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File Duval

UNITED STATES

Arizona . . .

Esperanza and Ithaca Peak ore grades, reserves, and costs

A comparison of the data shown in the adjoining tables shows how close the ore grades, gross revenues, and total costs per ton are for these two major porphyry coppers.

Also shown are the costs for Duval's much newer and smaller Battle Mountain, Nevada, operations.

Esperanza has been in production since 1959 and at Ithaca Peak since the latter part of 1964.

Ithaca Peak proven ore reserves are the largest. As of December 31, 1967, reserves were 54,538,000 tons assaying 0.49 percent copper and 0.044 percent molybdenum. Esperanza reserves were 41,215,000 tons assaying 0.45 percent copper and 0.032 percent molybdenum.

Esperanza milling rate during the first nine months of 1969 was 14,700 tons per day; Ithaca Peak 17,100.

In 1965, 1966, and 1967, Duval produced 3.0, 3.0, and 6.0 percent of the newly mined copper in the United States and 5.0, 4.0, and 5.0 percent of the molybdenum.

Duval Corporation's Production of Leach Copper in Pounds for Esperanza, Ithaca Peak, and Battle Mountain Mines from 1963 through September 30 1968 Together with Production Costs per Pound

Year	*Pounds of Copper Produced*	*Leach-Precipitation Production Costs Per Pound of Copper*[1]
	ESPERANZA	
1963	3,764,000	$0.145
1964	4,969,000	$0.143
1965	4,355,000	$0.159
1966	5,909,000	$0.164
1967	6,132,000	$0.167
1968[2]	3,459,000	$0.212
	ITHACA PEAK	
1965	1,458,000	$0.151
1966	4,837,000	$0.151
1967	7,005,000	$0.146
1968[2]	5,146,000	$0.184
	BATTLE MOUNTAIN	
1967	2,290,000	$0.234
1968[2]	3,287,000	$0.278

1. Operating costs include smelting and refining costs but exclude mining costs of leach material and depreciation of the leach-precipitation plants. Depreciation of the leach-precipitation plants was (in thousands of dollars) $46, $48, $52, $52, $57, and $43 for the years 1963, 1964, 1965, 1966, 1967, and the nine months ended in September 30, 1968, respectively, at Esperanza; $21, $30, and $23 for the years 1965, 1966, 1967, and for the nine months ended September 30, 1968, respectively, at Ithaca Peak; and $70 and $54 for the year 1967 and for the nine months ended September 30, 1968, respectively, at Battle Mountain.
2. First nine months.

Duval's subsidiary, Duval Sierrita Corporation, is developing the new 72,000 ton per day Sierrita copper-molybdenum mine adjacent to Esperanza. This will be the world's largest initial daily capacity copper mine and mill ever put in production.

Duval's third major base metal operation at Battle Mountain, Nevada, operates on a much smaller scale treating higher

Duval Corporation's Record of Tons Mined and Milled, Metal Contents per Ton, Gross Revenue per Ton, and Total Costs per Ton at Esperanza, Ithaca Peak, and Battle Mountain from 1963 through September 1968

Year	*Tons Ore*	*Metal Content, Percent* Copper	*Molybdenum*	*Gross Revenue Per Ton*[1]	*Costs Per Ton*[1]
		ESPERANZA			
1963	4,222,000	0.60	0.019	$3.64	$2.74
1964	4,131,000	0.56	0.024	$3.77	$2.77
1965	4,066,000	0.56	0.024	$4.09	$2.82
1966	4,207,000	0.58	0.024	$4.19	$2.90
1967	4,977,000	0.52	0.023	$4.35[3]	$2.93[3]
1968[4]	4,039,000	0.50	0.029	$4.62[3]	$2.94[3]
		ITHACA PEAK			
1964	387,000	0.47	0.027	$1.73	$1.51
1965	4,660,000	0.46	0.030	$3.72	$2.46
1966	5,379,000	0.51	0.032	$4.09	$2.53
1967	5,632,000	0.52	0.037	$4.86[3]	$2.89[3]
1968[4]	4,692,000	0.51	0.038	$4.63[3]	$2.93[3]
		BATTLE MOUNTAIN			
1967[5]	577,000	0.81	—	$7.12	$13.45
1968[4]	982,000	0.74	—	$5.77	$5.36

1. Excludes revenues from leach-precipitate operation.
2. Includes the cost of mining leach material and all mining, milling, smelting, refining, and indirect operating costs, but excludes depreciation, depletion, and interest. Depreciation and depletion cost per ton milled at Esperanza was 28¢, 27¢, 32¢, 39¢, 34¢, and 36¢ for the years 1963, 1964, 1965, 1966, and 1967 and for the nine months ended September 30, 1968, respectively; at Ithaca Peak 20¢, 44¢, 50¢, 44¢, and 49¢ for the years 1964, 1965, 1966, and 1967 and for the nine months ended September 30, 1968, respectively; and at Battle Mountain 88¢ and 80¢ for the six months ended December 31, 1967, and the nine months ended September 30, 1968, respectively.
3. During the latter part of 1967 and the first three months of 1968, Duval found it necessary to sell its copper concentrates and precipitates in the foreign market due to a work stoppage at the domestic smelters to which it normally shipped such products. During this period of time, the prices received were substantially higher than prices theretofore prevailing. A portion of the premium price received was absorbed by higher transportation and treatment costs. With the settlement of the strike at the smelters normally receiving Duval's copper production, which occurred in April 1968, Duval resumed its shipments to such domestic smelters.
4. First nine months.
5. Six months.

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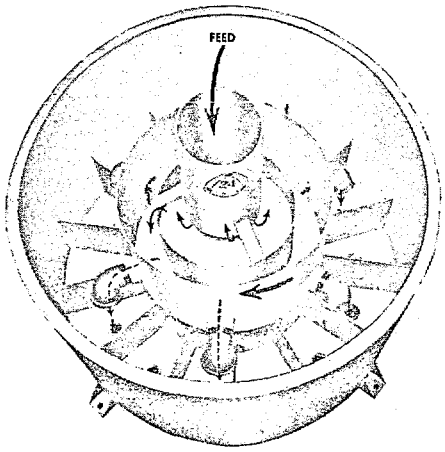

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~~JJC. WLK~~ JHC file
Mineral Park?

The

CRYSTALLIZATION, ALTERATION, and MINERALIZATION

of the

ITHACA PEAK INTRUSIVE

WALLAPAI MINING DISTRICT, MOHAVE COUNTY, ARIZONA

J. E. K.
MAY 25 1966

J. H. C.
MAY 24 1965

J. James Eidel

Protone 1% cu
at Ithaca Pk

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INTRODUCTION

Duval Corporation's Mineral Park property is located in the Wallapai Mining District approximately 16 miles north of Kingman, Arizona and 24 miles west of the Grand Wash Cliffs. The triumvirate of quartz monzonite intrusives, Ithaca Peak, Gross Peak, and Turquoise Mountain, form the core of the elliptical district whose axes trend 5 miles northeast and 20 miles northwest.

The earliest mining in what is now the Wallapai Mining District was for turquoise by Indians. Charcoal and stone hammers are still found in workings on Turquoise Mountain.

Gold was discovered in 1863 and concerted efforts to mine gold and silver began in the 1870's. The rich oxide zone silver chloride's were nearly depleted by the turn of the century and attention was diverted to argentiferous galena and sphalerite ores at depth.

Approximately $24,000,000 worth of gold, silver, lead, and zinc were produced through 1946. The Keystone Mine in Mineral Park was the last of over 225 mines and 1,000 prospects to close in 1948.

The porphyry copper-molybdenum mineralization at Mineral Park was first drilled in 1906; the first production, however, was in November 1964 by Duval.

The present mining operation is confined to Ithaca Peak, which was the highest at 5,200' and the easternmost of the above mentioned triumvirate of intrusives. This discussion will also be confined to Ithaca Peak and will be concerned with the petrology, theory of origin, mineralization, alteration, and structure of the Ithaca Peak intrusive.

ACKNOWLEDGEMENTS

The speaker wishes to emphasize the fact that the majority of the surface mapping was done by D. Clippinger and J. E. Frost. K. Martin, I. B. Gray, R. Sayers, and E. H. Lewis also contributed to the early mapping and logging. Dr. H. A. Schmitt

supervised the exploration phase. Discussions with J. E. Frost, D. Clippinger, H. A. Schmitt, and W. J. Roper have influenced the interpretation presented in this paper.

GEOLOGY

General

Quartz monzonitic magmas have intruded the Precambrian chlorite-biotite schists, amphibolite, and granite gneiss which comprise the Cerbat Complex. The copper-molybdenum mineralization is confined to the intrusives and their immediate environs.

The contacts of the Ithaca Peak stock with the Cerbat Complex are steeply dipping. The quartz monzonite magma was not chilled and is not foliated at the contact. The Cerbat Complex metasediments were deformed at the contact. These facts indicate that the quartz monzonites were forcibly intruded and then differentiated and crystallized in place.

The quartz monzonitic Ithaca Peak stock was extensively deuterically altered; it was then shattered and mineralized and altered by hypogene and supergene solutions. Finally, northwest trending vein-faults which are characteristic of the entire district were formed. These silver-lead-zinc veins also transect the Ithaca Peak stock.

The intensity of the deuteric, hypogene, and supergene alteration has made it impossible to obtain modal analyses to date.

GEOLOGY

Igneous Petrology:

Quartz diorite (?)

The quartz diorite (?) consists of small discordant injections into the Cerbat Complex and of a 5 to 10 foot rim containing inclusions of the Cerbat Complex. Weathered exposures of the quartz diorite (?) have been exposed at the north and northeast contacts of the Ithaca Peak stock and the Cerbat Complex. It should be emphasized that the volume of the quartz diorite (?) is very small when compared to the volume of the Ithaca Peak stock.

The quartz diorite (?) has a medium grained, subhedral granular texture. It is composed of red-brown biotite and/or hornblende, calcic plagioclase, and minor orthoclase and quartz.

The igneous texture, the presence of euhedral accessory minerals characteristic of igneous rocks, and the presence of inclusions of the Cerbat Complex attest to the igneous origin of the quartz diorite (?). The compositional differences between the quartz diorite (?) and the quartz monzonites suggest that the quartz diorite (?) is a facies of the quartz monzonite that was contaminated by reaction with the Cerbat Complex.

GEOLOGY

Igneous Petrology:
Quartz monzonite and quartz monzonite porphyry

The quartz monzonite and quartz monzonite porphyry form a continuous intermediate zone, 250 - 1,000' thick, between the quartz diorite (?) rim and the quartz porphyry core.

There are no significant textural differences between the quartz diorite (?) and the quartz monzonite. The quartz monzonite and quartz monzonite porphyry are equivalent units but due to subtle variances in grain size, they have not been differentiated in the field.

The quartz monzonites and the quartz porphyry (described below) contain sericite pseudomorphs after euhedral micas and sericite and/or clay pseudomorphs after subhedral plagioclase in a matrix of fine grained, anhedral quartz and orthoclase. Pervasive sericitization and argillization has replaced all the primary plagioclase and mica in the quartz monzonites and in the quartz porphyry.

A biotite facies of the quartz monzonite occurs adjacent to a large xenolith or septa of Cerbat Complex metasediments near the north end of Ithaca Peak. This facies crops out for a distance of 2 to 200 feet normal to the contact with this xenolith. The biotite facies of the quartz monzonite is similar in all respects to the quartz

monzonite with the exception of the presence of red-brown biotite and somewhat stronger argillization. The biotite either is disseminated throughout the quartz monzonite or is restricted to the margins of veins leaving intravein areas that are void of biotite.

The restriction of the biotite to vein margins in some cases and its occurrence in the proximity of the Cerbat Complex suggest that the stability of the biotite may be due in part to contamination by the Cerbat Complex.

Accessory minerals in the quartz monzonites are rutile, apatite, and zircon.

GEOLOGY

Igneous Petrology:
Quartz porphyry

In contrast with the sometimes vaguely porphyritic quartz monzonite, the quartz porphyry forms the distinctly porphyritic core of the Ithaca Peak stock. The core is roughly elliptical with a northeast trending major axis of 2,000' and a northwest trending minor axis of 1,400'. Roughly in the center of the quartz porphyry is an elliptical area 700' by 500' which contains numerous quartz, aplite, and orthoclase pods and irregular veins as well as crenulate quartz veinlets in a matrix of quartz porphyry.

The quartz porphyry is characterized by quartz phenocrysts which range in size from 2 mm at the contact with the quartz monzonites to 15 mm, 20' to 100' from the contact. The sericitized and/or argillized plagioclase phenocrysts range from 5 to 10 mm and the sericitized mica phenocrysts are somewhat smaller. The grain size of these phenocrysts is greater than that of the quartz monzonites. The phenocrysts are contained in a matrix of fine grained, anhedral quartz and orthoclase.

Accessory minerals are rutile, apatite, and zircon.

Two small bodies of a biotite facies of the quartz porphyry are similar to the biotite facies of the quartz monzonite. The similarities suggest that these bodies may be almost completely digested xenoliths of the Cerbat Complex metasediments.

THEORY OF DIFFERENTIATION AND CRYSTALLIZATION

The consideration of the differentiation and crystallization of the Ithaca Peak stock is necessarily based upon evidence gathered from exposures in an essentially horizontal plane through what was the upper portion of a much larger igneous mass. This discussion is, therefore, restricted to a closed, planar system. No mobile components are assumed to have been introduced into this system until the late deuteric and hypogene stages. The successive igneous units are considered in the order in which they crystallized from the periphery toward the center of the stock.

The lack of significant disparity in grain size between the quartz diorite (?) and the quartz monzonites indicates that the quartz diorite (?) was not chilled at the contact with the Cerbat Complex metasediments. Significant reaction between the metasediments and the melt resulted in the disparity in the compositions of the quartz diorite (?) and the quartz monzonites.

Following this period of reaction with the Cerbat Complex, the melt was encased in a solid quartz diorite (?) rim and underwent normal differentiation following Bowen's reaction series. The composition of the quartz monzonites, disregarding the ferromagnesian components lay within the system Or-Ab-An-SiO_2. The micaceous texture of the fine grained sericite pseudomorphs after primary mica indicate that only hydrous ferromagnesian phases precipitated. As biotite and calcic plagioclase crystallized, the melt was gradually enriched in potash, silica, water and other low melting constituents. The vapor pressure within the melt gradually increased as the concentration of volatiles was increased in the remaining melt.

During the late stages of quartz monzonite crystallization, the composition of the melt approached the system Ab-Or-SiO_2-H_2O and the melt became supersaturated with respect to silica. Rounded quartz phenocrysts precipitated with alkali feldspars (composition inferred due to the intense alteration of the feldspars) and biotite. The quartz phenocrysts increased in size as the melt was enriched in silica. A cry-

stal mush developed within the nearly solid quartz monzonite shell. The composition of the remaining liquid approached the system $Or-SiO_2-H_2O$. No ferromagnesian components remained in the melt.

When the crystal-liquid ration in the mush contained within the solidified quartz monzonite shell was approximately 2:1, the vapor pressure exceeded the load pressure of the overlying and surrounding Cerbat Complex metasediments. The quartz monzonitic shell and the Cerbat Complex metasediments were ruptured. Potash and silica rich residual fluids were injected into the fractures and the groundmass of the quartz porphyry crystallized. Pressure equilibrium was rapidly attained; thermal equilibrium was not significantly disturbed.

