

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 STATE OFFICE BUILDING
PORTLAND 1

COPPER IN OREGON: SUMMARY OF WORK DONE IN THE SUMMER OF 1960

By George S. Koch, Jr., and Richard G. Bowen

Summary: Work on copper in Oregon in the summer of 1960 was concentrated on the basic geology of two adjacent 15-minute quadrangles in northeastern Oregon. Geologic mapping of one of these quadrangles, the Sparta quadrangle, was completed (see attached index map of topographic maps in Oregon). Work in the other quadrangle, the Baker 1 quadrangle, was advanced sufficiently so that mapping of this quadrangle can be completed during the 1961 summer field season. Significant progress was made during the summer in deciphering the geology of the Clover Creek greenstone formation, which is of both Triassic and Permian age, rather than being entirely of Permian age as was previously believed.

No direct work on copper mineralization was done during the summer because we believe that an understanding of the basic geology is essential for an understanding of the copper mineralization. Commercial interest has been indicated in the area.

Besides the geologic investigations in northeastern Oregon, work was done in the Bohemia mining district of Lane County by Mr. Richard Lutton. His work has stressed geologic mapping of the rocks and a study of the changes in the rocks caused by the introduction of the metals into the veins.

Personnel: Work was under the general direction of George S. Koch, Jr., Assistant Professor of Geology at Oregon State College, and Richard G. Bowen, Geologist with the Department. Koch and Bowen spent most of their time in geologic mapping in the Baker 1 quadrangle. Koch was in the field for two months and Bowen for about three months.

Harold Prostka completed mapping of the Sparta quadrangle, with the assistance of Richard L. Bateman. Both Prostka and Bateman were in the field for three months.

James N. Lukanuski assisted Koch and Bowen in mapping in the Baker 1 quadrangle for three months.

Richard Lutton spent about three months in the Bohemia mining district, working under the supervision of Hollis M. Dole and Herbert G. Schlicker, also of the Department.

Although working for the Department but not assigned to the copper project, David A. Bostwick, Assistant Professor of Geology at Oregon State College, spent a good deal of the summer identifying fossils obtained mostly from rocks in the Baker 1 and Sparta quadrangles. His age determinations were essential for the progress of the geologic mapping.

Geology of the Clover Creek greenstone: Work in the Baker 1 quadrangle thus far has been restricted to the geology of the Clover Creek greenstone. The largest outcrops of this formation are in this quadrangle as well as the type locality where Gilluly first defined the formation in the early 1930's.

Gilluly (U. S. Geological Survey Bulletin 879 and 830-a) believed that the rocks of the Clover Creek greenstone formation are mainly altered lavas of Permian age. Our investigations indicate that the rocks that we have studied thus far are mainly altered sedimentary rocks of both Permian and Triassic ages.

While the Clover Creek greenstone is most extensively exposed in the Baker 1 quadrangle (northeast one-quarter of the Baker 30-minute quadrangle) it extends through several other quadrangles. The most westerly known exposures are in the Baker 2 quadrangle (northwest one-quarter of the Baker 30-minute quadrangle). Additional Clover Creek greenstone is found in the Telocaset 3 and Telocaset 4 quadrangles (together comprising the south one-half of the Telocaset 30-minute quadrangle). Eastward, Clover Creek greenstone extends through the Sparta and Halfway quadrangles into the Copperfield and Homestead quadrangles. In Idaho, extensive exposures of similar rocks are found in the Seven Devils Mountains where they are known variously as the Seven Devils volcanics and the Lucille series. It is unfortunate that scarcely anything has been written about these rocks in Idaho since it is very likely that many answers to problems and the geology can be found there.

The following preliminary description of the Clover Creek greenstone is drawn from Gilluly's description (U. S. Geological Survey Bulletin 830-a) with modifications and additions by us.

Gilluly writes that the rocks "are strongly sheared and characteristically break along chlorite seams, which divide the rocks into rounded and lozenge-shaped forms. Since the rock is essentially uniform in its resistance to erosion, the surface forms developed in this formation have been slightly governed by its strike and are smoothly rounded." A further result of this shearing is that the rocks are difficult to identify in the field. We have made a practice of slabbing all rock samples and examining each rock under a binocular microscope. This practice, which was adopted this summer, has proven extremely valuable and almost essential to the progress of the mapping.

