CONTACT INFORMATION
Mining Records Curator
Arizona Geological Survey
416 W. Congress St., Suite 100
Tucson, Arizona 85701
520-770-3500
http://www.azgs.az.gov
inquiries@azgs.az.gov

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JDS

ASARCO

Southwest Exploration Division

December 12, 1984

R. L. Brown
New York Office

Christmas Mine
Gila County, AZ

At the bottom of my in-basket I have unearthed your letter of February 14, 1983 concerning the question as to whether there are any outstanding and untested exploration possibilities still available at Christmas.

From the review, H. G. Kreis and I cannot see any smaller high-grade reserve being available at Christmas.

James D. Sell

James D. Sell

JDS/cg

cc: HGK

ICC - Christmas

% John Alice 473-3461 Claypool.

11/29 telephone.

Open pit w/ = 7.5 million tons @ 0.63 Total copper

+ UG to SE = 15.4 million tons @ 1.29 Total copper

and mostly in Escobosa (only part of the reserves being carried).

New area of "Old mill" pit - UG of

317 million tons @ 0.393 % Total Cu.

~~with~~ includes central core of somewhat higher values.

All Christmas ore runs 12-14 cents/ton in gold.

Will discuss all week of Dec. 13th

Both OP + UG evaluation studies now underway. They are open to any kind of deal.

The Man Who Owns Christmas

ASARCO
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GEOLOGY AND PORPHYRY COPPER-TYPE ALTERATION-MINERALIZATION OF IGNEOUS ROCKS AT THE CHRISTMAS MINE, GILA COUNTY, ARIZONA

A DISSERTATION

SUBMITTED TO THE DEPARTMENT OF GEOLOGY

AND THE COMMITTEE ON GRADUATE STUDIES

OF STANFORD UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

By

Randolph Allan Koski

March 1978

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ABSTRACT

The Christmas copper deposit, located in southern Gila County, Arizona, is part of the major porphyry copper province of southwestern North America. Although Christmas is known for skarn deposits in Paleozoic carbonate rocks, ore-grade porphyry-type copper mineralization also occurs in a composite granodioritic intrusive complex and adjacent mafic volcanic country rocks. This study considers the nature, distribution, and genesis of alteration-mineralization in the igneous rock environment at Christmas.

At the southeast end of the Dripping Spring Mountains, the Pennsylvanian Naco Limestone is unconformably overlain by the Cretaceous Williamson Canyon Volcanics, a westward-thinning sequence of basaltic volcanic breccia and lava flows, and subordinate clastic sedimentary rocks. Paleozoic and Mesozoic strata are intruded by Laramide-age dikes, sills, and small stocks of hornblende andesite porphyry and hornblende rhyodacite porphyry, and the mineralized Christmas intrusive complex.

Rocks of the elongate Christmas stock, intruded along an east-northeast-trending fracture zone, are grouped into early, veined quartz diorite (Dark Phase), biotite granodiorite porphyry (Light Phase), and granodiorite; and late, unveined dacite porphyry and granodiorite porphyry. Biotite rhyodacite porphyry dikes extending east and west from the vicinity of the stock are probably coeval with biotite granodiorite porphyry. Accumulated normal displacement of approximately 1 km along the northwest-trending Christmas-Joker fault

system has juxtaposed contrasting levels (lower, intrusive-carbonate rock environment and upper, intrusive-volcanic rock environment) within the porphyry copper system.

K-Ar age determinations and whole-rock chemical analyses of the major intrusive rock types indicate that Laramide calc-alkaline magmatism and ore deposition at Christmas evolved over an extended period from within the Late Cretaceous (∿75-80 m.y. ago) to early Paleocene (∿63-61 m.y. ago). The sequence of igneous rocks is progressively more alkaline and silicic from basalt to granodiorite.

Early (Stage I) chalcopyrite-bornite (-molybdenite) mineralization and genetically related K-silicate alteration are centered on the Christmas stock. K-silicate alteration is manifested by pervasive hornblende-destructive biotitization in the stock, biotitization of basaltic volcanic wall rocks, and a continuous stockwork of K-feldspar veinlets and quartz-K-feldspar veins in the stock and quartz-sulfide veins in volcanic rocks. Younger (Stage II) pyrite-chalcopyrite mineralization and quartz-sericite-chlorite alteration occur in a zone overlapping with but largely peripheral to the zone of Stage I stockwork veins. Within the Christmas intrusive complex, K-silicate-altered rocks in the central stock are flanked east and west by zones of fracture-controlled quartz-sericite alteration and strong pyritization. In volcanic rocks quartz-chlorite-pyrite-chalcopyrite veins are superimposed on earlier biotitization and crosscut Stage I quartz-sulfide veins. Beyond the zones of quartz-sericite alteration, biotite rhyodacite porphyry dikes contain the propylitic alteration assemblage epidote-chlorite-albite-sphene.

Chemical analyses indicate the following changes during pervasive alteration of igneous rocks: (1) addition of Si, K, H, S, and Cu, and loss of Fe^{3+} and Ca during intense biotitization of basalt; (2) loss of Na and Ca, increase of Fe^{3+}/Fe^{2+}, and strong H-metasomatism during sericitization of quartz diorite; and (3) increase in Ca, Na, and Fe^{3+}/Fe^{2+}, and loss of K during intense propylitization of biotite rhyodacite porphyry dikes. Thorough biotitization of biotite granodiorite porphyry in the Christmas stock was largely an isochemical process.

Fluid-inclusion petrography reveals that Stage I veins are characterized by low to moderate populations of moderate-salinity and gas-rich inclusions, and sparse but ubiquitous halite-bearing inclusions. Moderate-salinity and gas-rich inclusions become less abundant, and halite-bearing inclusions are absent in Stage II veins. The distribution of gas-rich inclusions suggests that fluids were boiling during Stage I mineralization, particularly at higher levels in the porphyry copper system.

A sequential two-stage model for intrusion, alteration, and mineralization at Christmas is proposed. During Stage I, K-silicate alteration, stockwork veining, and chalcopyrite-bornite mineralization were broadly contemporaneous with emplacement of quartz diorite and repeated surges of biotite granodiorite porphyry. The fracture-controlled, predominantly hydrolitic alteration and high total sulfide, pyrite-chalcopyrite mineralization of Stage II probably commenced with the first significant incursion of ground water into the porphyry copper system. A convection cell model may reasonably account for the distri-

bution of Stage II alteration and mineralization.

At Christmas the tendency to form biotite during K-metasomatism of basalt has greatly expanded the dimensions of the K-silicate alteration zone. The recognition and interpretation of secondary biotite in mafic volcanic terranes should be an important contribution to future exploration for porphyry copper deposits in the region.

T.H. Courtright

NEW DEVELOPMENTS AT THE CHRISTMAS MINE

GILA COUNTY, ARIZONA

By

JOHN T. EASTLICK

Prepared for presentation at the Annual Meeting
of the Arizona Section of the American Institute
of Mining, Metallurgical and Petroleum Engineers

December 2, 1957

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of the Inspiration Consolidated Copper Company.

NEW DEVELOPMENTS AT THE CHRISTMAS MINE, ARIZONA

By

JOHN T. EASTLICK

INTRODUCTION:

The Christmas Mine, located in the Banner Mining District, is in the southwestern corner of Gila County, Arizona, approximately 10 miles to the north of Winkelman along State Highway 77. The mine is situated on the eastern slope of the Dripping Springs Range about one mile to the west and 900 feet above the Gila River. Elevations range from 2100 feet at the Gila River to 4250 feet at the crest of the prominent ridges above the mine.

Discovered in the 1880's the mine has passed through the control and ownership of various mining companies. The isolated location of the property, and the fluctuation of metal prices caused intermittent operations until World War II. According to mine records, production through 1954 was 1,554,500 tons for a total of 54,969,573 pounds of copper. av ± 3.0?

27,000 tons copper 1.5 1.8 %

The ore bodies at Christmas have drawn the interest of many mining companies and several exploration programs were initiated. Of these earlier programs, the exploratory work in the deeper horizons below the 800 level by the United States Bureau of Mines is most significant.

During the present three and one-half year program of development, preparation for a new shaft has been started; the No. 3 shaft has been deepened 534 feet with stations cut at the 1100, 1300, and 1400 levels; 16,800 feet of drifts and raises have been driven; and 73,060 feet of diamond drill holes have been completed.

GEOLOGIC SETTING:

Rocks in the Dripping Springs Range are represented by pre-Cambrian and Paleozoic sediments, intrusive diabase of Cambrian (?) age, extrusive andesite of Cretaceous age, intrusive quartz mica diorite of early Tertiary age, and intrusive basaltic and ande-

sitic dikes of late Tertiary age.

Sediments of the Pre-Cambrian Apache Series outcrop to the northwest of Christmas and are the oldest rocks exposed in the area. Above the Mescal formation of the Apache group are Cambrian sediments composed of the coarse pebbly Troy quartzite with a thickness of approximately 400 feet, succeeded by about 175 feet of fine-grained, argillaceous, and limy quartzites. Uncomformably overlying the Cambrian quartzites are approximately 265 feet of Devonian Martin limestone comprised of shaly and dolomitic limestones in the basal member, massive limestone in the middle horizon, and shales and shaly limestone in the upper member. Above the Devonian Strata are 550 feet of massive Mississippian Escabrosa limestone, followed by approximately 1,000 feet of Naco limestone of Pennsylvanian and Permian (?) age consisting of interbedded shaly limestones, shales, and limestones with local cherty and quartzitic layers.

Intruded into the Mescal limestone and the Troy quartzite are irregular masses and sills of diabase. No exposures of diabase cutting rocks above the Troy have been noted in the area.

Resting on the Paleozoic sediments are a thick series of undifferentiated volcanics consisting of andesitic flows, tuffs, flow breccias, and conglomerates. In the vicinity of Christmas, the volcanics are fine to medium grained andesites consisting essentially of feldspar phenocrysts set in a matrix of fine, dark ferromagnesian minerals.

All the earlier rocks are cut by a generally east-west series of quartz mica diorite dikes. Numerous sills and irregular apophyses extend out into the surrounding rocks. These intrusives occur with several textural variations and are composed primarily of quartz, feldspar, and biotite. Generally, the smaller bodies contain varying amounts of hornblende and biotite. In the Christmas area, the most common quartz mica diorite occurs as a light gray, coarse-grained, even-textured rock becoming porphyritic near the outer margins with large phenocrysts of quartz and feldspar in a fine-grained, dark ground mass. Some narrow quartz mica diorite porphyry dikes cut

irregularly through the main intrusive masses, probably representing a late phase of the same magma.

In the Christmas mine, narrow post-mineral dikes of basalt and andesite cut through the Paleozoic sediments and the diorite intrusives. They commonly trend from slightly west to east of north with steep irregular dips. Two dikes along the north contact, varying from the general trend, strike approximately N60°E and dip steeply northwest.

STRUCTURE:

The Dripping Springs Range is indicated by Ransome (2) to be a complexly faulted, anticlinal structure. The dominant structural features of the region are the generally east-west trending quartz mica diorite dikes, and the series of major northwest-trending faults. The orientation and distribution of the diorite dikes suggest that they were intruded along a system of steep, N70°W - N70°E trending fissures approximately parallel to the axis of the regional deformation. The major faults are normal faults of the Basin and Range type with their hanging wall or down-thrown sides towards the valleys.

At Christmas one of these major structures, the Christmas fault, separates the area into two geologic settings. To the west, Naco limestone, capped by andesite, forms the prominent outcrops along the steep ridges above the mine, and on the east side andesite comprises the predominent rock eastward to and across the Gila River. The surface outcrops of the quartz mica diorite, intruding the limestones to the west and the volcanics to the east, form an irregular elliptical outline with the long axis trending about N70°E across the Christmas fault zone. Development work underground indicates the intrusive to consist essentially of two thick dikes, converging to the west towards No. 3 Shaft and to the east towards No. 4 Shaft, with numerous branching sills and interfingering smaller dikes. In the footwall of the Christmas fault, the greatest mass of quartz mica diorite is centered to the east of No. 3 Shaft between the 500 and 1100 levels where several thick sills and numerous irregular apophyses

extend into the adjoining limestones.

The sediments surrounding the intrusive contacts have generally south to southeasterly dips of 10° - 20°. Much of the original structure is obscured by later post-mineral faulting and by the intrusion of the quartz mica diorite, but it is apparent that some deformation preceded the intrusives. Along the south contact zone, the diorite cuts across the north limb of a small anticlinal fold, and the downward steepening of the sedimentary beds near the north contact suggests that the North dike intruded along the flank of a small flexure. Compressional stresses are also indicated by minor bedding-plane slips, small thrust faults, and local rolls along the bedding.

Pre-mineral fractures are evidenced by the numerous steep-dipping sulphide and quartz stringers in the diorite and in the surrounding rocks. These occur along definite conjugate pre-mineral fracture systems, one set consisting of essentially parallel fractures along the intrusive contacts, and the other set comprising of fractures approximately at right angles to the contacts.

Underground the Christmas fault is exposed on the 300, 400, and 800 levels on the north contact, and at the portal of the 400 level on the south contact. This fault, with a normal displacement of approximately 1200 feet down to the east, strikes generally N20° - 25°W and dips 65°-75° northeast. Movement occurs along a 10 to 20 foot crushed zone with brecciated blocks and fragments of diorite, andesite, and limestone between several fault strands. Another paralleling structure, the Joker fault, has been discovered on the 800 level, 900 feet to the east of the Christmas fault. It strikes N10° - 25°W and dips 75° northeast with a normal displacement down to the east of an unknown distance. Numerous smaller faults occur throughout the three major fault blocks. The majority, with normal movements of a few inches to 40 feet, have north to northwesterly strikes, trending obliquely to or parallel to the major structures. In the footwall area of the Christmas fault, two prominent east-west structures form the

borders of a characteristic graben. On the north side, the 1301 fault strikes generally N70° - 75°W and dips 55° - 60° southwest with movement down 60 feet to the south. The No. 3 Shaft fault along the south border strikes approximately N85°W and dips 60° - 70° northeast with a displacement of about 150 feet down to the north.

The age of faulting, particularly that of the major structures, has been the subject of much discussion. There can be no argument that at least part of the displacements along the Christmas and Joker faults are post-mineral, and evidence points strongly, both on a regional and a local scale, to the fact that probably the major part, if not all, the movement was later. Displacements along the 1301 and the No. 3 Shaft faults appear to be post-ore, but may reflect later post-mineral movement along pre-mineral fault or shear zones. The smaller northeasterly to northwesterly striking faults are definitely post-ore in age, cutting and displacing the sedimentary strata, the mineralized beds and stringers, the post-mineral basic dikes, and the diorite intrusive dikes and sills.