The rapid decrease in pressure caused the remaining melt to quickly crystallize yielding a eutectic mixture of fine grained, anhedral quartz and orthoclase.

The extruded fluids, on the otherhand, crystallized as aplite and pegmatite veins in the quartz monzonite and the surrounding rocks. The lack of chilled margins at the contacts of these veins suggests that thermal equilibrium existed between the injected fluids and their wall rocks within the vicinity of Ithaca Peak. Movement of the semi-solid pegmatite masses created marginal leucocratic gneisses along the pegmatite contacts. The rhyolite dikes characteristic of the western portion of the Wallapai Mining District may represent chilled fluids of the same origin and composition as the aplites and pegmatites.

THEORY OF DEUTERIC CRYSTALLIZATION AND ALTERATION

Upon reviewing the use and definition of the term deuteric since its original definition by Sederholm in 1919, Robertson (1962, p. 1264) applied a more exacting definition to the term, one which was applicable to the silicic Boulder batholith and which is equally applicable to the Ithaca Peak stock. The high temperature limit of deuteric crystallization in intermediate and silicic igneous rocks is defined by "postgroundmass potassic feldspar crystallization".

Following the crystallization of the quartz-orthoclase groundmass of the quartz porphyry at Ithaca Peak, an aqueous intergranular phase existed in equilibrium with "pockets" of remaining, trapped liquid. These "pockets" of liquid crystallized as isolated masses of coarsely crystalline quartz and orthoclase with vague altered contacts with the wall rocks due to reaction with them.

The intergranular fluids deuterically altered the quartz porphyry groundmass forming oikocrysts or postgroundmass deuteric porphyroblasts of orthoclase which included groundmass quartz and orthoclase, and the mica and plagioclase phenocrysts. These oikocrysts have single dimensions as great as 6 inches.

Optically continuous quartz overgrowths on the primary quartz phenocrysts are also considered deuteric.

The large amounts of silica in the central portions of the quartz porphyry may represent the first mobile components introduced from below the system being considered or silicic fluids that were the final differentiate in place of the planar system described. The concentration of the gray-white quartz at the center of the quartz porphyry seems to favor the latter explanation. The pod-like and irregular configuration of the quartz masses suggests intrusion into what may have been semi-consolidated quartz porphyry. The dimensions of the quartz masses are tens of feet. The quartz contains trace amounts of pyrite and molybdenite.

Silica, in the vicinity of the quartz masses was also apparently injected into the quartz porphyry as sub-parallel, 1 - 3 mm thick, crenulate veinlets. These veinlets also suggest that the quartz porphyry may have been semi-consolidated at the time of their inception. Intergranular recrystallization within these veinlets, shearing of irregular protrusions from the veinlets, slightly biaxial quartz, and microfaults are all evidences of stress applied during and after the formation of the crenulate textures. The proximity of the crenulate quartz to the gray quartz masses suggests that they may have had a common origin by post differentiation injection.

HYDROTHERMAL MINERALIZATION AND ALTERATION

The lower temperature deuteric-hypogene boundary "is defined by the change from a stable-feldspar assemblage to an unstable-feldspar assemblage involving the alteration of feldspar to sericite and clay minerals" (Robertson, 1962, p. 1264). At Ithaca Peak the change from a stable to an unstable orthoclase assemblage is coincident with the first rupturing of the Ithaca Peak stock as a unit yielding a stockwork of throughgoing veinlets. The deuteric-hypogene boundary at Ithaca Peak is, therefore, both chemical and structural.

Three types of hypogene mineralization are recognized. Each succeeding type of mineralization occurs in fractures which transect the preceding type. Each succeeding type of mineralization was presumably precipitated at a lower temperature.

First Type: (Pyrite, replacement quartz)

Following the late-deuteric precipitation of minor amounts of pyrite and molybdenite in quartz pods and masses, vapor pressures again exceeded the load pressure and the now exposed portion of the Ithaca Peak stock ruptured, forming the first stockwork.

These earliest veinlets contain millimeter thick pyrite which filled the entire open space and is enclosed within bands of replacement quartz or soak silica and sericite. Orthoclase adjacent to the pyrite veinlets was replaced by sericite, probably yielding most of the replacement quartz. Some potash was introduced and lime and soda were removed from the quartz monzonite and the quartz porphyry. The primary micas were altered to white mica containing primary rutile and hydrothermal rutile, sphene, ilmenite and quartz.

The removal of iron from the primary micas provides a probable source for much of the iron in the pyrite veinlets. Part of the iron may, then, have been syngenetic and may have reacted with introduced sulfur.

Some molybdenite and probably some chalcopyrite were precipitated during this first period of mineralization.

HYDROTHERMAL MINERALIZATION AND ALTERATION

Second Type: (Pyrite, quartz)

The second type of mineralization followed a second period of rupturing which was, in general, areally coincident with the first period of rupture.

The second type of fractures contain quartz and pyrite. Quartz forms crude comb textures the center of which is filled with pyrite, coarse white mica, or supergene turquoise. The quartz in all cases preceded pyrite, chalcopyrite and molybdenite precipitation.

During the alteration associated with the second type of mineralization, iron, soda, and lime were leached from the stock and sulfur and potash were introduced.

The iron in solution may have reacted with introduced sulfur as suggested by the first type of mineralization. Pyrite which was less soluble than calcium sulfates in alkaline solutions, filled the vugs in the quartz veins.

Coarse white mica precipitated in some of the remaining open space.

Molybdenite was precipitated along the quartz vein selvages. Smaller amounts of molybdenite were precipitated in vugs in the quartz veins and within strongly altered vein margins. Chalcopyrite occurs as minute blebs and veinlets within the coarse grained pyrite.

The distinction between the first and second types of mineralization may be physical and not chemical. Pyrite, molybdenite, and probably chalcopyrite were deposited during both periods of mineralization. The extent and intensity of the associated alteration does differ between the two types of mineralization. The first type contains a small volume of fracture fillings with varied thicknesses of replacement quartz adjacent to the fractures in contrast to the much larger volume of fracture fillings with negible replacement quartz adjacent to the fractures of the second type.

It is suggested that the differences between the first two types of mineraliza-

tion may be a function of the reaction time of the hydrothermal solutions with the wall rocks. A lack of intensive replacement, therefore, may suggest throughgoing solutions, which did not have time to react with the wall rocks.

HYDROTHERMAL MINERALIZATION AND ALTERATION

Third Type: (Argentiferous galena, cupiferous sphalerite)

The third type of mineralization occurs within the Ithaca Peak stock as well as throughout the Wallapai Mining District. Within the Ithaca Peak stock several northwest trending veins contain sphalerite with exsolved chalcopyrite, argentiferous galena, minor covellite, and pyrite. The veins, in general, contain brecciated pyrite with post-brecciation sphalerite and galena; they represent the lowest temperature and latest hydrothermal mineralization within the Ithaca Peak stock.

The Wallapai Mining District is roughly a laterally zoned district with a peripheral zone of gold and silver mineralization, an intermediate zone of lead, zinc, silver, and minor gold mineralization and an intrusive core of copper-molybdenum mineralization with superimposed lead-zinc-copper-silver mineralization. This zonal distribution suggests that the mineralization of the northwest trending fissures was controled by thermal gradients and that as temperatures decreased later, lower temperature lead-zinc mineralization were superimposed upon the earlier, higher temperature copper-molybdenum mineralization.

SUPERGENE ENRICHMENT

Late movement brecciated the pyrite in some of the veins and veinlets in the northern and southern portions of the Ithaca Peak stock, exposing a much greater surface area of pyrite to supergene solutions, than in the veins and veinlets which suffered no movement. The chalcocite which coated pyrite surfaces is, therefore, the richest in the areas of brecciated pyrite.

Nearly all chalcopyrite was totally replaced by chalcocite within the blanket of enrichment.

The supergene enrichment has formed in irregular blankets, the top of which roughly conform to the topography of Ithaca Peak.

Roughly horizontal barren zones between thin blankets perched approximately 500 feet above the present water table have been explained by Schmitt (1962, p. 6) as attempts by the blanket to reach equilibrium during uplift. Schmitt (1962, p. 7) tentatively correlated the initial enrichment to a peridd of Late Miocene and Early Pliocene quiescence and the uplift to the Early Pliocene to Pleistocene uplift of the Colorado Plateau. Damon has suggested (1964, p. 1) that similar porphyry enrichment occurred during an Early Tertiary quiescent period preceding mid-Tertiary orogeny. The possibility remains that the ore body was exposed twice, which may explain some of the irregularities in the enriched zone. Erosion has dissected the initial blanket and the blanket migrated downward as evidenced by the thinner blankets now present. The fact that the blankets are now perched is evidence that equilibrium was never attained.

SYNOPSIS OF STRUCTURE

The Ithaca Peak, Gross Peak, and Turquoise Mountain intrusives may have been regionally controlled by the inferred Grand Wash fault 24 miles east of Mineral Park or by a parallel structure or structures. They may also have been influenced by other major Laramide lineaments.

At Mineral Park the intrusives may have been localized by the intersection of dominantly northwest trending foliation and northeast and northwest trending faults. Fold axes in the Cerbat Complex metasediments may also have localized the intrusives.

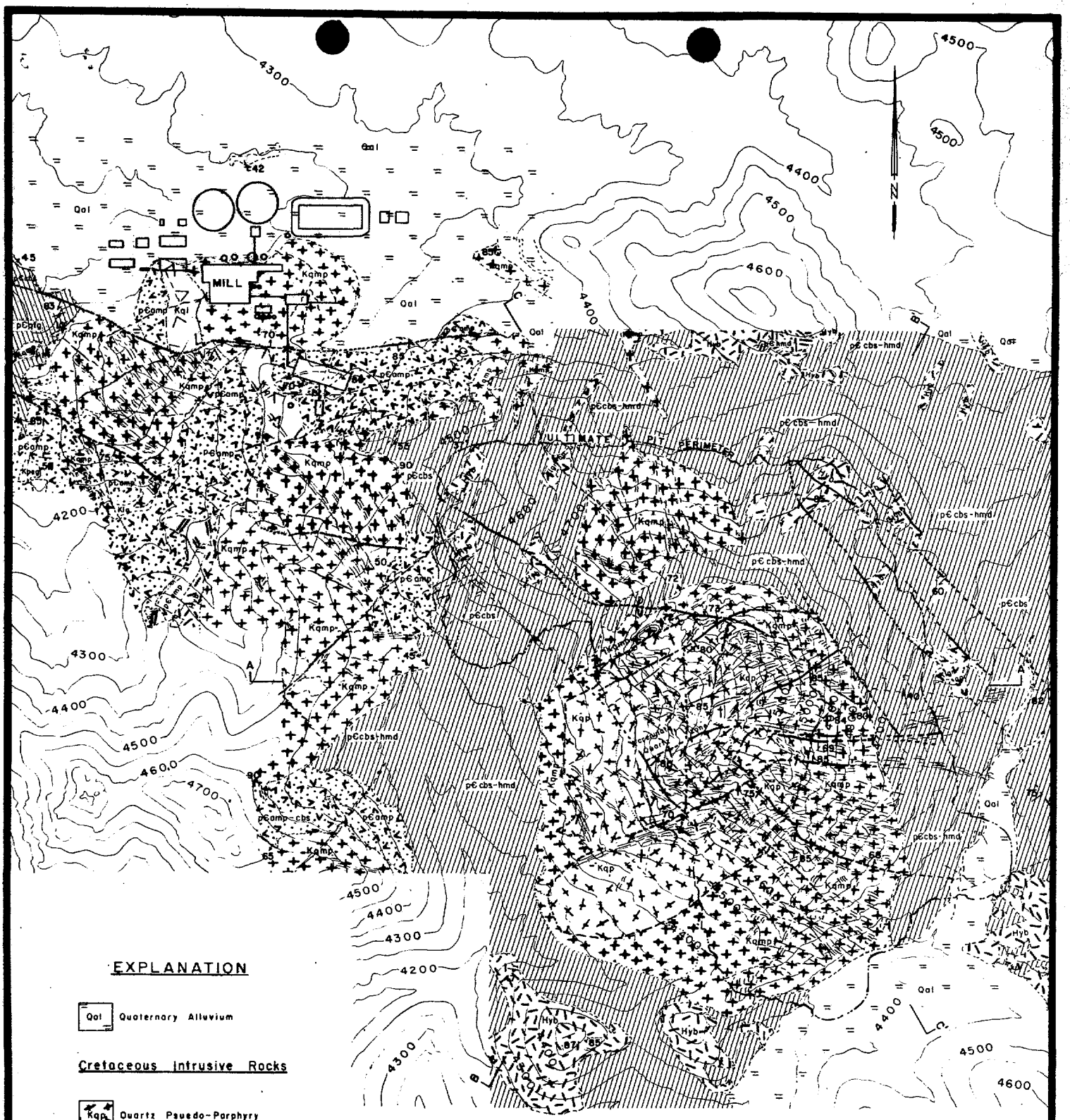
The intrusion and the crystallization of the monzonitic intrusives took place in a dynamic environment of regional stress. Local stress, however, developed during magmatic intrusion and later during crystallization due to increased vapor pressures.

Following the monzonitic intrusions, rhyolite intruded regional NNW-NNE trending structures in the western part of the district. Aplites and pegmatites discordantly

and concordantly intruded the Cerbat Complex metasediments in the vicinity of Ithaca Peak.

The Ithaca Peak stock itself was probably ruptured by stress developed by the crystallizing magma. The resultant stockwork is comprised principally of steeply dipping NE, NW, and EW trending veins and veinlets. The movement on the veins and veinlets in the northern and southern parts of Ithaca Peak was predominantly vertical. The central part of the intrusive underwent little movement.

The northwest trending vein-faults which occur throughout the Wallapai Mining District continue through the monzonitic intrusives. The vein and veinlet patterns of the stockwork are displaced by these vein-faults. These facts indicate that following the hydrothermal "healing" of the stockwork, the monzonitic intrusives and the Cerbat Complex metasediments reacted as a unit to regional stress. The pre-existing northwest trending structures in the Cerbat Complex were reopened, extended through the monzonitic intrusives, and then mineralized.



