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WISSER AND COX
CONSULTING GEOLOGISTS

COPPER DEPOSITS OF EASTERN SAN BERNARDINO CO., CALIF.

OFFICE REPORT

INTRODUCTION

The writer was superintendent of the Ivanpah gold mine, 1923-4, and has a general knowledge of this area. For the present study the literature has been thoroughly combed over, the main sources being the Annual Reports of the State Mineralogist and the California Journal of Mines and Geology, together with two Bulletins of the State Division of Mines on copper in California. To save time and for the sake of brevity, references are not cited in the present report, but they are available in my office.

The present report covers the eastern half of San Bernardino County, for reasons that appear below. However, there are important copper deposits in the western half of the county, especially in the Ord Mountains area; it may prove desirable to compile a brief report on that area also.

GENERAL CONSIDERATIONS IN EXPLORATION

Nearly all the major mining districts of western United States have been known for generations, the San Manuel copper deposit being one of the few exceptions. Extensive exploration campaigns by experienced major companies have achieved relatively little success.

One reason for this lack of success, in my opinion, is failure to unearth certain fundamental generalizations related to the localization of mining districts. The empirical method dominates exploration: a San Manuel deposit is discovered, a more or less typical "porphyry copper" peeping out from under a post-mineral

cover. Immediately exploration is concentrated on what look like similar environments.

The "classical" porphyry copper involves a stock,of intermediate composition, commonly altered by sericitization and kaolinization, leached and iron-stained in its surficial portion,and carrying below secondary and primary copper in joint planes,small fissures and pepper through the rock. But at Ray and Inspiration,far more ore occurs in the Pinal schist than in the respective porphyry stocks. At Ajo, ore is associated with pegmatitization,only barren pyrite with sericitization. At Pima,ore occurs in unaltered Cretaceous arkose. At Pilares and in parts of the Cananea district,ore is found in volcanics,of the same age as volcanics extensively distributed in Arizona,but not as yet known to carry important ore deposits there. Yerington is a heretical,not a classical porphyry copper,and for that reason was overlooked for many years.

Undoubtedly many ore deposits lie concealed below post-mineral cove volcanics,sediments and valley wash. In 1949 the writer pointed this fact out to the American Mining Congress,and in a sense foretold the finding of the Pima copper deposit. But I believe also that expensive and risky exploration beneath cover rocks should be postponed until all promising exposures of premineral rocks have been evaluated.This does not mean that structural-mineral trends exposed in premineral rocks should not be traced,by geophysical and geochemical means,and by drilling,beneath adjoining valley wash. It was in that way that the Pima ore body was found.

Ore deposits found in exposures of premineral rocks will probably be of heretical types,because most or all good bets based on empirical comparisons with known deposits have been tested. Heretical ore depos

by definition,may take on almost any form,and may occur in almost any type of premineral rock. Their ore cannot have cropped out extensively,or the deposit would probably have been found. How then should heretical deposits be searched for without the expenditure of prohibitive time and expense,without searching for the needle in the haystack? In may opinion, by study of the distribution of the metal in question,in this case copper,on a continental scale. Such a study may link scattered copper districts together along a genetic belt or area,and serve to concentrate exploration in those belts or areas most likely to yield ore deposits.

DISTRIBUTION OF MAJOR COPPER DEPOSITS IN THE UNITED STATES AND NORTHERN MEXICO.

Refer to accompanying map showing axes of geosynclines.

Major copper deposits in the western United States,Northern Mexico, as well as western Canada,relate to the following continental structural features:

1.Pacific Geosynclines.- Britannia, Surf Inlet, Chelan,Shasta district, Mother Lode Foothill belt. These are all areally related to batholiths,but the latter are concentrated along this belt of geosynclines,and the major ones are elongated parallel to the geosynclinal axes. To the list may probably be added Yerington.

2. Cordilleran or eastern geosynclines. The Boulder batholith invaded a complex of superimposed geosynclines,and contains the richest copper district, Butte. Butte lies also along an axis of uplift and orogeny essentially coextensive with the Cordilleran group of geosynclines or belts of crustal weakness. The same applies to Bingham,both with regard to geosynclines and to the axis of orogeny (Mid-Cretaceous and Laramide in age).

3. Southern Geosynclinal Belt.- In southeastern California and southern Nevada Pacific geosynclines of Mesozoic age merge with the eastern group of troughs and continue southeast along the west coast of Mexico. A string of intrusives lies along the geosynclinal belt, the larger intrusives being elongated parallel to the belt. The intrusives are accompanied by copper deposits.