ORE DEPOSITS:

The known ore bodies of the Christmas mine are classified as pyro-metasomatic in type, occurring as replacements in metamorphosed limestones of the Naco, Escabrosa, and Martin formations. The relationship of the ore deposits to the intrusive is almost diagrammatic. The type and intensity of mineralization varies with distance from the intrusive contacts, with the degree of metamorphism, with the physical and chemical properties of the sedimentary rocks, and with the intensity of pre-mineral fracturing and shearing.

The sedimentary rocks near the intrusive contacts are highly altered and metamorphosed. In the Naco and Escabrosa limestones, garnet and marble are the principal contact-metamorphic products along with lesser amounts of epidote, wollastonite, idocrase, chlorite, and serpentine. In the Martin limestone, the lower beds are highly altered to serpentine, dippside, tremolite, and chlorite with garnet sparingly

present. Shale beds like the upper member of the Devonian are altered to fine-grained, banded hornfels and, in some of the thin-bedded limestones, silicification is almost complete. The numerous steep stringers and seams of sulphides which cut the ore deposits attest the fact that much of the metallization took place after development of the lime silicate minerals. Mineralizing solutions, undoubtedly traveling along the pre-mineral fracture zones near the limestone-diorite contacts, formed the extensive replacement ore bodies at intersections with favorable horizons in the metamorphosed limestones.

The principal metallic minerals are chalcopyrite, bornite, magnetite, pyrite, sphalerite, and pyrrhotite. Small amounts of galena and specular hematite are commonly present near the outer margins of the mineralized zones. Some minor molybdenite occurs sparsely in the mineralized beds, generally localized in the siliceous and silicified zones. Magnetite increases with depth, becoming a predominant constituent in ores in the Escabrosa and Martin limestones. Oxidation was almost complete above the 300 level, and extends locally to below the 800 level. Supergene ore minerals include chalcocite, native copper, copper oxides, and copper carbonates.

Naco Limestone:

Production up to 1953 was principally from the middle member of the Naco limestone. The deposits occur as gently dipping, tabular replacements in garnetized zones between thin shale and shaly limestone beds. Peterson and Swanson (1) identify nine distinct ore-bearing horizons along the north contact, and eleven beds on the south side. Viewed on a horizontal projection (Plate I), mineralized bodies in these favorable horizons, yielded ore along the entire lengths of the main intrusive contacts. The individual ore-bearing beds range from 5 to 12 feet in thickness and extend laterally 150 to 200 feet away from the contacts. Oxidation masks much of the character of the primary mineralization, but it is apparent that magnetite and pyrite were predominant against the intrusive contacts, yielding to chalcopyrite and bornite

in the intermediate zone, and grading to chalcopyrite, pyrite, and sphalerite with minor galena along the outer margins.

Ore bodies in the Naco limestones to the east of the Christmas fault are known only from diamond drill hole intersections and from a few exposures on the 800 level, but they show the same characteristics of the deposits to the west. A 1290 foot diamond drill hole, drilled from the 800 level near the center of the block between the Christmas and Joker faults, cut 955 feet of sediments which definitely can be identified as typical Naco beds.

Escabrosa Limestone:

Ore bodies in the Escabrosa limestone, in contrast to the tabular flat-lying deposits in the Naco limestone, occur as irregular, massive replacements near the quartz mica diorite contacts. Generally, the vertical dimensions are greater than the horizontal thicknesses, the ore bodies terminating abruptly into marbleized limestone away from the contacts. The known ore deposits, separated by a thick diorite sill, are in the upper and lower part of the formation.

Ore bodies developed in the Escabrosa upper horizon on and below the 800 level show the common characteristics of these deposits. Intrusive relationships are generally complex with ore deposition occurring in blocks of limestone completely or almost surrounded by diorite. Other deposits occur as replacements of limestones in embayments between diorite dikes projecting westward from the main intrusives, and as thick, shell-like masses against the outer intrusive borders. The ores are usually higher in grade than those of the Naco with chalcopyrite, bornite, pyrite, magnetite, and sphalerite occurring in a garnet gangue. Magnetite and pyrite commonly predominate near the intrusive contacts with sphalerite localized in the outer margins.

In the lower part of the Escabrosa, ore bodies are known only from diamond drill hole intersections, but they show the same characteristics of deposition peripheral to the intrusive contacts. Other important deposits occur between the main intrusive

masses.

Experience indicates that wherever the Escabrosa limestones are in contact with the main intrusives, sizeable ore bodies can be anticipated.

Martin Limestone:

The most extensive of the replacement ore bodies is found in the lower part of the Devonian limestones. Mineralization in this horizon, extending north and south from the main intrusive dikes, occurs as a flatly-dipping, massive tabular deposit. These lower limestones, developed to the north on the 1300 level (Plate 3) and to the south on the 1400 level (Plate 4) have proved to be consistently mineralized over an area 2700 feet in width across the intrusives, and 1400 feet in length along the intrusive contacts. Diamond drilling to the east and west of the developed area indicate extensions to 3000 feet along the south contact and to 2000 feet along the north contact. The lower 30 feet of the Martin limestone, consisting of thin-bedded dolomitic and shaly limestones, is the most favorable zone for replacement. However, adjacent to the intrusives, where the intensity of metamorphism and mineralization was greatest, the ore replaces up into the lower part of the massive limestones of the middle member.

Along the south contact, the deposit lies along the south limb of a small anticlinal fold which plunges gently to the west. Mineralization extends throughout a thickness of 65-80 feet for at least 1300 feet along the strike and for 600 to 850 feet down-dip, thinning abruptly to the south and to the west. Adjacent to the north dike, the thicker mineralization extends with a thickness of 55-75 feet for 1600 feet parallel to the intrusive contact, and for 200-400 feet up-dip along the bedding, becoming thinner to the northwest. Between the dikes the more favorable, thin-bedded, impure limestones are replaced, but mineralization above is spotty.

Magnetite forms the predominant metallic mineral throughout the deposit, comprising from 15 to 25 per cent of the total content. Steep-dipping seams of anhydrite and gypsum are common, and local occurrences of fluorite are noted. The sulphide minerals

commonly show both a vertical and lateral zonal arrangement. Laterally the mineralization grades from a pyrite -- chalcopyrite zone near the intrusive borders, to a chalcopyrite-bornite intermediate zone, and to a pyrrhotite-pyrite-sphalerite-chalcopyrite outer zone. Vertically in the thicker sections, pyrite, chalcopyrite, sphalerite, and sometimes galena generally border a chalcopyrite-bornite central zone.

CONCLUSION:

Inspiration Consolidated Copper Company has developed sufficient tonnage of ore to warrant a mine operation. Plans and preparations have been made for a new shaft in conjunction with a 2500 ton-per-day mill. Culmination of these plans is expected if and when the present copper situation improves.

ACKNOWLEDGEMENTS:

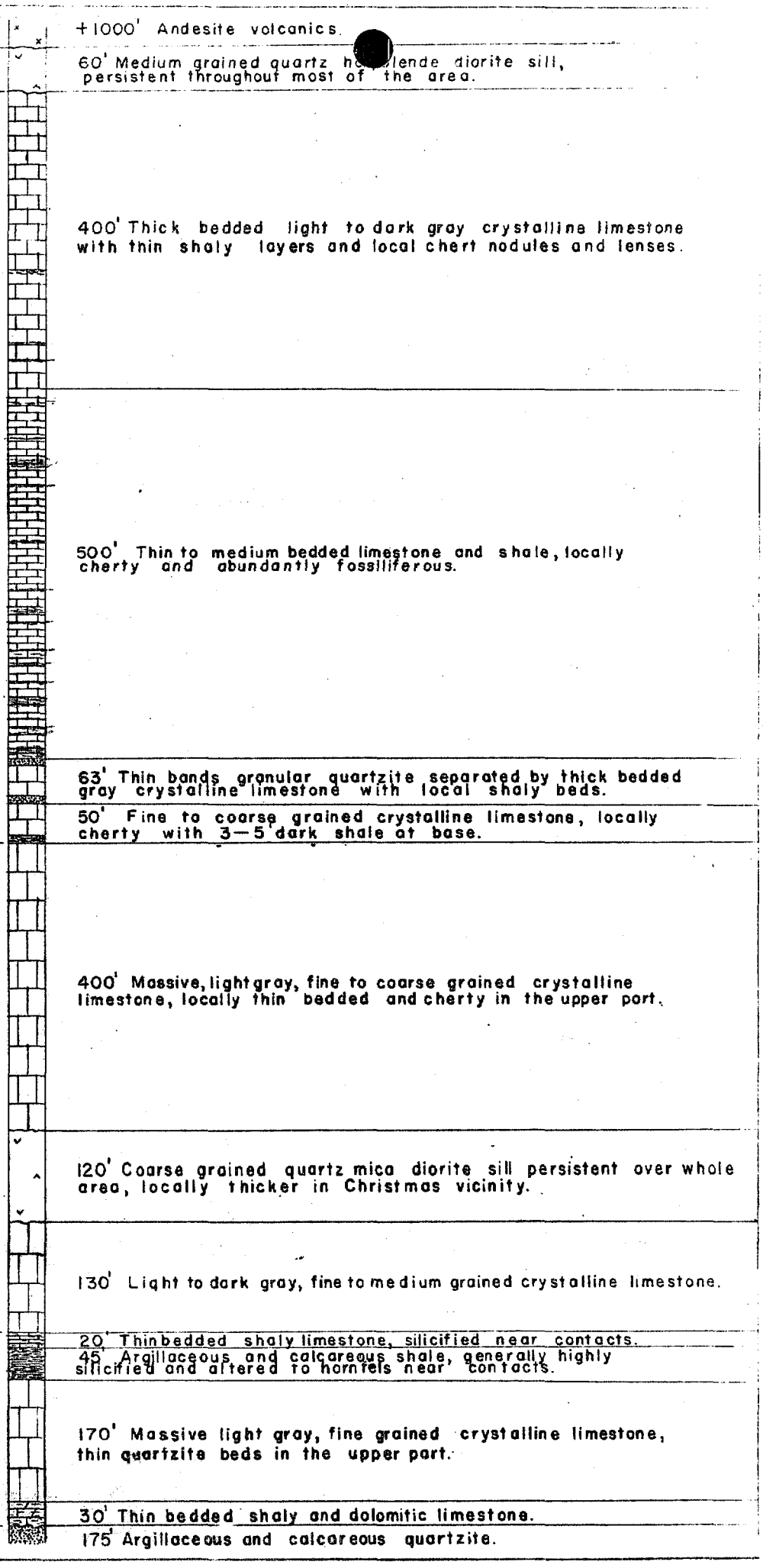
Acknowledgements are due the management of the Inspiration Consolidated Copper Company for their cooperation in making this report possible, and to the geological staff at Christmas for their aid in its preparation.

REFERENCES:

1. N. P. Peterson and R. W. Swanson, Geology of the Christmas Copper Mine, Gila County, Arizona: U. S. Geol. Survey Bull. 1027-H, 1956.

2. F. L. Ransome, Copper Deposits of Ray and Miami, Arizona: U. S. Geol. Survey Prof. Paper 115, 1919.

PLATE 2, GENERALIZED STRATIGRAPHIC SECTION IN VICINITY CHRISTMAS MINE WEST TO TORNADO PEAK. Compiled from Diamond Drill Hole Data and Surface Geological Mapping.