EXPLANATION

Qal — Quaternary Alluvium

Cretaceous Intrusive Rocks

- Kqp — Quartz Psuedo-Porphyry
- Kqmp — Quartz Monzonite Porphyry
- Kql — Quartz Latite
- Kpeg — Pegmatite
- Kqmd — Leucocratic Gneiss
- Kap — Aplite
- Hyb — Hybrid Rock (Kqmp & pЄcbs)

pЄ Cerbat Complex

- pЄqfg — Quartz-Feldspar Gneiss
- pЄcbs — Chlorite-Biotite Schist
- pЄamp — Amphibolite
- pЄhmd — Hornblende Metadiorite

Structural Symbols

- Fault, dashed where inferred
- Contact, dashed where inferred
- Shear Zone
- Schistosity

SCALE 1" = 800'

0 200 400 600 800 1200 1600

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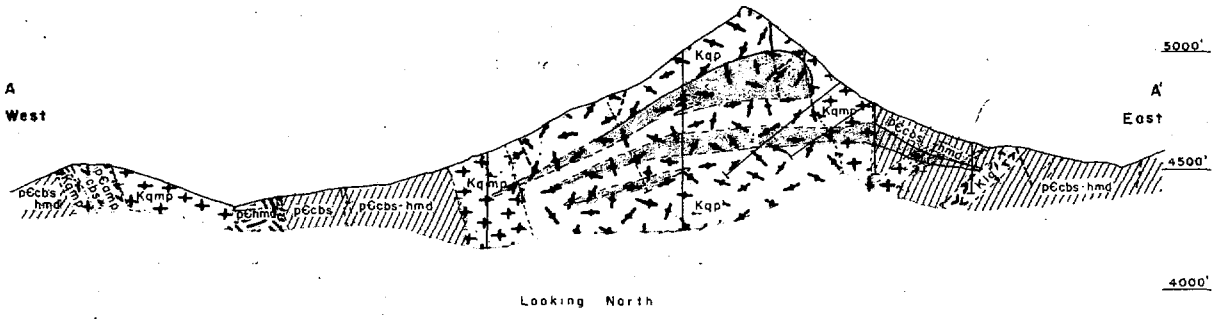
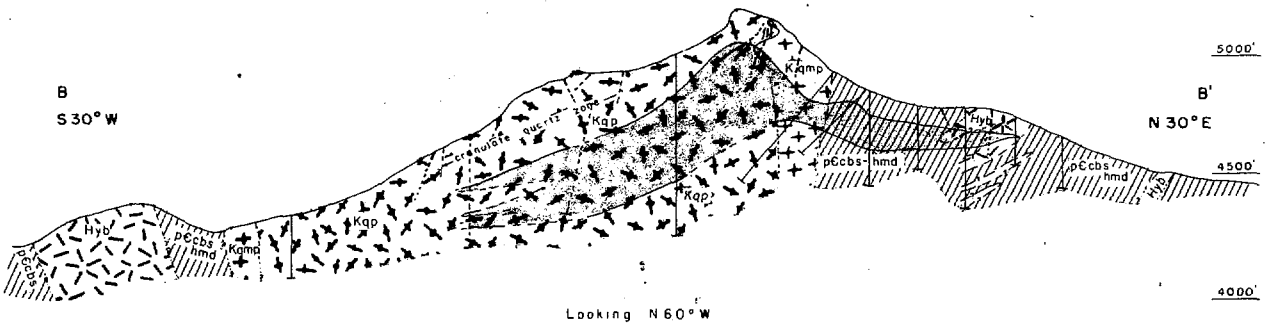
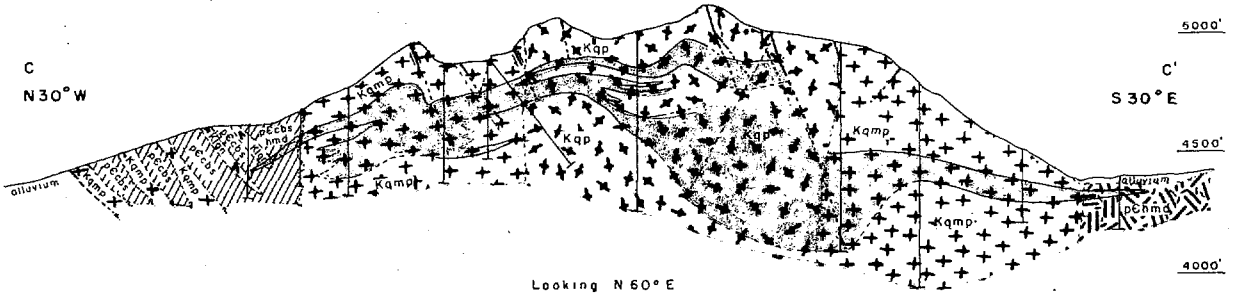
SURFACE GEOLOGY

DRAWN BY	SCALE	DATE
W.G.L.	1" = 800'	Sept. 1, 1964
GEOLOGY BY J.E.F. D.M.C. J.J.E.	APPROVED BY J.E. FROST	







EXPLANATION

Cretaceous Intrusives

- Kqp — Quartz Psuedo-Porphyry
- Kqmp — Quartz Monzonite Porphyry
- Klgn — Leucocratic Gneiss
- Kap — Aplite
- Hyb — Hybrid Rock (Kqmp & pЄcbs)

pЄ Cerbat Complex

- pЄcbs — Chlorite-Biotite Schist
- pЄamp — Amphibolite
- pЄhmd — Hornblende Metadiorite

- Fault, dashed where inferred
- Contact, dashed where inferred
- Drill Hole
- Ore Body

SCALE 1" = 800'

0 200 400 600 800 1200 1600

DUVAL CORPORATION
COPPER DIVISION
MINERAL PARK PROPERTY, KINGMAN, ARIZ.

VERTICAL SECTIONS

DRAWN BY	SCALE	DATE
W.G.L.	1" = 800'	Sept. 1, 1964
GEOLOGY BY J.E.F. D.M.C. J.J.E.	APPROVED BY J.E. FROST	

Fr[illegible] Chace
Jim Pollock } Hanna

Frank [illegible]
Dan Heatwol } Anaconda
Baker
Dennis Temple

Bill Lundby - West Range
Doris M Clippinger - some [illegible]

mineral Park — mill — water from valley, lift 2000'
depth to valley water ≠ 700'

ABSTRACT

J. H. C.

MAY 24 1965

WATER RESOURSES OF THE KINGMAN AREA, MOHAVE COUNTY, ARIZONA

A PROGRESS REPORT

Craig B. Bentley, U.S.G.S.

picking up water table as well as bed rk with seismic methods

A project by the Water Resources Division of the U. S. Geological Survey, financed on a matching fund basis by state and federal funds, is underway in the Hualapai and Sacramento Valleys, Mohave County, Arizona. The purpose of the project is to determine the quantity and quality of ground water in storage in the two valleys, depths to water, hydrologic characteristics of the aquifers, amount of water being added to and taken from the aquifers through natural recharge and outflow respectively, and the amount and characteristics of surface-water runoff in the drainage areas of the two valleys. To date, a ground-water inventory of all known springs and wells has been completed; water level recorders have been installed on four key wells; stream gages have been installed on several streams (washes) in the area; and a reconnaissance study of the geology, including some seismic work, is 50 per cent complete.

The geology of the area is typical of that of the Basin and Range Province, with tilted fault blocks of Precambrian granite and metamorphic rocks forming north-south trending mountains. The intermontaine Hualapai and Sacramento Valleys have been filled with Tertiary and Quaternary alluvium to depths in excess of 2,000 feet. Valcanics up to several hundred feet thick are present in the mountains and are interbedded with the alluvium in the valleys. Several hundred feet of saline deposits have been found in the Hualapai Valley. Ground water occurs in minor amounts in the volcanics and Precambrian rocks and at shallow depths in the alluvium on the pediments around the mountains, but most of the ground water lies in the alluvium in the valleys at depths of 200 to over 1,200 feet in the Sacramento Valley and from 250 to 600 feet in the Hualapai Valley. Of the 200 wells in the area, most are small stock and domestic wells in the

mountains and on the pediments. Few of these wells produce over 10 gpm, although some produce up to 100 gpm. Approximately 15 deep wells produce water from the valley alluvium. Yields from these wells vary from 200 to over 1,000 gpm. Little is known of the quality of the water except that it is quite hard, especially in the Sacramento Valley. Salt water has been found in one or two deep wells in the Hualapai Valley. Additional geologic, seismic, drill hole, and pump test data will supply information on the thickness, extent, and transmissibilities of the water-bearing alluvium in the valleys and on the amount of ground water flowing out of the valleys toward the Colorado River. Runoff and infiltration studies will indicate the amount of natural recharge to the aquifers.

THE MINERAL PARK ORE DEPOSITS

by Harrison A. Schmitt

ABSTRACT

Like the Esperanza Mine and of course many others, Ithaca Peak and the Mineral Park area had a long if not very productive mining history. At Mineral Park four different attempts were made to develop porphyry copper ore, two of these were on and around Ithaca Peak.

The regional setting of Mineral Park and the Kingman mining area is of possible interest. I place the area on the extreme west side of the Wasatch-Jerome orogenic belt and just north of the north side of the Texas orogenic belt. Ajo, as I read it, is also on the west side of the meridianal belt but on the south border of the Texas belt.

The extensive sampling work done tends to support the "rule" that the bigger the sample the more nearly the assay approaches the average assay.

Keith Martin (where now?)
Bert
Bill Roper
~~Bill~~
Don Clippinger

1907
1910 Cal + Ariz
1950 – Anderson several CD holes
1951 BCr. drilled 6 holes – 2 in ore – ~~Fr~~
Thomas wrote thesis – stated por cop ore dep
Dings – stwk
1958 – Duval

— evidence for enrichment of molly – Jordesite (?) soot black
fine grained mo sulph – not visible in chalcocite.
— .01 % cu average under, vs drill holes

J. H. C.
MAY 24 1965

Rock Type Sample Number Location Mineral	K%	Ar^{40} radiogenic $\times 10^{10}$ moles/gram	Ar^{40}/K^{40} $\times 10^{-3}$	Ar^{40} atmos %	Apparent Age in m.y.	Reference
phlogopite-molybdenite rock[1,2] RM-4-64 La Colorada Ore Body 30°58.9'N., 110° 17.6'W, Cananea, Sonora, Mexico phlogopite	7.70	8.13	3.50	29.7	58.5 ± 2.1	This work
quartz diorite[2] PED-39-60 Torreon-Cananea Road 30° 57.78'N, 110° 34.73'W., Sonora, Mexico biotite	6.91	8.39	4.02	22.5	67.2 ± 2.2	Damon et. al. 1964
quartz diorite[2] RM-7-63 Patagonia Mountains 31°23.2'N., 110° 43.1'W., Santa Cruz Co., Ariz. biotite	6.26	7.23	3.83	17.3	63.9 ± 2.0	this work
granodiorite[2] RM-6-63 Santa Rita Mountains 31° 42.9'N., 110°52.5'W., Santa Cruz Co., Ariz. biotite	7.13	8.76	4.07	18.3	67.9 ± 2.1	This work

$K^{40} = 1.21 \times 10^{-4}$ gram/gram K
$\lambda_\beta = 4.76 \times 10^{-10}$ yr.$^{-1}$
$\lambda_e = 0.589 \times 10^{-10}$ yr.$^{-1}$

Constants used to calculate results from the Univ. of Arizona Lab.

1. contains copper sulfides
2. on Cananea - Kingman zone

quartz monzonite[1,2] RM-3-64 Anaconda Co. Property Twin Buttes Area 31°55'N., 111°02' W., Pima Co., Ariz. biotite	7.69	7.41	3.19	28.7	53.5 ± 1.9	This work
phlogopite-sericite rock[1,2] RM-1-62 Esperanza Pit, Duval Corp. Twin Buttes Area 31°52.0'N., 111° 07.7'W., Pima Co. Ariz. phlogopite	8.37	9.46	3.75	19.1	62.6 ± 2.0	Mauger, 1965, in prep.
muscovite-quartz veinlet[1,2] RM-3-62 Esperanza Pit, Duval Corp. Twin Buttes Area 31°52.0'N., 111° 07.7'W., Pima Co. Arizona muscovite	7.74	8.47	3.62	10.8	60.6 ± 1.8	" "
granodiorite[2] PED-8-62 Twin Buttes Area 31° 53.95'N., 111° 06.95 W., Pima Co. Ariz. biotite	7.71	8.17	3.51	9.4	58.7 ± 1.8	Damon, etl al. 1964

albite-muscovite-quartz-pegmatite[2] RM-9-63 Twin Buttes Quad 31° 59.1'N., 111°07.8'W Pima Co., Arizona muscovite	8.99	8.25	2.96	7.1	51.0 ± 2.7	Mauger, 1965, in prep
granodiorite[2] PED-11-63 Tucson Mountains 32° 17.67'N., 111° 09.77'W., Pima Co., Ariz. biotite	6.66	8.78	4.46	12.0	72.9 ± 2.2	Bikerman and Damon, 1965, in press
granophyre[2] PED-12-63 Tucson Mountains 32° 17.63'N., 111° 09.77'W., Pima Co., Ariz. biotite	7.08	9.63	4.51	5.3	75.1 ± 2.2	" " "
granite[2] PED-3-64 Tucson Mountains 32° 16.37'N., 111° 12.37'W., ~~1~~ Pima Co., Ariz. biotite	5.16 5.16	6.36 6.99	4.08 4.49	34.6 27.8	71.4 ± 3.3 ave.	Bikerman and Damon 1965 in prep
granodiorite[2] MB-10-64 Cocoraque Butte, Roskruge Mountains 32° 13.10'N., 111° 20.62'W., Pima Co., Ariz. biotite	7.34	9.12	4.11	19.2	68.6 ± 2.2	Bikerman, 1965 in prep

alaskite [2] PED-22-59 Silver Bell District 32° 24.82'N., 111° 33.10'W., Pima Co., Ariz. biotite	6.26	7.31	3.87	28.8	64.6 ± 2.5	Mauger, et. al 1965
quartz monzonite [2] PED-21-59 Silver Bell District 32° 23.87'N., 111° 31.77'W., Pima Co., Ariz. biotite	5.54	6.72	4.02	35.3	67.1 ± 2.7	" " "
quartz monozonite [1,2] PED-3-63 Silver Bell District El Tiro Pit 32° 25.67'N., 111° 32.22'W., Pima Co., Ariz. biotite	6.88	8.15	3.92	19.7	65.5 ± 2.0	" " "
quartz monzonite [2] PED-20-64 Slate Mountains 32° 32.6'N., 111° 53.2'W., Pinal Co. Ariz. biotite	7.61_5	9.07	3.95	66.5	65.9 ± 6.6	This work
quartz monzonite [1,2] PED-17-64 Bagdad Copper Co. open pit Bagdad, Yavapai Co., Ariz. 34° 35.0'N., 113° 12.5'W., biotite	6.87_5	8.82	4.25	21.9	70.9 ± 2.3	This work

Quartz monzonite[1,2] RM-5-65 Mineral Park Pit Duval Corp., Kingman, Ariz. 35° 22.70'N., 114° 08.55'W., Mohave Co. phlogopite	7.70	9.96	4.29	29.2	71.5 ± 2.6	This work
quartz monzonite[1] PED-4-64 Lone Star District Graham Co., Arizona plagioclase and sericite	3.41_5					
quartz-orthoclase-biotite[1] pegmatite, RM-2-62 New Cornelia Pit Ajo, Arizona 32° 21.52'N., 112° 52.00'W., Pima Co. biotite	5.97_5	6.81	3.77	28.6	63.1 ± 2.2	Damon, et.al., 1964
Schultze Granite Globe-Miami District Gila Co., Ariz. biotite	7.32	7.77	3.41	not listed	58	Creasey and Kistler, 1962

Schultze Granite PED-5-59 2 miles west of Miami, Arizona on U.S. Highway 60-70. 33° 23.00'N., 111° 54.17'W., Gila Co. biotite	7.01 5	7.31	3.45	19.7	57.8 ± 1.8	Damon, et.al. 1964
Lost Gulch Quartz Monzonite[1] Miami District Gila Co., Ariz. biotite	7.24	8.36	3.7	not listed	62	Creasey and Kistler
Granite Mountain Porphyry[1] Ray District, Pinal Co., Ariz. biotite	6.86	7.96	3.72	not listed	63	" " "
quartz diorite porphyry Christmas District Gila Co., Ariz. biotite	6.49	7.39	3.66	" "	62	" " "
quartz monzonite[1] Chino, New Mexico 32° 47.5'N., 108° 04.2'W., biotite	6.77	7.76	3.76	" "	63	Schwartz, 1959
biotite-augite monzonite porphyry, Bingham stock Bingham, Utah 40° 31.17'N., 112° 07.00'W., biotite	5.67	5.00	2.90	24	49 +7 -2	Armstrong, 1963**

** Argon analysis by neutron activation

A CASE HISTORY OF COPPER AND MOLYBDENUM GEOCHEMICAL PROSPECTING AT THE MINERAL PARK MINE OF DUVAL CORPORATION

J. H. C.

MAY 24 1965

By Donn M. Clippinger

Spectrophotometer

mo not appreciably leached –

ABSTRACT

At the outset of the exploration program at Mineral Park, Mohave County, Arizona a geochemical survey was planned. It was decided that this prospecting method might aid in delineating the areas of highest metal concentrations and reflect the ultimate potential area.