"The rocks are highly albitized to a spillitic association as defined by Dewey and Flett. Pillow structure, a common but not invariable feature of spillitic lavas was not recognized, although its absence may be due to later shearing." We have not recognized pillow structure either, although good pillow structure can be seen in spillites in the central Oregon Triassic area mapped by William Dickinson of Stanford University, west of the town of Seneca. Gilluly states that "common varieties of lava identified, named in order of abundance, are quartzose keratophyre, spillite, albite diabase, meta-andesite, and metabasalt."

"The quartz keratophyres, which make up large portions of the greenstone series are dense greenish rocks, weathering dark gray. They contain variable amounts of dark quartz and feldspar phenocrysts, the largest nearly one centimeter in diameter. Commonly the phenocrysts are rounded by resorption. The groundmass is dense and chloritic. Thin sections show quartz, albite, in both phenocrysts and groundmass, chlorite, epidote, clinozoisite, and the common accessories, apatite, magnetite, and zircon. The texture is felsitic to trachytic." To date, we have found relatively few of these rocks.

"Non-quartzose keratophyres are common in the greenstone series. They are dense to finely porphyritic dark green rocks with locally recognizable flow structure. In thin section albite crystals, commonly representative of two generations, epidote, clinozoisite, and chlorite seem to form the bulk of the rock. Magnetite and apatite are accessories. A few

specimens show an altered augite, but in some specimens this is replaced by . . . amphiboles, with green and brown pleochroism, and in other chlorites pseudomorphic after augite is present." While we have found a number of these rocks, we tend to call rocks without recognizable flow structure tuffs rather than lavas, since these rocks can often be traced into undoubted tuffs.

The best exposures of keratophyres that we have found are in and near a small quarry at the junction of the Medical Springs - Baker highway with a road leading due east along the line between secs. 14 and 23 of T. 7 S., R. 41 E.

"Phyllites carrying more hornblende and augite than the keratophyres are common. The dark minerals are chloritized; the feldspars are albite, some carrying epidote probably derived through the albitization of the more calcic feldspar. It is difficult to draw a sharp line between these rocks and meta-andesites and meta-basalts, whose spillitic affinities are marked only by very slight albitization."

"Normal meta-andesites, with andesine or clay andesine feldspars, are common members of the greenstone series. Their texture is ordinarily felted and shows some slight suggestions of flow lines characteristic of andesite." We have identified some of these rocks; normally the texture is characteristic.

Gilluly believed that the prevalence of clearly secondary albite in the greenstone series suggests that all of the albite in them is of post-magmatic, metamorphic origin. We have done no work to prove or disprove this theory.

Marine limestones make up only about 3 percent of the formation, but these rocks are very prominent in outcrop and are important because they have yielded most of the fossils thus far found in the formation. We have distinguished two types of limestone. The first type is a dirty, brown sandy limestone, generally interbedded with volcanic wacke and conglomerate. This limestone contains bryozoans and brachiopods that have been dated by D. A. Bostwick as of undoubted Permian age. Unfortunately, the stage of the Permian represented cannot be learned from the material found thus far. This limestone is not widespread, having been definitely identified only in the area in the Baker 1 quadrangle west of the Medical Springs - Baker highway and in outcrops within a 1-mile zone east of the highway. Similar limestone, bearing similar fossils, occurs near the Iron Dyke mine at Homestead on the Snake River.

The other type of limestone is a dark blue limestone that weathers to a light blue color on the surface and, while somewhat impure, is by no means so impure as the first type. This limestone contains the fossil Pentacrinus, indicating that it is of Mesozoic or younger age. From the general geologic relations and from other poorly preserved fossils, this limestone is believed to be Triassic and is certainly Triassic or younger.

Some of the Triassic(?) limestone is found very close to the type locality of the Clover Creek greenstone formation. If the limestone is interbedded with the other units of the greenstone formation, as it appears to be, then the Clover Creek greenstone formation is not Permian as Gilluly believed but must be Triassic(?). For the present at least, we have restricted the name Clover Creek to the Triassic(?) greenstones and are using the name Big Creek to refer to the Permian part of the greenstone formation.

