopyrite. Molybdenite is found in typical association with quartz occurring as minor blebs and disseminations. The protore of these deposits is very similar to that of other deposits in the district, assaying between 0.08 and 0.25 percent copper. Evidently there was very little migration of copper with subsequent weak supergene enrichment.

UPPER OX HIDE PIT

Early in 1968, Inspiration completed its evaluation of the OxHide orebodies and decided to go ahead with the construction of the launder precipitation plant and associated facilities. Three collection reservoir dams were constructed in the natural drainage areas to the West of the two orebodies. In July, mining was started in the Upper OxHide pit with tractors and scrapers. While construction was in progress, the number one heap area was cleared, graded, and sealed with two coats of asphalt.

Heap emplacement was started in the number one heap area. Initial heaps were emplaced in stair steps up the canyon so that the deepest part of the heap was 40 feet. Subsequently overlays were emplaced in 20-foot lifts. The objective was to create a large surface area as quickly as possible, to allow increases in the volume of solution applied.

Early heap construction was done by building a fill from the finished top elevation by casting. Scrapers spread their load near the crest of the dump and two graders windrowed the material over the edge. Two tractors with dozers and parallelogram rippers were used to loosen the rock and load scrapers. Four 24 cubic yard scrapers were adequate at the start of the job due to the short haul and favorable grades.

The schist ore in the Upper OxHide pit was well shattered but the fractures had been re-cemented in some areas. Rippability varied from easy to impossible. On two occasions, it was necessary to drill and blast hard ribs to maintain the continuity of the mining operation.

Excessive rainfall in 1972 caused flooding of the Upper OxHide pit to the extent that mining was temporarily suspended. The decision to move the mining operation to the Lower OxHide pit was hastened by the need for a large capacity storage reservoir to contain the excess discard water generated by runoff. By the time the water system was back in balance, the Upper OxHide pit contained 200 million gallons of water, standing at a depth of 190 feet.

During a 4 1/2 year period, 11.2 million tons of ore was deposited in the number one and number two leach areas. This ore contained 87.7 million pounds of copper, of which 40.4 million pounds, or 46%, has been recovered.

LOWER OX HIDE PIT

In January 1973, mining was started in the Lower OxHide pit. Drill holes indicated the quartz porphyry orebody contained 33 million tons assaying 0.296% copper with a 0.5/1 (waste to ore) stripping ratio. This orebody is a fractured granite porphyry with two hard zones running the length of the pit. It was necessary to initiate a drilling and blasting program to avoid abusing the tractors that were attempting to rip this hard material. Most of the ore in the Lower OxHide pit digs readily and with the aid of blasting to ease the hard zones, we should be able to mine the 12,000 tons of ore per day required to meet the production goal of 34,000 pounds of copper per day.

The Research Department determined from bench leaching tests that 47% of the total copper in the ore is acid soluble. The refractory remaining portion is probably copper oxides locked up in clays formed by altered feldspar. Ultimate recovery in the heaps will probably exceed the level indicated in the bench tests.

LEACHING PRACTICE

Three experimental leaching pads containing 10,000 tons of ore each were built to ascertain the best method of emplacement for the granite porphyry ore. This was thought to be necessary since mining the Lower OxHide ore generated an excessive amount of fines. Even the coarse material was all minus 4 inches in size.

The first heap was built with a stacker conveyor and subsequently levelled with a bulldozer and ripped to a depth of 4 feet.

The second heap was built as a typical truck dump, levelled and ripped.

The third heap was laid in with scrapers in 30" lifts, ripped, and filled another 30" until a depth of 10' was reached. It was then levelled and ripped.

All of the ore in these heaps was mined in the same manner by ripping before loading. Water distribution lines were laid on the three pads and a one percent sulfuric acid solution was applied. After the first 30 days, copper recovery from the truck and scraper pads was about 10%, while the stacker dump had produced 17% of the copper contained in the ore. After 120 days, all three heaps had produced 85% of the acid soluble copper. On the basis of this test, the so called "laying in" method was chosen as the most economical method of the three and was adopted for the Number Three leach area.

After fifteen months of heap emplacement on number three leach area, the percolation rate was 14 GPM per 10,000 square feet of heap area. This low percolation rate continues to be a challenge for the development of improved emplacement methods.

In order to keep copper production at an acceptable level, it is necessary to bring new heap areas on stream about every 12 days. Each new area requires about 130,000 tons of ore. Currently, we have 40 acres of heap area under irrigation. A leach cycle for an individual heap is a minimum of 120 days, after which the area is allowed to dry for 60 days.

Sometimes the surface of an old heap requires considerable preparation to restore permeability before the addition of a new 15 foot lift.

The minimum preparation consists of ripping in two directions with a nine foot Kelly ripper shank that penetrates six and a half feet.

Frequently it is necessary to cut deep slots with scrapers to penetrate hard pans and replace the excavated material with coarse rock to re-establish percolation.

Currently, we are planning to acquire a dragline with a 50' boom. Deep narrow slots will be excavated to release entrapped solution from perched water tables. These slots will then be backfilled with coarse rock to insure future drainage.

Two old heaps have been drilled with blast hole drills on a 50' grid to within 10 feet of the original ground. Two inch perforated plastic pipe was then placed in the holes to assure drainage even if the holes cave. Water is sprayed on the surface and allowed to drain into the drill holes. Water running down the side of the hole is more apt to soak out into the surrounding ground than if it is introduced into the pipe.

Solution containing from 0.6% to 3.0% sulfuric acid is distributed on the heaps with 2" polyethylene plastic pipe laid on 18' centers and drilled on 4' centers with 3/16" holes. These pipes are fed by a 3" plastic pipe manifold which is connected to the 12" transite main line with a rubber pinch valve.

Another method of distributing solution is to divide a large area into several parts with low dikes separating the sections. Then 2" plastic lines with pinch valves are laid to conduct solution to each area by running the water down a header ditch which feeds each furrow created by ripping.

PRECIPITATION PLANT

The OxHide precipitation plant was designed to process 1500 GPM of pregnant solution in 10 conventional iron launders. Solution is piped from the three collection reservoirs by gravity through 12" epoxy lined 150 class transite lines to a receiving box which empties into the feed launder of the plant. Stainless steel gates are used to control the flow of solution to each of 10 launders or to isolate a launder while it is being washed or serviced. Each launder is made up of two halves 4' wide by 30' long. A center wall 26' long separates the two sides leaving a 4 foot gap so that solution can flow down one side and return on the other side. A stainless steel punched plate false bottom supports the scrap metal in the cell and below this is a sloping floor that drains to a pneumatic discharge 12" gate valve. The punched screen is 52" below the top of the cell. Recently 8" was added to the top of the walls to increase the capacity of the plant to 2200 GPM. The 10 cells operate in series giving an effective length of 600 feet when all the cells are in operation. There is a 6 inch drop between cells to insure an adequate flow velocity.

The tail water is conducted to a settling sump consisting of a head section with a splitter gate to adjust flow into two separate pump sumps. Acid is metered into each pump sump separately as needed. The number one sump is equipped with four vertical turbine pumps designed to pump against a 500' head. The number two sump is equipped with four vertical turbine pumps to serve the lower heaps where the maximum head is 400 feet.

Fisher and Porter magnetic flowmeters are used to measure and record the flow of pregnant solution from the heaps and acidified solution pumped to the heaps.

Three 80-ton tanks for acid storage and a 260-ton iron storage area are located on the bench above the plant. A service road above this bench accomodates acid and iron truck deliveries.

Iron is fed by a front end loader through a hole in the floor to a pan feeder located in a short tunnel under the floor. This feeder discharges iron to a tripper conveyor which traverses the center line of the iron launders. A chute with splitter gate conducts iron to the left or right chute to distribute iron to any part of the plant as needed.

In practice, it is necessary to wash the cement copper out of 5 to 8 cells per day, depending on the grade of the pregnant solution. To wash a cell, gates are dropped into the feed launder to isolate the cell. The 12" pneumatic dump gate is opened to discharge the cement copper slurry into the decant sump. Two high pressure washing hoses are then clamped to a rail support at one end of the cell and the cell washer proceeds to wash the cement copper off the remaining scrap cans through the perforated floor into the decant sump. After both sides of the cell is washed, the discharge gate is closed and the cell is recharged with scrap cans. On day shift, the cells are washed and recharged with scrap cans, but only a few cells are filled with solution and put back on stream. Usually two cells are reserved for afternoon shift and two more for graveyard shift to be put into the circuit as needed to maintain a low tailing.

The cement copper is allowed to settle in the decant sump after which the water is pumped back to number one launder cell. The afternoon shift plant attendant removes the cement copper from the decant sump with a front end loader and piles it on a draining slab. The following day the cement copper is transferred to a drying slab and ultimately shipped via truck to the smelter. The cement contains about 20% moisture and assays from 80 to 90% copper when shipped.

PRODUCTION STATISTICS - Month of February 1974

Mine

Ore Mined (1.5 mile haul)	277,410 tons @ 0.30% copper
Waste Mined (0.5 mile haul)	94,185 tons
Average daily production	13,271 tons

Precipitation Plant

	To Launders	From Launders
Flow GPM	2061	2061
Copper GPL	1.40	0.06
H_2SO_4 GPL	5.4	5.1
Fe GPL	17.1	19.2
Fe''' GPL	1.0	Trace

Copper Precipitated - 924,955 pounds or 33,036 pounds/day
Acid consumed per pound of copper - 11.34 pounds
Iron consumed per pound of copper - 1.95 pounds

FUTURE PLANS

The present mining rate will exhaust the ore reserves in about seven years. Leaching will continue as long as it is economically feasible, perhaps for an additional ten years period.

A small crew will be needed to operate the precipitation plant and to skim, trench, and drill the heaps and move solution lines as needed. The ultimate recovery will possibly be 60 - 70% of the total copper.