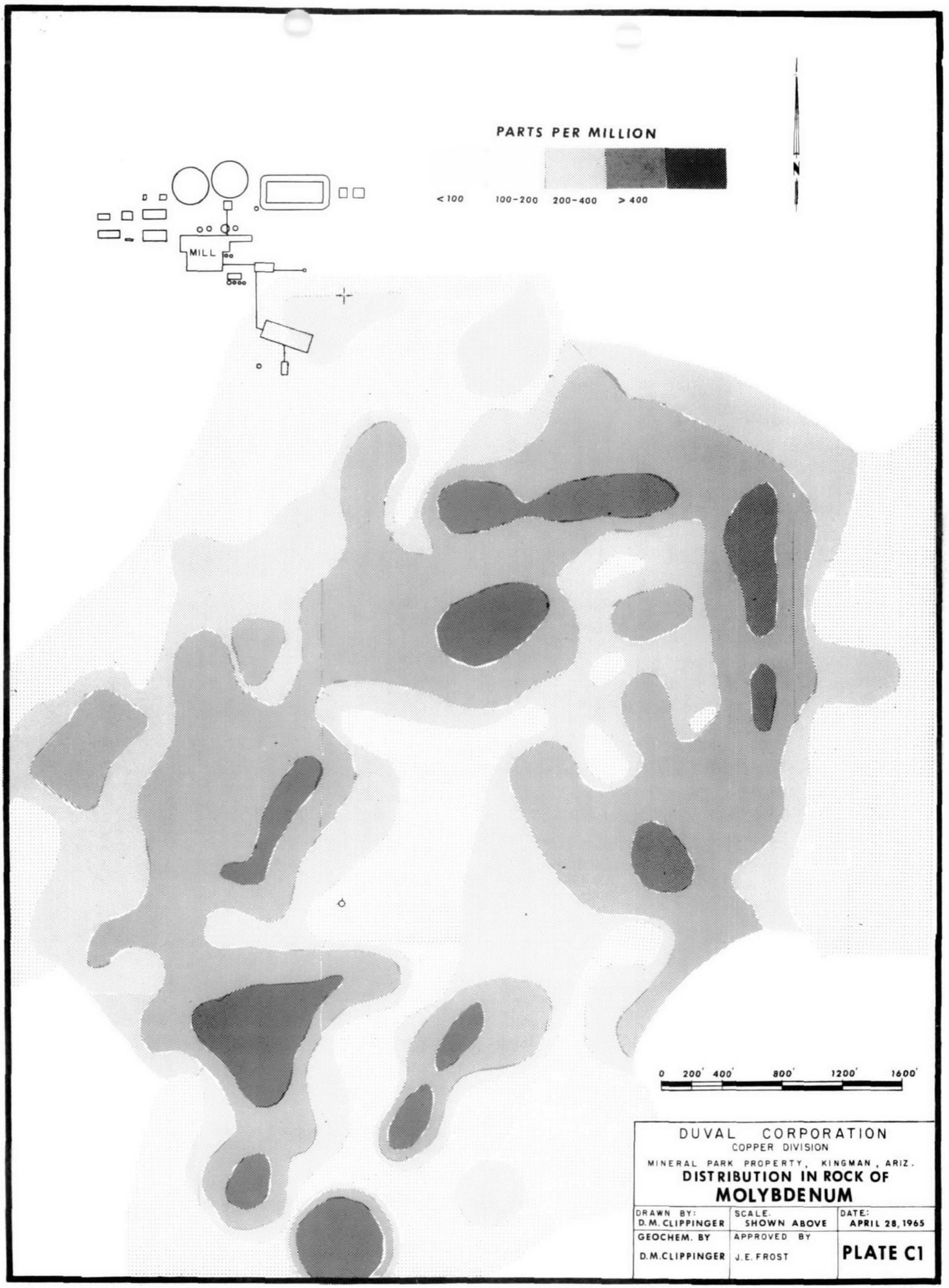
Methods chosen were sampling of rock outcrops, and of shallow soils. Geobotanical sampling, under similar conditions, had been found impractical so was not employed. Copper and Molybdenum, the economic metals concerned, were selected for analyses.

A 400-foot equilateral triangular grid pattern was sampled over an area of approximately one and three-quarter square miles. At each site the samples were taken as follows : (1) About one and one half pounds of soil was taken at depths not exceeding one foot. (2) Approximately twenty-five pounds of rock was obtained, by blasting, from the nearest outcrop within a radius of fifty feet. (3) A few ounces of rock chip specimens were selected for identification and reference. The minus 65-mesh screen fraction of the soil was used for soil analyses. All sample preparation and analytical work was done by laboratory methods. Analyses of both copper and molybdenum were determined colorimetrically by means of an electronic colorimeter.

At Mineral Park the distribution of molybdenum in either rock outcrops or soils serves as an excellent guide to exploration. Molybdenum does not migrate significantly. Rock samples are nearly as high in tenor as the underlying sulfide ores. The orebearing areas are found to be overlain by rock containing >300 p.p.m. and residual soil containing >150 p.p.m. of molybdenum.

Copper distribution in rock outcrops and in the residual soils is misleading. Factors such as structure of contemporaneous minerals, permeability, pH, soil development, and petrology infulence the migration and localization of copper. More data are required concerning the behavior of copper in the form of oxidation and soil development.

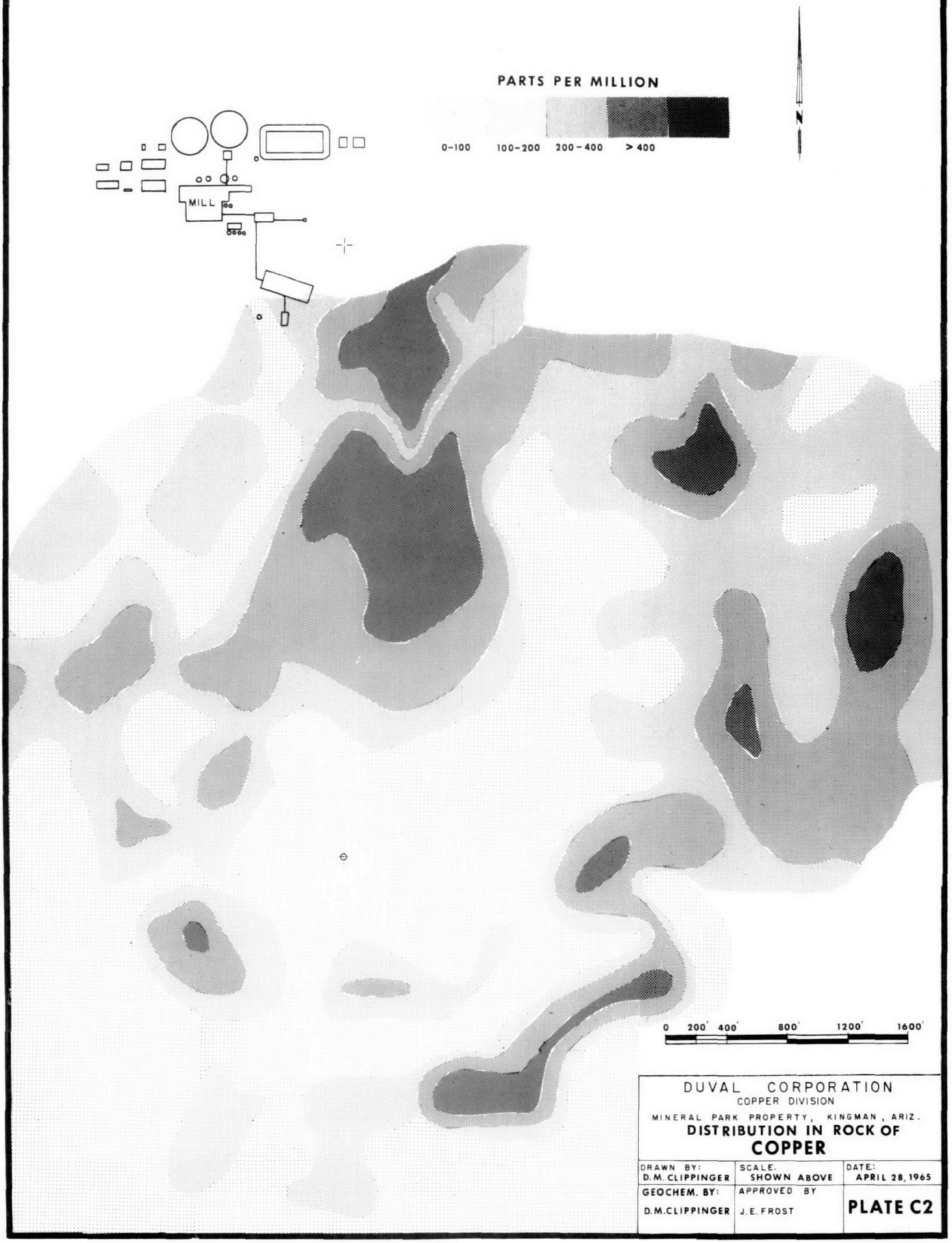
The combined molybdenum and copper rock analyses show a pattern (>400 p.p.m.) that can be used as ore guides in the Mesozoic (?) intrusive rocks.



DUVAL CORPORATION
COPPER DIVISION
MINERAL PARK PROPERTY, KINGMAN, ARIZ.

DISTRIBUTION IN ROCK OF MOLYBDENUM

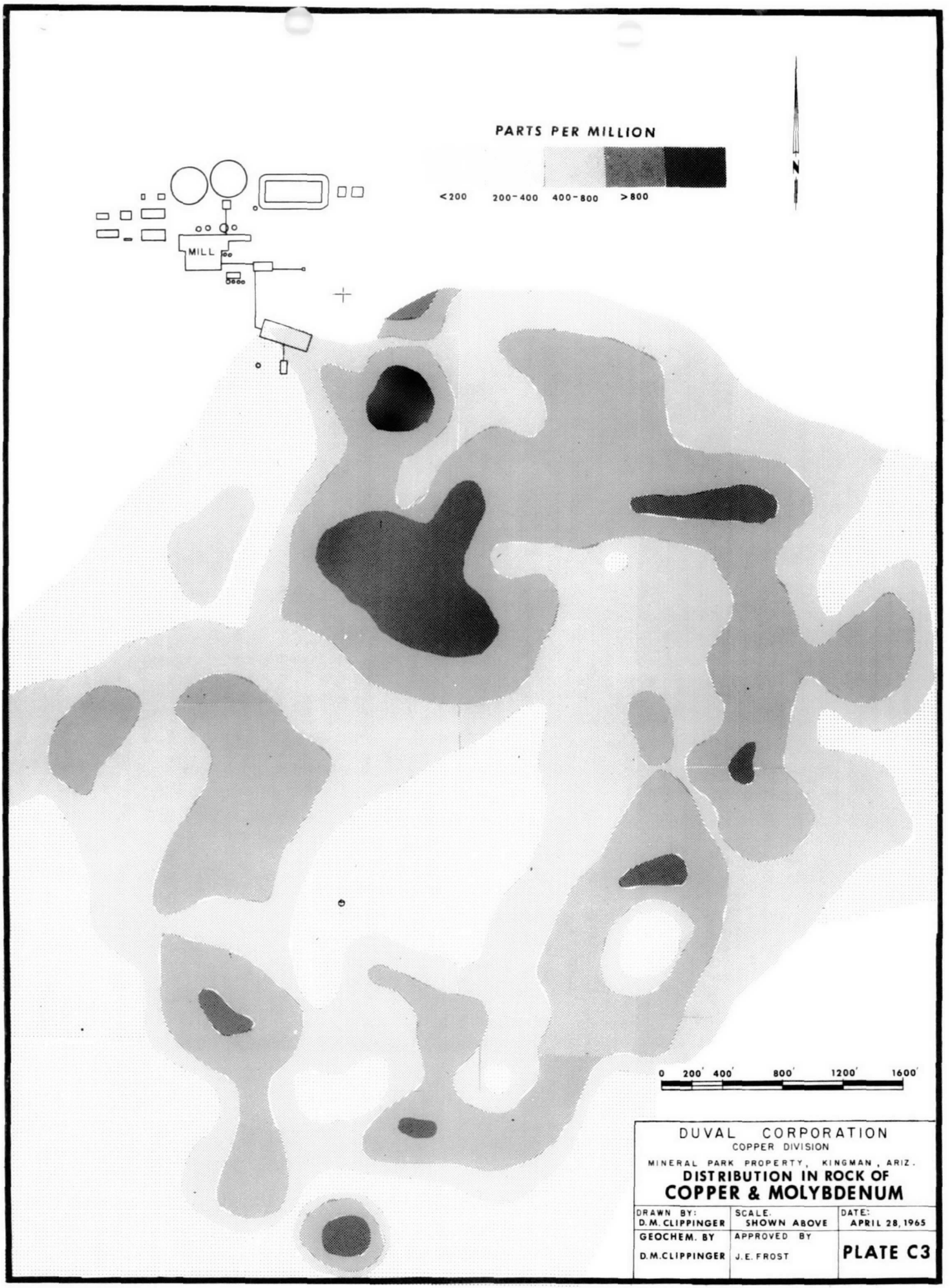
DRAWN BY: D.M. CLIPPINGER	SCALE: SHOWN ABOVE	DATE: APRIL 28, 1965
GEOCHEM. BY D.M.CLIPPINGER	APPROVED BY J.E. FROST	PLATE C1



DUVAL CORPORATION
COPPER DIVISION
MINERAL PARK PROPERTY, KINGMAN, ARIZ.