Gilluly states that a large part of the greenstone series is composed of pyroclastic sediments, breccias and tuffs. We believe these breccias and tuffs, many of which have been sufficiently reworked to be designated as volcanic wackes, are more abundant than the lavas although sufficient work has not yet been done to completely prove this.

Gilluly states that "the coarser breccia members are composed of angular and subrounded fragments of volcanic rock. In many localities it is difficult to decide whether the somewhat sheared fragmental-appearing blocks composing a given member of the greenstone series are volcanic bombs and boulders or originally blocky lava (aa), or whether they are portions of an originally massive flow which has been sheared, rounded in part, and separated by chloritic zones formed during the later deformation of the series."

"Finer-grained tuffaceous sediments are rather common. Characteristically they are faintly banded rocks whose laminations are emphasized on weathered surfaces. They range in color from gray to buff, light green, dark green, and blue green to nearly black. Some are dense rocks without recognizable granular structure or recognizable minerals; others are clearly clastic rocks in a recognizable feldspar, quartz, and chlorite, or small pellets of volcanic rock. Many are highly silicified and break with conchoidal fracture." Those that are dense we tend to call tuffs, those that are coarse we tend to call volcanic wackes. Often these rocks are so closely interbedded that a distinction cannot be made for mapping purposes.

We have also recognized a few samples of quartz crystal tuff, in which the quartz crystals are not rounded.

Gilluly points out that some of the crystal tuffs are so fine grained that they resemble argillite very closely. We have not so far been able to distinguish argillite from these volcanic rocks.

Conglomerates are not common in the greenstone series, although some beds of conglomerate are fairly persistent, being traceable for perhaps a mile. The conglomerates contain poorly sorted pebbles of volcanic rocks, some quartz pebbles, and, at least in the Sparta quadrangle, granite pebbles. We have not thus far seen granite pebbles in the conglomerate of the Baker 1 quadrangle but have not made a very intensive search.

Gilluly believes that the Clover Creek greenstone must have a thickness of several thousand feet at least. This estimate seems reasonable although since we know very little about the structure of the formation we have no definite facts.

The Sparta quadrangle: Geologic mapping in this quadrangle was completed by Hal Prostka and Richard L. Bateman this summer. A preliminary map has been prepared, copies of which can be examined at the Department's main office in Portland and at the Baker field office. A preliminary report on the geology of the quadrangle is being written by Prostka and will be available about November 1. Prostka's final report will be available about June 1962.

The following notes on the greenstone units in the Sparta quadrangle may be of use prior to the completion of Prostka's preliminary report.

The Dark Canyon group indicated on the map has been restricted since the drawing of the map to include only the unit in the northeastern part of the quadrangle. The units in the west-central part of the quadrangle on Balm Creek and Cottonwood Creek areas adjoin the type section of the Clover Creek greenstone and are close to the type locality. Furthermore the lithologies do not differ from the rocks on Clover Creek which were mapped as Clover Creek formation by Gilluly. The rocks remaining in the Dark Canyon group are dated so far, at only one locality, on Eagle Creek at the extreme east of the quadrangle. Here the group is Triassic. Other very poor fossils found near the Daddy Lode mine have not yet been identified. Prostka believes that the Dark Canyon group conformably underlies the Martin Bridge limestone, but this is not entirely certain. If these rocks underlie the Martin Bridge limestone conformably, then they correspond to the Lower Sedimentary Series defined by Smith

and Allen in Oregon Department of Geology Bulletin 12. However, the lithologies are different, being finer grained, and containing a larger portion of sediments. Prostka's interpretation is best established from the Dark Canyon group in the ground near the Daddy Lode mine and the ground in the West Fork of Goose Creek on the Collins road.

This leaves the Dark Canyon group in the very large block of ground above Eagle Creek on the southwest and also extending across Eagle Creek down to the east edge of the quadrangle. This block of greenstone in part is overthrust on the Martin Bridge limestone. It is possible that not only part of the greenstone but rather the entire block is thrust over the Martin Bridge limestone.