4. Geanticlinal Arches and the Colorado Plateau.- The orogenic belt passing through Butte, Bingham, Tintic, Goodsprings and other districts took the form, in later Cretaceous and early Teriary times, of a geanticlinal arch, with folding and thrusting along its eastern flank. The geanticline swings around the western border of the Colorado Plateau, following the belt of geosynclinal troughs, but south of the Plateau it leaves this belt and heads southeast through western Mexico, between the western and eastern Mexican trough belts. The following copper districts formed along the crest of this great arch: Ajo, Cananea and Pilares, with many lesser districts.

An east-west belt of major copper districts parallels the southern edge of the Colorado plateau in striking fashion: Bagdad, Ray-Miami, San Manuel, Silver Bell, Morenci and Santa Rita. Bisbee, somewhat farther from the edge of the Plateau, lies between the Plateau copper belt and that along the crest of the Occidental or Mexican geanticline. It probably shares in the localizing features of both belts.

Ely lies somewhat west of the Cordilleran geosynclinal belt but probably belongs to that system.

LOCAL STRUCTURAL CONTROLS OF MAJOR COPPER DISTRICTS

It is proposed to enlarge on this subject,of vital importance to exploration,in one or more future reports.The matter is treated briefly here becauze of its possible bearing on exploration in eastern San Bernardino Co. For the present,discussion is limited to copper districts in the Southwest,except for Bingham.

District	Structure
Bingham	In a broad,flat,steep-walled syncline.Bingham lies upon an arcuate belt of uplift,deformation,xxx intrusion and metallization crossing the syncline nearly at right angles (Uinta axis,along which Park City,Cottonwood, Bingham and Ophir). The transverse uplift is superimposed upon the syncline.
Santa Rita	In broad,shallow southeast syncline,on which is superposed a northeast arch. Santa Rita stock on southeast flank of the arch;stock produced a local dome.
Morenci	On irregular dome elongated northeast,superimposed on northwest folds. Stock is elongated northeast,parallel to and along the axis of elongation of the dome.
Bisbee	On southwest flank of northwest Mule Mt.anticline.
Cananea	On northeast flank of major northwest anticline with intrusive igneous core.
Silver Bell	In graben on crest of major northwest anticline.
Ray-Miami	On a faulted major northwest broad anticline,with Pinal schist forming the core.
Bagdad	On a structural dome,with radiating fractures and joints controlling the metallization.

The country rock invaded by most of the stocks associated with these districts is the Precambrian basement,plus in some cases a limited thickness of Paleozoic and Mesozoic cover sediments (Morenci, Bisbee, Ray-Miami, San Manuel and Bagdad).

Since these copper deposits are not thought to have formed at extreme depths,the preference of so many of them for the Precambrian basement would suggest that much of the cover had been stripped off

by the time the ore was emplaced. The major uplifts with which these porphyry copper deposits are associated had been completed, and the uplifts subjected to erosion, by the time of metallization; but, as at Santa Rita, local superimposed uplifts often attended invasion of the stocks with which the ore bodies are associated.

At Santa Rita the cover above the ore-bearing stock had been removed by Mid-Tertiary time, for oxidation had started before Miocene(?) lavas were poured out over the deposit, halting oxidation until erosion had stripped off the volcanics and exposed the deposit once more to surficial agencies.

The above generalizations have an obvious bearing on exploration for copper in the Southwest.

POSITION OF EASTERN SAN BERNARDINO COUNTY IN THE REGIONAL PICTURE

As shown on the Geosyncline map, the area lies where the Cordilleran belt of troughs is joined by several Pacific troughs, and about where the east-west copper belt around the southern margin of the Colorado Plateau would leave the Cordilleran belt of troughs, orogeny and mineralization. From a broad regional standpoint, eastern San Bernardino County occupies a srategic position.

There is at hand a set of maps illustrating a PhD thesis of one C.W.Burnham of California Institute of Technology. The maps, covering western United States, show relative concentrations of trace elements in chalcopyrite and in sphalerite, for western mining districts. That showing total trace elements in chalcopyrite exhibits a remarkable correlation with the major structural features mentioned above. An eastern belt of maximum trace element concentration passes southwest

from Park City and Bingham through Ely,not far west of the axial portion of the old troughs,to the California line,where it swings southeast through Inyo and eastern San Bernardino Counties,thence east bordering the Colorado Plateau through Bagdad, Ray-Miami,Christmas and San Manuel,where the belt turns southeast along the axis of the Occidental geanticline, and passes through Johnson, Bisbee and Pilares.