DISTRIBUTION IN ROCK OF COPPER

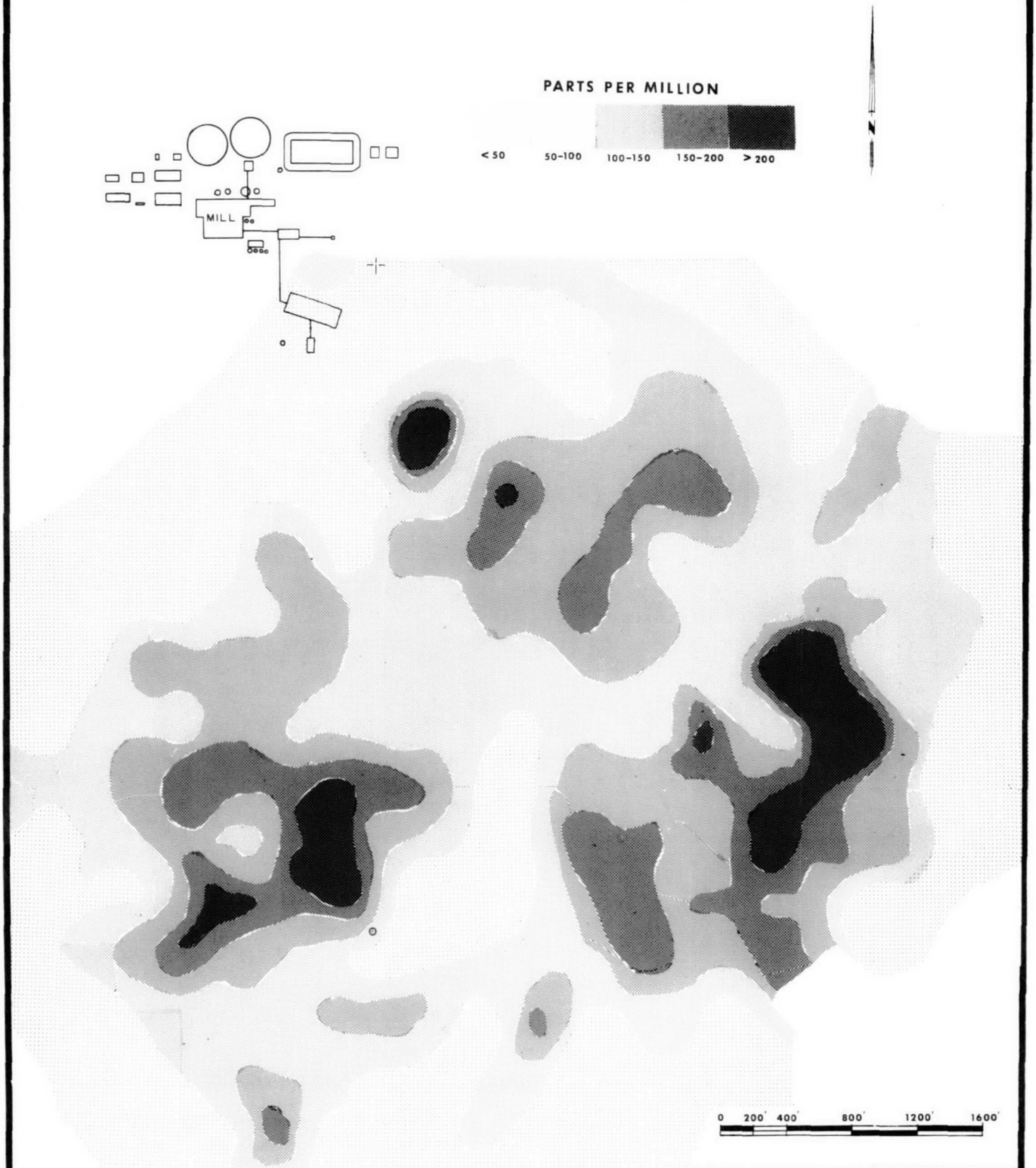
DRAWN BY: D.M. CLIPPINGER	SCALE. SHOWN ABOVE	DATE: APRIL 28, 1965
GEOCHEM. BY: D.M.CLIPPINGER	APPROVED BY J.E. FROST	PLATE C2



DUVAL CORPORATION
COPPER DIVISION
MINERAL PARK PROPERTY, KINGMAN, ARIZ.

DISTRIBUTION IN ROCK OF
COPPER & MOLYBDENUM

DRAWN BY: D.M. CLIPPINGER	SCALE. SHOWN ABOVE	DATE: APRIL 28, 1965
GEOCHEM. BY D.M.CLIPPINGER	APPROVED BY J.E. FROST	**PLATE C3**

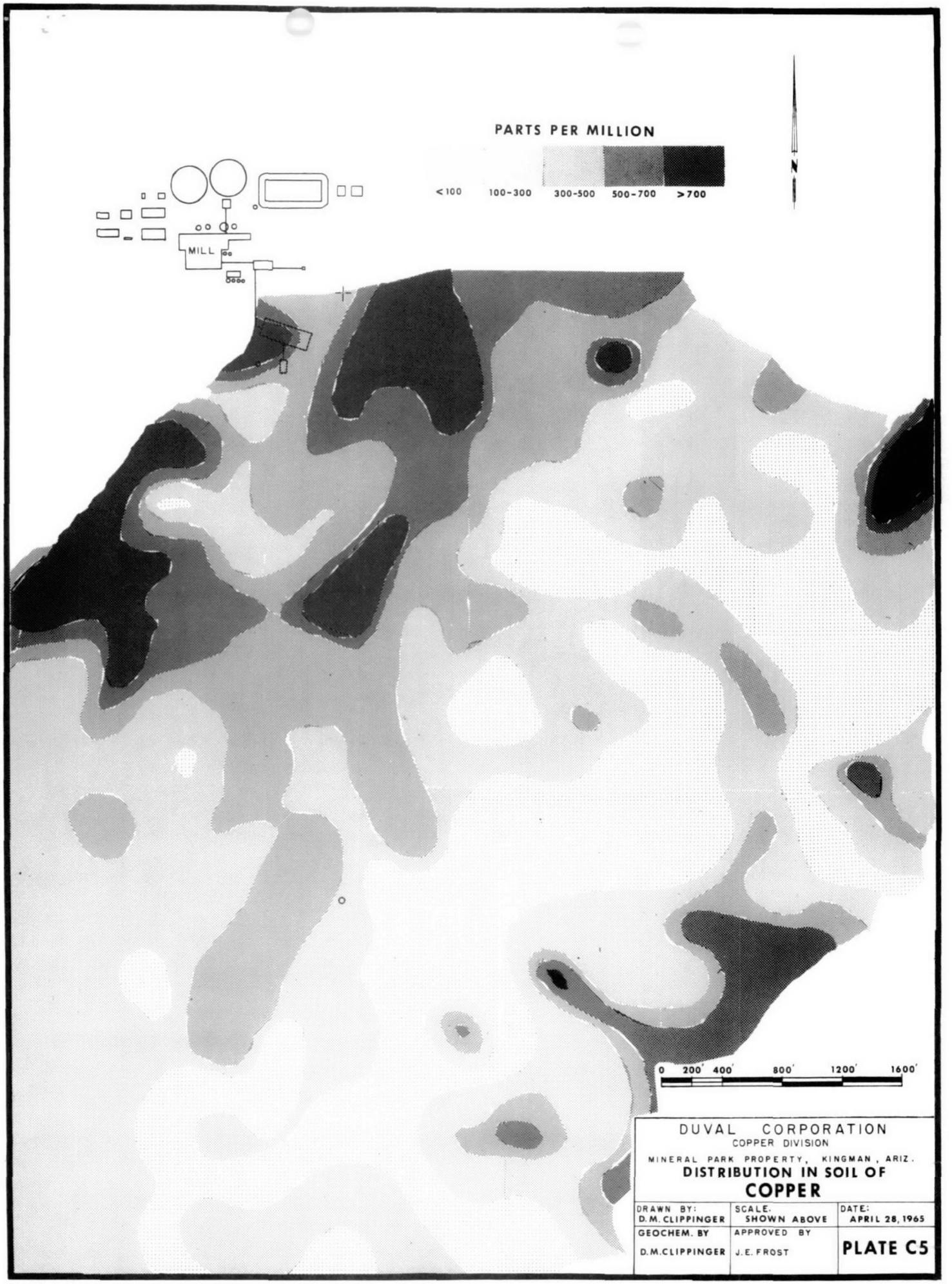


DUVAL CORPORATION
COPPER DIVISION

MINERAL PARK PROPERTY, KINGMAN, ARIZ.

DISTRIBUTION IN SOIL OF
MOLYBDENUM

DRAWN BY: D.M. CLIPPINGER	SCALE: SHOWN ABOVE	DATE: APRIL 28, 1965
GEOCHEM. BY D.M. CLIPPINGER	APPROVED BY J.E. FROST	PLATE C4

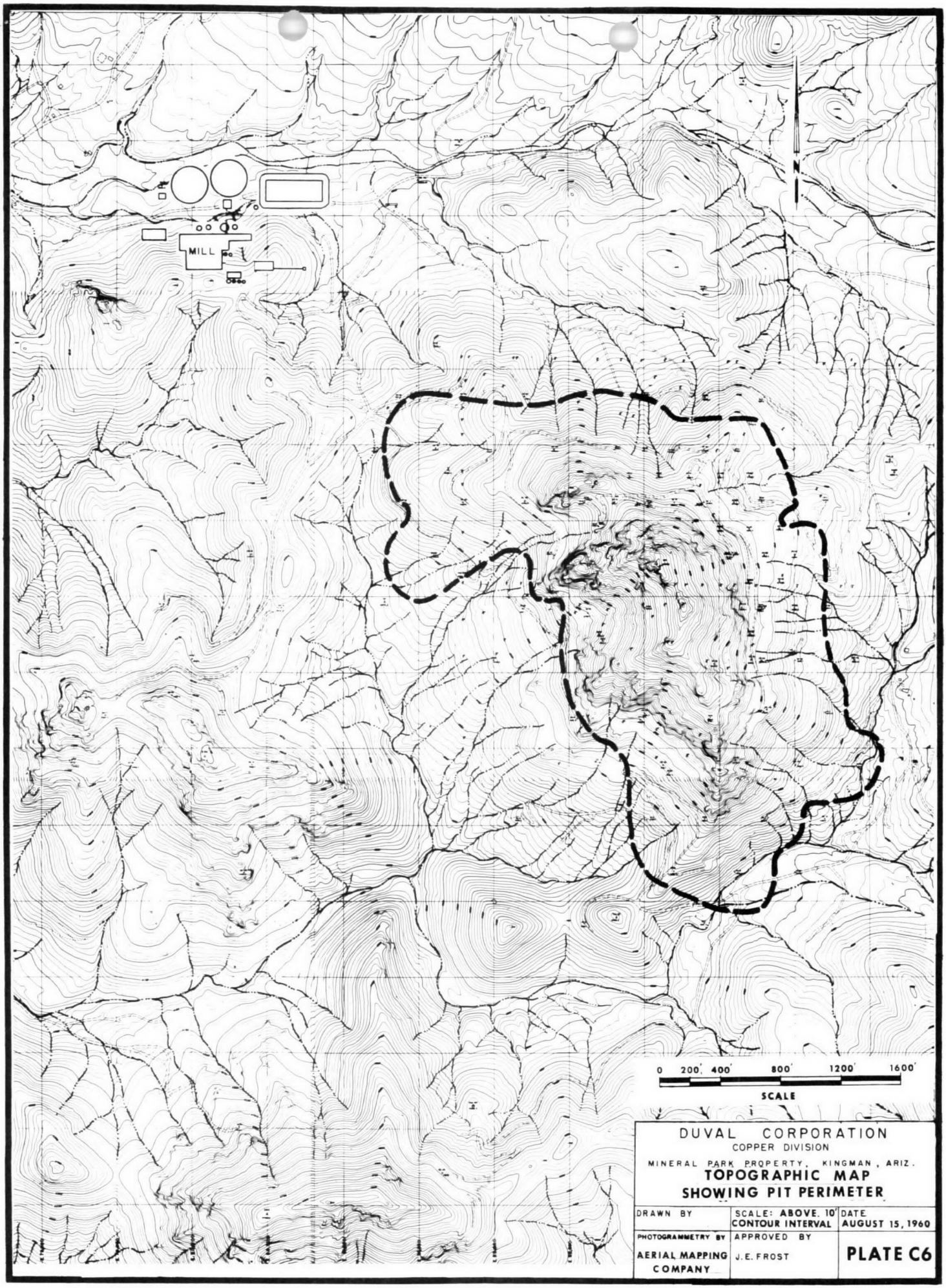


DUVAL CORPORATION
COPPER DIVISION

MINERAL PARK PROPERTY, KINGMAN, ARIZ.

DISTRIBUTION IN SOIL OF COPPER

DRAWN BY: D.M. CLIPPINGER	SCALE: SHOWN ABOVE	DATE: APRIL 28, 1965
GEOCHEM. BY D.M.CLIPPINGER	APPROVED BY J.E. FROST	**PLATE C5**



DUVAL CORPORATION
COPPER DIVISION
MINERAL PARK PROPERTY, KINGMAN, ARIZ.

TOPOGRAPHIC MAP SHOWING PIT PERIMETER

DRAWN BY	SCALE: ABOVE. 10' CONTOUR INTERVAL	DATE AUGUST 15, 1960
PHOTOGRAMMETRY BY AERIAL MAPPING COMPANY	APPROVED BY J.E. FROST	PLATE C6

Drill holes 1, 2 and 3 appear to have penetrated a chalcocite blanket. It is peculiar that Bear Creek did not pursue this lead.

JOHN E. KINNISON

Attachment
JEK/ds
cc: KERichard
JHCourtright

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona
November 28, 1960

FILE MEMORANDUM

GROSS RANCH PROSPECT
Bear Creek Drilling

While informally discussing Duval's Ithica Peak Cu prospect near Kingman, November 22, 1960, with W. K. Wallace of Kern County Land Company in Tucson, he volunteered some results of Bear Creek's drill holes of 1955.

The attached map shows the location of holes and below are the assay averages of the oxide, chalcocite, and primary ore zones. Wallace did not say how he obtained the data; it is reproduced here exactly as I copied it.

DDH 1 -45° N45W
0 - 117' Oxidized. No assays.
- 417 300' @ .62% Cu. Enriched zone.
- 706 289 @ .30% Cu
369 - 706 337' @ .069% MoS2

DDH 2 Flat N45W
0 - 155' Ox. No assays.
- 790 635 @ .29% Cu. Enriched zone.
150 - 790 640 @ .043% MoS2

DDH 3 Vertical
Caved @ 186'. No assays.