Taken as a whole, the lithologies of the Dark Canyon group rocks are similar to those in the Clover Creek greenstone described in the preceding section of this report.

Very little is known about the greenstone marked with a capital "G" on the map near the northeast boundary of the quadrangle. No fossils have been found in it. This greenstone may underlie the Lower Sedimentary Series with conformity, and it certainly underlies the Lower Sedimentary Series in some manner. This greenstone may be part of the Lower Sedimentary Series as defined by Smith and Allen, but Prostka believes that following their definition the formation would be Clover Creek in their terminology. (Smith and Allen's use of the term Clover Creek is not the same as Gilluly's use nor the same as our use.) No copper prospects are known in this greenstone.

PROGRESS REPORT ON GEOCHEMICAL WORK IN THE BAKER AREA

By Richard G. Bowen

Geochemical testing in the Baker area was limited to two types of tests; heavy metals (Zn, Cu, Pb) in water using dithizone extraction (Huff, 1948) and copper in soils using 2, 2'-biquinoline extraction (Canney and Hawkins, 1958).

During the early part of the season, most of the flowing streams in the northwestern part of the Sparta quadrangle were tested for their heavy metal content. Because zinc and lead are unknown and copper is widely scattered through this area, positive results on the dithizone test are believed to indicate copper. Using the dithizone test, the only time copper was detected was along Balm Creek, and this was believed to be due to contamination from the extensive workings along Balm and Slide creeks. Here the range was from 0.04 ppm at approximately a mile and a half below the junction of Slide and Balm creeks to 0.05 ppm at the junction. Sample sites are shown in Fig. 2. Although these tests are extremely sensitive, their lower limit of detection is about 0.002 ppm, they have many limiting factors mostly due to the nature of stream water. At the time of the year these tests were run (early July), stream flow was very low and much water was being diverted for irrigation purposes. As the water was very low, only the center part of the channel (the most washed so least likely to contain the metals sought) was tested. During time of low stream flow organic activity is highest, and much of the metal normally in the water is fixed organically and hence undetectable. Another limiting factor was unavailability of metal-free ammonia; this cut the sensitivity of the test to approximately 0.04 ppm. Consequently, for mapping purposes a heavy metal content of less than 0.04 ppm was considered nil.

Because of these limiting factors, I believe this type of testing would be more suited to a time of the year when slope wash and runoff are high and to an area where contamination from agricultural and mining activities would be more limited; for example, the Cascade and Coast ranges.

The test for copper in soils was much more successful and I believe more applicable to the area. In this test only a partial extraction of the copper is made, as a measure of the readily available copper is just as indicative of mineralization as total copper. This eliminates, to some extent, the problem of large variation of background in rock type, ranging from about 25 ppm in granites to 150 ppm in basalts.

The procedure on this test was to take a 0.2 gr soil sample just below the grass roots, usually 4 to 6 inches. It was then treated with 1 ml of cold HCl for 30 seconds to extract the copper. The buffer and biquinoline were then added, and copper content was estimated by comparing the pink coloration of the biquinoline with standards. Standards carried in the field ranged from 1 to 30 ppm.

The original plan for the summer was to do enough sampling around the Baker area to establish a background of the copper content for the various rock units. As most of the copper mineralization appears to be in the Clover Creek greenstones, exploration was concentrated in that unit.

Altogether 226 sites were sampled in a series of 11 traverses. Most of these traverses were made across structure in order to detect the variation, if any, of the different units within the Clover Creek greenstones. The rock types sampled consisted of albite granite, metabasalts, keratophyres, wackes, and cherts. These traverses are shown on Fig. 3. There were no significant variations in the background, all being about 5 ppm.

After the random traverses were run for background establishment, I asked N. S. Wagner, Field Geologist in charge of the Baker office, for a suggestion of a place to run a traverse on an area of known mineralization that had not been dug up, so not too contaminated. He suggested the Burkemont property on Tucker Creek.

At Burkemont I ran a north-south traverse for 500 feet on each side of the shaft at 50-foot intervals. In addition I planned two east-west traverses 250 feet long crossing the north-south line. These traverses were 250 feet apart. Fig. 4 shows the results of these traverses and their extensions.