The accompanying map of eastern San Bernardino Co.shows a segment of this geochemical belt, as well as segments of the old troughs mentioned.

It is because eastern San Bernardino Co.lies within the major copper belt of western North America that it was selected for office study leading to examination in the field.

GENERAL GEOLOGY OF EASTERN SAN BERNARDINO COUNTY

Refer to accompanying map. The region is one of extensive exposures of older Precambrian (Archean) crystalline rocks,and of limited exposures of the younger Precambrian(Beltian) sediments and sedimentary schists.

As shown on the map,Paleozoic rocks are confined to the northwestern part of the area,and the extreme southeastern part,in Arizona. 3200' of Middle Cambrian,mostly carbonate rocks, occurs in the Providence Mts. Devonian limestone is also found in the Providence Mts.and north of Cima. Mississippian Monte Cristo limestone,exposed at Goodsprings is exposed in the Providence Mts. Pennsylvanian rocks occur also in the Providence Mts.

Intrusions, largely quartz monzonite to granite in composition, are abundant and appear to belong to two epochs, one the Jurassic, the other, Upper Cretaceous to early Tertiary.

Scattered as the Paleozoic exposures are, they represent remnants of a very thick section, deposited in the geosynclinal troughs shown on the Geosyncline map. According to D.F.Hewett, this indicates that the area was persistently uplifted and vigorously eroded from late Mesozoic until Middle Tertiary time. Hewett estimates that the Mojave crustal block, of which the area in question forms a part, rose 15,000 to 20,000 feet during this interval, and that the rocks were removed as the block rose.

Volcanic flows of basalt and andesite, of Tertiary and later age, are widespread. None appear to carry ore deposits.

Most of the thrusts shown on the map date from the late Cretaceous as do some of the high-angle faults; these are premineral with respect to copper deposits. Many of the larger high-angle faults date from the Pleistocene and area postmineral.

COPPER DISTRICTS

These will be taken up, starting with the Whipple Mts. on the southeast.

Whipple Mts.- Never mapped in detail. The country rock consists of Precambrian gneiss and schist, overlain in places by Quaternary basalt. No post-Cambrian intrusions are known, nor any Paleozoic or Mesozoic sediments except at the River View mine-see below. Thrusts are also unknown, but the area contains a number of high-angle faults.

American Eagle Mine

Ore bodies occur along a strong fracture zone striking N35°W, dipping steeply southwest. Hanging wall is mica schist, footwall meta-

rhyolite. Foliation in the schist strikes and dips with the fracture, and a narrow diabase dike follows the hanging wall of the zone. Copper ore occurs along the fracture zone and in subsidiary fractures in the metarhyolite footwall. The fracture zone is explored by a 300' vertical shaft, with levels at 80', 120' and 180'. Secondary chalcocit enriched the ore down to the 120' level. The main ore shoot extended from the surface, near the shaft collar, to the 120' level; it was 50' long by 20' wide. The shoot yielded about 700 tons of 8% copper ore. Primary chalcopyrite makes smaller ore bodies of lower-grade ore on the 180' level.

The above is from a report by Philip Wilson, a competent geologist and should be reliable.

Appraisal.- The mine is of some interest for the following reasons

1. Ore occurs along what is probably a fault of considerable exten

2. Permeability of the fault zone is shown by the presence of the diabase dike.

3. Chalcopyrite ore running 2% or so in copper might exists in bodie of considerable size, especially in the schist hanging wall. The geologic setting resembles that of the United Verde mine at Jerome, where or lenses occurred in schistose metarhyolite.

Recommendation.- The fracture zone should be traced as far as possi on the surface. If it proves to be a major fault, and especially if it shows persistent mineralization, consideration should be given to th possibility of diamond drilling it.

Copper Basin

The country rock,character not stated,has been intruded by several quartz porphyry and diorite dikes,striking north-south and dipping from vertically to 45°E. Two well-defined mineralized zones appear to be associated with quartz porohyry dikes,although one source s ys the zones striko northwest. One zone is said to be 5-40' wide and 2000' long.Explored by opencuts,adits and shallow shafts,the deepest of which (100') exposed in 1908 an 8' vein carrying 5% copper. 400' south of an incline shaft two north-south veins are displaced 50-100' by a fault striking N70E and dipping 70N. Where the veins are intersected by the fault there is a mineralized zone 50-100' wide.