DDH 4 -20° S70W
0 - 178' Oxidized. No assays.
178 - 320 142 @ 1.00% Cu. Enriched zone.
320 - 462 142 @ 0.21% Cu
178 - 462 284 @ .045 % MoS2

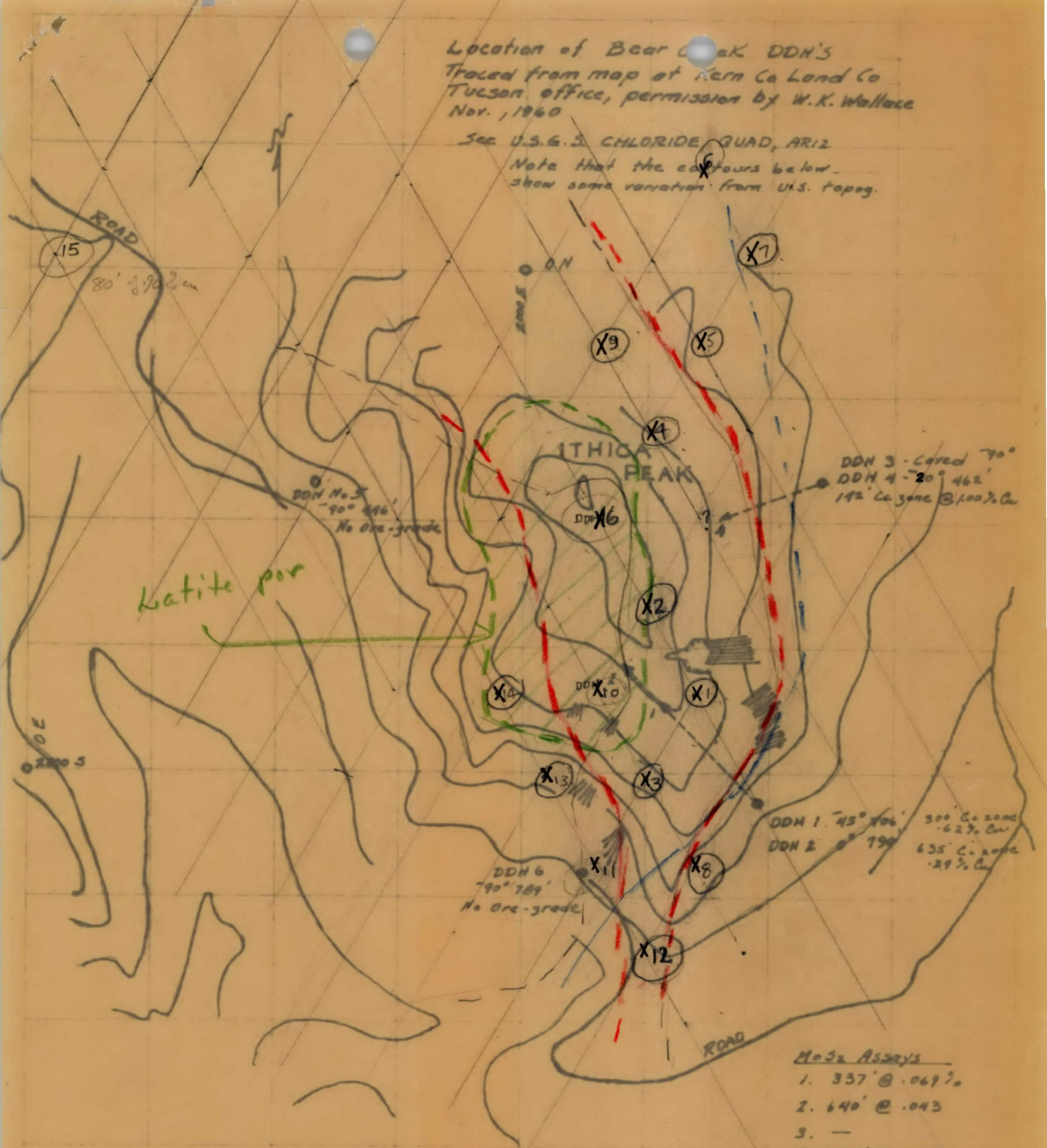
DDH 5 Vertical
0 - 103' Ox. No assays.
102-- 183 80 @ .19% Cu. Enriched zone.
183 - 446 263 @ .10% Cu
94 - 446 352 @ .043% MoS2

DDH 6 Vertical
0 - 202' Ox. No assays.
202 - 255 53 @ .10% Cu. Enriched zone.
255 - 789 534 @ .02% Cu
175 - 789 614 @ .039% MoS2

2225' of hole average .046% MoS2

Location of Bear Creek DDH's
Traced from map at Kern Co Land Co
Tucson office, permission by W.K. Wallace
Nov., 1960

See U.S.G.S. CHLORIDE QUAD, ARIZ
Note that the contours below show some variation from U.S. topog.



MoS_2 Assays

1. 337' @ .069%
2. 640' @ .043
3. —
4. 284' @ .045
5. 352' @ .043
6. 614' @ .039

MINE GROSS RANCH LOCATION ITHICA PEAK LEVEL SURFACE
GEOLOGY BY SURVEY Unknown SCALE 1" = 500' DATE

Mineral Park — Duval Corp

Pay Dirt — Nov 20, '64

Trip to 4 metals, messer .035 mo?

58,400,000 tons @ .76 copper equiv. (.56 cu .06 MoS_2 ?
.50 " .07 ")

Stripping ratio 1.53 to 1

35' benches, waste — 25' benches, ore

Flight altitude set for 1:2400 (contacts?)

10' countours — later photo by air at 1:3000

also prepared 1:1200 map —

Pre mine — 23,000,000 tons waste

Total drilling 46,500' — 82 CD holes / ore
29 DD " / body

7 CDH outside
5 DDH

.76 cu equiv at 80% rec. = 12 lb cu / ton

8

60.8

J. H. C.

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

December 12, 1960

FILE MEMORANDUM

MINERAL PARK (GROSS RANCH-ITHACA PEAK) AREA
Mohave County, Arizona

Bear Creek Mining Company abandoned the Gross Ranch-Ithaca Peak prospect north of Kingman in 1955 after a short exploration program. Duval Sulphur acquired the property and commenced drilling in 1959, completing 16 holes that year. Drilling was resumed early this year; reportedly, a total of 50 holes have been completed to date. Results of Bear Creek exploration are given in John Kinnison's memo of November 28, 1960. We now have some information on Duval's first 16 holes, drilled on a 400 ft. equilateral triangle grid. The locations of these and of Bear Creek holes are shown on the attached map.

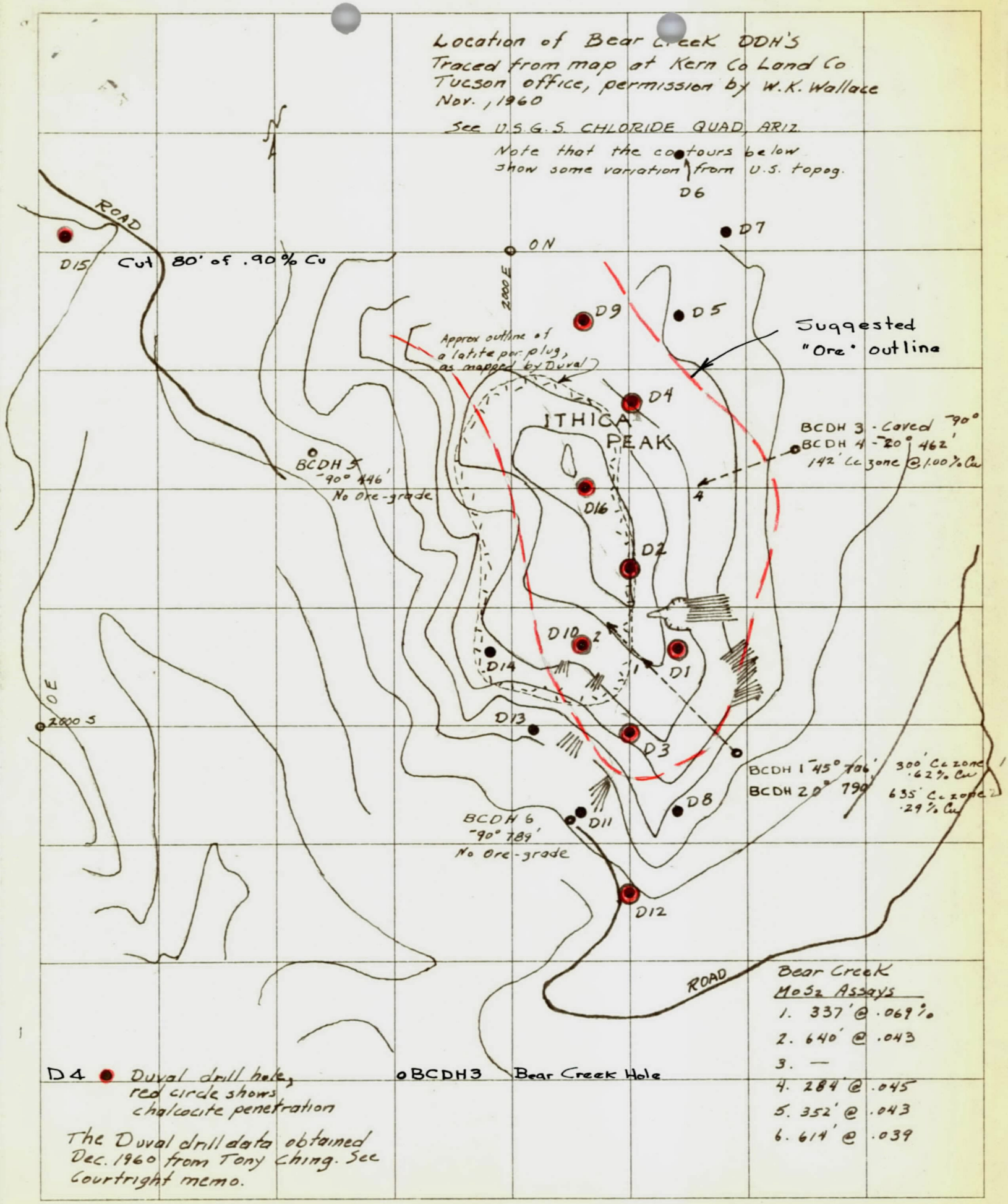
Of the 15 Bear Creek holes on and around Ithica Peak, 8 cut 20 ft. or more of chalcocite ore averaging about .60% Cu (.40% cutoff). One hole (No. 15) located about 2000 ft. northwest of Ithica Peak cut 80 ft. of .90% Cu.

Hole	Top of Intercept	Length of Intercept
D10	466'	410'
D 9	180	220
D16	365	160
D 4	130	110
D 2	110	100
D 3	120	80
D 1	95	35
D12	130	20

The ore indicated by this preliminary drilling forms a zone about 500 ft. wide and 2000 ft. long, trending northerly beneath Ithica Peak. Assuming an average thickness of 150 ft., there would be around 12 million tons in this area. The non-sulphide content is about 15% of the total, giving an average sulphide grade of .50% copper. Molybdenum values average around .05% MoS_2.

Original signed by
J. H. Courtright
J. H. COURTRIGHT

JHC/ds
Attachment: Map
cc: CPPollock, w/att



MINE GROSS RANCH LOCATION ITHICA PEAK LEVEL SURFACE
GEOLOGY BY SURVEY Unknown SCALE 1" = 500' DATE

NOTE FILE ON "PORPHYRY COPPER"

Location: Mojave Co., Arizona (North of Kingman)

Property: Gross-Ithaca
District: Peak Area
Mt. Range: Wallapai Cerbat Mts.

See Index Map (p. .....)

Source of Information
- [x] Field Observations
- [ ] Publications
- [ ] Company Files
- [ ] Other

Explantion: Reconnaisance of area by K.R. and J.H.C. made 11-30-55 to check exploration activity by Kennecott reported 5-3-55 by F.V. Richard.

Date.....

Recommended Company Interest Classification:
- [ ] Active
- [ ] Possible
- [x] None
- [ ] Scientific

Qualifying Remarks: No exploratinn possibilities were recognized in previous examinations (see Por. Copper Note 2-24-53). Recent drilling (by Kennecott) appears to substantiate these conclusions.

(see p.....)

MINERALIZATION (See Sketch Map .....)

Alteration and Metallization:

Leached Outcrops: Early drilling consisted of at least 3 churn drill holes. Recent drill holes spotted in the field include 5 diamond drill holes and two churn drill holes. Locations of all holes observed are shown on the attached map. (see p.....)

Enrichment: (see p.....)

Associated Metal Deposits: (see p.....)

STRUCTURE (See Sketch Map p.....) (see p.....)

Fissures:

Intrusives: There is no activity at present, but it has been reported that Kennecott still holds the property. (see p.....)

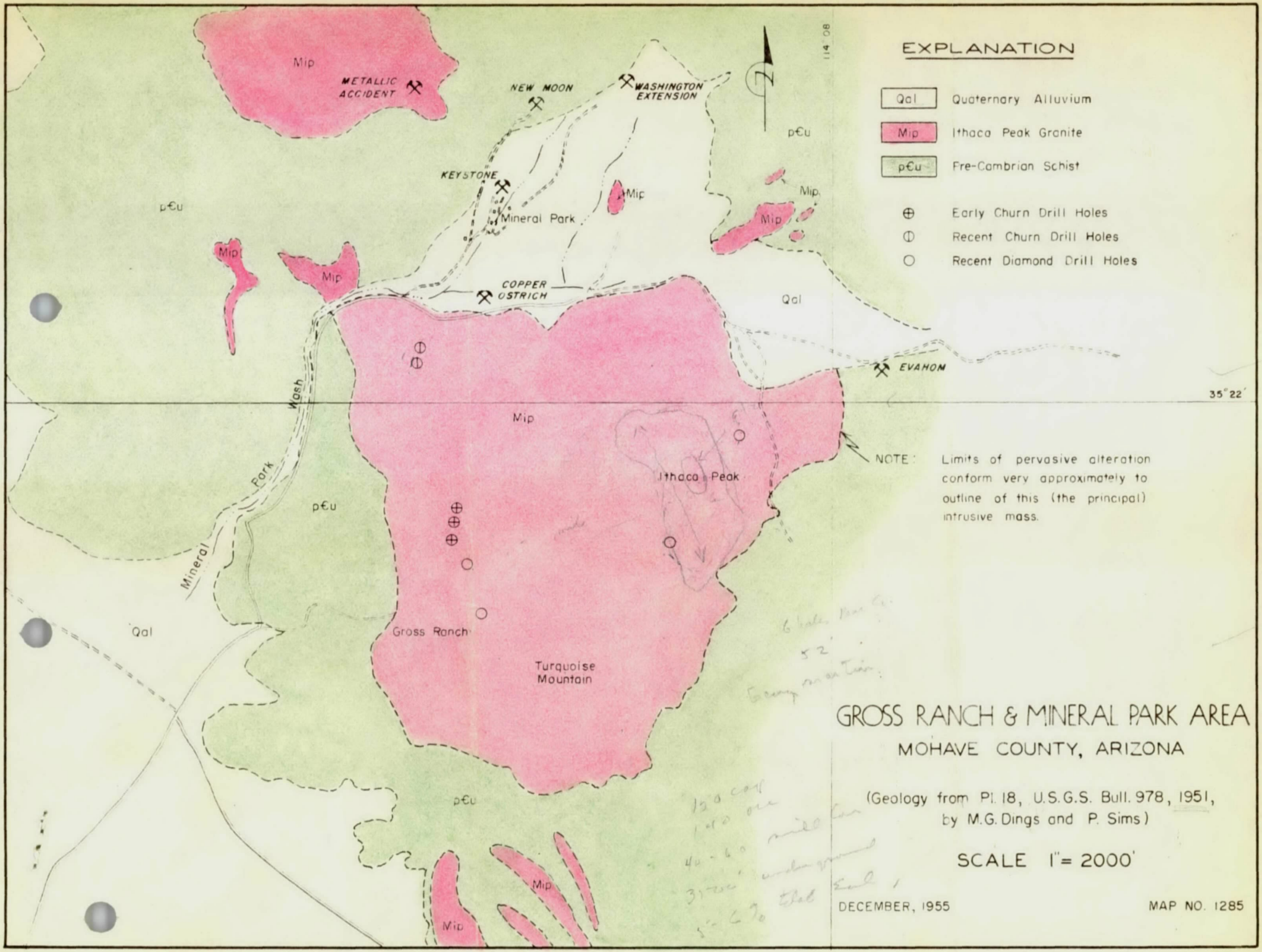
Breccia Pipes: (see p.....)