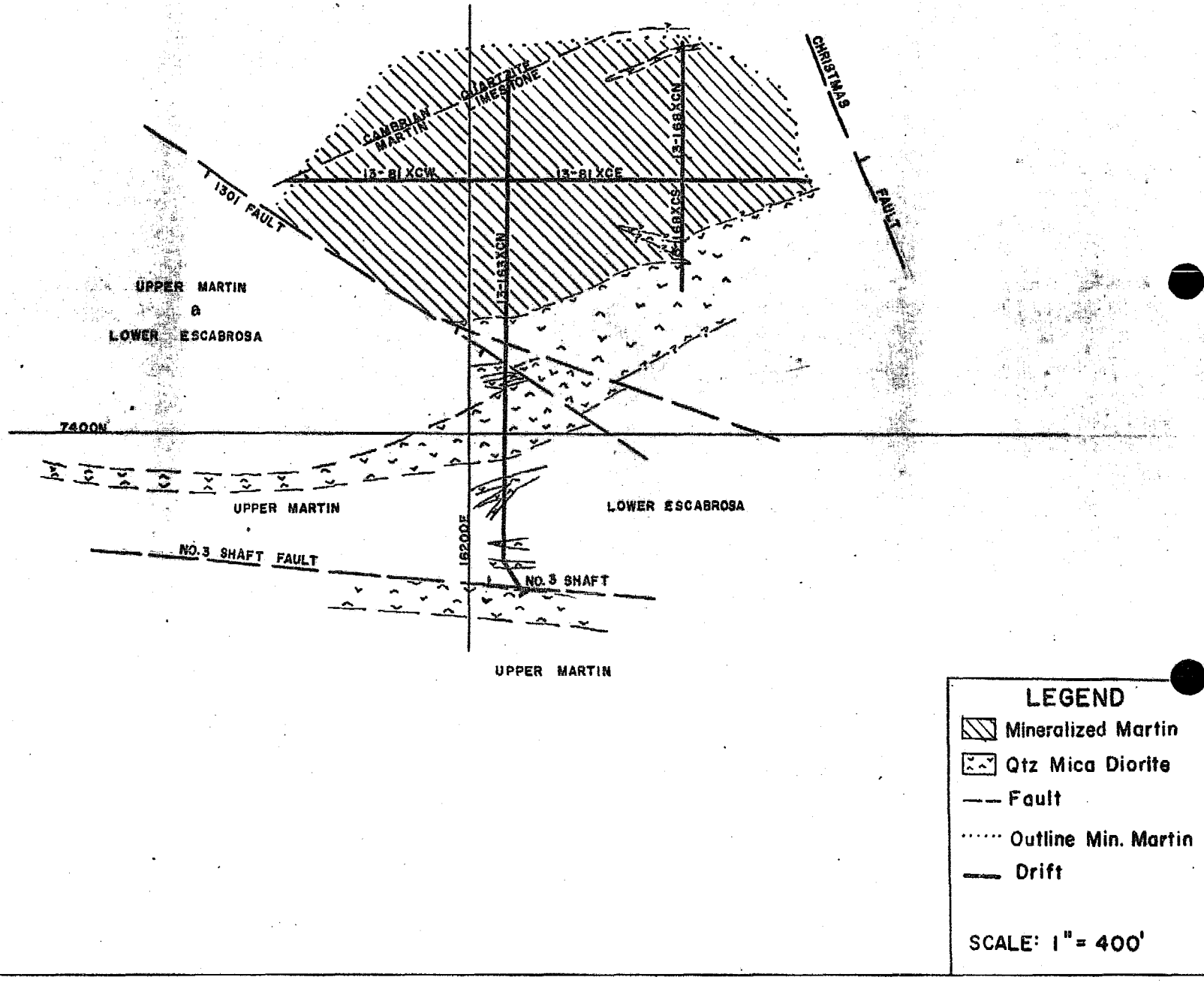


PLATE 3, GENERALIZED 1300 LEVEL GEOLOGY, CHRISTMAS MINE, I.C.C. COMPANY

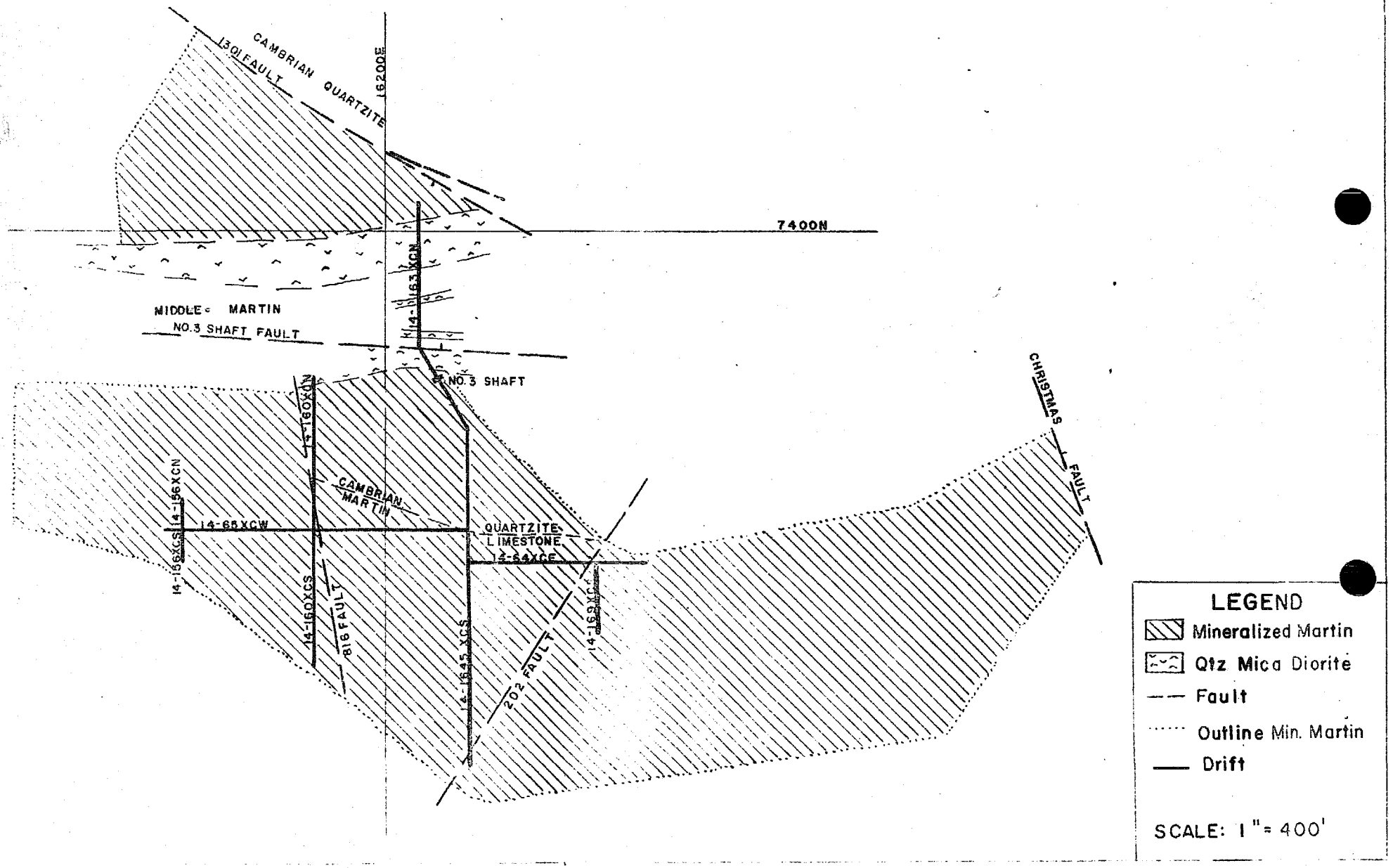
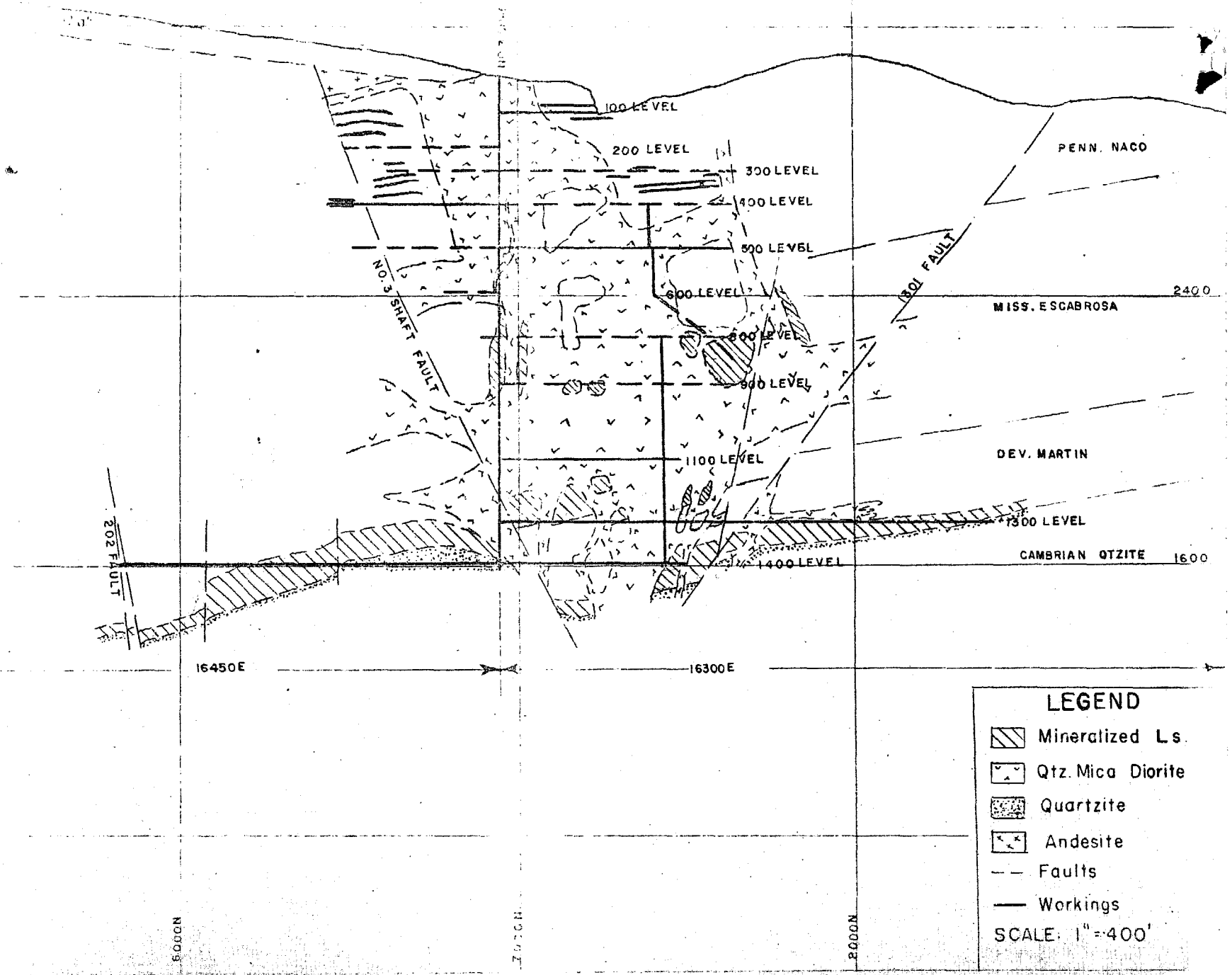


PLATE 4, GENERALIZED 1400 LEVEL GEOLOGY, CHRISTMAS MINE, I.C.C. COMPANY



GENERALIZED N-S SECTION THRU NO.3 SHAFT, LOOKING WEST; CHRISTMAS MINE

C
O
P
Y

JHC ...

New York, October 29, 1956

Mr. W. G. Rouillard
Salt Lake City

Inspiration Consolidated Copper Company
Christmas Mine

You and those receiving copy of this letter will be interested in the following extract from the Inspiration Consolidated Copper Company's interim report to stockholders dated October 29, 1956:

"Christmas Mine Area

Development work so far completed indicates an ore reserve of 10,000,000 tons of 2% grade copper ore in the O'Carroll Bed, with the possibility of additional tonnage of lower grade ore. In the course of drilling to the O'Carroll Bed, ore of lower grade has been encountered in intermediate levels. Presence of high grade primary mineralization in another area was also disclosed. These other ore occurrences have not been sufficiently well evaluated to permit an accurate estimate of tonnage and grade, but the aggregate addition to ore reserves will be substantial.

Present planning envisions a concentrator of 2500 tons daily capacity, designed so that it may be readily expanded as needed. The new McDonald production shaft and hoisting equipment will have a capacity of more than twice the expected initial mill tonnage. Engineering and design work is progressing, and physical construction on numerous phases of the project will be well started by early 1957. On the basis of a preliminary construction schedule, the Christmas Mine should start producing in the second half of 1959.

Drilling continues on other properties adjacent to the Christmas Mine without significant result to date.

Total development costs in the Christmas area amounting to $854,140 for the first nine months of 1956 have been charged against income."

J. D. MacKenzie

cc-RLJourdan
BDRoberts
RFWelch
FJDowney

COPY

El Paso, Texas

November 1, 1956

Mr. J. D. MacKenzie, Vice President
American Smelting and Refining Company
New York 5, New York.

INSPIRATION CONSOLIDATED COPPER COMPANY
CHRISTMAS MINE

Dear Sir:

Thank you for copy of your note of October 29 to Mr. Rouillard concerning developments at the Christmas Mine as reported in the interim report of the same date of Inspiration Consolidated Copper Company. It is interesting to observe that the Company is not yet ready to report on the possibilities of the primary ore body, although I imagine they have developed a great deal of knowledge about the possibilities.

I think Mr. Honeyman will entertain a bid from A. S. and R on the contemplated concentrate production, and Mr. Welch will pursue this in due course.

Mr. Downey told me the other day that one drill hole at about 1,700 feet on the old 79 Mine, now under option to Inspiration, showed a bed of good grade copper ore similar to the Christmas. Since the 79 Mine is probably only three or four miles airline from Christmas this discovery may be a continuation, although, as you know, one drill hole does not make a mine.

Yours truly,

/s/ BEN ROBERTS

cc: W. G. Rouillard
R. L. Jourdan
Reed F. Welch
F. J. Downey

Mr. Courtright
As-7.2.3

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

August 21, 1950

MEMORANDUM FOR MR. WILSON

CHRISTMAS AREA, NORTHWEST
Banner District
Gila County, Arizona

In accordance with the instructions of your Memorandum dated July 8th, 1950, I have carried out a preliminary reconnaissance of the subject area, spending five days in the field during the period July 13th to August 12th. The objective of this study was to appraise the chances of finding ore in the limestones around the diorite intrusive bodies some two miles northwest of the Christmas Mine.

As pointed out by Mr. Pollock in his Memo of June 30, 1949, the copper ores of the Christmas, the lead-zinc-copper ores of the London-Arizona and the Seventy-Nine Mines occur as replacements of limestone adjacent to small plugs of quartz-mica diorite; consequently, around other plugs, such as in the area northwest of Christmas, exploration opportunities could exist in limestones concealed by Cretaceous lavas; or, an exceptionally favorable bed, such as the O'Carrol, might contain ore mineralization hidden by comparatively barren overlying limestone beds.

A map (Attachment B) essentially the same as that accompanying Mr. Pollock's Memo is attached hereto for reference. Since the geology of the area of interest (marked by a half-circle) as mapped by Ransome, checked fairly well with my observations in the field, I did not undertake the preparation of an original map. The contact prints from your file of aerial photographs were quite suitable for location purposes.

A map (Attachment C) was prepared to depict the trends of shearing and mineralization in the diorite and volcanics in and around the Christmas deposit. Surface geology west of the No. 4 shaft was reduced from a map by N. P. Peterson; the shearing which is shown east of this shaft was sketched on an aerial photograph.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Extensive zones of shearing and fracturing are considered indispensable to the formation of ore deposits such as that at Christmas. The disseminated sulphide mineralization which characteristically occupies these zones is manifest on the surface at Christmas as leached and altered outcrops of diorite and volcanic rock. The area of diorite stocks northwest of the Christmas Mine was found to be devoid of this essential feature; further, a number of limestone horizons are exposed on the surface, including the O'Carrol bed, and significant mineralization is absent. For these reasons principally, the area is considered to hold no exploration possibilities worthy of further investigation.

Memorandum for Mr. Wilson

GEOLOGY

For reference, the geologic column of the Christmas area (after unpublished work by N. P. Peterson as discussed by Entwistle in his report of February 24, 1945) is listed below in sequence, with youngest at top.

FORMATION	THICKNESS, FEET	AGE
Gila conglomerate	0 to ?	Pleistocene
Quartz mica diorite Hornblende diorite		(Early Tertiary (?) (Intrusives
Volcanics: Andesite flows, tuffs, breccias	Plus 2000	Cretaceous
Diabase -- sills and dikes		(?)
Galiuro) Tornado	700	Pennsylvanian
Escabrosa) limestone	550	Mississippian
Martin limestone	325	Devonian
Santa Catalina shale	200	(Cambrian
Troy quartzite	300	(
Mescal limestone	100?	Pre Cambrian

Two miles northwest of the Christmas Mine the diorite porphyry occurs as stocks, dikes and sills on either side of the fault which has been mapped by Ransome as the northwesterly continuation of the Christmas fault. Some variation was noted in the appearance of the diorite; there may be two separate intrusives, as Entwistle has observed in the Christmas Mine, but at any rate the diorite is for the most part similar to that of the Christmas stock and thus is considered a like occurrence. The diorite cuts the Carboniferous limestones and the Cretaceous volcanics, and all three are overlain in part by the post-mineral Gila conglomerate. A slender rhyolite dike, less than twenty feet in width, cuts the diorite in an east-west direction and is, apparently, the latest intrusive rock of the area.