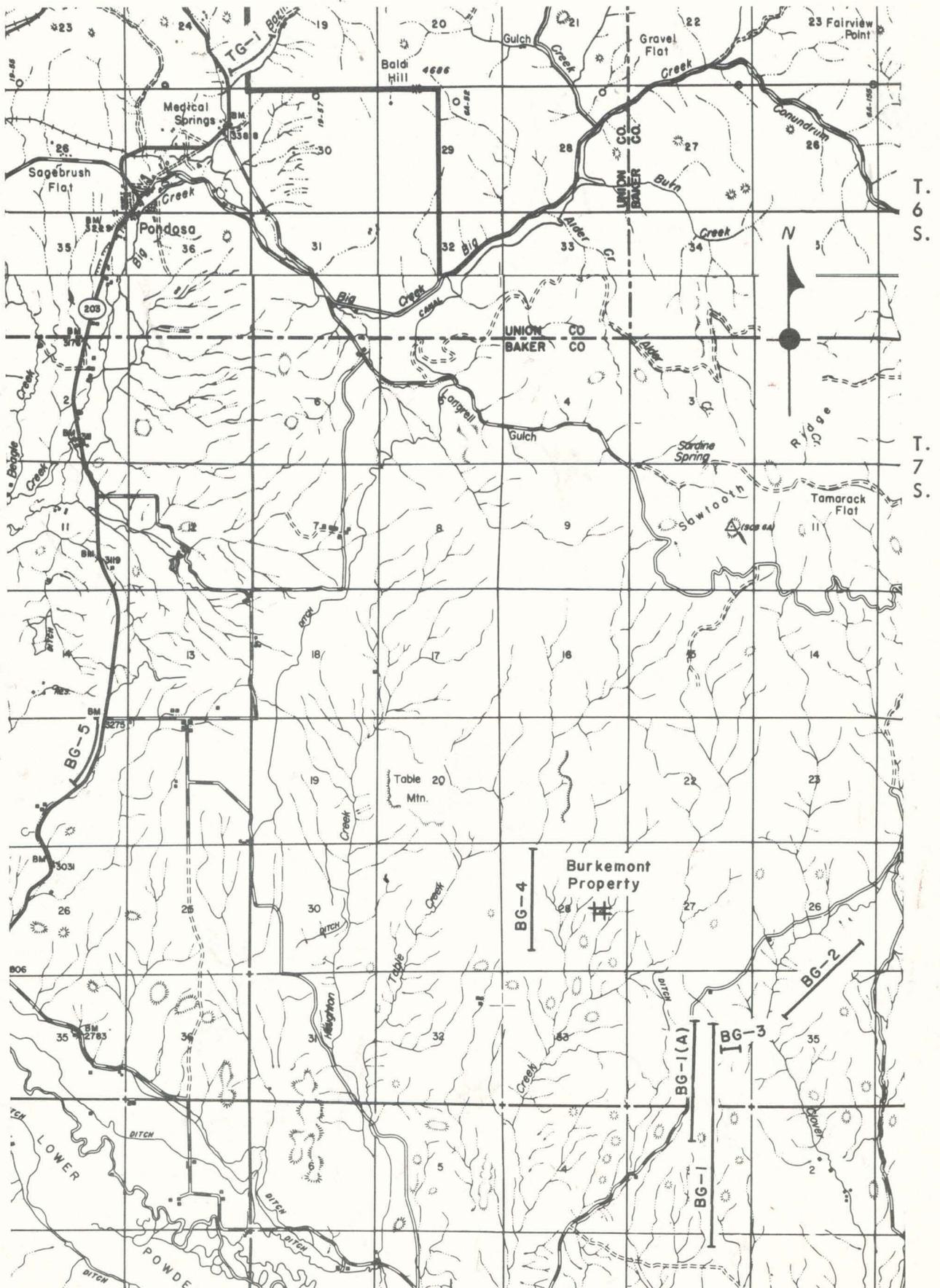
Next season further work will be done using both the dithizone and biquinoline methods. Water samples will be tested for heavy metals in the spring when runoff and slope wash are

greater than during the summer. At that time all of the accessible streams will be checked. Soil samples will be taken in selected areas in an attempt to more fully evaluate the copper potential of the area. This work will then be summarized with a geochemical map.