The incline,300' deep,was sunk on the east vein,which here strikes N30W and dips 45°E.The footwall is diorite,the hanging porphyry. At the 90' level a south drift exposed an ore body 65' long and 6' wide,averaging 5% copper.

600' SW of the incline is a 100' vertical shaft on the west vein which parallels the east vein. Thie west vein,in diorite,dips 80°W and is 4-8' wide. Ore shipped from the dump ran 12% Cu.

In general, copper carbonates prevail down to 100(,where they are succeeded by bornite and chalcopyrite.

Appraisal.- Here,as at the American Eagle,there is "room" for a mine.While the ore bodies so far found have been small,there are several of them.The mineralized zones appear to have been only meagerly explored.

Recommendation.- If reconnaissance is encouraging,map the area in detail.

River View (Tuscarora)

According to one source, a vein occurs, 5-10' wide, between a diorite hanging wall and a schist footwall. The vein may be traced for 2500'. It carried 2.5% copper ore, with $10-25 in gold. According to another source, the main vein lies on a contact between gneiss or schist and limestone. The vein strikes NE and dips 35°NW; it is 4-8' wide. The limestone forms the hanging wall, the schist the footwall. Copper averages 3-6%, as carbonate; gold averages $10 per ton.

Appraisal.- In itself this property appears of little interest except for the possible presence of limestone. The major producer of the eastern San Bernardino Co. area, the Copper World at Clark Mt., lies in limestone. Much closer to the Whipple Mts., the Planet and Swansea copper mines in Arizona exploited oxidized copper ore bodies at or near the base of Paleozoic limestones resting on the Archean complex. The Planet deposit is now thought to have lain in the upper plate of a flat thrust separating the sediments from the crystaline basement.

Recommendation.- The limestone in the River View area should be mapped (if it exists), keeping in mind the possibility of finding structural conditions similar to those prevailing at Planet and Swansea.

General on Whipple Mts.

While the above properties are the only ones that look of interest, to judge from the literature, a few days, at least, should be spent in looking over the whole area, which may show possibilities not apparent in an office study.

Turtle Mts.- The major portion of the area appears to be underlain by post-mineral basalt, but Archean is exposed at the southern end of the range. The only known copper deposit is that of the Horn mine.

Horn Mine

This lies on the southeast slope of the range. The country rock is Archean quartzite, gneiss and schist. Two veins cut through the crystalline rocks, striking N55°W and dipping steeply. The veins are explored by short adits and surface cuts. An ore body on the northeasterly vein formed at the intersection with a N75° cross fracture.

The same cross fracture localized an ore body at its intersection with the southwesterly vein.

1951-1952, 200 tons of ore were shipped to a smelter, running 4.8-6.7% Cu. There were previous shipments, amount unknown.

Appraisal.- Probably devoid of interest, but should be looked over, reconnaissance fashion, especially since it lies close to Highway 95.

Old Woman Mts.- Here Jurassic stocks intrude Archean crystalline rocks.

Lucky Jim Mine

Location on map is uncertain. A quartz vein lies along either side of a porphyry dike. Ore lenses are found on either wall of the dike, which strikes N65°W and dips 85°N. Lenses are narrow, averaging 4' in width. A 100' ore body was stoped, running over 100 oz. silver per ton, $3.00 in gold, 5% in copper and 5% in lead.

Appraisal.- The Lucky Jim, and another small producer in the area, the Long Shot, seem devoid of interest. The stocks, if they are truly of Jurassic age, would appear to lack potentialities of producing porphyry copper deposits, since the latter favor intrusives of Laramide age. But the age of the stocks is probably uncertain, and they might be looked over with the possibility of porphyry copper deposits in mind.

Ship Mts.- These seem to be ~~xxxxxx~~ made up of a granitic intrusion, presumably of Jurassic age, and limestone, probably of Paleozoic age,

Vulcan (McClintock) Mine.

Lies on NW slope of the Ship Mts. Developed by two vertical shafts, the north shaft being 500' deep, the south shaft, 150' to the south, 175'. There are two veins in quartz diorite, striking N10°E and dipping E. The westerly vein carries mainly gold. 1500 tons of ore were shipped to Hayden, 1941-2, averaging 0.345 oz. gold per ton and 0.21% Cu. The easterly vein, not far in the hanging wall of the gold vein, is 6-12' wide and lies on the contact between quartz diorite on the west (footwall) and limestone on the east (hanging). It is said to carry ore averaging 2-3% Cu, $6 in gold.