According to Ransome, (see Attachment B) the Martin limestone, with the favorable O'Carrol bed at its base, reaches the surface about one mile west of the larger diorite mass; however, just south of the Christmas fault near the bottom of a gully the writer observed some 25 feet of gray-green soft shale which closely resembles the Santa Catalina shale underlying the Martin limestone at the London-Arizona Mine. It is believed that the limestone immediately overlying this small exposure of shale represents the O'Carrol bed at the base of the Martin formation. These flat-lying shale and limestone beds terminate abruptly against the Christmas fault on the north, limiting the outcrop (of the O'Carrol bed) to an area some 200 feet square in the bottom of the gully.

A very minor amount of mineralization was noted in the area. This occurs almost exclusively in the limestone just south of the Christmas fault, as narrow (less than two feet in width) discontinuous veins containing rusty iron gossan material with black manganese oxides and small amounts of blue copper carbonates.

Memorandum for Mr. Wilson

Development consists of a few shallow pits and short drifts. Mineralization appeared to have had little or no inclination to follow the bedding; a narrow but well mineralized vein cuts through the O'Carrol bed and underlying shale in the outcrop mentioned in the foregoing without showing any migration of mineralization along the bedding planes.

In Bulletin 771 the Premier Group of ten unpatented claims is listed as being located two miles northwest of the Christmas Mine. The deposit is described as an east-west vein in limestone up to three feet in width, that could be traced for half a mile. This undoubtedly is the vein observed by the writer.

The diorite, and the volcanics of the area exhibit little more than traces of mineralization and alteration. A few specks of limonite after pyrite were noted, also a narrow zone of weak shearing containing thin seams of limonite. The latter was about ten feet in width. Minor amounts of epidote occur in the volcanic talus; some of this may have been derived from the limestone, although none was observed in place. No evidence of garnet or other so-called silicates, was found in the limestones at the diorite contact --or elsewhere.

MINERALIZATION IN THE CHRISTMAS AND LONDON-ARIZONA MINES

The surface features of these two deposits were briefly scrutinized for purposes of comparison to the area northwest of the Christmas Mine. Both of these are characterized by extensive disseminated sulphide mineralization in the small diorite stocks partly surrounded by limestone replacement ores.

At the Christmas Mine some of the diorite outcrops are similar in appearance to those found on the fringes of porphyry copper deposits -- showing weak to moderate hydrothermal alteration accompanied by pale brown limonite in veinlets and grains. Only small amounts of limonite after chalcocite were noted. This disseminated mineralization occurs for the most part in zones of east-west, nearly vertical shearing (Attachment C). One exception was noted southwest of the No. 3 shaft; here the sheeting trends northeasterly, and is probably the surface expression of the northeast sheeting described by Entwistle (Report February 24, 1945) as occurring frequently along the south contact. Also, he noted that (1) the shears were often filled with pyrite and copper minerals, (2) were predominantly east-west and (3) were in part responsible for the localization of the ore.

Only portions of the diorite are mineralized. On the surface and underground much of the diorite is quite fresh appearing and contains no veining or other evidence of mineralization. The sheeted and mineralized zones show assays ranging from .2% to 1.0% copper, averaging perhaps about 0.4% according to Entwistle.

On the surface the mineralized shear zones are aligned roughly in an east-west direction, conforming to the trend of the dike pattern in the vicinity. They extend from the western edge of the Christmas deposit to the Gila River on the east, a distance of 1½ miles.

The shearing and mineralization is confined largely to the diorite, extending but a few tens of feet into the volcanics and appearing to terminate rather abruptly in the limestone. However, as I observed on a brief visit to the 300 level northwest of the No. 3 shaft, the ore in garnetized limestone contains numerous parallel veinlets of pyrite-chalcopyrite persistently trending east-west.

Memorandum for Mr. Wilson

The possibility of finding ore in the down-dropped limestone block east of the Christmas fault has been recognized by several investigators. Of course, the near-marginal tenor of the Christmas deposit as so far developed, certainly offers no encouragement to search for more of such material, especially at depths greater than 1500 feet, the approximate depth (measured from the surface) of the drill hole on the bottom level of No. 4 shaft. This hole did not reach the limestones but did cut mineralized diorite and volcanics running from 0.1% to 0.9% copper, averaging about 0.4% copper. This fact, coupled with the evidence of mineralization in the diorite and volcanics on the surface, means I believe, that the limestone beneath the volcanics quite likely contains copper mineralization. However, the strongest disseminated mineralization and alteration observed in the diorite outcrops occurred in the zone west of the No. 3 shaft, near the apparent juncture of the north and south contact ore zones; east of the Christmas fault mineralization appears comparatively weak and alteration is definitely quite feeble.

At the London-Arizona, extensive replacement of the O'Carrol limestone bed by lead, zinc and copper sulphides, occurs a few hundred feet south of a small diorite stock surrounded by diabase and Troy quartzite. All three formations, the diorite, diabase and quartzite, contain disseminated copper mineralization in zones of shattering and shearing. Judging by the outcrops the strongest of this mineralization has been adequately probed by exploration drifts on the Chilito property. A small body of disseminated copper mineralization was found here in the diabase; J. Pollock estimated a possible two to three million tons of .8% copper ore in his Chilito report of September 18, 1947. Incidentally, erosion has stripped off the Paleozoic limestone in the Chilito area and in the process has perhaps removed important replacement orebodies that quite likely existed in the limestone adjacent to the disseminated copper zone.

Erosion has not reached the pre-Cambrian Mescal limestone which underlies the Troy Quartzite, but the diabase in the Chilito Mine appears to have stoped out much of this bed. Small remnants of limestone are represented as inclusions of the Mescal formation in the diabase on maps accompanying James Pollock's report of September 18, 1947.

The exceptional favorability of the O'Carrol bed here (or elsewhere) for ore may be due, I believe, to the physical environment of the bed rather than any special receptivity for chemical reasons. The bed immediately overlies a thin shale horizon, the Santa Catalina, which divides two thick and relatively incompetent rock units — limestone and quartzite. This shale is the logical layer to relieve stresses and thus become a bedding fault zone, producing in the wall rocks fractures which allow the migration of gasses or liquids laterally along the bedding, resulting in replacement of the limestone — in this case the O'Carrol bed, in the hanging wall.

. . . . . .

Deposits such as the Christmas may be regarded as miniature "porphyry coppers" especially from the standpoint of origin. The diorite magma was apparently guided principally by zones of structural weakness in the pre-existing rocks, as were the monzonite and related porphyries generally associated with disseminated copper deposits. In occupying these zones the solidified diorite was "in line" for shearing wherever stresses were renewed or continued. Subsequently, rising solutions, following the fracture pattern, replaced the carbonate rocks with various

silicates and oxides, eventually filling available openings in all rocks with sulphides of iron and copper.

In some of the porphyry copper deposits of the western states garnetized or "silicified" limestone accounts for a substantial part of the total tonnage. This type of ore usually occupies a border or fringe position in relation to the main ore body in "porphyry". Relationships parallel to those of the Christmas deposit occur in the western part of the Ely district of Nevada. Here, in one deposit, the garnetized limestone comprises the disseminated copper ore body, averaging around 1.0% copper, the monzonite porphyry which cuts the limestone is submarginal, averaging about .2% copper.

CONCLUSIONS AND RECOMMENDATIONS

In appraising the chances of ore occurrence in the limestones around the quartz mica diorite stocks northwest of the Christmas Mine, the most unfavorable feature is considered to be the general lack of evidence of mineralization on the surface. The limestone horizon generally believed most favorable, the O'Carrol bed, and several hundred feet of higher beds, are well exposed near the diorite contacts, and are for the most part quite fresh and unaffected by silicate or sulphide mineralization - in contrast to the widespread garnetization in the limestones around the Christmas stock. It is believed unlikely that this garnetization, or sulphide mineralization, can be credited to the "touch" of the diorite magma, otherwise, fresh, unaffected limestone would not occur in contact with the diorite, as it does quite often in the Christmas deposit. The generally accepted theory is, I believe, that so-called contact metamorphism is controlled essentially by fractures or faults. In the diorite stocks associated with the Christmas and London-Arizona deposits we find abundant evidence of mineralized fractures or shears; in the diorite stock northwest of the Christmas, shearing and mineralization is conspicuously absent.

It is considered evident in the district under consideration that the physical rather than the chemical aspects are likely the most important in the formation of ores -- that extensive shattering and shearing of the rock was vital to the introduction of ore solutions which replaced limestone, more likely on a basis of proximity rather than purity. The diorite stocks are considered essential features, but not closely and directly related to the ore, except to the extent that they have determined the shape of orebodies by sculptoring the limestone host rock.

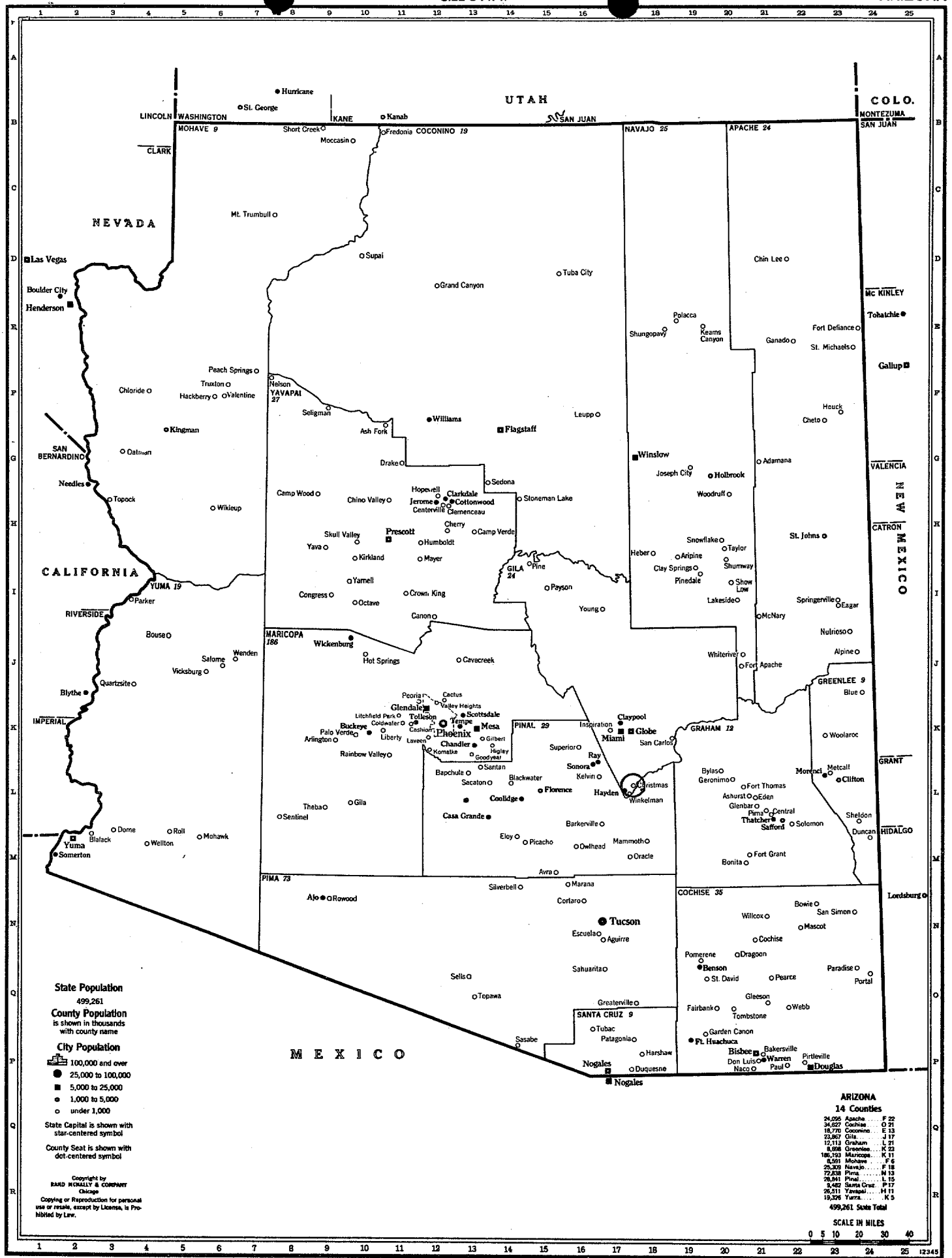
It is concluded that there is no reasonable chance of ore occurrence in <u>any</u> horizon of the limestone around the <u>unmineralized</u> diorite intrusive masses northwest of the Christmas Mine.

It is recommended that the area be dropped from further consideration.