OX HIDE MINE LABOR FORCE - TOTAL PERSONNEL - 80

Administration
1 Superintendent
1 Mining and Leaching General Foreman
1 Maintenance General Foreman
1 Clerk

Shop Crew
1 Shop Foreman
3 Welders
9 Heavy Equipment Mechanics
1 Pump Mechanic
7 Mechanic Helpers and Servicemen

Mine Crew
4 Shift Foreman
4 Grader Operators
8 Tractor Operators
20 Scraper Operators
4 Water Truck Drivers
1 Equipment Operator Instructor
1 Driller

Precipitation Plant and Leach Pad Crew
1 Shift Foreman
1 Leach Pad Attendant
1 Plant Operator
4 Plant Attendants
1 Tripperman
2 Cell Washers
3 Laborers

OX HIDE MINE EQUIPMENT

Mine
4 Model D9G Caterpillar Tractors with dozers and rippers
6 Model 631C Caterpiller Scrapers (24 cu yd)
3 Model S24 Euclid Terex Scrapers (24 cu yd)
1 Model 16 Caterpillar Grader
1 Model 16G Caterpillar Articulated Grader

1 Model R22 Euclid Water Truck - 4,000 gallon capacity.
1 Model 769 Caterpillar Water Truck - 4,000 gallon capacity
1 Model 769 Caterpillar Lube Truck
1 Model 750 Chicago Pneumatic Rotary Drill
2 Model D1012 - 3" Pacific Centrifugal Pumps
Powered by 90 H.P. Deutz Diesel Engines - Trailer Mounted

Precipitation Plant
1 - 750 KW Transformer and Power Center
1 - Model 950 Caterpillar Loader - 2 1/2 cu. yd. bucket
1 - Model 7231 Euclid Terex Loader - 2 1/2 cu yd bucket
1 - WABCO 100 cu ft stationary compressor

Pumps - 316 Stainless Steel

No.	Make	Type	Stages	Head	GPM	H.P.	RPM	Application
3	Worthington	Turbine	2	400'	500	75	3550	On Solution
3	Worthington	Turbine	3	500'	500	100	3550	On Solution
1	Floway	Turbine	5	400'	500	100	3550	On Solution
1	Floway	Turbine	7	500'	500	125	3550	On Solution
1	Worthington	Centrifugal(S)		300'	300	40	1750	Decant
1	Layne Bowler	Turbine	2	300'	250	25	1750	Make Up

Transportation
2 - 3/4 Ton Pickups
4 - 1/2 Ton Pickups

INSPIRATION OPEN PIT OPERATIONS

SUMMARY

By

James H. Lundy, Jr.
Open Pit Superintendent

Open Pit Division - A.I.M.E.
Spring Meeting
May 10, 1974
Inspiration, Arizona

UNIQUE OPERATION

Although Inspiration's mine has much in common with its sister operations throughout the Southwest, in the employment of mining equipment and the techniques of their several operations, it is unique in the ore production area.

Here at Inspiration, we must produce three distinct types of ore, along with two types of heap leaching material, in addition to our stripping of barren waste. The three types of plant feed are (1) oxide - which term is applied to all acid soluable minerals; specifically Chrisocolla, Azurite and Malachite. (2) Sulfides - mostly chalcocite and some chalcopyrite - known as Direct Mill Feed; and (3) Dual process ore which contains such an intimate mixture of the first two that it must be treated first by vat leaching, and then flotation of the Leaching Plant tails.

In addition to the plant grade ores, we also mine heap leaching waste as a part of scheduled production. Then, of course, the barren waste which must be dumped in non-leachable areas. These, then, are the five products which we must separate continually on the basis of our ore control information.

To this we add one more operational activity - for every tank of "Discard" which is the oxide ore that is vat leached only in the leaching plant, we must, at the completion of the leaching cycle, send one fleet of haul trucks to dispose of the tailings.

One might conclude hastily that this should not be too great a problem, since the non-leachable overburden will be encountered at the surface - the leachable waste on the upper benches - the oxide ores on the intermediate levels - grading into a dual product zone, which the direct mill feed sulphides being found at depth.

Unfortunately this is not the case. Non only do we have sulphide ores high in the column in certain areas, but also previous mining by block caving has moved large blocks of ground down - the result of which is that we find pipes of ore and waste throughout the mine - with all products being frequently encountered in close approximation, all on the same bench. Dealing with this complexity makes scheduling production from Inspiration's Mine a real challenge.

SCHEDULING PRODUCTION

Ore reserves are continually upgraded by the Mine Engineering Department in cooperation with the Geologists.

Exploration drilling, blast hole drilling, and analysis of recoveries of immediate past mining are used to supply management with a detailed analysis of all available reserves. This, in turn, is fitted to the overall plant capabilities, and modified by economic consideration to constitute annual goals.

Thus the Mine is tied to its own long-range commitments, 5-year schedules, annual production goals, and finally the quarterly and monthly mining plans - as approved by management.

The Mining Department is broken down into four areas of activity: Engineering, Mining Operations, Dump Leaching and Maintenance. Working closely with Engineering, Operations must ask Maintenance for a minimum level of availability of all necessary equipment to meet the production requirements of both plant and Dump Leaching.

Currently our schedule is this: 27,500 tons per day ore and 64,500 tons per day waste. The ore is broken down into an average of 6,800 tons per day Dual, 7,200 tons per day Discard and 13,500 tons per day sulfide. Since all the dual also goes to the concentrator, this amounts to a mill feed of 20,700 tons per day. The Leaching Plant generally keeps twelve tanks in circuit on a 9-day cycle.

It is obvious, then, that to maintain this rate of production; i.e., 6 discard tanks per 12-tank cycle, one fleet of haul trucks will be tied up at the Leaching Plant approximately fifty percent of the time.

To maintain this rate of production, the mine runs three shifts, seven days a week, with four equally staffed crews. Each crew works twenty-one shifts every four weeks. This provides equal strength of crews, even rotation, equal distribution of scheduled overtime, no short changes - one long change each four weeks and one crew off at all times for emergency call-outs.

PRODUCTION SEQUENCE

Inspiration, at this time, has three active mines combined into one operation. They are the Thornton Pit on the East, the Live Oak Pit on the West, and the Red Hill Mine just North of the Live Oak. Distribution of shovels indicates fairly well the rate of production from these three divisions.

We now have eight Electric Shovels, three 10-yard loaders and forty-two haul trucks, divided into four major fleets. In the Thornton Pit, we have one 5-yard and one 6-yard shovel. In the Live Oak, we have our 8-yard shovel and on the Red Hill we now employ one 5-yard, one 6-yard, and three 10-yard shovels distributed from the 4050 bench to the 3750 bench.

Each pit is developed initially by one main haul road breaking off to 50-foot benches. These 50-foot benches are in turn split into 25-foot benches whereever loaders are intended to be used or sorting is required. Each pit has some of both 50 and 25-foot benches.

Production crews are scheduled to run five loading units each shift. The crews consist of four 2-man shovel crews, one loader operator, three wheel dozer operators, two pitmen (laborers who may flow to any operating classification), three water truck drivers and twenty-six haul truck drivers.

Although we would prefer to operate four shovels and one loader each shift, at times we find it necessary to schedule a second, and even a third loader in place of shovels - to provide the required plant feed, or maintain some particular development schedule. When we are discarding from the Leaching Plant, one unit is of course shut down in the pit.

The crushing schedule for ore is 2 1/2 shifts for six days a week, two shifts on the seventh day. This allows for four hours six days for daily maintenance and eight hours on one day for major maintenance work each week to the crushing and conveying system. Of this scheduled crusher operating time of 20 hours/day, we actually average approximately 18 hours. This means that the crushing system must average 1,530 tons per hour. The maximum rate sustained for any length of time is 2,000 tons per hour. Generally we try for 1,800 tons per hour. To produce this amount of ore, we may use one 10-yard shovel; the 8-yard shovel with any other unit; two 6-yard units; one 6-yard unit plus one loader; two loaders or two 5-yard shovels with about 1/2 the production of one other small unit. As the larger units are seldom in ore, we usually end up operating two and three units in ore in some staggered sequence - thus sacrificing shovel efficiency to gain quality control in ore blending.

Loading capacities of the various units in well fragmented bench blasts have recently averaged the following tonnages:

TONS PER SHIFT	10-yard shovels	12,000
	8-yard shovels	9,000
	6-yard shovels	6,500
	5-yard shovels	5,000
	10-yard loaders	5,600

Frequently we choose to dig the undercut material - or other ground badly broken by movement - without blasting. While this reduces unit capacities by 10 to 15 percent, it greatly improves sorting and is a useful technique.

The Haulage fleet, as of April 1, 1974, consisted of:

1 - 105 ton - 2772 Dart
8 - 85 ton - 85-C WABCOs
3 - 85 ton - M-85 - Lectrahauls
11 - 75 ton - 2662 Darts
19 - 40 ton - 37SL Darts

This gives a weighted mean-haul capacity of 65 tons per unit. Considering the average lengths of hauls and the mean capacity of our loading units, we may calculate a production potential of 120,000 tons per day. So far, however, our high has been a little over 116,000 tons. Theoretical maximums are difficult to achieve.

Running ore units too lightly covered, to insure proper grade proportioning, cleaning up final toes, and frequent shovel moves all reduce shovel efficiency. Although we have scheduled crews to operate 105 loading units per week, scheduled discard and predictable absenteeism, along with unscheduled downtime reduces this to an average of 94 shifts per week.

IMPORTANT ANCILLARY OPERATIONS

Rock breaking here is rather conventional. Drilling is done by three C.P. 750 truck mounted rotary drills. These drill an average of 550 feet per shift of 9-inch blast holes. Drilling is scheduled on two shifts, seven days per week. Blasting agent is ANFO for dry holes, and bagged slurry for wet holes. Fifteen percent of our holes require slurry. All powder is bagged in 50-pound units. (We will be converting to ANFO bulk loading later this year.) We use 3,500,000 pounds per year, and break 4.5 tons per pound. Only 70% of our muck requires blasting, as much of the undercut material digs readily with the larger shovels.