Bibliography

- Canney, F. C., and Hawkins, D. B., 1958, Cold acid extraction of copper from soils and sediments - A proposed field method: Economic Geology, vol. 53, no. 7, p. 877-886.
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GEOCHEMICAL SOIL TRAVERSES



R. 41 E.

Fig. 3

R. 42 E.

GEOCHEMICAL TRAVERSES
 Run near Burkemont property
 Sect. 28, T.7 S., R.42 E., Baker County

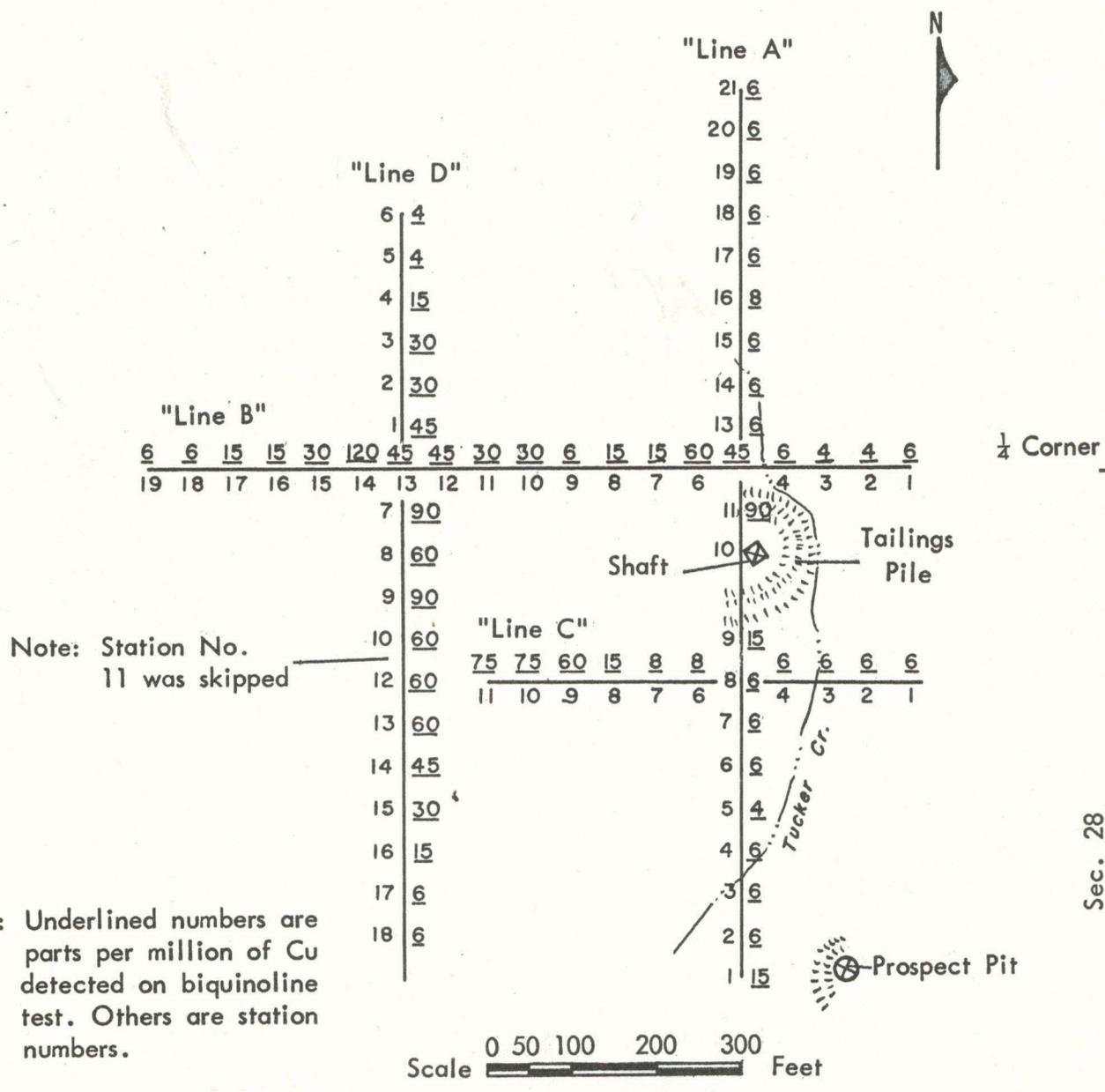


Fig. 4

oregon resource development

**Electrowinning
Copper and Zinc
From Oregon Mines**

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A METHOD OF ELECTROWINNING COPPER AND ZINC (OR BRASS)
FROM THE MINES OF OREGON

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INTRODUCTION

Significant quantities of copper and zinc ores exist in the State of Oregon. * These metallic deposits are not presently being mined because of the high cost of conventional ore processing techniques.

This report suggests that the economics associated with this problem may be favorably altered by a method of electrowinning copper and zinc which was recently studied in the Department of Chemical Engineering at Oregon State University.

The method suggested allows one to obtain copper and zinc separately in a reasonably high state of purity or together (as the ingredients of brass) by a relatively simple technique which utilizes inexpensive chemicals and electricity.

* See appendix.

COPPER AND ZINC ORES OF OREGON

Copper ores are widely distributed throughout the world, occurring in every continent and in almost every country. They are furthermore found in practically every type of ore deposit and are associated, in one place or another, with every metallic and rock-forming mineral. This distribution, though wide, is not uniform, so the present world production comes mainly from certain definite, limited localities (1).

The ores containing copper and zinc in Oregon are classified as sulfide ores which are of low-grade and must be mined and milled on a large-scale, low-cost basis if they are to be treated at all. A typical analysis with respect to the major elements might run something like this: Copper - 0.96%, Zinc - 10.1%, Sulphur - 37.0%, Lead - 17.7% and Iron - 25.4% (all figures weight percent). Because it is more difficult to leach and treat sulfide ores than the common oxide ores of the Rocky Mountain and Great Basin area, the ores of Oregon stand at a disadvantage when considered from the point of view of conventional processing.