J. H. Courtright

J. H. COURTRIGHT

JHC:ar
Attachments: A - Index Map
B - Geologic Map - 1" = 1 Mi.
C - " " - 1" = 1000'


UTAH
COLO.
NEVADA
CALIFORNIA
NEW MEXICO
MEXICO
LINCOLN
WASHINGTON
KANE
SAN JUAN
MONTEZUMA
CLARK
MOHAVE 9
COCONINO 19
NAVAJO 25
APACHE 24
Mc KINLEY
SAN BERNARDINO
YAVAPAI 27
VALENCIA
CATRON
YUMA 19
RIVERSIDE
GILA 24
MARICOPA 186
GREENLEE 9
IMPERIAL
PINAL 29
GRAHAM 12
GRANT
HIDALGO
PIMA 73
COCHISE 35
SANTA CRUZ 9
Hurricane
St. George
Kanab
Short Creek
Moccasin
Fredonia
Mt. Trumbull
Las Vegas
Boulder City
Henderson
Supai
Grand Canyon
Tuba City
Chin Lee
Polacca
Shungopavy
Keams Canyon
Fort Defiance
Ganado
St. Michaels
Tohatchie
Gallup
Peach Springs
Truxton
Hackberry
Valentine
Chloride
Nelson
Seligman
Ash Fork
Williams
Flagstaff
Leupp
Houck
Cheto
Kingman
Oatman
Needles
Topock
Wikieup
Drake
Sedona
Winslow
Joseph City
Holbrook
Adamana
Woodruff
Camp Wood
Chino Valley
Hopewell
Jerome
Clarkdale
Cottonwood
Centerville
Clemenceau
Stoneman Lake
Cherry
Camp Verde
Prescott
Skull Valley
Yava
Humboldt
Kirkland
Mayer
Snowflake
Taylor
Heber
Aripine
Clay Springs
Shumway
Pinedale
Show Low
Lakeside
St. Johns
Pine
Payson
Yarnell
Congress
Octave
Crown King
Canon
Young
Springerville
Eagar
McNary
Nutrioso
Alpine
Whiteriver
Fort Apache
Parker
Bouse
Salome
Wenden
Vicksburg
Wickenburg
Hot Springs
Cavecreek
Blythe
Quartzsite
Peoria
Cactus
Valley Heights
Glendale
Scottsdale
Litchfield Park
Tolleson
Tempe
Coldwater
Buckeye
Palo Verde
Cashion
Mesa
Phoenix
Arlington
Liberty
Laveen
Gilbert
Higley
Chandler
Komatke
Goodyear
Rainbow Valley
Santan
Claypool
Inspiration
Globe
Miami
San Carlos
Superior
Ray
Sonora
Kelvin
Bapchule
Blackwater
Secaton
Florence
Hayden
Christmas
Winkelman
Coolidge
Casa Grande
Gila
Thebo
Sentinel
Woolaroc
Bylas
Geronimo
Fort Thomas
Ashurst
Eden
Glenbar
Pima
Central
Thatcher
Safford
Solomon
Morenci
Metcalt
Clifton
Sheldon
Duncan
Dome
Roll
Mohawk
Blalack
Wellton
Yuma
Somerton
Barkerville
Eloy
Picacho
Mammoth
Owlhead
Oracle
Fort Grant
Bonita
Avra
Silverbell
Marana
Ajo
Rowood
Cortaro
Tucson
Escuela
Aguirre
Lordsburg
Bowie
San Simon
Willcox
Mascot
Cochise
Pomerene
Dragoon
Benson
St. David
Pearce
Paradise
Portal
Sahuarita
Sells
Topawa
Greaterville
Gleeson
Fairbank
Webb
Tombstone
Tubac
Patagonia
Garden Canon
Ft. Huachuca
Sasabe
Harshaw
Bisbee
Bakersville
Don Luis
Warren
Pirtleville
Naco
Paul
Nogales
Duquesne
Douglas
State Population
499,261
County Population
is shown in thousands with county name
City Population
100,000 and over
25,000 to 100,000
5,000 to 25,000
1,000 to 5,000
under 1,000
State Capital is shown with star-centered symbol
County Seat is shown with dot-centered symbol
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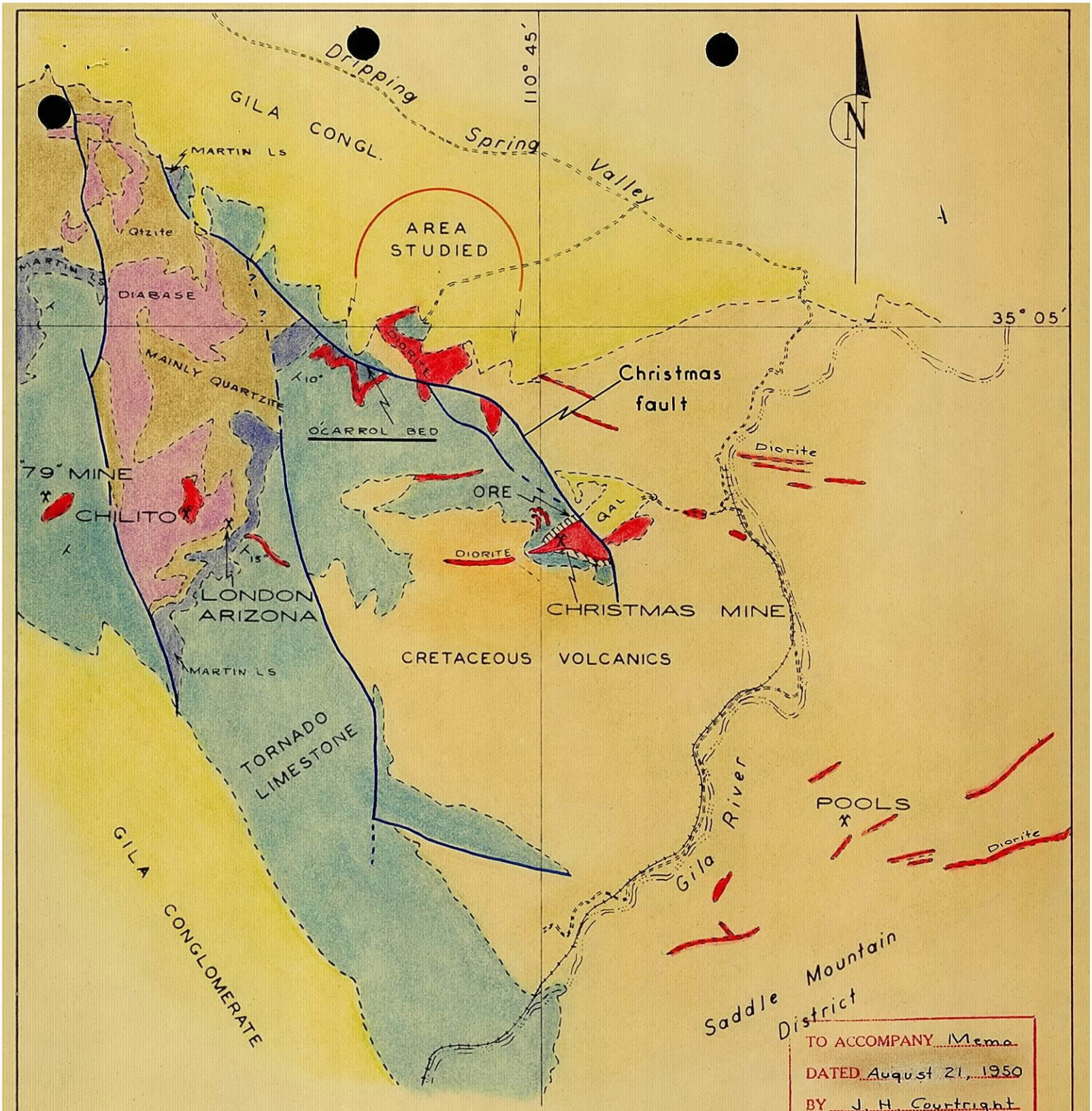
ARIZONA
14 Counties
24,095 Apache F 22
34,627 Cochise O 21
16,770 Coconino E 13
23,867 Gila J 17
12,113 Graham L 21
8,898 Greenlee K 23
186,193 Maricopa K 11
8,591 Mohave F 6
25,309 Navajo F 18
72,838 Pima N 13
28,941 Pinal L 15
9,482 Santa Cruz P 17
26,211 Yavapai H 11
19,326 Yuma K 5
499,261 State Total
SCALE IN MILES
0 5 10 20 30 40



GEOLOGIC MAP OF THE CHRISTMAS AREA

Banner Mining District, Gila County, Arizona

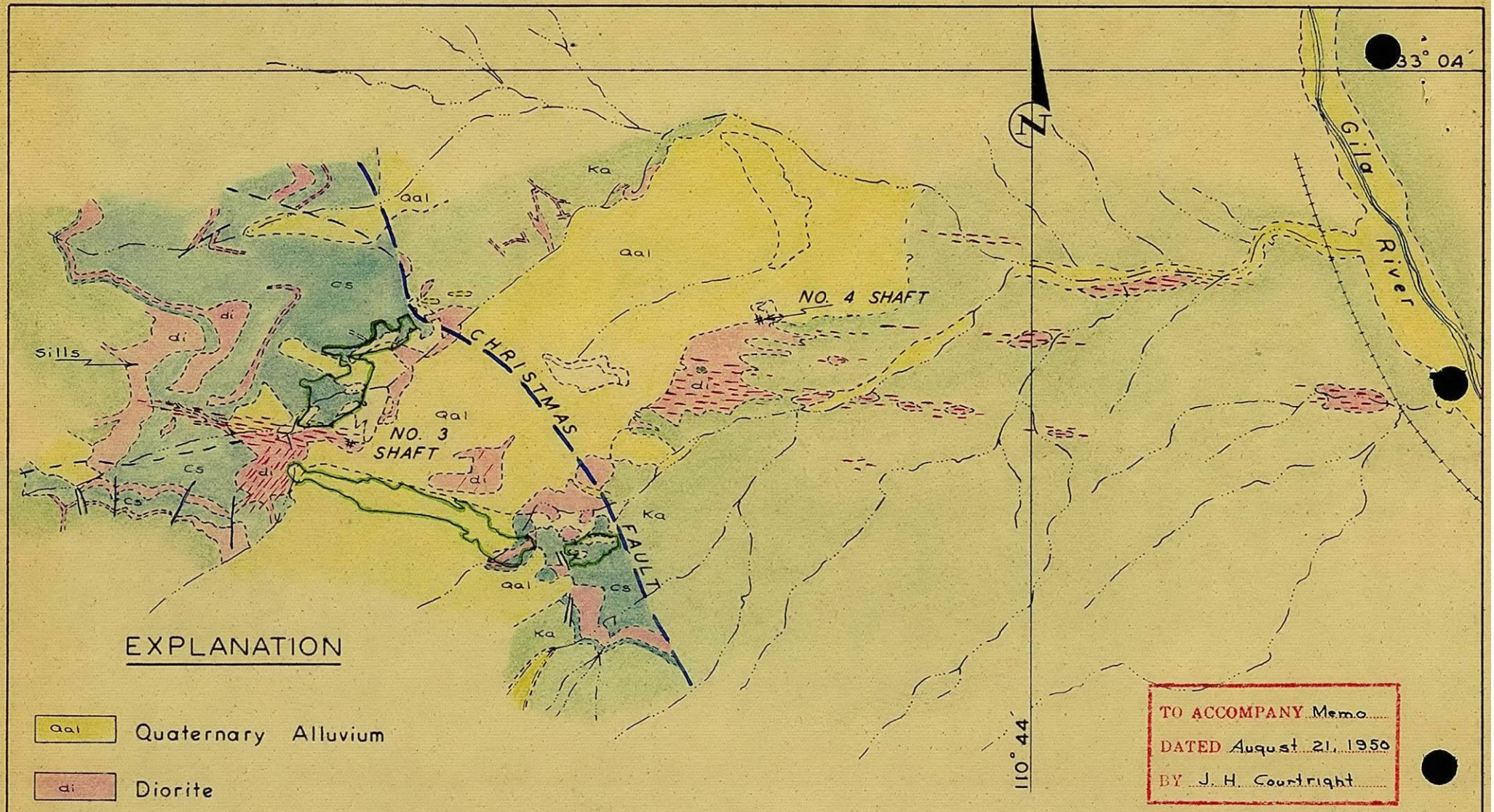
SCALE 1 INCH = 1 MILE

After U.S.G.S. Maps by Ransome and Ross, Bulletin 771

JULY, 1950

Map No. 929

ATTACHMENT B



TO ACCOMPANY Memo
DATED August 21, 1950
BY J. H. Courtright

EXPLANATION

- Qal — Quaternary Alluvium
- di — Diorite
- Ka — Cretaceous Volcanics - Andesitic
- Cs — Carboniferous Limestone
- Trend of shearing in outcrops which show evidence of some disseminated sulphide mineralization and generally very weak hydrothermal alteration
- Composite stope outline

GEOLOGIC MAP OF CHRISTMAS MINE AREA

Banner Mining District, Gila County, Arizona

SCALE 1″ = 1000′

After N. P. Peterson (unpublished) and C. P. Ross.
Shear zones and mineralization mapped by J. H. Courtright
Drainage pattern of eastern half from enlarged S. C. S. aerial photograph.

August 1950 Map No. 928

ATTACHMENT C

Mr. Courtright
Aa-7.19.3

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

August 15, 1950

FILE MEMORANDUM

CHRISTMAS MINE
Saddle Mountain District
Gila County, Arizona

The mine was visited on August 11, during an investigation of nearby areas. Mr. Sam Knight, Office Manager, provided the following information.

Around 2000 tons of 2.7% copper ore is being shipped monthly to Hayden for lime flux. They hope to increase the rate to about 2500 tons per month or 100 tons per day for the 6-day week, this being about the minimum in tonnage for over-all economy of operation. At one time they obtained 4 tons per man shift. The present rate is about two tons per man shift, as they employ 35 men underground and 5 or 6 on the surface. This lower rate per man is attributed partly to generally lower efficiency in the miners available and partly to the greater difficulties encountered in extraction from the deeper level. On the 905 or bottom level considerable difficulty is being experienced in handling wet muck which packs and sticks in the ore passes.

Room and pillar mining is in use exclusively. Recovery by this method was estimated to be between 60% and 80% of the ore bed. The ores below the 770 level, because of a relatively low lime (and high magnesia, iron) content, require mixing with high lime ores above the 770 level. At present about 40% of the total is mined from the 905 level. The lime content of the mined ore is around 25%. The ore from the 905 runs from 3.5% to 4.0% copper, but the ore as shipped is under 3.0% due to the lower grade of the more limey ore mined above the 770. At present, development is being pushed on the 500 and 600 levels on the south contact in the expectation of opening up limey type ore carrying at least 2.5% copper.

Deepening of the workings from the 770 to the 905 level two years ago has not added appreciably to the water inflow, some 30,000 gallons per day.

JHC:ar

J. H. COURTRIGHT

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

July 10, 1950

MEMORANDUM FOR MR. COURTRIGHT

CHRISTMAS AREA
Saddle Mountain District
Gila County, Arizona

About this time last year Mr. Pollock recommended a reconnaissance of the area northwest of Christmas Mine, where intrusives of diorite similar to the Christmas have been mapped by Ransome and Ross.

It is suggested that the O'Carroll bed of the Martin (Devonian) limestone may be a favorable prospect for exploration because of its susceptibility to replacement near intrusives at Magma and at the Christmas. Attractive replacement orebodies of lead-zinc or copper could conceivably exist at this horizon with only weak or indirect evidence of mineralization finding its way through some 1,000 to 1,500 feet of overlying limestones to surface. In my letter of July 14, 1949, copy to Mr. Landwehr, I endorsed a program of investigation.

Mr. Pollock was unable to follow through on the recommendation before going to Peru but I believe that the problems involved here still warrant a conscientious study - to either point up or to discount the implications of hidden replacement ores at depth. It is the type of study which, in suggesting that you undertake it, I believe you will welcome as something of a change from your disseminated copper studies. Here the problems for solution will combine stratigraphy, structure, ore habitat and the relations of "parent intrusives". Please see my Memorandum of April 23, 1949, on unpublished rock column.