Appraisal.- This property would be of only moderate interest, were it not for the limestone in contact with the dioritic intrusive. For that reason it merits at least reconnaissance examination.

Ventrigger-Ibex Area.- Scattered exposures west of Needles and north of Goffs. Several plutonic intrusions, probably invading Archean rocks.

Ventrigger Mine

Country rock Archean gneiss and schist. Slightly brecciated zones, discontinuously mineralized with copper, trend NE, parallel with the planar structure of the schist and gneiss. Ore is malachite to about 120' down, succeeded by chalcopyrite.

The Medburry incline shaft, sunk at 55°, is 280' deep. Southwest of the shaft ore has been stoped above the 100' level. Surface showings suggest a length of 400' for the mineralized zone, and widths from 20-110'.

The Goodwin shaft, 500' to the east, is vertical and 300' deep. Northeast of the Goodwin shaft, on the same mineralized zone, are two other shallow shafts. Surface exposures indicate a zone mineralized with copper extending from the Goodwin shaft, where the zone is 20' wide, to one of the shafts mentioned, 600' NE of the Goodwin; at this NE end the mineralized zone is 250' wide.

Production has been considerable. In 1909 30,000 tons of ore were piled on dumps for leaching. This operation probably was unsuccessful. But in 1926-9 the California Gold & Copper Co. shipped 3729 tons of 5% copper ore. Lessees in 1944-5 shipped 1175 tons of ore averaging less than 3%.

Appraisal.- The mineralized zones are large; there is plenty of room for one or more good-sized chalcopyrite ore bodies; if these exist they will probably be found in the schist. One source says that diorite, porphyry and granite are present, which if true would add interest to the area.

Recommendation.- The area should be examined and if promising, mapped, with the possibility in mind of drilling the more favorable mineralized zones.

Josie K Prospect

A quartz vein at contact of rhyolite and granite, showing oxidized copper minerals, running as high as 14% Cu and $11 in gold. Structure traced by shallow shafts for 4000'.

The Josie K does not sound attractive, except for the great length of the structure and the possibility that it may be an important fault. It is close to the highway however and might deserve a visit.

Providence Mts.- A detailed map and description of this area appears in Bulletin 170, Geology of Southern California, Chapter IV, Structural Features, Contribution 4: Rocks and Structure of the Northern Providence Mts., by John C. Hazard, p.27-35 (Calif. Division of Mines, 1954). This publication should be taken into the field.

The country rock includes Tertiary tuffs, Lower Triassic limestone, sandstone and shale, Permian limestone*, Pennsylvanian limestone*, Missizsippian Monte Cristo limestone*(ore formation at Goodsprings), Devonian Sultan limestone, Cambrian limestone, dolomite, shale and quartzite, *and Precambrian crystallines. Those formations marked * carry ore.

Syenite crops out as a large mass in the southern portion of the mapped area, and as a small intrusion northeast of the Bonanza King mine. Northeast of the syenite is a large intrusion of rhyolite, and rhyolite dikes are abundant throughout the eastern part of the area. The rhyolite is probably Miocene in age, and therefore post-mineral with regard to copper.

The area is one of the most complexly faulted units I have seen or read about. Maps accompanying the paper cited show the fault mosaic.

The Providence Mts. area appears to be one of lead and precious metals rather than a copper district. Hazard ties in the mineralization of the Bonanza King silver-lead-gold mine with the Miocene rhyolite intrusion. The nearby Bell-Gilroy, on the same N-S fault, dates presumably from the same period.

The only two properties in connection with which copper is mentioned are the Big Horn(Mabel-Contention) and the Break of Day(Three States).

Big Horn

Veins less than 4' wide on either side of porphyry dikes. Pyrite, chalcopyrite,with main values in gold. Probably without interest.

Break of Day

Limestone intruded by diorite and porphyry dikes. Ore chalcopyrite, but details of deposit are lacking. A few tons of ore said to have been shipped but high transportation costs made the venture a loser.

General

The Providence Mts.abound in favorable carbonate beds and pre-mineral fractures. They just seem to lack copper deposits. The Bell Gilroy is thought to offer possibilities for further ore,and so does the Bonanza King. If interest is felt in lead-silver ore,these properties might be examined. Details concerning them are on file.

New York Mts.- Although separated from the Providence Mts.by Cedar Canyon,the New York Mts.are the physiographic northeast continuation of the Providence Range.

In the New York Mts. a large Tertiary(?) stock and several smaller Jurassic(?) stocks intrude Precambrian crystallines.