Secondary blasting is a very minor part of the operation, and when it is necessary, it is done by drilling 2 1/2" percussion holes with a truck-mounted jumbo drill. These are shot with 2 x 12 stick powder at the end of day shift when danger of fly rock is minimized.

Building haulage roads, drill roads, and maintaining benches is accomplished with three D-9 bulldozers and one D-8. Three CAT, Number 16, motor graders operate 15 shifts per week. Haul road berms, bench and road repairs are maintained by use of a CAT 988 6-yard loader.

Flood waters which cannot be diverted around the perimeter of the pit, are allowed to drain to the bottom levels where whey gradually seep into old underground workings and eventually are pumped to the surface for use in leaching, from either our Live Oak or Inspiration shafts. Surface sumps are occasionally necessary, and they are pumped by four 200-foot head by 500 GPM trailer-mounted portable pumps.

It is not possible to mention here all the services rendered to Operations by Maintenance and Engineering, but this report would not be complete without mentioning the close cooperation required for an efficient operation from these supporting units. Operations ask Maintenance to provide a minimum of 28 haul trucks per shift; five of nine shovels; two of three loaders; four of six wheel dozers; four of six water trucks; and eight out of ten service vehicles each shift. In addition to this, we expect two of three drills on a two-shift basis. Two out of three bulldozers around the clock; and two of three motor graders each day shift.

Indeed, the success of Operations is dependent as much on mechanical excellence as on mining expertise.

By Fred D. Rice, Chief Planning
Engineer

LEACHING OPERATIONS AT INSPIRATION

Leaching of waste dumps, old cave areas and heap leaching have provided Inspiration with a good source of supplemental copper. Through January 1, 1974, 230 million pounds have been recovered from this leaching. As far back as 1926, reference is found to the possible heap leaching of a waste dump at the sulphide tunnel, located on the South side of our Live Oak ore body. Natural leaching in the Block Caved areas of our ~~ore~~ body began to show up in 1939 when an iron pipe column from the underground mine, that had lasted 24 years, was eaten up by corrosive mine waters. The next column lasted about a year and others even a shorter length of time until lead lined iron pipe was installed in August 1941. No doubt this natural leaching was greatly accelerated by the 28.92 inches of rain which fell from October 1940 through March 1941, about two and one-half times the average for that period. Just before this final column was installed, a 150' launder filled with scrap iron was constructed to strip the mine water of some of its damaging copper before it entered the pump and pipeline.

By 1944, over 200,000 pounds of copper from these underground launders had been shipped to the smelter. Sprays of fresh water were installed over a limited area in the old underground caves and water was applied. Within four days there was a response of solutions running 15 GPL, more than the limited launders could accommodate. After adding additional launder capacity, water was again intermittently applied during the next 17 months. From the normal mine flow of 50 GPM, plus an estimated 6 1/4 million gallons of leach water, a quarter of a million pounds of copper were recovered during these 17 months. This led management to begin formalizing plans for the active leaching of mined out areas.

All earlier solution collection had been done on the Inspiration Division 600 level (3342 elevation). In an effort to get under more of the ore body, the new facilities were constructed on the Inspiration 850 level (3101) elevation). Here it was necessary to open up some old drifts, build dams and ditch boxes for water collection and control, and a pump station and sump. Both the pump station and sump were excavated below the normal haulage level, as an additional safety factor. From the pumps, solutions went up the shaft almost 700' vertically and then across to the leaching plant, 300' to the South for treatment. New launders and supporting facilities were constructed at the Leaching Plant for this additional flow. By April 1950, everything was ready and acid solutions were applied to the old cave areas. During this same period Open Pit mining was started at Inspiration, removing some cave areas from possible leach but adding waste dumps over others that were available for leaching. This method was continued until 1965 when down the hole leaching or L.I.D. (Leaching in Depth) was started. Churn Drill holes were drilled to within 40' of the old undercut elevation, perforated 4" P.V.C. was then installed to release the leach solutions at the desired depth. Excellent results were obtained for a number of years by continually adding new holes to the project. Open Pit mining has now limited the area available for this type of leaching and it will be phased out later this year with the new Joe Bush Pit. The final phase of the underground collection of solutions was the automation of the 850 pump station during 1973, eliminating the need for a pumpman around the clock. A Motorola Control Panel was installed in the hoist house that allows automatic or manual control of both underground pumps and also provides selenoid activated-air operated valves on the two main sources of leach solutions. Power for these operations is 124 volt D.C. from constantly charged wet cells. Monitoring points covered by this system are: High and Low solution levels in the main sump, an alarm on the pump cooling water sump, and monitors that check vibration, cooling water and bearing heat on both pumps. Also located underground is an air receiver with sufficient supply to operate both valves several times in the event of a power failure. Problems are indicated at the control panel by a horn and flashing lights.

As open pit mining progressed, efforts were made to segregate waste into potential leach and non-leach dumps. During 1962 facilities were constructed in Davis Canyon, at the base of #5 dump, to collect solutions and pump them back to the leaching plant for treatment. This more than doubled our capacity to leach and led to the construction of still another plant to leach the Live Oak Dumps. The Live Oak Plant had 10 iron launders in series, iron charging facilities, drying pads for cement copper and pumps for returning solutions to the dump or discarding them to Webster Lake. It was soon discovered that 10 cells were not needed in series, so the plant was split in half into two 5 cell units - effectively doubling capacity. Later a tower, which is really a vertical launder, was also added. Here solutions are injected through nozzles in the bottom and flow upwards through tin cans and out around the top. While this does increase capacity, it is not nearly as efficient as launders, having a tail of 0.25 to 0.30 GPL. To improve this, tail water goes through a scalping launder to remove residual copper. High concentrations of ferric iron in the OFF solutions cause excessive consumption of tin cans. To help overcome this, all solutions from the Live Oak Dumps now go through a "heavy iron" launder before the regular launders to reduce ferric iron. Scrap iron for this launder is obtained from around the plant or bought at a considerably lower price than shredded iron. With both of these facilities on the South side of mining operations it seems only natural that something would be needed on the North side to keep haulage distances to a minimum. A dam and pipeline were built above the small Black Copper Pit and leach waste from Black Copper and the Red Hill Pit have been leached there for about five years. Solutions from here are conveyed by gravity to the leaching plant for treatment. ON solutions are pumped back up to the dump from the leaching plant. The Black Copper or #24 Dump is rather limited in capacity so another larger operation is being constructed in Willow Springs - North and West of Black Copper. This new plant, featuring three towers of modified design, is scheduled to go into production later this year. It will serve a vastly larger dump area that can accomodate a major portion of the leach waste from Red Hill. Presently being applied to the various projects are the following gallonages: L.I.D. 525 GPM with all OFF solutions pumped to the leaching plant; Davis Canyon 1600 GPM with 1/3 of the OFF solutions pumped to the leaching plant and 2/3 to Live Oak launders; Live Oak Dumps 2100 GPM with all OFF solutions treated at Live Oak and Black Copper 425 GPM and all OFF solutions treated at the leaching plant. Normally we expect to average about 95% return on our leach solutions to the treatment plants.

Present leaching operations call for dumping waste in overlays, over previously leached areas and whenever possible new lifts are limited to 50' in height. These areas are then leveled, bermed and ripped by dozers. Two inch plastic hose is laid on 18-foot centers and 3/16" holes are drilled in these plastic hoses every four feet. Since most of these dumps take solutions very well, average application rate is 30 GPM/10,000 sq. ft.

Acid is generally applied at a rate of 6 - 10 GPL with off solution acid desired in the 1/2 to 1 GPL range to maintain good iron launder efficiency. Some slope leaching has recently been done by spraying with generally excellent results. Number 5 Dump alone had 5 million tons in the slope that had not previously been leached. Some drilling has also been done to introduce solutions into the slopes and to drain parts of the Live Oak Dumps where old haul roads have made apparent water courses. Wetting agents have been tried but results at best are inconclusive.

With Inspiration shortly to have a good supply of low cost acid from its new acid plant at the smelter, increasing the potential for new and additional leaching projects in the future.

ASPECTS OF
PIT SLOPE STABILITY
at
INSPIRATION, ARIZONA

By
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INTRODUCTION

Geologic structure plays a very important role in the orientation of pit slopes and their susceptibility to failure. Faults, joints, and bedding provide planes of weakness, which when daylighted, are prone to failure. To exemplify this statement, two areas of the Inspiration Consolidated Copper Company Mine at Inspiration, Arizona, are to be examined.

BACKGROUND

Physiographically, the Globe-Miami district, of which Inspiration is a part, is situated in the middle of the Mountain Region of the Basin and Range Province. Geographically, Inspiration is situated 65 airline miles East of Phoenix and 85 miles North of Tucson (Figure 1).

The Inspiration property began production in 1915 as a block caving operation. Open pit mining began in 1948 and continues through the present. Underground mining ceased in 1954. The present operation is designed for 25,000 TPD and requires three distinct ore products. These are 1) a sulfide ore, subjected to flotation, 2) an oxide ore, treated by vat leaching, and 3) a mixed oxide-sulfide ore treated by both flotation and vat leaching. The resultant products of the two processes are in turn treated by smelting or electrowinning. The three ore products are mined from three mines - the Thornton, Live Oak and Red Hill (Figure 2).

GEOLOGY

There are four principal rock types at Inspiration, these are shown in Table A and Figure 3.