You will find our files on the Christmas Mine contain thorough coverage and of course a knowledge of the Christmas ore occurrence is a necessary prelude to the regional study. However, we do not consider the mine itself of present interest for exploration purposes. As you will recognize, the London-Arizona mineralization lies west of the Christmas and still further to the west is the Chilito copper prospect which we examined some time ago. I do not believe the Chilito requires any further attention.

I would suggest that the over-all results of the examination should either (a) preclude any need for future inquiry or reconsideration later on or (b) should show basis for planning a more concerted program of detailed mapping in selected areas. In any event, the aerial photographs I have obtained for this initial reconnaissance are available for preparation of better geologic data than Ransome's scale of mapping, and a general map incorporating your original work should be prepared to illustrate the findings in your report. Whether or not time in the field to accomplish this extends beyond a few days or a week or so is of course dependent on what the study shows.

L. KENNETH WILSON

LKW:ar
cc: WRLandwehr

ASARCO EXPLORATION RECORD

☐ FIELD EXAMINATION ☐ LITERATURE SEARCH ☐ ASARCO FILE ☒ Mine Tour

Section I General Indexing

① Name(s) of Property or Area	② Country	③ State or Province
CHRISTMAS MINE, Banner Mining District	U.S.A.	Arizona
	④ Co. or Map Sheet: Gila Co.	⑤ File or Gore No.: Aa-7.2.3B

⑥ Latitude	⑦ Longitude	⑧ Mer.	Tws.	Rng.	Sec.	⑨ Examined by	⑩ Date
33° 4'	110° 45'		4S	16E		See below	2/2/77
						⑪ Office: Tucson	⑫ Field Days: One

Examined by: JRKing, DMSmith, Jr., DJKrasowski, and ORadislao Typed: 2/9/77

Section II Sources of Information

⑬ References

Author	Date	Title	Publications	Vol. No.
Cook, D.	1977	Tour Guide; geologist, Inspiration Copper Co.		
Eastlick, J.R.	1968	Geology of the Christmas Mine..., Graton & Sales-Ore Deps.		
Peterson	1956	Geology of the Christmas Mine, USGS Bull. 1027H		

Section III Appraisal

⑭ Recommendations
- ☐ Action Now
- ☐ Too Low Grade
- ☐ Too Small
- ☐ Ownership Problem
- ☐ Access Problem
- ☒ Excellent technical tour

⑮
- ☐ Past Producer
- ☒ Producer
- ☐ Mineral Deposit
- ☐ Prospect
- ☐
- ☐
- ☐ Geologic Concept
- ☐ Geochem Anomaly
- ☐ Geophy. Anomaly
- ☐

⑯ Production

Commodity	Tons	Grade
Cu	≈6000/dy	0.6%

⑰ Reserves 1975 ☐ Measured ☒ Estimated

Commodity	~~Tons~~ lbs.	~~Grade~~
Open Pit Cu	251,000,000	
Undergrnd Cu	567,000,000	

⑱ Num. Drill Holes _____ Approx. Total Footage _____

⑲ Excavations

⑳ Spectro. Analysis Attached

㉑ Assays Attached

㉒ Geochem Results Attached

Section IV Geologic Data

㉓ Commodity or Contained Metals: Cu, Ag, Zn, Au

㉔ Ore Minerals - Major: Cpy, Bn; Minor: Sph

㉕ Host Rocks - Major: Limestones, Diorite por's.; Minor: And. vol.

㉖ Age of Host Rocks: Paleozoic, Laramide (?56 my); Cretaceous

㉗ Nature of Exposures

㉘ Alteration: Lms - contact metasomatic tactite around biotitized dior. por. stock.

㉙ Total Extent

㉚ Structure: Post-min. Christmas-Joker faults displaced eastern half of deposit down.

㉛ Ore Occurrence: Ore grade strictly from tactites, dior. por. average between 0.2% & 0.4% Cu.

㉜ Age of Mineralization: (?) 56 m.y.

㉝ Conclusions and Recommendations: See attached sheets for zonation patterns.

Note: that the stockwork qtz. veining in the diorite por. carries only minor sulfide mineralization;

: that MoS_2 is singularly absent;

: competitor activite -- Phelps Dodge deep drilling 1975? two to three miles southeast of mine, sec. 4, R16E, T5S.

(For additional space use extra sheets)

qtz grd stock — K span to secondary bio in vicinity
central core of stock — grd — little veining with qtz

ARIZONA GEOLOGICAL SOCIETY DINNER MEETING

Tuesday, February 3, 1981

THE HILTON INN, 1601 Miracle Mile Strip

SPEAKER: David S. Cook

SUBJECT: Update on the geology of the Christmas Mine

Dinner reservations must be made before 5:00 p.m. on the Friday prior to the meeting date.

SOCIAL HOUR	6:00 p.m.	MEMBER'S DINNER	$7.00
DINNER	7:00 p.m.	NONMEMBER'S DINNER	$9.00
MEETING	8:00 p.m.	STUDENT DINNER	$3.50

Late Reservations: Call 747-0770

Michael R. Wolfhard, Secretary
Arizona Geological Society
P. O. Box 12487
Tucson, Arizona 85732

NON-PROFIT ORG.
U.S. POSTAGE
PAID
PERMIT NO. 1346
TUCSON, ARIZONA

.6 — grade
.3 — cut-off
.4 on ∈ in vole

10/05/1 — 3/ past 2 years

American Smelting & Refining Company
Geology Department
1150 North 7th Avenue
Tucson, Arizona 85705

3 — conc 35% Cu — 6 oz Ag

INSPIRATION CONSOLIDATED COPPER COMPANY

CHRISTMAS DIVISION

MINING INFORMATION

Mining Method: Open Pit (7-Day-24 Hour)
(Underground Operations ceased in 1966)

Pit Slope: 1 to 1 (20 ft. benches with safety bench every 40')

Stripping Ratio: 5.0 to 1.0

Mill Capacity: 5,600 TPD

Recovery Method: Sulfide Flotation

Average Ore Grade: 0.60% Cu

Ore Reserves (lbs. of cu): Open Pit - 251,000,000 lbs.* ± 20M tons
Underground - 567,000,000 lbs.* 13 " "
(at 2.0%)

Equipment: Drills: 2 Robbins Rotary
1 Ingersoll-Rand Rotary

Trucks: 16 Caterpillar 769B 35 ton

Loaders: 7 Caterpillar 988 w/6 yd bucket

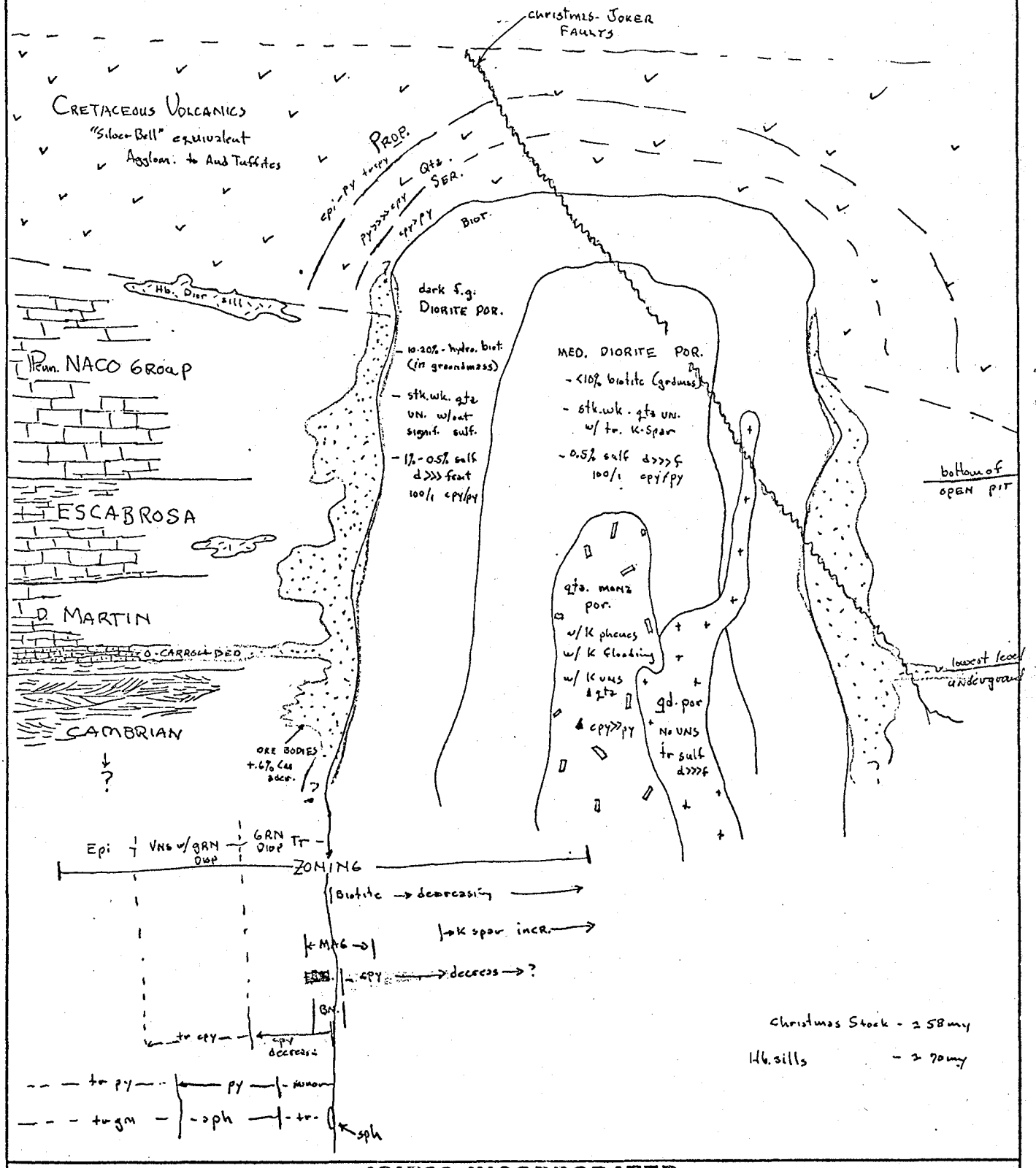
*Ore Reserves from 1975 Inspiration Annual Report