Cover Rocks: (see p.....)

DEVELOPMENT, PRODUCTION, FACILITIES, ECONOMIC POSITION, ETC.: (see p.....)

Date 12-8-55 By J.H. Courtright

WHL (2), TAS, KR, JHC - File (2)


EXPLANATION
Qal Quaternary Alluvium
Mip Ithaca Peak Granite
p€u Pre-Cambrian Schist
Early Churn Drill Holes
Recent Churn Drill Holes
Recent Diamond Drill Holes
NOTE: Limits of pervasive alteration conform very approximately to outline of this (the principal) intrusive mass.
METALLIC ACCIDENT
NEW MOON
WASHINGTON EXTENSION
KEYSTONE
Mineral Park
COPPER OSTRICH
EVAHON
Mineral Park Wash
Ithaca Peak
Gross Ranch
Turquoise Mountain
35°22'
114°08'
Mip
p€u
Qal
GROSS RANCH & MINERAL PARK AREA
MOHAVE COUNTY, ARIZONA
(Geology from Pl. 18, U.S.G.S. Bull. 978, 1951, by M.G. Dings and P. Sims)
SCALE 1" = 2000'
DECEMBER, 1955
MAP NO. 1285

Mr. Courtright

Aa-13A.2.7E

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

June 27, 1950

MEMORANDUM FOR MR. WILSON

GROSS COPPER PROPERTY - ITHAGA PEAK AREA
Wallapai Mining District
Mohave County, Arizona

In your Memorandum of May 22nd, you suggested that some further study of the above area might be warranted in view of the widespread occurrence of mineralization resembling that characteristic of porphyry copper deposits. In his report of October 7th, 1949, Mr. Pollock concluded that some secondary enrichment had occurred in the area, but the grade of the primary was in general too low to form commercial chalcocite deposits. After reading his report and the other references listed in your Memorandum, a trip was made to the district. My impressions, based on two days in the field -- June 23rd and 24th -- are contained in the following.

The areal extent of significant alteration and disseminated sulphide mineralization appears to conform roughly to the outline shown on Map No. 840, (copy attached) after Thomas, accompanying Pollock's Wallapai District report of November 18, 1949. The dimensions are approximately two by three miles, elongated northwesterly. This zone, which is characterized by disseminated pyrite in sericitized granite and gneiss, feathers out in an irregular fashion into comparatively fresh rock on all but the western border. Here, relatively small pyritic zones persist beneath the valley alluvium, as evidenced in the dumps from shallow shafts situated in the gravels below the mouth of Mineral Park wash. There appears to be little chance of a sizable zone existing here, in view of the numerous protuberances of unaltered bedrock in this pediment area. With this exception, the limits of the principal zone of disseminated sulphide mineralization are clearly exposed.

In general, the leached outcrops of the principal zone described above display yellow-brown to buff color tones, characteristic of those over pyritic mineralization in strongly altered rocks. Locally, somewhat darker shades were noted. Close inspection of these outcrops revealed the presence of an occasional speck or veinlet of black, or dark red limonite, the type considered to be derived from the leaching of a chalcocite-pyrite mixture. The best showings of this limonite occur in the vicinity of churn drill hole No. 5, associated with relatively strong mineralization in a network of narrow veins. The intersection here of a minor cross-breaking system of fissuring with the major northwest trend appears to have been the control chiefly responsible for this concentration of mineralization. About 300 feet north of the above mentioned churn drill hole an adit has been driven southerly into the sulphide zone. The dump shows pyritized, altered rock with occasional thin films of chalcocite on the pyrite. Traces of molybdenite were also noted. A grab sample assayed .03% copper. Feeble enrichment of a very low grade primary copper is also the condition a few hundred feet south of the churn drill hole, as demonstrated by Pollock's assays of the sulphide dump material - from adit No. 1. This adit passes under outcrops which are representative of the better zones of mineralization and alteration of the area. Pollock's sample of this, the No. 1 dump, assayed .06% Cu, .05% MoS_2; the writer's two samples averaged .05% Cu.

A grab sample was also taken of the Malik shaft dump, situated some 600 feet west of the No. 1 adit. This assayed .05% Cu.

Ac-134.2.7E
June 27, 1950

Memorandum for Mr. Wilson

An attempt was made to find in the leached outcrops the limonite after molybdenite, described by Blanchard as occurring in thin foliated flakes having at times the same dark maroon color as the limonite derived from chalcocite. I was unable to identify this material, but did note occasional thin seams and minute patches of greenish yellow powder, probably molybdic ochre, an oxide derived from the sulphide, molybdenite.

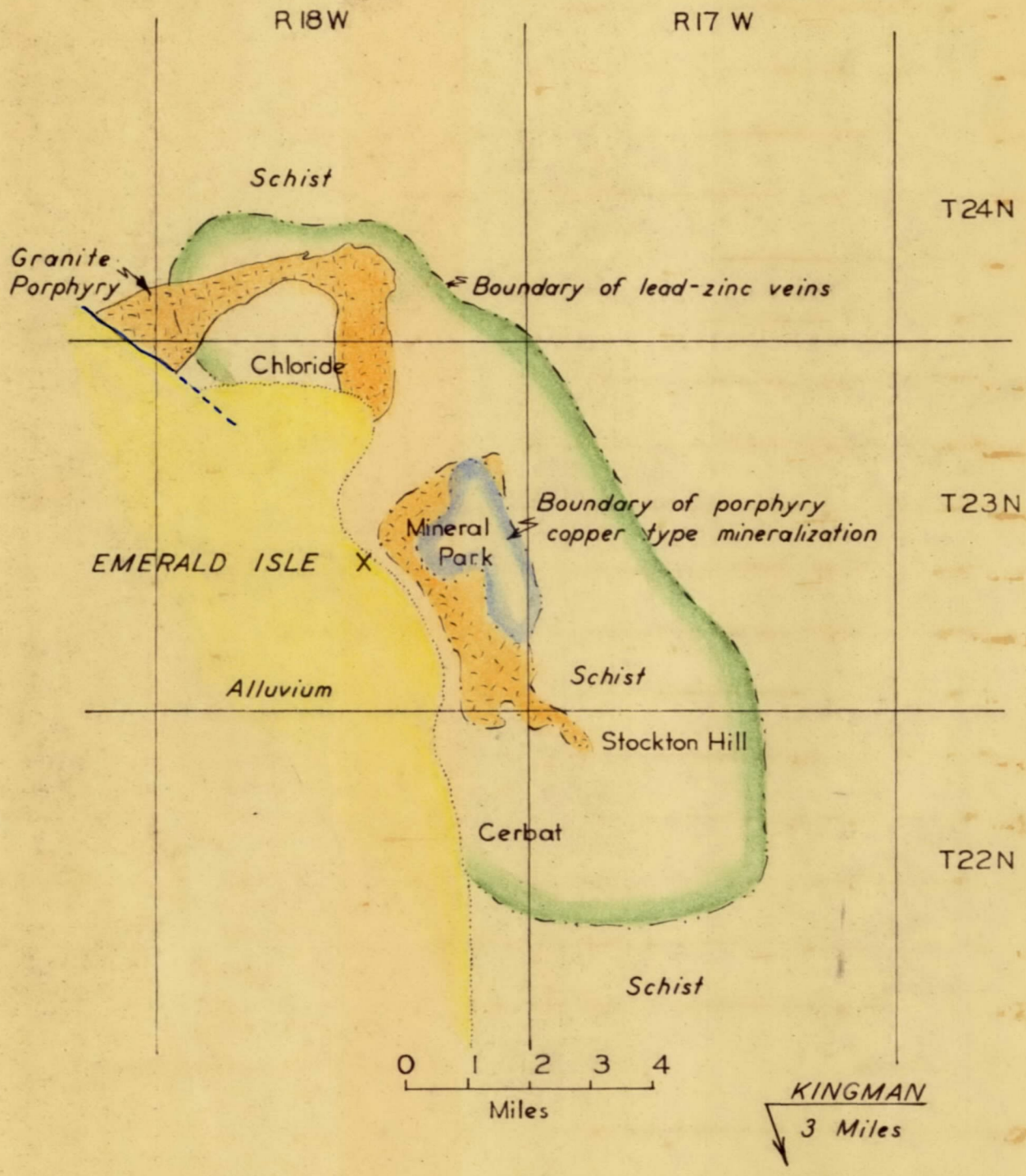
A brief visit was paid to the Emerald Isle chrysocolla deposit, situated west of the Gross Ranch along the eastern edge of the main valley. The copper silicate occurs here as a cement in sandstone and conglomerate and also as fissure fillings. The conglomerate, probably related to the Gila deposits, is overlain by recent, unconsolidated gravels. An unsuccessful attempt was recently made to extract the copper by acid leaching. The property is now idle. In discussing the origin of the deposit, Fred Searles, Jr. (Economic Geology, March-April, 1950) stated: ".....Acid copper bearing solutions trickled along bedrock..... and have been raised by capillary action into the lower layers of the gravel..... a large mass of sulphide protore carrying a few hundredths copper lies adjacent to and east of the chrysocolla deposit. There is little doubt that this dissemination (over several hundred acres) constitutes the roots or protore of a more important, and possibly at one time commercial porphyry copper deposit."

The foregoing contains what seems to be a plausible explanation for the formation of the veins. The chrysocolla which occurs as a cement in the ancient gravels was probably precipitated by repeated evaporation of copper bearing waters in shallow basins. Certainly, ample copper has been available to solution in surface waters, ever since erosion caught up with leaching. Sulphides are exposed in the present canyon bottoms; elsewhere, the leached capping is quite thin, as evidenced by exposures in the several adits. But I see no reason to assume that this "protore", including the Gross-Mineral Park area, constitutes the roots of a higher grade deposit; it could just as well be the heart or best portion that is now exposed. The Emerald Isle deposit and several more like it could well have been formed by leaching of even less than .05% copper from several hundred million tons of rock.

In conclusion, it is considered that the outcrops of the Gross Copper-Ithaca Peak area bear a fairly close resemblance to those over some commercial porphyry copper deposits. Lacking other evidence, further work, including exploration, would be required to provide a conclusive opinion, I believe. However, the various adits which penetrate the sulphide zone in the most strongly mineralized and altered area offer conclusive evidence that these outcrops represent the oxidized and leached portions of a disseminated sulphide body composed principally of pyrite, carrying sub-marginal values in primary copper and molybdenum, and insignificant amounts of secondary copper as chalcocite. Consequently, I agree with previous conclusions— that no exploration is warranted — as stated in your letter of transmittal November 7, 1949, to Mr. Landwehr, accompanying Mr. Pollock's report.

J. H. COURTRIGHT

JHC:ar



TO ACCOMPANY Letter
DATED June 27, 1950
BY J. H. Courtright

INDEX MAP
WALLAPAI MINING DISTRICT
MOHAVE COUNTY ARIZONA
SCALE 1" = 2 1/2 MILES
AFTER THOMAS, NOVEMBER 1, 1949

MAP NO. 840

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 22, 1950

MEMORANDUM FOR MR. COURTRIGHT

GROSS COPPER-ITHACA PEAK AREA
Wallapai Mining District
Mohave County, Arizona

This will confirm our discussion of an occurrence of widespread limonites in the vicinity of Ithaca Peak subject area, which I was hopeful might point to a potential porphyry of copper or molybdenum. Subsequently Jim Pollock referred to this phase of his detailed study in his report on the Gross property and its environs around Mineral Park, all near Kingman, Arizona. The report is dated October 7, 1949.

When you have a chance to do so, I would suggest that you read this reference as well as the following as a prelude to your possibly visiting the area if you agree that it might sound inviting. You will note that my letter of transmittal of November 7, 1949 summarizes the apparent porphyry prospects although I had felt they were probably extremely low grade. The northeasterly fractures which form a striking pattern from the Gross property through to the Ithaca Peak is the nucleus of the most attractive color tones and it is here I believe the possibilities are confined. The surface expression of molybdenum as well as copper should be considered. For your convenience, I am attaching hereto prints of the original field sheets on this area which you might return after they have served their purpose.

Selected and pointed references include (in addition to Pollock's above report):

1. Blanchard on the tones of limonite that may point to molybdenum in this area, Economic Geology Volume 30, No. 3, 1935.

2. "Ore Deposits of the Wallapai District". Economic Geology Volume 44, No. 8 December, 1949.

3. Fred Searle's discussion of the Emerald Isle copper deposit. Economic Geology Volume 45 No. 2 March, 1950.

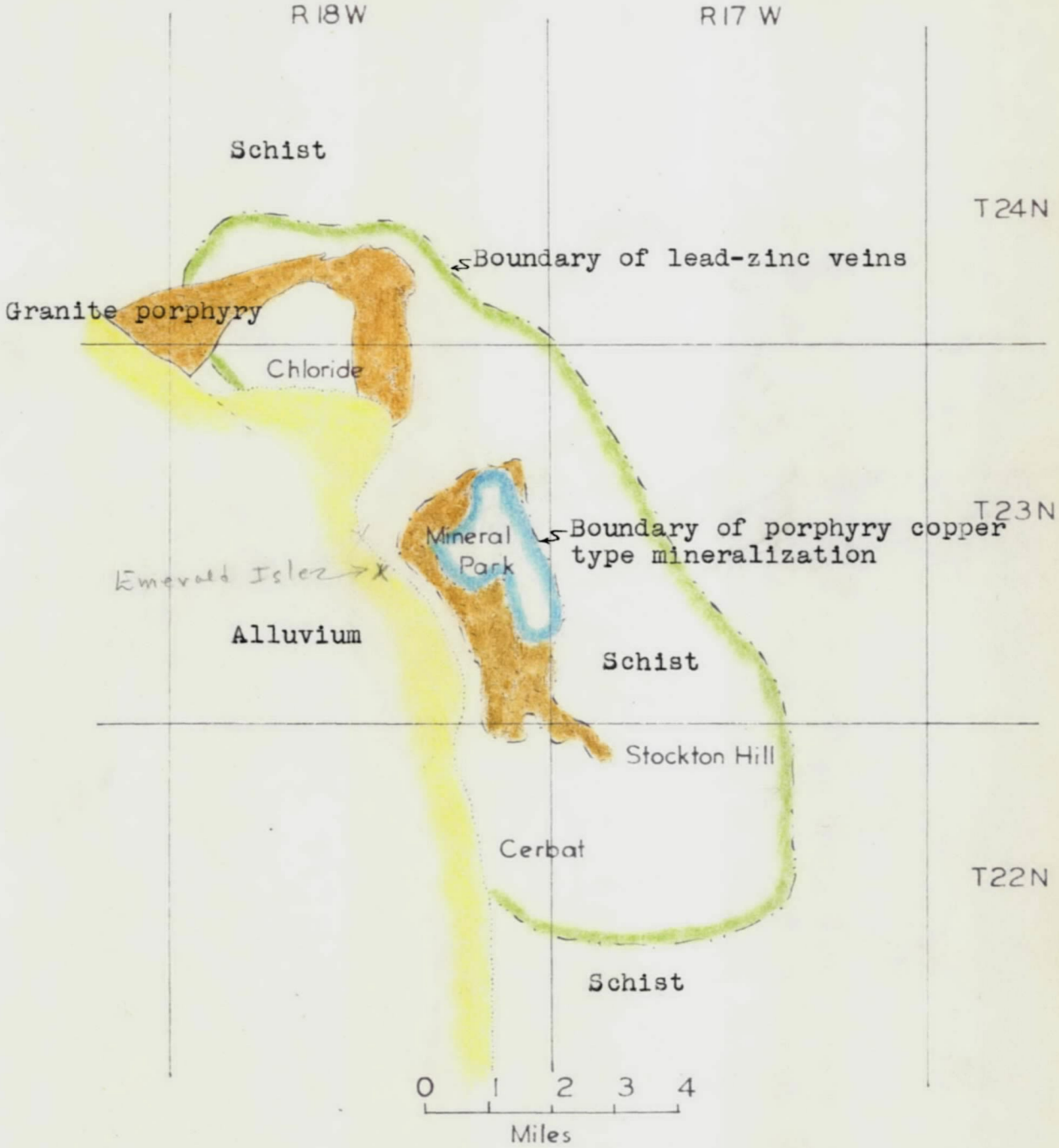
4. Although there is negligible reference to this particular area, a good geologic map of the entire Wallapai District is attached to Pollock's district report of November 18, 1949.