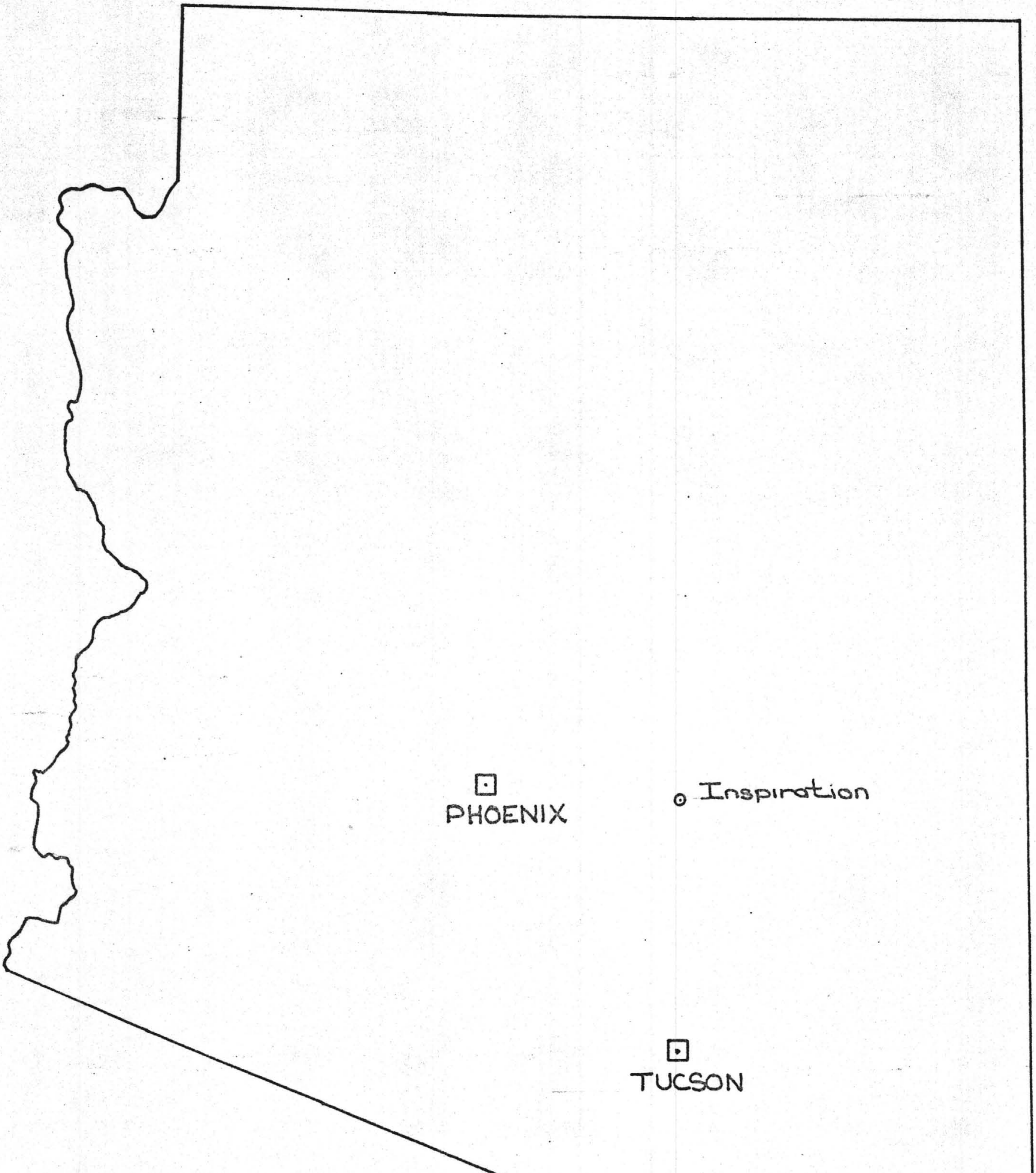
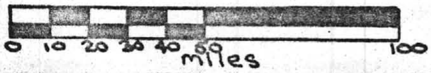
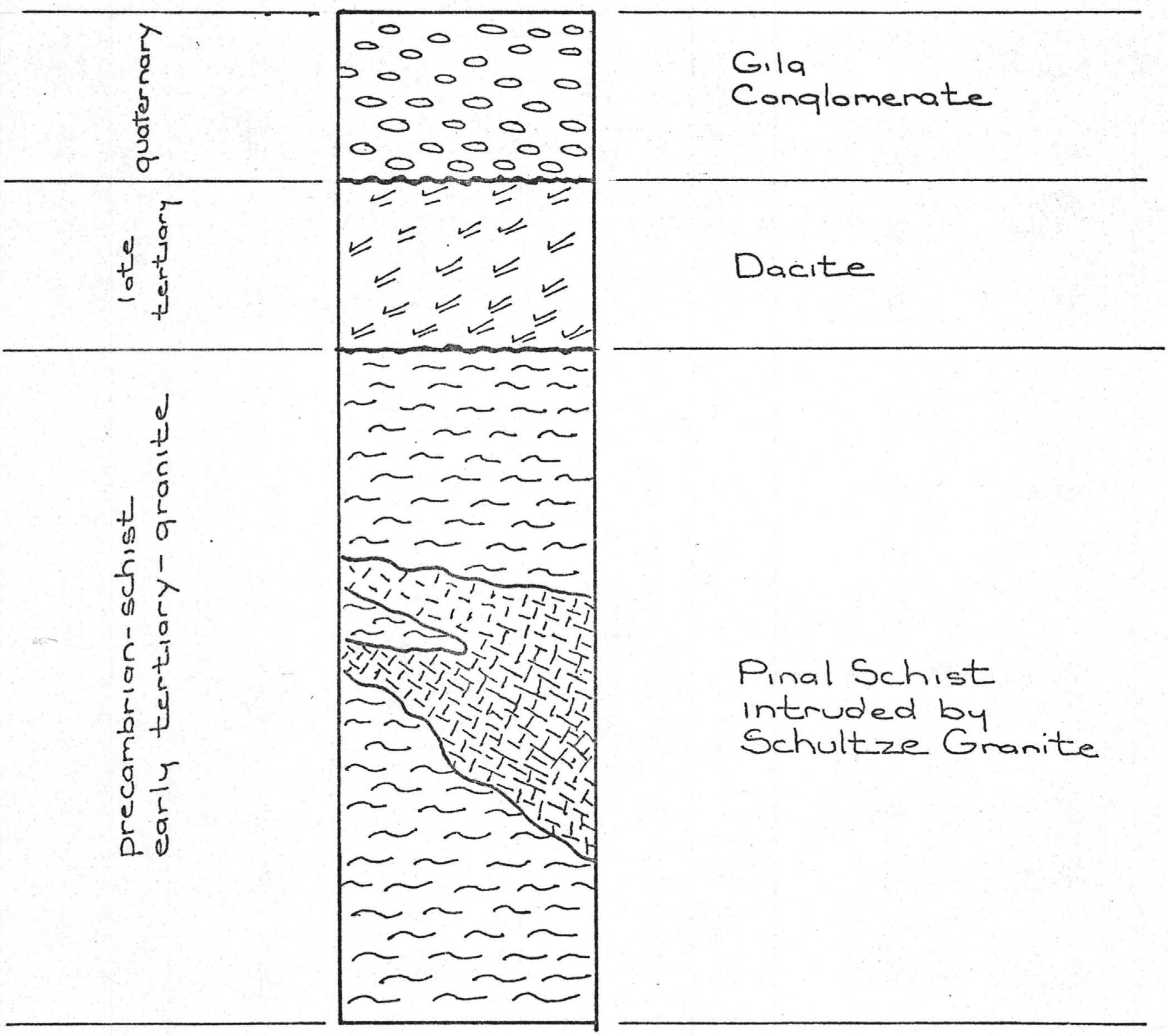


Figure 1
Location Map
Inspiration, Arizona



General
Stratigraphic Column
at
Inspiration, Arizona

Figure 3



Inspiration
Mine Area
1" = 1000'

Figure 2

TABLE A

TYPE	AGE	REMARK
1) Pinal Schist	Precambrian	Host Rock for approximately 1/2 of the ore mineralization
2) Schultze Granite	Early Tertiary	Intrudes the schist-host rock for approximately 1/2 of the ore mineralization
3) Dacite	Late Tertiary	Small remnants of dacite cap present
4) Gila Conglomerate	Quaternary	Moderately, cemented by caliche

There are two principal directions of faulting in the areas to be examined. Pre-ore faulting trends NW and dips steeply SW to 45° NE. Post-ore faulting trends NE and dips 25° to 60° SE. The Bulldog and Number Five Faults are of this type (See Figure 2). The Bulldog offsets the ore-body between the Thornton and Live Oak Pits, and ranges between 200 and 300 feet thick. It is apparent that all displacements in the areas of interest are due to normal faulting.

FAILURE BLOCK GEOMETRY

The pit wall failure in the northwest corner of the Thornton Pit (Figure 4) is governed by the Bulldog and Joe Bush Faults. The Bulldog strikes N 24° E and dips 28° SE while the Joe Bush strikes N 30° W to N 50° W and dips 83° SW. In places the hanging wall of the Bulldog has been penetrated into the fault zone by mining. Where the pit slope has been flattened, a basal failure plane exists. This failure plane strikes N 20° E and dips 13° SE. This plane is a joint set established by running a detail line along the north side of the pit in the hanging wall of the faults. The existence of such a mode of failure has been established within a probability of 98%.

A second failure block exists on the northwest corner of the Live Oak Pit (Figure 5). This zone of subsiding ground is bounded on the north and west sides by the Number Five Fault. This fault trends N 40° E, 35° SE on the north side of the failure and turns onto a N 18 W, 85° NE trend on the west side. A set of headwall cracks forms the east margin of the subsiding ground. These cracks are comprised of two intersecting predominant joint sets. The first trends N 70° W, 68° NE and the second, N 69° W, 45° SW.