Sagamore (New York) Mine

A complex of quartzite,crystalline limestone and granitic rocks lies between a large body of limestone on the east, and another on the west. It is 5000' from one body of limestone to the other. A series of parallel veins strike roughly east-west.The strongest one traverses the entire complex and penetrates the limestone at either end.

The main vein is a quartz-filled fault,from 4 to over 15 feet wide. None ore shoots are said to have been found along it,carrying sulphides of copper,lead and zinc,plus huebnerite. The shoots averaged 100' in length, and were 4-15' wide.

Two long adits,repectively 1100' and 700' long,and several shafts. In 1958 the longer adit was caved at 680' in,the other at 280'.

No data on copper production;some tungsten ore was milled, War I.

Appraisal.- This property if idle and available is worth a visit. The main vein is long and reasonably wide,there are parallel veins but little explored, and the limestone at either end of the showing offers promise.

XXXXX Trio Mine

In a belt of crystalline limestone trending north-south, 1000' wide and 5 miles long. The property lies at the south end of the belt. Steeply-dipping E-W fractures in the limestone carry short lenses of copper ore at irregular intervals. Lenses are narrow,up to 2.5' wide. Ore is chalcopyrite and bornite. There is a 300' shaft,now filled and several small adits.

Appraisal.- The only interest here is the possibility of replacement ore bodies in the limestone. Chances look slim.

Clark Mt.-Ivanpah Mt.Area.- These minor ranges form an arcuate, roughly north-south physiographic unit;they lie NW of the New York Mts.,across the Ivanpah Valley,up which runs the Union Pacific line from Los Angeles to Salt Lake.

This area has been by far the most productive;it has also been the most intensely explored district.

As my map shows, the area lies where the north-south belt of geosynclines and orogeny, extending from Bingham through Ely, Pioche, Goodsprings etc., crosses the east-west geochemical belt which heads east to pass through Bagdad, Ray-Miami and other major camps.

A monograph by D.F. Hewett on geology and ore deposits of the Ivanpah quadrangle is in process of publication as a Professional Paper of the U.S. Geological Survey. Presumably it will cover the New York Mts. and part of the Providence Mts., as well as the Clark Mt.-Ivanpah Mt. area. It should contain far more reliable data on copper deposits than I have been able to glean from the present literature.

The country rock of the area is largely lower Paleozoic sediments, mainly limestone, The salient structural features are the Clark Mt. high-angle fault, with downthrow to the west of 12,000 ft., and a major west-dipping thrust, west of the Clark Mt. fault. As suggested on the map, the copper deposits are aligned along a NNW belt parallel to and close to these faults.

Copper World Mine

This is the leading producer of eastern San Bernardino Co., having yielded well over 1,000,000 lbs. of copper. It had its own smelter at Valley Wells, from which was shipped $750,000 worth of blister copper. The copper ore, largely carbonates, occurred associated with bodies of contact metamorphic silicates in the Cambrian Goodsprings dolomite, and near sill-like bodies of quartz monzonite.

Workings are extensive. A crosscut from a winze sunk from an adit is said to have cut 15' of 4% sulphide ore. In general the lowest workings were entering chalcopyrite ore averaging about 2% copper, unmineable at the time. More details are available in my file.

Copper Commander Prospect

This adjoins the Copper World on the NW. Ore occurs in a broad mineralized zone along a contact of granite porphyry with limestone or dolomite. The zone trends NW and is 200 feet wide. It contains veinlets of carbonate ore. Average grade is said to be 4% Cu; this probably applies to certain areas in the zone.

Appraisal of Copper World and Copper Commander.- It is usually a good bet that additional ore is most likely to be found where substantial ore was found before. There seems to be plenty of additional prospects for ore in this area, both laterally and in depth.

Recommendation.- If ground is available here, a detailed study of this area should be made. Such a study may well lead to exploration, by drilling or otherwise.

Conditions in this area resemble those at the lead-zinc camp of Goodsprings, Nevada, where the chief production came from the upper member of the Mississippian Monte Cristo limestone, immediately beneath the thick Yellowpine sill. The Goodsprings dolomite, in which the Copper World ore bodies were found, is less favorable for ore than is the overlying Monte Cristo limestone, and was unproductive at Goodsprings.

When Hewett's Professional Paper on the Ivanpah quadrangle appears, the Monte Cristo limestone will be shown on his maps. It should be followed in the field and studied in detail, in the hope that favorable structures, plus perhaps the presence of quartz monzonite sills or other intrusions may indicate a promising place to search for virgin copper ore bodies.