L. KENNETH WILSON

LKW/fh
cc: DJPope
WRLandwehr
FVRichard

Aa-13A, 23.0A

Extra set — have in file, except two photostats



Index Map of Districts
Wallapai Mining District
Mohave County, Arizona
After Thomas Nov.1,1949

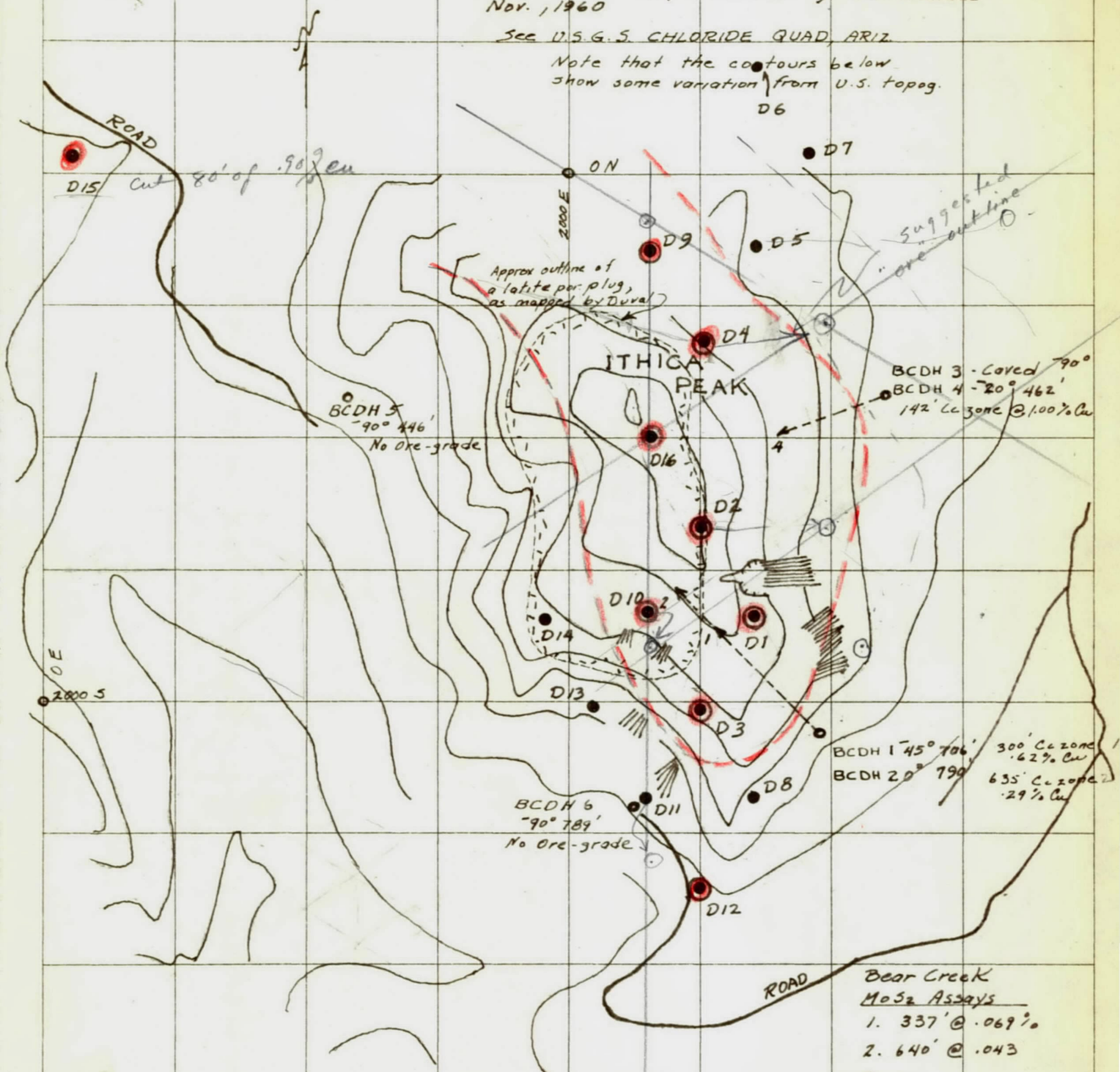
TO ACCOMPANY REPORT
DATED Nov 18, 1949
BY POLLOCK TO WILSON

Map No. 840

Location of Bear Creek DDH's
Traced from map at Kern Co Land Co
Tucson office, permission by W.K. Wallace
Nov., 1960

See U.S.G.S. CHLORIDE QUAD, ARIZ.

Note that the contours below show some variation from U.S. topog.



Bear Creek
MoS_2 Assays

1. 337' @ .069%
2. 640' @ .043
3. —
4. 284' @ .045
5. 352' @ .043
6. 614' @ .039

D4 ● Duval drill hole, red circle shows chalcocite penetration

● BCDH 5 Bear Creek Hole

The Duval drill data obtained Dec. 1960 from Tony Ching. See Courtright memo.

MINE GROSS RANCH LOCATION ITHICA PEAK LEVEL SURFACE
GEOLOGY BY _____ SURVEY Unknown SCALE 1" = 500' DATE _____

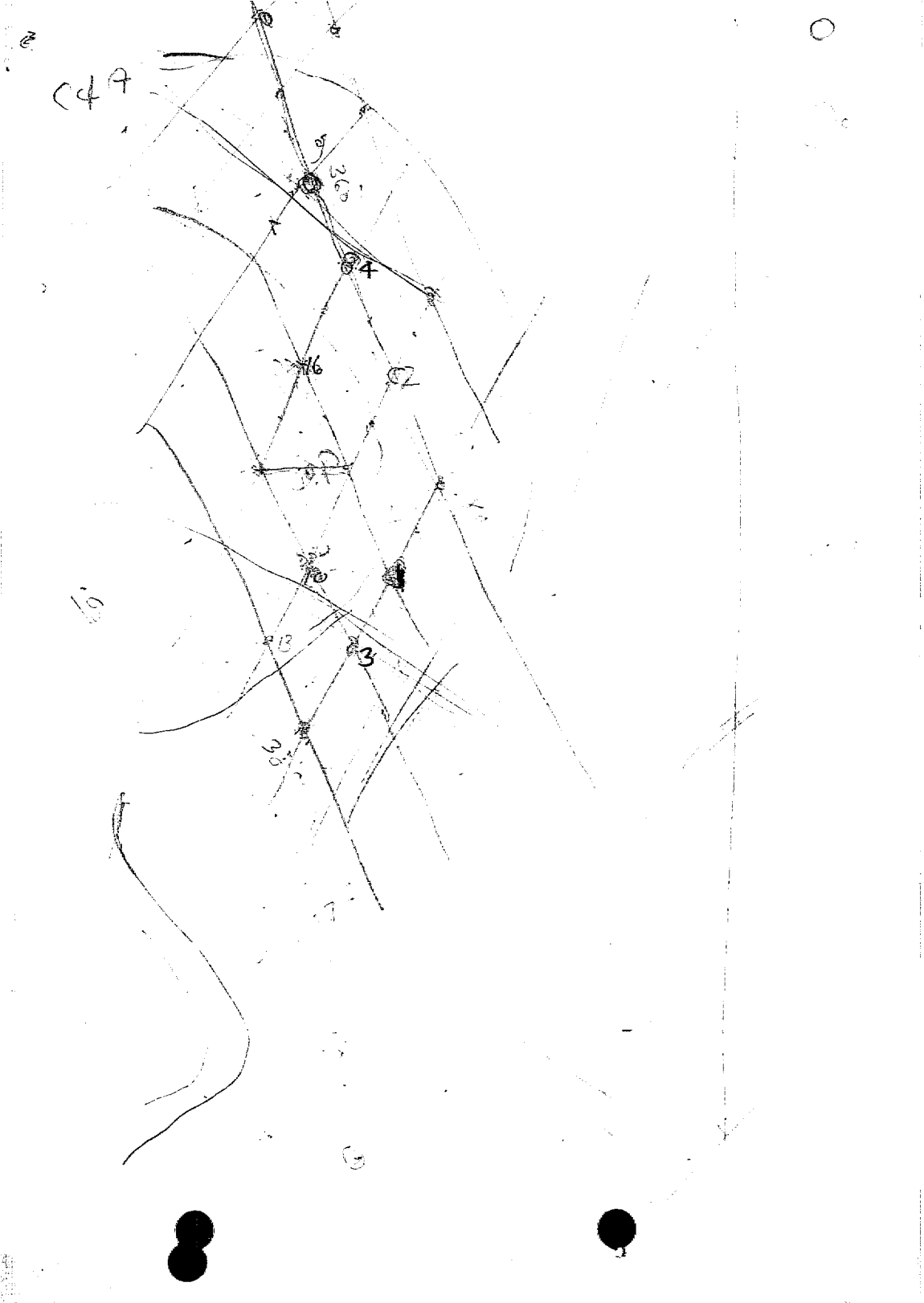
		Ore + 0.40% Cu		
CD 9	Top 180'	220'		
+ 4	130	110'		
+ 2	110	100'		
+ 3	120	80'		
1	95	35'		
12	130	20'		
DDH 10	466'	410'	spotty	TD 876
16	365'	160'	spotty	750

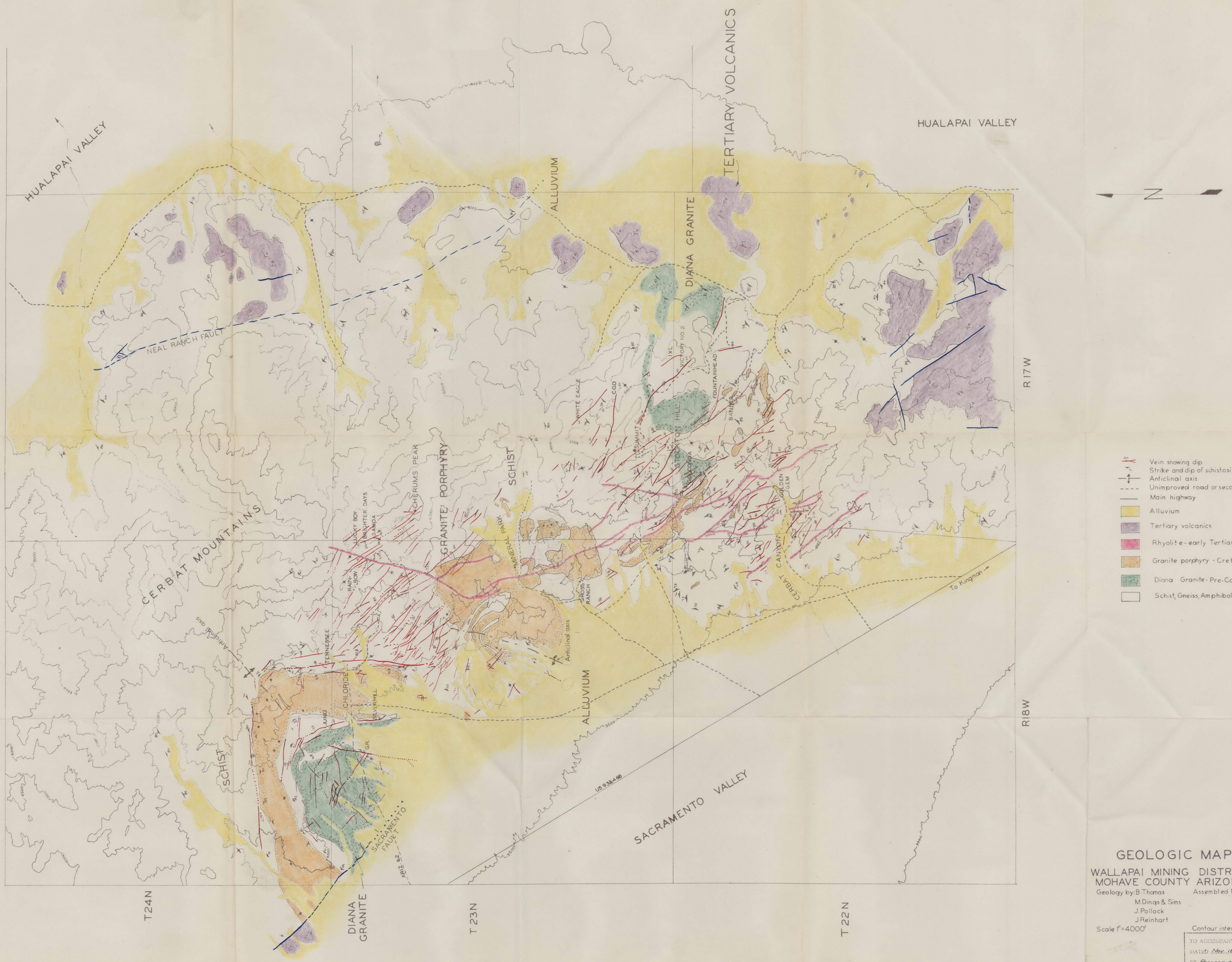
av # .6 Cu

Total 1135' @ .63% Cu
.035% Mo

Hole #15 Top 65' Ore 80 (incl 15' of lean zone)
high as Cu

.05 .03 a


4
16
3



GEOLOGIC MAP

WALLAPAI MINING DISTRICT
MOHAVE COUNTY ARIZONA

Geology by: B. Thomas
M. Dings & Sims
J. Pollock
J. Reinhart

Assembled Nov. 1, 1949

Scale 1" = 4000'

Contour interval 500'

TO ACCOMPANY REPORT
DATED Nov. 18, 1949
BY POLLOCK TO WILSON

MAP NO. 841