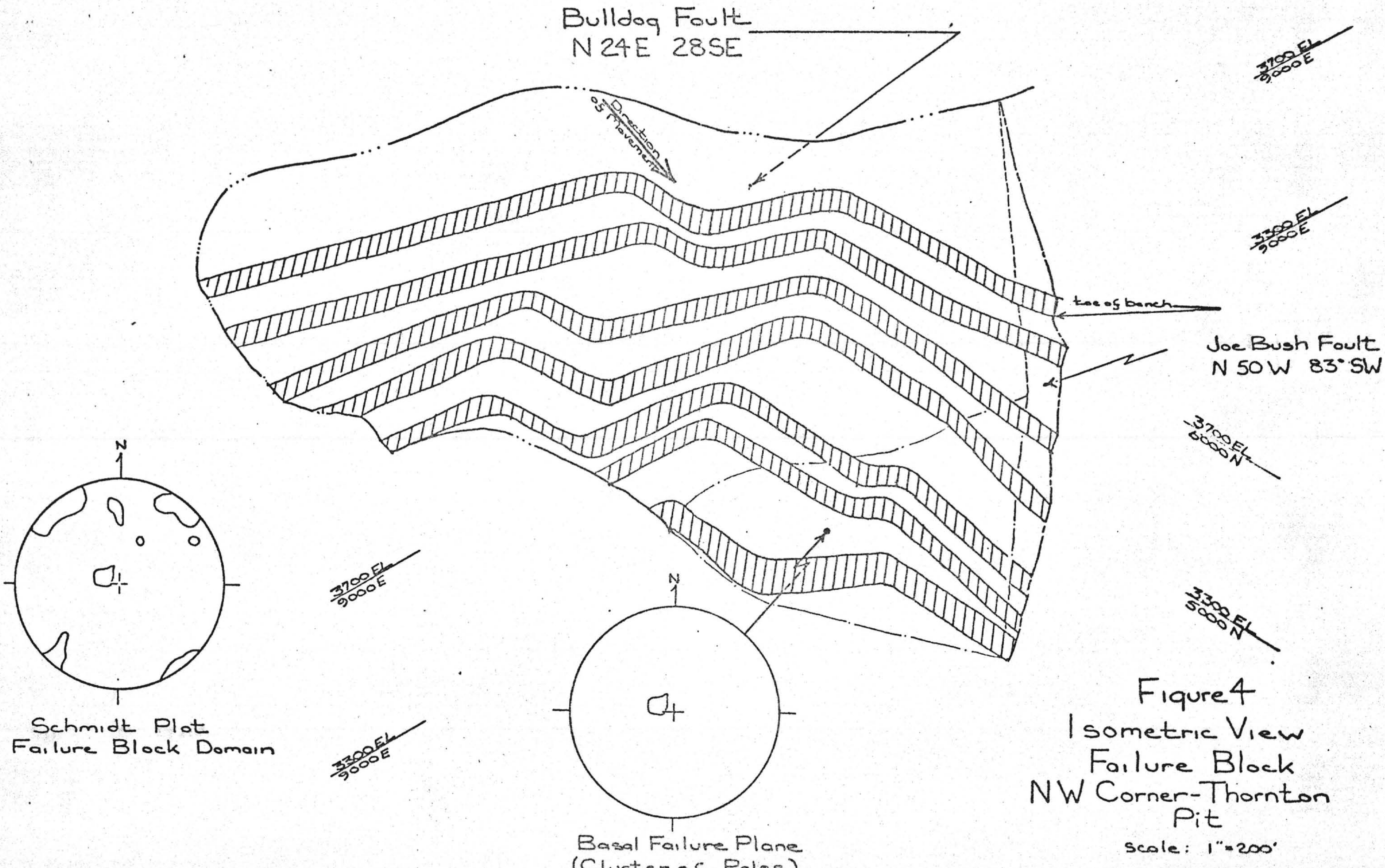


Figure 4
Isometric View
Failure Block
NW Corner-Thornton
Pit

Scale: 1" = 200'

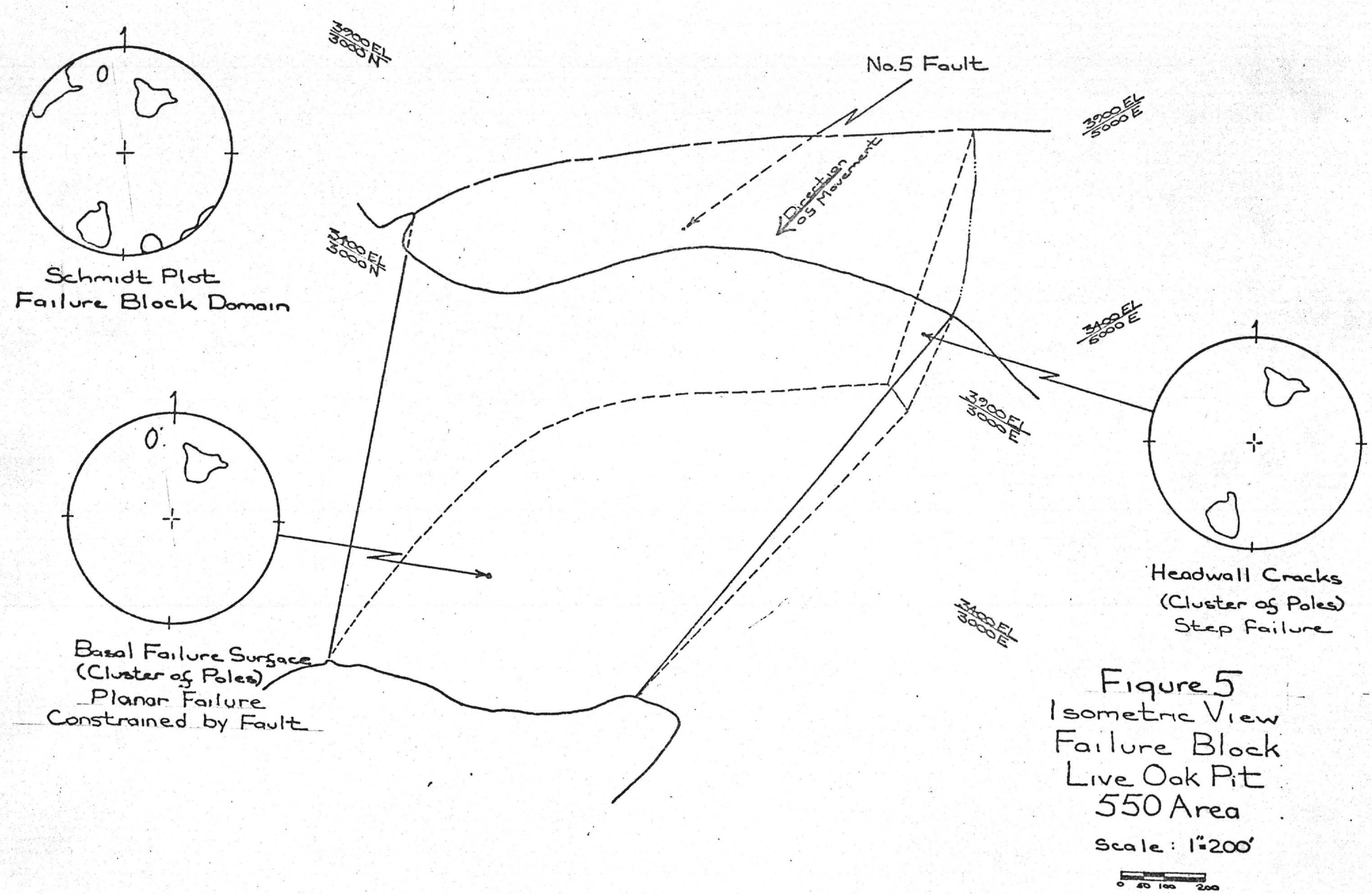


Figure 5
Isometric View
Failure Block
Live Oak Pit
550 Area

Scale: 1"=200'

Since the fault is not daylighted, the subsiding ground must be moving along a basal plane of failure. From a detail line along the north wall of the Live Oak Pit, it appears, within a probability of 99.9%, that a joint set exists which strikes N 69° W and dips 45° SW. It is along the intersection of this joint set and the #5 Fault plane that the movement takes place. The direction of movement is S 18° E which coincides with the plunge of the intersection.

It has been suggested that the mode of failure is a joint set gently dipping to the northwest due to heaved ground found at the toe of the slide. From the evidence gathered from detail line work, this failure mode does not seem likely. There is no statistically valid evidence of the existence of such a joint set. The heaved ground is probably the result of broken, subdrilled rock being displaced by the sliding mass above.

HISTORY OF SLOPE STABILITY PROBLEMS

The moving ground in the northwest corner of the Thornton Pit is of critical importance due to the proximity of its margins to the primary and tertiary crushers. The formation of headwall cracks east of the primary crusher was first noted as early as 1956. Steel pins were placed on opposite sides of the cracks and displacement between which, readings were taken. Movement continued during the early and middle 1960's as the hill between the pit and the primary crusher was mined. Headwall cracks continued to develop, "slumping" occured along the Bulldog Fault and cracking with subsequent ground movement developed between the pit and Joe Bush Fault.

Until Fall, 1969, movement in this area was of little consequence. However, at this time the tension cracks had proceeded to within 10 feet of the primary crusher base and these cracks exist for approximately 1000 feet in strike along the Bulldog Fault zone. A consultant from Anaconda's Mining Research Department was solicited and among his proposals are the following:

1) Move the primary crusher as soon as possible.
2) Drill the Bulldog fault zone for assay valves.
3) Mine out the fault zone and establish a new pit slope 300 to 400 feet to the west.
4) Establish a monitoring system. (Figure 6).

A monitoring system of 26 triangulation pins was established.

In the meantime, an increasing number of tension cracks developed adjacent to the road across from the tertiary crusher. It was evident at that time this crushing plant, also, should be moved.

Movement accelerated during the winter of 1970. Tension cracks had progressed within 30 ft. of the tertiary crusher. The accelerated break-up of this area is partially attributed to a decrease in rock mass strength due to increased pore water pressure. This was caused by seepage from Webster Wash, to the north of the crushing plant and runoff from precipitation flowing into the newly formed tension cracks. To prevent seepage from precipitation, the cracks were filled and the area affected was graded. Intermittent stream flow in the wash was restricted by a small holding dam upstream.