2oz /ton .1oz Au /ton concen

2.5 201

Geol Info -

IDEAL SECTION THRU RECTOR
CHRISTMAS DEPOSIT

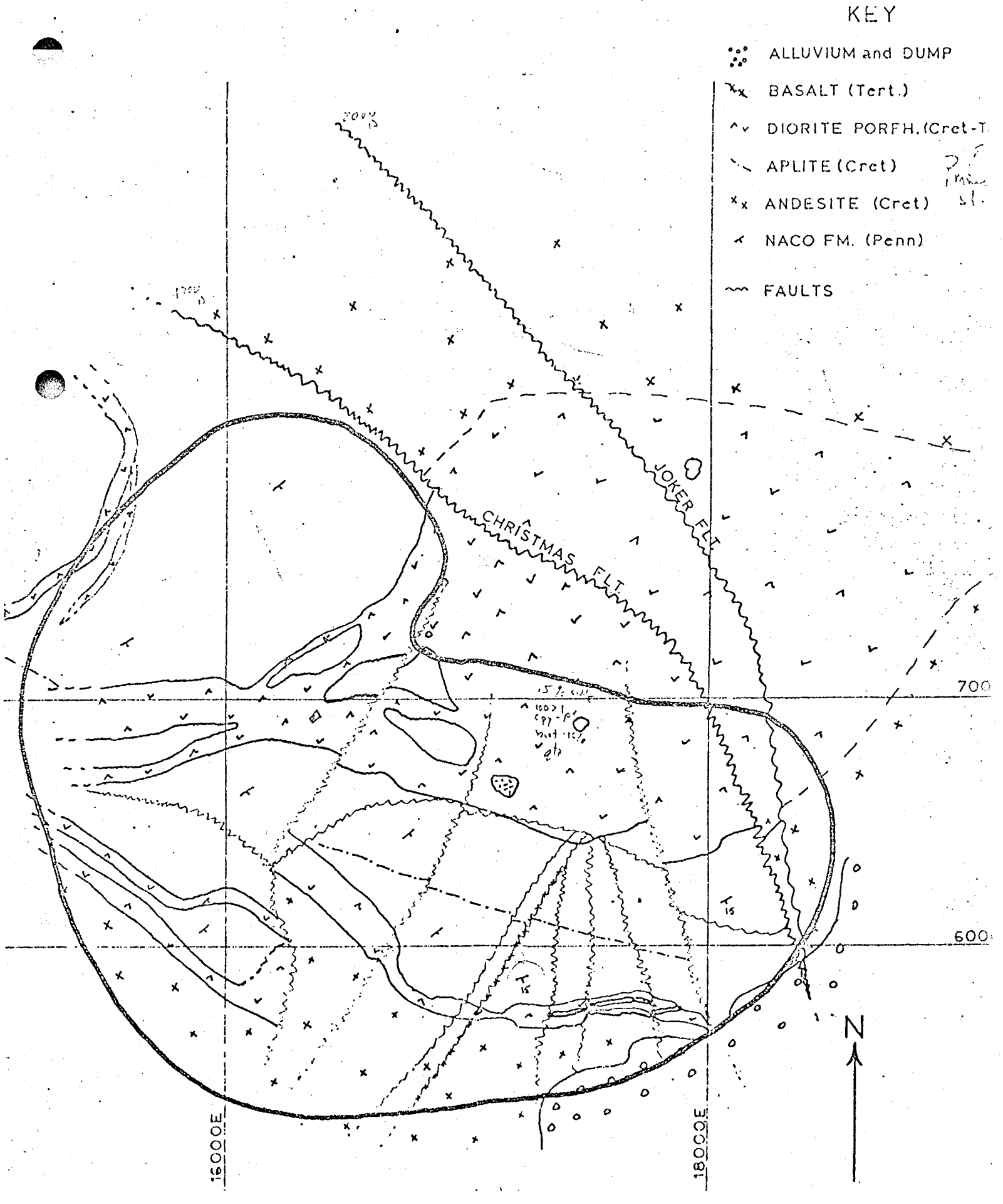


ASARCO INCORPORATED

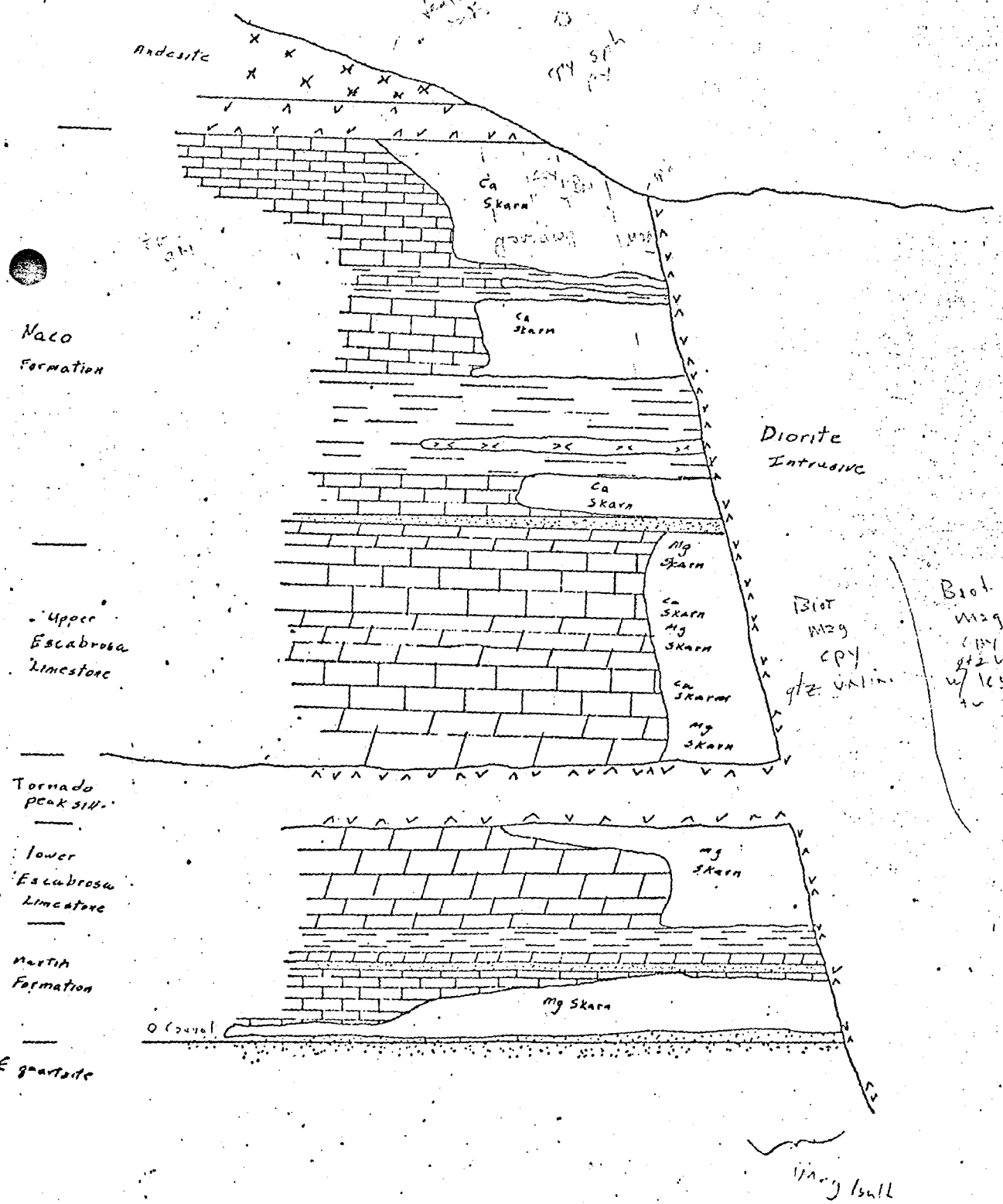
area	data by	state	township-range	revisions-date
CHRISTMAS MINE	JRK	ARIZ		
title	drawn by	county Gila	map number	PLATE
	JRK			
mining district BANNER	date	contour interval		

GEOLOGY OF THE CHRISTMAS MINE

SCALE 1" = 500'



Generalized Christmas Stratigraphic Section



CHRISTMAS COPPER COMPANY
CHRISTMAS, GILA COUNTY, ARIZONA
GEOLOGIC SURFACE MAP
WEST HALF
SCALE 1 INCH = 500 FEET
0 100 500 1000
To accompany report by Guy N. Bjorge, December 1929
Topography compiled from old maps and approximately correct.
Geology west of Christmas Fault copied from map by O. H. Hershey, Dec., 1912.
Geology east of Christmas Fault by Guy N. Bjorge, Dec. 1929.
Mine workings revised to Dec. 1, 1929
SEDIMENTS
Coarse Diorite-porphyry
Fine Diorite-porphyry
Porphyry Sills
Andesite Complex
Black Shale
Garnet & Epidote
Limestone
Shale
Limestone & Shale alternated
Shale & Red Chert
Debris
Iron Bed
NOTE:
Main porphyry area largely float covered at surface but approximately as shown.
N
TIDAL WAVE
LAST CHANCE
SUPERIOR
RED HOT
ALOPA
APACHIA
SAN CARLOS
SAVANNAH WEST EXT.
ALABAMA
JOKER
CALIFORNIA
SAVANNAH
CHRISTMAS No. 2
CHRISTMAS No. 1
URANUS
NEW YORK
SUNNY SLOPE
DELAWARE
HARRIS BURG
KEARSARGE
BLACKHAWK
IRON CAP
YELLOW BIRD
WOODPECKER
RED DYKE
FARREL
SOUTH STAR
RED BIRD
GOLCONDA
AGARETA
FAIRVIEW
CEDAR No. 2
SQUAW PEAK No. 1
SQUAW PEAK No. 2
RIM No. 1
MESCAL
CANNON BALL
GEOLOGICAL CONTACT

Copy of Report by Harrison Schmitt, Mining Geologist, Silver City
on CHRISTMAS MINE, BANNER DISTRICT, GILA CO., ARIZONA

Mr. W. L. Allison, President
Riviera Mines Company
Christmas, Arizona

Subject: Interim appraisal of the Christmas mine

Mr. Morris Blumberg stated that he would like to have certain engineering and geological data on the Christmas mine. You have instructed me to write this report for his and your use.

General

The geographic data have been covered in many previous reports. It is sufficient to note that the property is 10 miles north of the Hayden smelter, and 33 miles south of Globe, Arizona. The elevation of the collar of the main No. 3 shaft is 3,042 ft. The Gila River canyon, about one mile east, is at about 2,050 ft. or about 1,000 ft. lower. At this point is a terminous of an 11 mile railroad spur of the Southern Pacific R.R. that extends north from the Hayden smelter. A good but steep road extends from the railroad terminal to the mine. Globe, Winkelman and Hayden can be reached by fair mountain roads. Water for the mill is obtained from a well in the gravel of the Gila River. A 6-inch pipeline has been laid to the mill. The lift is about 700 ft. Power is obtained from a 66,000 V. power line that passes over the property. Some local company houses are available for the staff and labor and more are being built.

The mine is now served by a 3-compartment shaft 915 ft. deep. The compartments are 4 x 5 ft. There is an adequate hoist and three compressors with a total rated capacity of around 2450 C.F.M. Near the shaft a new change house has been built. There is a machine and blacksmith shop. A timber framing shed is now being built.

The mill is about 2,500 ft. east of the mine and 400 ft. lower. The ore reaches the mill by means of a 4,000 ft. tram from the No. 3 shaft, 2,000 ft. of which is an adit on the 400 ft. level. The mill is now operating at a capacity of 200 tons a day. This can be easily raised to 500 tons a day with equipment now in the mill and about to be installed.

By careful planning and a moderate expenditure the shaft capacity can be raised to 500 tons of ore daily.

Geology

The Christmas mineralization is contact pyrometasomatic ("contact metamorphic") in type. The ore replaces limestone at the contact of a plug-like quartz diorite intrusive. The gangue is largely garnet with minor magnetite and talc. The average width of the ore zone is about 100 ft., but locally a width of 150 ft. or more is attained. The ore usually occurs in beds of from 5 - 70 ft.

in thickness. A minor amount is found in vertically tabular bodies along contacts and the new ore on the north contact below the 770 ft. level is a more or less pod-like mass extending more than 600 ft. along the strike. It is at least 150 ft. high in one place and averages about 100 ft. wide. It reaches and extends to an unknown depth below the floor of the 905 ft. level.

The total length of ore bearing porphyry plug contact is about 4,000 ft. Above the 500 level most of the ore produced was partially or wholly oxidized. Some of it was smelted directly on the property, some was shipped to Hayden for use as a flux ore and some 300,000 tons was milled locally. Altogether 1,517,044 tons of ore averaging 2.408% Cu was mined up to December 19, 1953. This was largely from above the 500 ft. level, but includes ore from block 72 now being mined on the north contact.

The ore was all in the Pennsylvanian limestones and shales now called the Galiuro limestone. This formation is roughly equivalent to the Magdalena limestone at Hanover, New Mexico. The new ore occuring on and below the 770 ft. level appears to be in the Mississippian and Devonian limestones. These are locally called the Escobrosa and Martin limestones. The Escobrosa is roughly equivalent to the Lake Valley limestone at Hanover, New Mexico.

Throughout southwestern Arizona the Escobrosa and Martin limestones are especially favorable horizons and the Lake Valley is the most favorable horizon in western New Mexico and particularly at Hanover, New Mexico. The lower levels of the mine then, are just penetrating the favorable lower limestone horizons. It appears significant that the grade of the ore on the 770 and 905 levels as well as that in drill holes below these levels is higher than the average of the levels above the 500 ft. level. The ground between the 770 and 500 ft. levels is not well known, but to date appears to be less attractive than the ground below the 770.

The diamond drill data on hand indicate that in the vicinity of the No. 3 shaft the deepest ore known bottoms on "sandstone" and "quartzite." This is as deep as 490 ft. below the 905 ft. level on the north contact. On the south contact the ore bottoms on "quartzite" 565 ft. below the same level. The average known depth of the ore in this area then is 525 ft. below the 905 ft. level. Because of the formation dip the quartzite contact would be deeper eastward toward the Christmas fault.

This fault has a throw of more than 1,800 ft. and bounds the ore bodies on the east side of the mine. I the hanging wall of this fault the remainder (more than one-half) of the contact zone around the porphyry plug should exist. This affords a good probability of extending the life of the mine but will entail some costly development work.

Andesitic volcanic rocks, also in the hanging wall of this fault, but exposed at the surface, are mineralized by low grade copper minerals. The boundaries of this mineralization are not known, but the "ore" is 1,500 ft. deep at the No. 4 shaft and an alteration blot in the vicinity measures about 3,000 by 5,000 ft. The ground in the immediate vicinity of the No. 4 shaft averages about .45% Cu.

Ore Reserves

No attempt will be made to submit a detailed ore reserve report. The gross possibilities, however, appear to be of critical interest. As noted earlier the contact zone on the foot-wall of the Christmas fault, i.e., the present mining area, has produced 1,517,044 tons of ore, which averaged 2.408% Cu. This production was from the surface down to the 905 ft. level, but most of it came from above the 500 ft level. In the vicinity of the No. 3 shaft which is on the west side of the zone, the ore is known to extend to at least 700 ft. below the 770 ft. level. Since the formation dip is southeast and the Christmas fault dips 70 degrees east of the volume of ground available as a host for ore below this level is about equivalent to that above it. Thus the lower country should produce at least as much as the upper country. Actually now it appears to have a greater concentration of ore per vertical foot. The grade of the ore averages about 25 per cent better also as revealed by the development so far done.

In more detail the ore so far developed below the 770 level is as follows:

The development of the north contact ore is more advanced than the other areas. It has been done by diamond drilling, drifting, raising and by stoping. The area most thoroughly developed (block 72) is now being stoped. It is 300 ft. long along the strike, and averages about 100 ft. wide and 130 ft. high. The gross volume would be equivalent to 390,000 tons, but because of a small limestone core, the reserve has been estimated at 300,000 tons. About 60,000 tons of 3.84% Cu ore has been extracted from this block by means of irregular workings and "Golden Queen" slots recently started by the Riviera Mining Company.

A few months before the Riviera Company started active operations Mr. George Freeman under my direction cut 50 samples at regularly spaced intervals on the several levels and sub-levels driven in this ore body. The average assay of the samples was 3.68% Cu.

Extending east from this ore body but beyond a 50 ft. wide porphyry cross-dike or "finger dike" a drift on the 791 ft. level has been driven for a distance of 235 ft. in ore. This working produced 2,620 tons of ore which was shipped to the smelter. The average smelter assay was 4.56% Cu. This ore is the northeastern extension of the main ore body. If it retains the same vertical cross-section as the latter ore it represents 300,000 tons of additional ore. The distance from the face of the above drift to the Christmas fault, where any eastward extension of ore will be cut off, is 450 ft. If, on a more tenuous basis, we extend the ore body northeastward over this interval using the same vertical cross-section we can estimate an additional 585,000 tons of ore.

North contact ore reserve between 905 and 770 ft. levels - Recapitulation

	Tons	Grade % Cu*
Block 72	240,000	3.32
793 Dr	300,000	4.11
To Xmas Fault	585,000	-
	1,125,000	3.75

*Reduced by 10 per cent for probable sampling and dilution error.

Some of this ore may dip below the 905 ft. level as it is followed eastward, but there is as yet no firm indication that it does this. Recent experience suggests that a dilution factor of 20 per cent is too conservative because the ore body is so large that sloughing from the waste wall contacts is rarely substantial.

The south contact below the 770 ft. level and above the 905 ft. level has been only slightly developed and only in the vicinity of the No. 3 shaft station. This station has exposed a height of 27½ ft. of 3.42% ore and three diamond drill holes drilled from the 770 level cut ore above the 905 level. The average of four ore penetrations is 2.95% Cu. These may represent beds or vertically tabular ore elongated along the porphyry contact. Thus it is difficult to estimate the amount of ore, but there must be a minimum of 50,000 tons since two of the penetrations (the shaft and DDH 52B) are over 25 ft. high and could represent horizontal sections at least 50 ft. on a side.

Besides the north and south contact there are two other blocks of ground between the 770 and 905 levels that contain ore. These are in a "finger" or dike country 400 ft. and 600 ft. respectively northwest of the No. 3 shaft. Block 44 is below the 773 drift from which ore with an average width of 8 ft. has been mined along a dike contact. Two diamond drill holes have cut the ore below the 770 and above the 905 level. The ore in these penetrations average 10 ft. wide along the dike contact and 3.15% Cu in grade. Taking a strike length of 250 ft. and a height of 130 ft. we can estimate 32,500 tons.

A third hole, USBM No. 3, cut 20 ft. of ore that averages 3.48% Cu. This appears to be a bed between the two porphyry dikes or "fingers" and could be 16 ft. thick. It may represent ore at least 50 ft. in a side. This would be equivalent to 4,000 tons.