For use in this work, a stratigraphic section and structural map of

Goodsprings ~~face this page.~~ are furnished.

Emperor Mine

Lies NE of the Copper World. An east-west vein,dipping vertically, follows an intrusive contact between granite porphyry and limestone. Lead and copper carbonates with silver occur in the vein,width of ore varying between 1 and 4'. Short adits, a winze and an opencut. Last car shipped averaged 5.5% Cu.,11.5% Pb and 11 oz.Ag.

Appraisal.- Probably not of interest in itself, but it marks another ore showing in this productive zone.

Yucca Queen Mine

The Yucca Queen lies SE of the Copper World. It is the mine shown on the map immediately east of the Mohawk lead-zinc mine. Ore occurs on an east-west contact between Blue and white limestone,and is localized at intersections of E-W and N40W fractures in the limestone. Small bunches of lead carbonate with silver occur,but the chief point of interest lies in the Annex Tunnel No.6,where a NE drift starting at 410' from the portal was extended 200' in diorite porphyry "with low copper values." This seems worth investigating as a possible porphyry copper.

Mohawk Mine

A lead-zinc mine which has produced copper, especially in the early years of mining. On the south slope of Mohawk Hill, a contact between quartz monzonite and limestone ,intrusive but modified by faulting, strikes roughly E-W and dips 40°.The flat dip suggests that the intrusive may be a sill,a favorable indication. Zinc and lead carbonates,with some copper carbonates,are found in the limestone near the contact,and largely within a zone 30' wide along the latter.

Mineralization is strongest where fractures cross the contact zone. There are over 2500' of workings,largely adits.

Appraisal.- The Mohawk lies within the general ore zone,study of which I recommend.

Standard No.2 Mine

This mine lies at the SE end of what might be called the West ore belt,along whuch lie,from N to SE, the Emperor, Copper World, Copper Commander, Mohawk, Yucca Queen, Iron Horse(not described) and the Standard No.2. The belt should be investigated as a unit.

The country rock is Cambrian Goodsprings dolomite (as at the Copper World). This formation is extensively exposed on the west flank of Ivanpah Mt. In the Standard area the beds strike NW and dip 40-60°SW. Mineralization is associated in part with zones of alteration near basic dikes in brecciated parts of the limestone. There are over 1000' of adits and shallow shafts irregularly disposed along a mile-long belt. The main shaft,inclined 80°W,and 275' deep,penetrates one of the brecciated zones. Shipments of ore mined through through the shaft averaged 13% Cu,$ 8 in gold and 16 oz. silver.

New Trail Mine

The New Trail lies NE of the Standard No.2. Ore bodies mainly in limestone,the beds of which strike NW and dip 20-40°SW.The limestone contains irregular tongues of queartz monzonite and irregular bodies of garnet-epidote rock. A large mass of quartz monzonite occurs in the area.The workings are on two veins about 1 mile apart. The

Colorado workings are on a fault zone containing a tabular copper carbonate ore body,now stoped, with widths of 5-30'.

The Anchor workings, 1 mile to the NW explore a vein striking N40°E and dipping 75°NW. This vein also is 5-30' wide. Ore is said t have averaged 7 oz.Ag.and 6.2% Cu.

The Colorado vein does not seem to have been adequately explored and may still offer possibilities. In 1950-51 however 25 diamond drill holes were put down,aggregating 1500',and 800 feet of underground exploration were driven,apparently without success. This work apparently was done on the Anchor vein.

Appraisal.- The New Trail may offer chances in itself;in any case,it lies within the ore belt recommended for study.

Allured Mine

Lies very close to the New Trail. Small workings have explored faulted and sheared zones along contacts between granite and Paleozoic sediments.One such fault zone lies between quartzite and limestone on the east and sheared granite gneiss on the west. A small quartz-chalcopyrite ore body averaged 6% Cu. Half a mile to the west, a gouge zone between granite on the east and limestone on the west yielded another small carbonate ore body averaging 8% Cu and &7 Au.

West Belt,General.-The West ore belt lies in the upper plate of the thrust fault zone on the map;the fault outcrop parallels the ore belt.

East Belt,General.- Mines along the East belt lie close to the Clark Mt.normal fault (12,000 ft.down on the SW) and seem to be genetically related to the fault,which may have served as the trunk ore channel.

Colosseum Mine

At the NW end of the East ore belt. Sandstone,limestone,dolomite and shale are folded into a great anticline,the core of which is granite hgneiss. A large dome-shaped quartz monzonite intrusion lies nearby; intrusion of a rhyolite plug elongated N30°E came later. Apparently the rhyolite intrudes the quartz monzonite.