To decelerate the movement of the failed block, it was decided to leave a buffer zone in the hanging wall. This was attained by maintaining

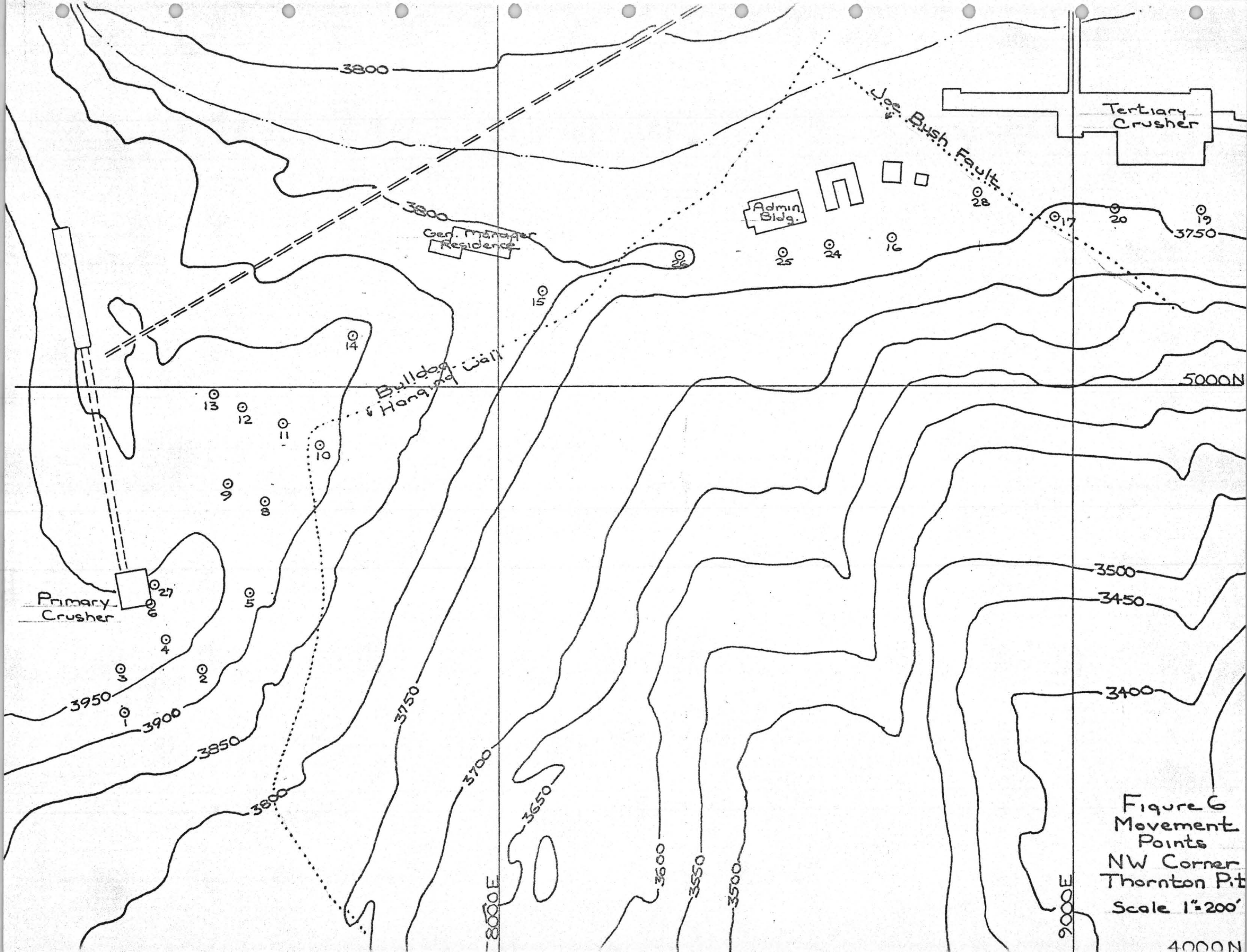


Figure 6
Movement Points
NW Corner
Thornton Pit
Scale 1" = 200'

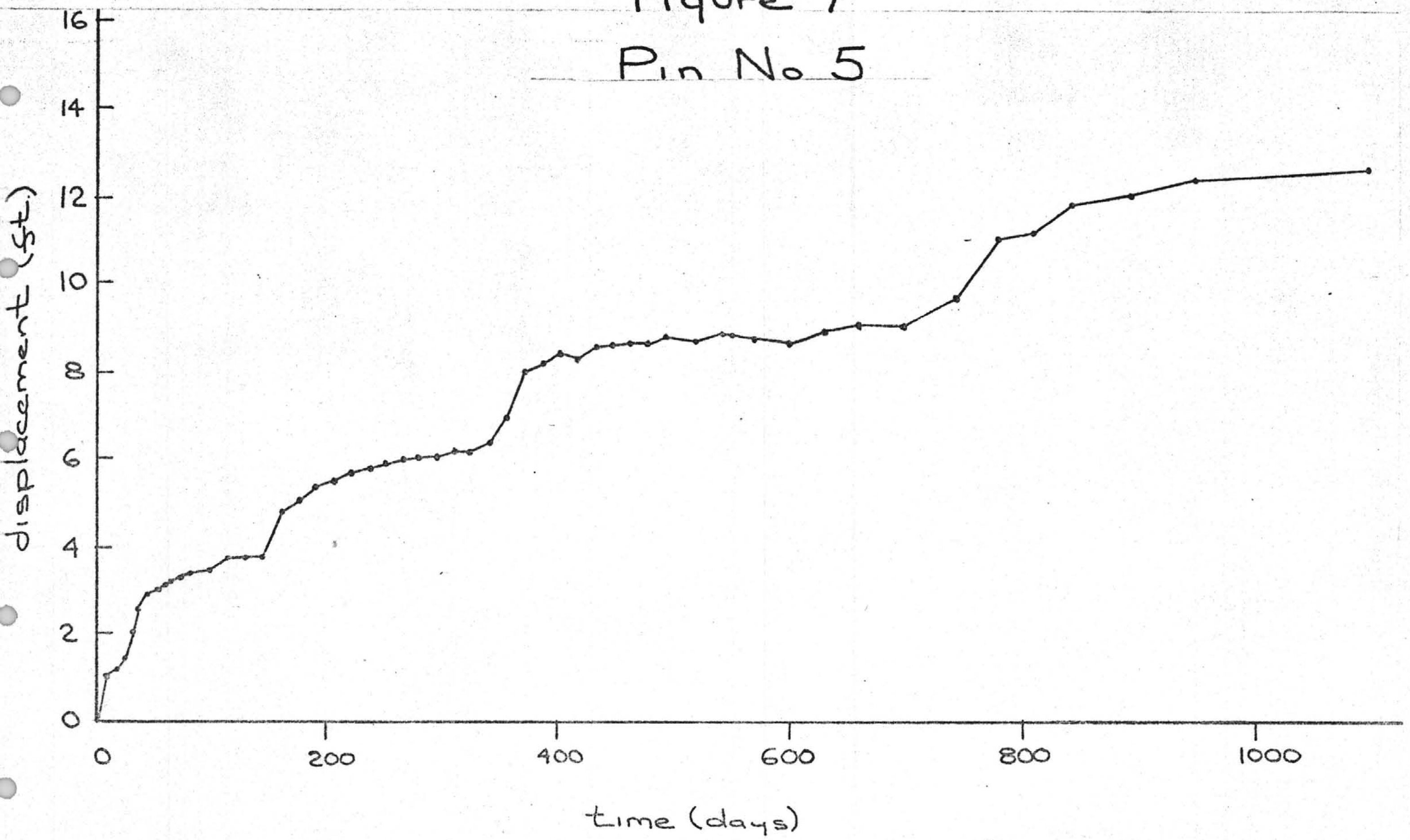
a flatter slope angle near the fault. This action was successful in ceasing movement along the north side of the pit. The cost was high in that a sizeable tonnage of previously stripped ore is tied up. This deceleration can be noted in the cumulative displacement plot of Pin No. 17 (Figure 7) which lies directly south of the tertiary crusher. Mining along the west side of Thornton Pit has, in places, progressed within a short distance of the Bulldog Fault resulting in movement. Pin No. 5 indicates the magnitude of displacement in this area (Figure 7).