The fourth block of ground is below old 771 stope which was in the 770 level. High grade ore occurred in the floor of this stope and should extend down to the 905 level. The tons per vertical foot is about 500 so here we can safely estimate 25,000 tons of possible reserve. The grade should exceed 3.0%.

Recapitulation of ore between 770 and 905 levels:

	Tons	Grade % Cu*
North Contact	1,125,000	3.75
South Contact	50,000	2.66
Block 44	36,500	2.83
Below 771 stope	25,000	-
Total	1,236,500	3.67

*After 10% reduction for dilution.

On the south contact as on the north contact a great volume of ground remains unprospected. This amounts to 2,000 lineal feet of contact. The partially developed south contact ore occupies 300 ft. of the contact so a minimum of 333,000 tons should remain undeveloped on the south contact between the 905 and 770 levels.

The ground below the 905 level that is known to contain ore extends to at least 550 ft. below the 905 level where quartzite comes in. At some time a level at least as deep as a 1,500 ft. level will presumably be driven. Two diamond drill holes, Nos. 23D and 24E have intersected significant runs of ore. DDH 24E cut ore 23 ft. high on the north contact that averages 9.53% Cu. The bottom of this is 230 ft. below the 905 level. DDH 23D on the south contact 700 ft east of the shaft cut ore that averages 3.21% Cu for a height of 32 ft. and when some low grade is included 2.83% Cu for a height of 80 ft. The bottom of this ore is 360 ft. below the 905 level. This same hole cut ore at a still greater depth averaging 2.76% Cu for a height of 50 ft. When lower grade ground is included a height of 65 ft. averages 2.63% Cu and a height of 85 ft. averages 2.55% Cu. The bottom of this ore is 565 ft. below the 905 level. Presumably at both ore intersections the maximum heights of 80 ft. and 85 ft. will be mined.

These penetrations represent large tonnages of ore if they cut beds, but probably lesser tonnages if they cut ore on porphyry contacts. Until more holes are drilled a tonnage estimate is nearly meaningless, but it is obvious that an expectation of at least several hundred thousand tons is not too liberal.

Ore Reserves - Recapitulation

Between 770 and 905 levels

Block or working	Positive	Probable	Geologically Possible	Total	Grade % Cu*
North Contact					
Block 72	200,000	40,000		240,000	3.32
793 Dr	50,000	50,000	200,000	300,000	4.11
793 Dr to Xmas Fault		50,000	535,000	585,000	(3.00*)
Sub-Total	250,000	140,000	735,000	1,125,000	3.75
South Contact					
300 ft of contact near No. 3 shaft	10,000	40,000		50,000	2.66
2000 ft.of contact remaining			333,000	333,000	-
Block 44	10,000	22,500		32,500	2.84
DDH USBM No.3	1,000	3,000		4,000	3.13
Below 771 stope		25,000		25,000	-
Sub-Total	21,000	90,500	333,000	444,500	
Below 905 level	50,000	50,000	100,000	200,000	(±3.0)
Grand Total	321,000	280,500	1,168,000	1,769.500	3.61

*Reduced 10% for probable dilution and sampling errors.

Mining

The best method or methods of mining to extract the various ore bodies on the 905 level is not yet apparent. The ground is heavier than it was on the upper levels of the mine where open stoping with pillars was the rule. The heavier ground can, of course, be mined by square setting, but a method that would use less timber and obtain a higher ton per man shift production would, of course, be preferable. In block 72 the "Golden Queen" slot method is being tried, but this may not be the method finally adopted in this area.

Much of the development work requires no timber but roof bolting is found advantageous for some of the drifts where timber would be needed otherwise. Even so, some timber will be needed in some drifts and particularly in raises through ore.

In the estimates on development costs to follow $30 a foot for direct costs is used. This was about right a few months ago, but the recently improved labor efficiency may make it possible to do the work for a lower figure at this time.

In order to maintain the proposed and nearly attained rate of production, (i.e. 200 tons), I should think that a round in three headings daily or about 12 ft. a day will be needed for some time with the possibility that this rate can be later reduced because of the high tons of ore per vertical foot now evident between the 770 and 905 levels. This would cost about $360 a day or $1.80 per ton of ore. After about three months when 900 ft. of work will have

been done it should be possible to half this rate. This would cost $.90 a ton of ore mined. About one shift of diamond drilling will be needed continuously. This would cost about $100 a day or $.50 a ton. The normal development cost, then, for the 200 ton daily rate of production would be about $1.40 a ton. This should be considered a current direct cost. The extra work to be done the first three months can be considered a capital charge for either daily rate of production selected. It would amount to $13,500 for the lower rate and $33,750 for the higher rate.

To get the mine in shape for a 500 ton daily rate will require more detailed planning and estimates than it is possible to make in this report. The operators say that the ore and waste to be moved in the shaft at this rate can be provided for by using double-decked cages. Possibly they will want to go to skip hoisting. But for this a large expenditure for shaft pockets would be needed.

The development work should proceed at two and one-half times the rate given above for the 200 tons a day rate of mining, i.e., 30 ft. of heading (8 headings) per day for three months, then one-half of this. The costs per ton of ore would be the same unless a lower cut-off grade for ore can be used. In this case less development will be needed per ton than when the slower rate is maintained. Because of the difficulties of waste disposal at the greater rate of development this development may be varied in pace. Thirty feet of drift will produce about 150 tons of waste and ore. All the waste can be used for stope fill. Very little of it will need to be hoisted in the shaft.

The question asked, "What additional underground capital expenditures will be needed (1) in order to maintain a 200 ton rate and (2) to maintain a 500 ton rate?" is answered as follows:

1) The 200 ton rate will require $13,500 for extra development for the first three months. This is over and above the development average cost which will be carried as a direct cost.

2) For the 500 ton rate including expansion of both development and mining the following items of equipment will be needed:

a) 20 drilling machines
b) 2 new cages
c) 50 new cars
d) 2 new Mancha type locomotives

These items and other miscellaneous ones would cost around $50,000. The extra development would cost $33,750. The total is $83,750.

Donald Case estimated that $5,000 will be needed to get the mill ready for a 500 ton rate of production.

Additional houses will be needed for both the 200 ton rate and the 500 ton rate. For the 200 ton set-up 10 additional houses and bunkhouses are planned. These will cost about $35,000. About 100 additional men will be needed for the greater rate. These will

require about 30 new houses and several bunkhouses. These would cost about $100,000. Thus, the total additional capital expenditure needed for the higher rate seems to be about $155,000.

Recapitulation-New Capital Expenditures

200 ton rate	
Underground	
Extra development first 3 months	$ 13,500
Surface	35,000
Total	48,500
500 ton rate	
Underground	
Extra development first 3 months	33,750
Machines, cages, Manchas, etc.	50,000
Surface	
Houses and bunkhouses	100,000
Mill	5,000
Total	188,750

Direct Costs

The most immediate critical factor in the direct costs is the method or methods of mining to be used, and the labor efficiency that can be obtained. Straight square set stoping should result in 3.0 tons per man shift on the basis of the better efficiency that is now showing up. The "Golden Queen" slot method now being tried should result in at least 4.0 tons per man shift when it is well underway. Most of the items in the following list excepting the mining and overhead costs have been fairly closely established. The overhead cost will be difficult to determine until the present construction work is completed.

Direct Costs per dry ton -
200 tons per day**

Labor (4 tons per man shift)	$ 5.26*
Timber	.55*
Supplies, power, etc.	.92*
Development (after 3 months)	1.40
Social Sec. and Ins.	.75
Milling	2.73*
Overhead	1.25*
Total	$12.86**

**Subject to revision based on current experience
*Based on revisions (of 6-15-53) by Frank and Sam Knight

Smelting Outcome (El Paso Smelter)

Market price ($0.29) less $.032 (for freight and refining)
Copper in conc. less 20 lbs.
Smelting charge $9.25, conc. 28.5% Cu

	Cr	Db
$0.29 - .032 = $0.258		
570 lbs - 20 = 550 lbs.		
550 x .258	$141.90	
Gold and Silver	5.28	
Trucking		$0.50
Smelting		9.25
R.R. Freight		5.50
	131.93	15.25

The concentration ratio (based on a 3.61% head and 90% recovery) is $\frac{550}{65} = \frac{8.5}{1}$. Therefore, a market price of 29 cents eastern seaboard gives a dry ton value at the mine of $15.52. This leaves $2.66 for royalties, amortization and profit on the 200 ton rate basis.

The 500 ton rate would give a reduction in milling and overhead costs. My rough estimate is that the milling would fall to about $1.50 a ton and the overhead to about $.75 a ton. This would result in total costs of $11.13. This leaves $4.42 per ton for royalties, amortization and profit. The milling rate may betoo high for such a simple and soft ore.

In the immediate future should an adverse condition in tons per man shift and/or market price arise it can probably be offset by the quick development and the mining of the high grade 4.11% Cu ore east of block 72. It would take about three months to get started on this ore. There could very well be 300,000 tons in this ore block under 793 drift and above the 905 level. This could supply the mill for over 4 years at the 200 ton rate and over 1½ years at the 500 ton rate.

Summary and Conclusions

The ore reserve of the Christmas mine disregarding the low grade lime fluxing ore of the levels above the 500 ft. level and including positive, probable and geologically possible ore to an average depth of 525 ft. below the 905 ft. level totals 1,769,500 tons with an estimated grade of 3.61% Cu. The ultimate potential is twice this if the probable deep ore east of the Christmas fault is considered. Furthermore, the tonnage estimate is conservative considering the large volume of unexplored ground below the 905 level. The estimate of grade is better for certain blocks than others. Two of five diamond drill holes put down in the lower country cut excellent penetrations of better than average ore.

The chances appear good for a large tonnage of disseminated porphyry ore east of the Christmas fault.

In order to complete the preparations for the 200 ton daily rate a capital expenditure of around $48,500 will be needed for a three months development campaign and for further housing.

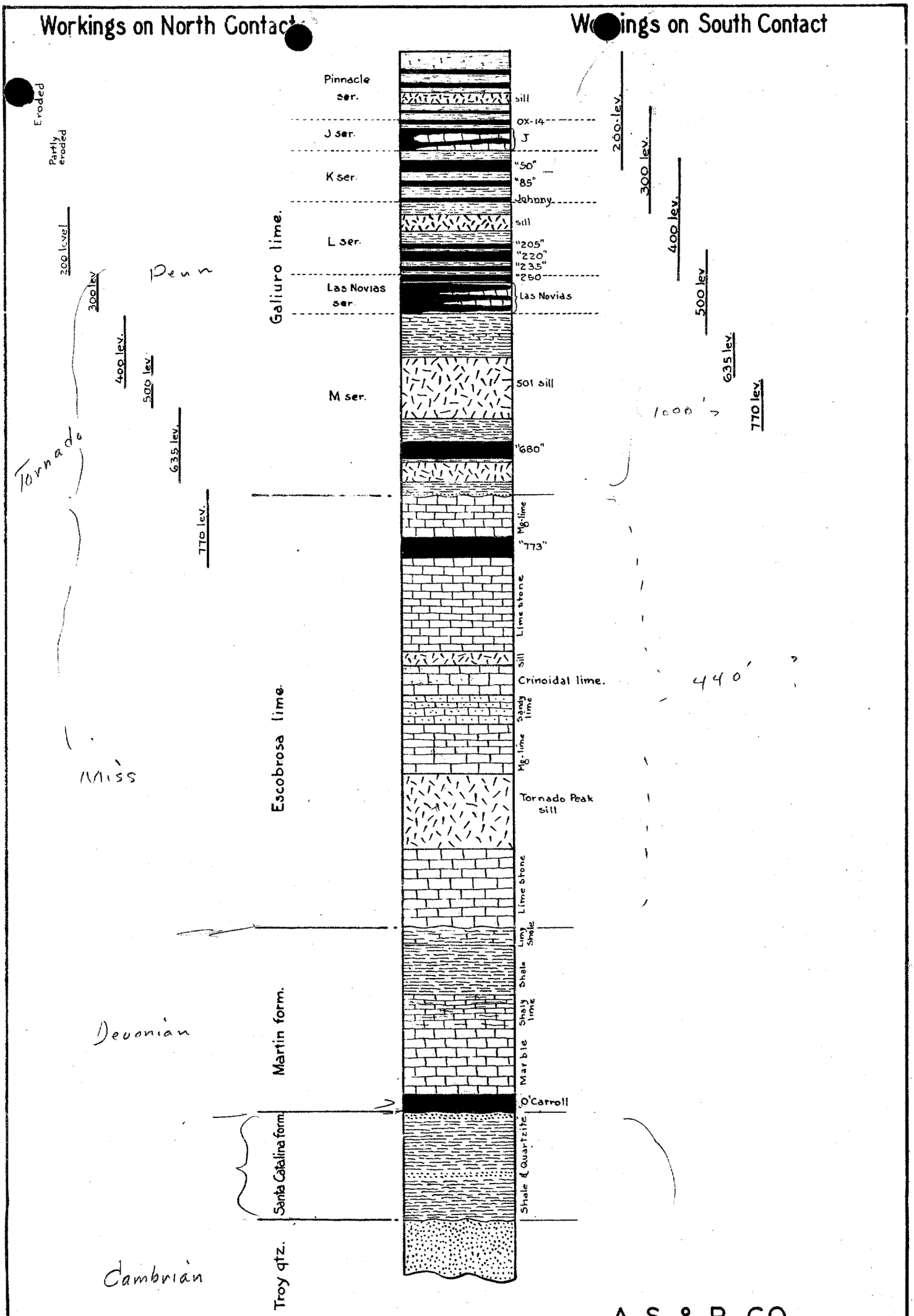
In order to raise the tonnage output to 500 a capital expenditure of around $188,750 will be needed for an underground campaign of development, new equipment, additional housing and expenditures for the mill.

On a 29¢ market and with production at a rate of 4 tons per man shift a profit before amortization and royalties of $2.66 per ton is indicated on the average grade of the ore reserve where the rate of production is 200 tons daily. At 500 tons daily the profit before amortization and royalties should be $4.42 per ton.

A temporarily adverse condition in the price of copper and production of ore per man shift probably best can be met by pushing the development and mining of the higher grade ore in the vicinity of the 793 drift. This is just east of block 72 now being mined. Tonnage estimates suggest that this block would last more than 4 years at the 200 ton rate and more than 1½ years at the 500 ton rate.

Original signed

HARRISON SCHMITT



A. S. & R. CO.
CHRISTMAS MINE
Generalized Columnar Section
Scale 1 in. = 200 ft.

L.P.E.

Dwg. No. 572 A