One ore body occurred as a stockwork within the highly altered rhyolite plug,and carried chalcopyrite, gold and pyrite. A second ore body lies along the contact of"granite" (quartz monzonite?) and the rhyolite plug. It strikes N60° and dips 80°S.

Apparently this ore had not been mined,at least entirely,in 1943, for a source of that date gives estimated tonnage of the two ore bodies as 116,000 tons averaging $8 in gold,copper content not stated.

Development workings aggregate 4000'.

In view of the tonnage of ore claimed,this mine merits investigation.

Keiper(Green Gold,Bank Roll) Mine

Lies just south of the Colosseum. Not extensively developed. The workings are clustered in several areas along a belt more than a mile long at or near the contact of quartz monzonite and a Paleozoic unit of limestone and shale. Ore occurs as discontinuous lenses and veinlets carrying galena,sphalerite chalcopyrite,with gold and silver. Some ore lies along fractures and bed planes in the limestone,and some along fractures in the quartz monzonite.

Recommendation.- This property could be looked at when the Colosseum is examined.

Carbonate King Mine

Near the SE end of the East belt. The lead-zinc ore body lies i the Yellowpine limestone member of the Monte Cristo limestone. (Main ore body of the Yellowpine mine at Goodsprings was in the Yellowpine limestone). The ore body did not crop out,only a few small ore stringers appearing above it on the surface, 60' above the top of the ore body. Ore body was elongated along the strike o the beds,the strike length being 120'.It did not however,quite follow the bedding,resembling Goodsprings again in this respect. The ore wedges out laterally into barren limestone and dolomite;it cur sharply off at its base by a flat thrust,showing drag ore along it.Below the thrust is barren limestone.

The thrust is postmineral,but as late as 1953 the faulted segme of the ore body had not been found.

Between 1940 and 1944, 4000 tons of ore were shipped,averaging 35.5% zinc (carbonate), 1% lead (carbonate),and 10 oz. silver.

Appraisal. This was a good little mine,but probably is too small to be of interest.

SUMMARY AND CONCLUSIONS

The strategic regional position of Eastern San Bernardino Co. with respect to major copper belts has been pointed out. In any major exploration scheme, gaps between known deposits in these belts must be examined. If results in any gap are negative,investigation must pass on to other gaps. Such a comprehensive and systematic plan should eventually yield results.

Eastern San Bernardino Co.is such a gap. Its favorable locatior does not guarantee the presence of a sizeable undiscovered copper mine,but chances of finding one are better here than outside the major copper belts.

Of necessity,only those properties appear in this report that look favorable from inspection of the literature. Better bets may exist,not mentioned in any publication. Field parties should continuously be looking for these.

I regard the Clark Mt.-Ivanpah Mt. area as the most favorable in t region. Exploration here will be greatly aided by Hewett's Ivanpah Professional Paper. I suggest that reconnaissance start in the south with the Whipple Mts.,then proceed to the Turtle,Old Woman and Ship Mts., followed by the Vontrigger area and the Providence Mts. By the time this work is done the Hewett paper may be published.

Probably no exploration work in eastern San Bernardino Co. has had possible porphyry copper deposits in mind. Most or all of the stocks shown on my small-scale map are probably too large to contain porphyry copper deposits,which favor stocks a few miles in diameter at the most. Stocks of this size should be looked for and examined.

Mineralized schist areas offer another possibility for large,low-grade deposits.These should be carefully looked for in PreCambrian exposures,especially where younger intrusions are present.

Chances for porphyry coppers are probably best in the Clark Mt.-Ivan pah Mt.area,where high-grade,easily smelted carbonate ore in lime-stone may have distracted attention from low-grade ore in monzonite. (See description of Yucca Queen mine,p.20).

The relation of porphyry copper deposits to domical and anticlin-al uplifts has been outlined (p.5-6).Such structures if recognized in association with stocks or mineralized schist areas would stimulate their exploration.

I have ownership data on most of the properties mentioned,down to 1953. The field party should contact me when in need of such data. Details of mine workings are also at hand for mamy of the properties, and will be made available as called for.

The 1:250,000 and 1:500,000 geologic maps should be carried in the field.(Calif.State Div.of Mines). The U.S.G.S. 1:250,000 topographic maps, Kingman and Needles sheets,will also prove useful.

Edward Wisser

Berkeley, Calif.
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