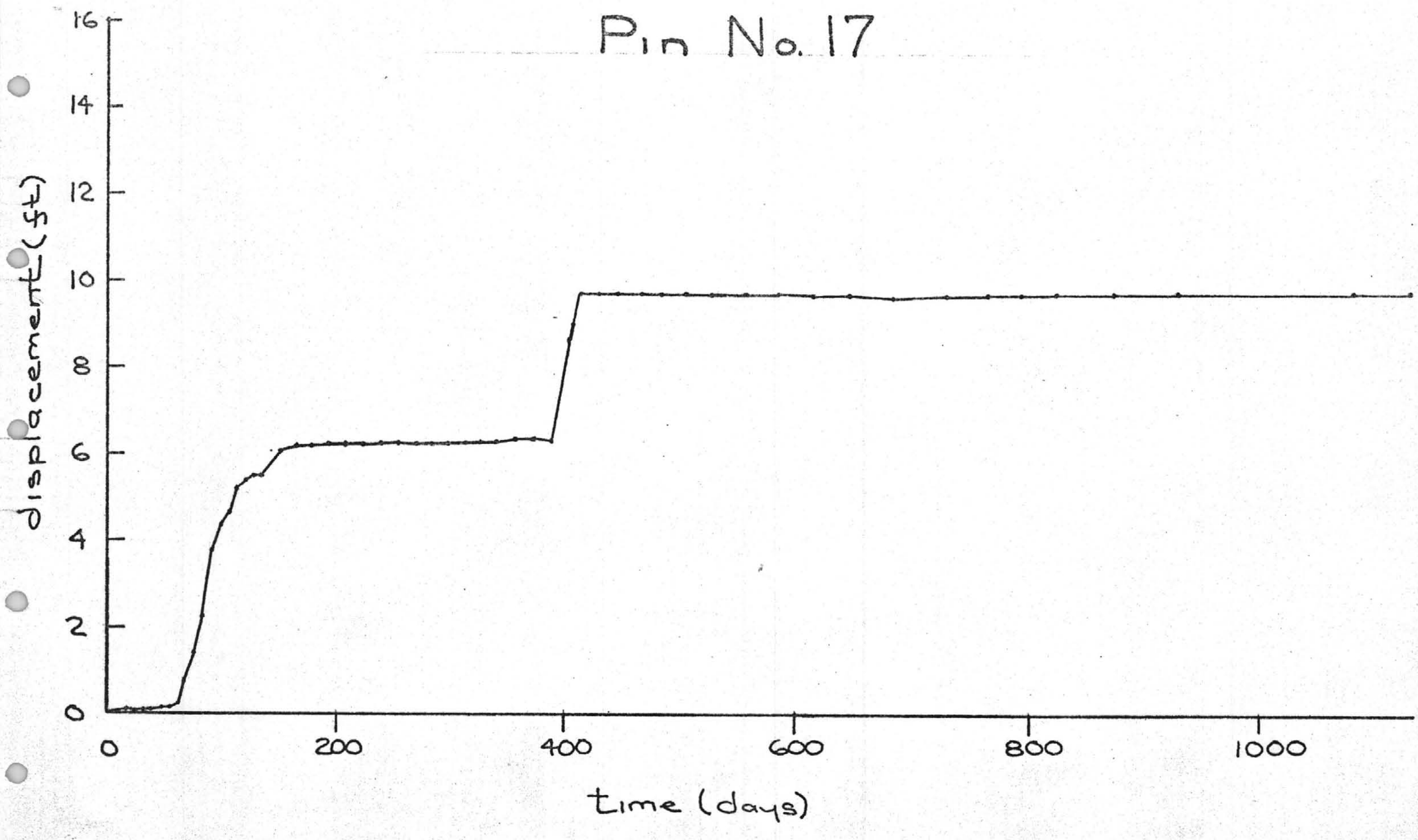
The failure in the Live Oak Pit (the 550 Area) has been of less importance from an operation's standpoint. A displacement of approximately two feet along the No. 5 Fault resulted from prior subsidence caused by the block caving operation. As early as the early 1960's, ground movement in the 550 Area has been a nuisance. Although the ground movement has caused some operational problems, it has not meant tieing up a large tonnage of ore. Displacement has been immense. Survey Station P-215 has moved over 100 feet in elevation since its establishment in 1954 (Figure 8). Pins now straddle the "plane of failure" and displacement readings are taken on a weekly basis. Figure 9 illustrates the vertical displacement of the failure block over a short time span.

CONCLUSION

The geometry of potential planes of failure is critical to pit slope design. A slope failure may only provide an annoyance or it could cripple an operation. Therefore, the evaluation of geologic factors is paramount in determination of a pit slope.

Thornton Pit
Horizontal Displacement
Slope Stability Points
Figure 7





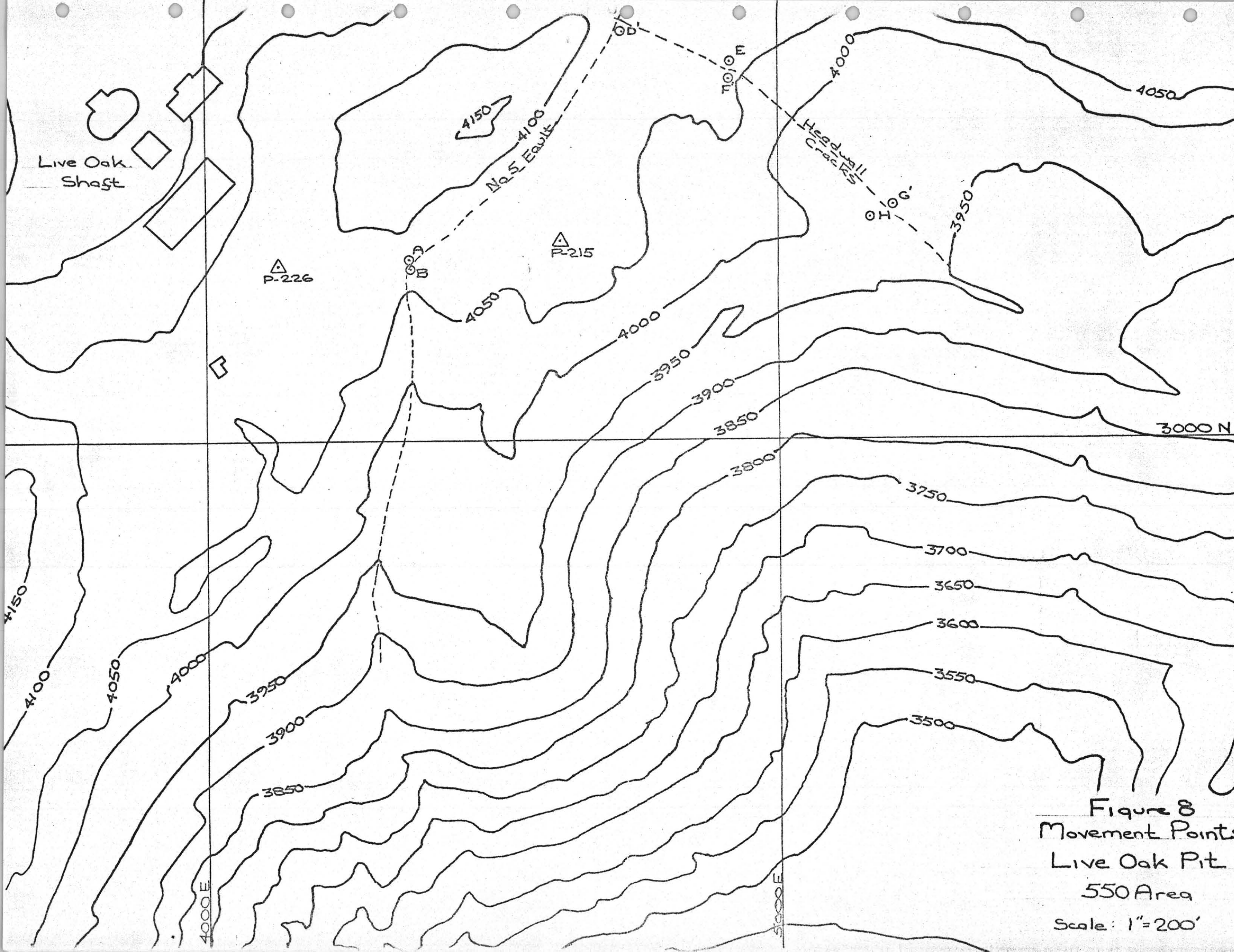
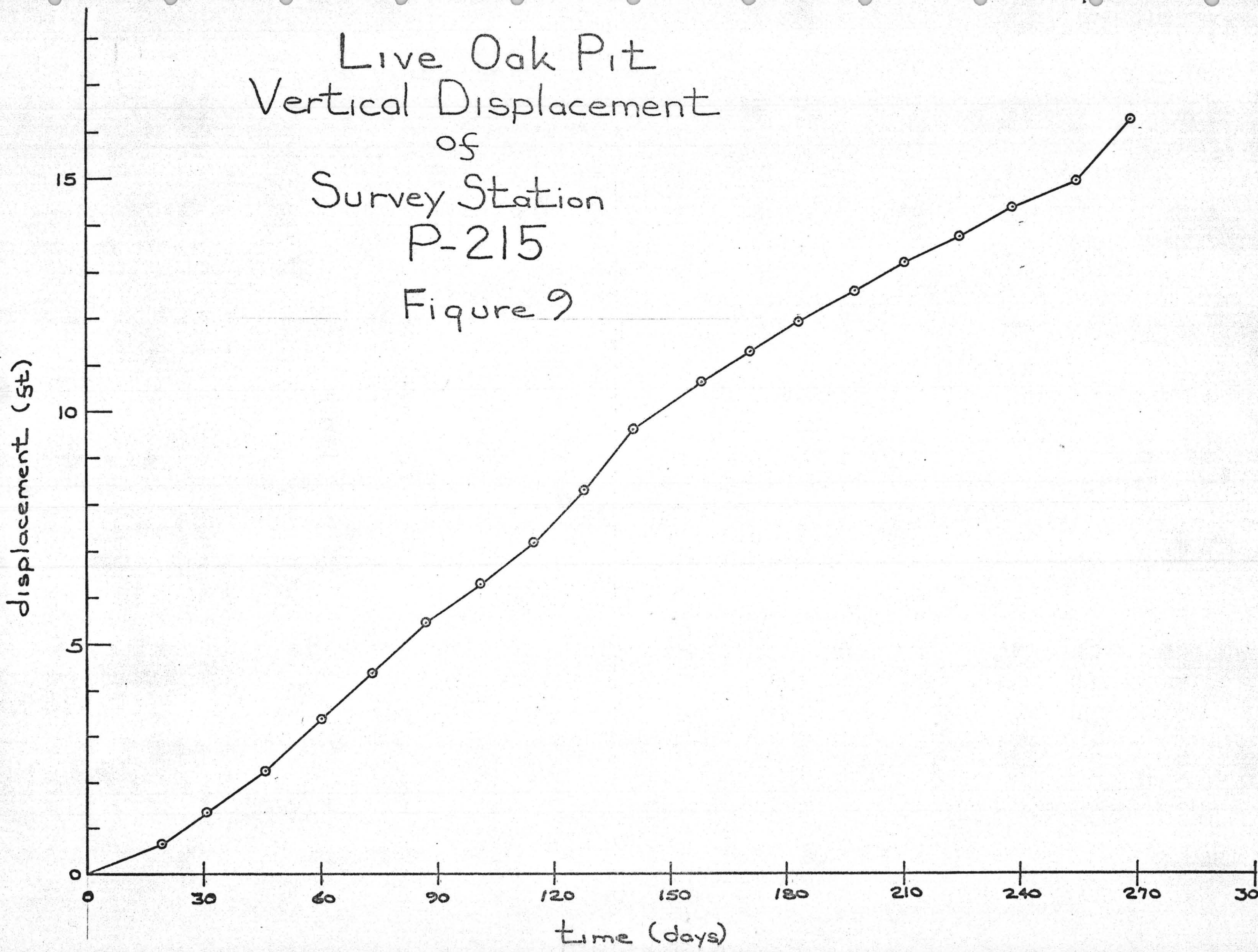


Figure 8
Movement Points
Live Oak Pit
550 Area
Scale: 1" = 200'


Live Oak Pit
Vertical Displacement
of
Survey Station
P-215
Figure 9
displacement (ft)
0
5
10
15
0
30
60
90
120
150
180
210
240
270
300
time (days)

INSPIRATION CONSOLIDATED COPPER COMPANY
Inspiration, Arizona

November 28, 1973

OPEN PIT EQUIPMENT

Shovels:

2 - P & H Electric, Model 1400	5 yd.
2 - P & H Electric, Model 1500	6 yd.
1 - P & H Electric, Model 1600	8 yd.
3 - P & H Electric, Model 1900	10 yd.

Haulage Trucks:

19 - 37 SL Dart Trucks	37 tons
3 - M85 Electra Haul	85 tons
1 - D2772 Dart	100 tons
1 - M70 Mack	75 tons
11 - D2562 Dart	75 tons
8 - Wabco 85C	85 tons
9 - Wabco 85C (March 1974)	85 tons

Front End Loaders:

3 - Caterpillar 992 (Rental)	10 yd.
1 - Caterpillar 988	6 yd.

Drills:

4 - T750 Rotary Drills CP	9" hole
1 - Joy-Beaver Mobile Drill	

Motor Graders:

3 - Caterpillar #16

Wheel Dozers:

5 - Caterpillar 824B
2 - Caterpillar 814

TIRE SHOP

1 - Tire Service Truck
1 - Hyster Forklift

HEAVY DUTY REPAIR

1 - Ford 2-ton Truck

WELDING SHOP

6 - Portable Welders
1 - 2-Ton Truck
1 - 1-Ton Truck

OPEN PIT SURFACE

1 - 3/4 Ton Stake
1 - 2-Ton Flatbed

SUPPORT EQUIPMENT

27 - Pickups
1 - Sedan
1 - Bronco
2 - Man Trucks
1 - Powder Truck
1 - Shovel Cable Truck

DUMP LEACHING

1 - Euclid 2.95 yard Front End Loader
1 - Hough 2.5 yard Front End Loader
1 - Terex 4.0 yard Front End Loader
1 - 25-ton B. E. Crane
1 - Marion Dragline

Crawler Tractors:

1 - Caterpillar 46A D-8
3 - Caterpillar D-9

Water Trucks:

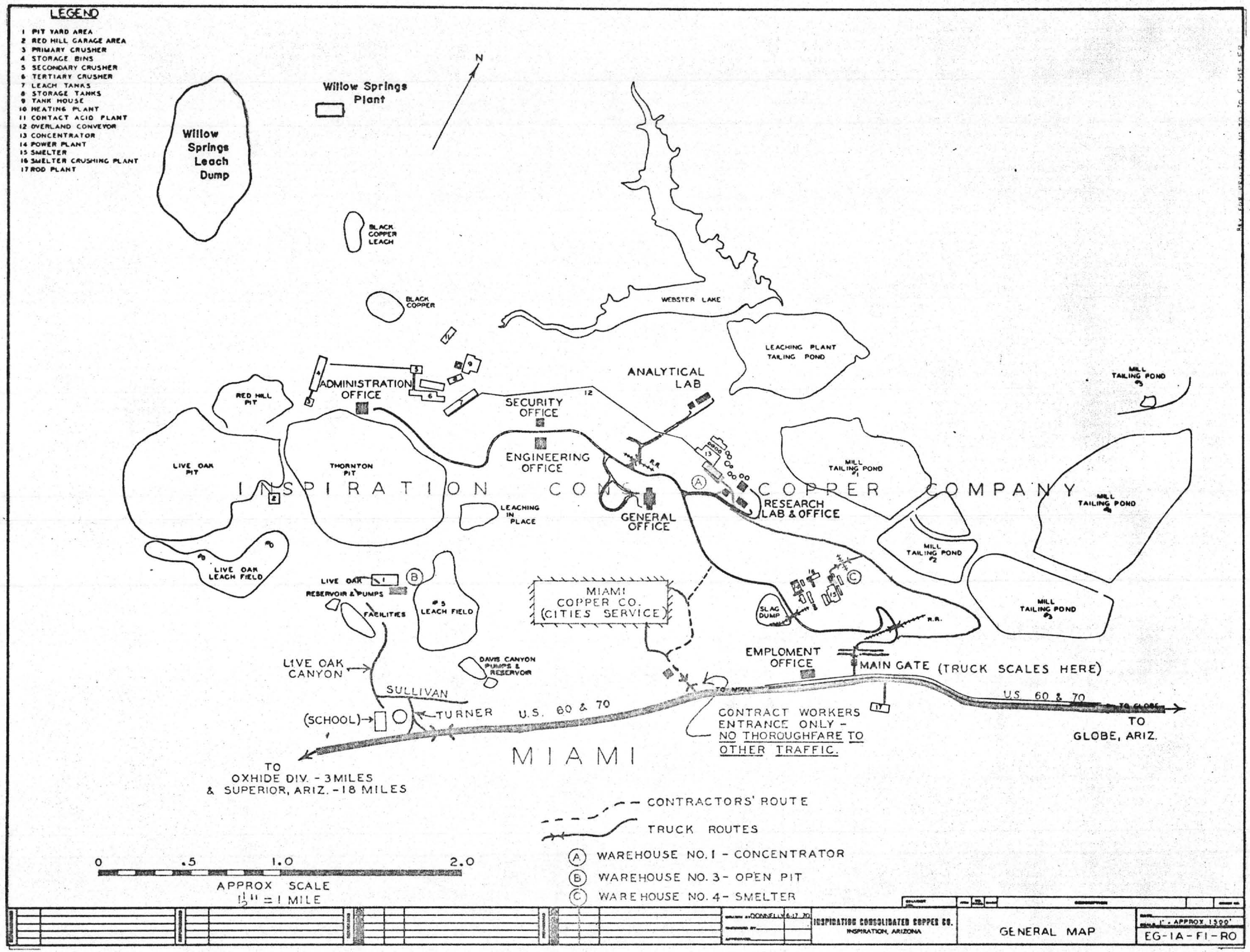
2 - 8,000 Gal
4 - 6,000 Gal
1 - 2,000 Gal

Service and Fuel Trucks:

1969 International 2-ton Service Truck
355L Fuel Truck
1972 Ford 2-Ton Lube Service Truck
1963 2-Ton Ford Heavy Duty & Fuel Truck
1969 2-Ton Ford Lube Service Truck

GARAGE

5 - Portable Pumps
1 - P & H 15-ton Crane (Rental)
1 - P & H 30-Ton Crane
1 - Austin Western 5-Ton Crane
1 - Galion 12 1/2 Ton Crane
4 - Hyster Forklifts
2 - Hyster Karry Cranes
3 - Portable Compressors


LEGEND
1 PIT YARD AREA
2 RED HILL GARAGE AREA
3 PRIMARY CRUSHER
4 STORAGE BINS
5 SECONDARY CRUSHER
6 TERTIARY CRUSHER
7 LEACH TANKS
8 STORAGE TANKS
9 TANK HOUSE
10 HEATING PLANT
11 CONTACT ACID PLANT
12 OVERLAND CONVEYOR
13 CONCENTRATOR
14 POWER PLANT
15 SMELTER
16 SMELTER CRUSHING PLANT
17 ROD PLANT
N
Willow Springs Plant
Willow Springs Leach Dump
BLACK COPPER LEACH
BLACK COPPER
WEBSTER LAKE
LEACHING PLANT TAILING POND
ANALYTICAL LAB
MILL TAILING POND #3
RED HILL PIT
ADMINISTRATION OFFICE
SECURITY OFFICE
ENGINEERING OFFICE
LIVE OAK PIT
THORNTON PIT
INSPIRATION CONS COPPER COMPANY
LEACHING IN PLACE
GENERAL OFFICE
RESEARCH LAB & OFFICE
MILL TAILING POND #1
MILL TAILING POND #4
MILL TAILING POND #2
MILL TAILING POND #3
R.R.
LIVE OAK LEACH FIELD
LIVE OAK RESERVOIR & PUMPS
FACILITIES
#5 LEACH FIELD
MIAMI COPPER CO. (CITIES SERVICE)
SLAG DUMP
DAVIS CANYON PUMPS & RESERVOIR
LIVE OAK CANYON
SULLIVAN
(SCHOOL)
TURNER
U.S. 60 & 70
EMPLOMENT OFFICE
MAIN GATE (TRUCK SCALES HERE)
U.S 60 & 70
TO GLOBE
TO GLOBE, ARIZ.
CONTRACT WORKERS ENTRANCE ONLY - NO THOROUGHFARE TO OTHER TRAFFIC.
MIAMI
TO OXHIDE DIV. - 3MILES & SUPERIOR, ARIZ. - 18 MILES
CONTRACTORS' ROUTE
TRUCK ROUTES
(A) WAREHOUSE NO. 1 - CONCENTRATOR
(B) WAREHOUSE NO. 3 - OPEN PIT
(C) WAREHOUSE NO. 4 - SMELTER
0 .5 1.0 2.0
APPROX SCALE
1½" = 1 MILE
INSPIRATION CONSOLIDATED COPPER CO.
INSPIRATION, ARIZONA
GENERAL MAP
1" = APPROX 1300'
EG-1A-F1-RO