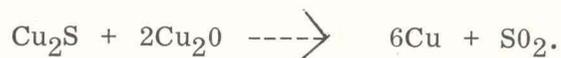
CONVENTIONAL COPPER PROCESSING OF SULFIDE ORES

Concentrating the ore:

For low-grade ores the first step in the operation is to float off the light undesired rock and ore with flowing water or by the use of shaking tables. The concentrated ore that remains is finely crushed or ground and coated with an oil before entering the flotation tank. In the next step of the process, the oil covered ore is mixed with water and agitated either with paddles or air in order to make an emulsion or froth. The "coating oil" has a selective action on the ore at this point; the sulfides of interest are lifted into the froth and removed for mechanical filtering while the worthless material sinks to the bottom of the vat.

Smelting of the concentrated ore:

After the sulfides have been concentrated and dried, they are fed to a reverberatory furnace and heated with excess air. Some of the cuprous sulfide is converted to an oxide and at the higher temperatures crude copper, called blister copper, is formed from the following chemical reaction:



Electrolytic refining of the crude copper:

The blister copper, formed above, may be as high as 98% pure copper. Further purification is obtained through an electrolytic process in which the blister copper is electrochemically forced into a solution containing copper sulfate and sulfuric acid. In this same step, pure copper is deposited in metallic form on a cathode. Impurities such as nickel, lead, iron, and zinc dissolve and remain in the electrolytic solution. Materials such as zinc are considered a detriment to this operation and as such are not normally recovered.

CONVENTIONAL COPPER PROCESSING OF OXIDE ORES

Most of the low-grade copper ores in the oxide form are processed by hydrometallurgical techniques. Such techniques are concerned with methods of dissolving copper values from ores by use of aqueous solvents. This approach may often be used on ores which do not lend themselves to other methods of concentration, either because treatment costs are too high or because the over-all recovery of the contained copper is too low.

Leaching of the ore:

Conventionally most operations which deal with this class of ore use aqueous solvents containing sulfuric acid or sulfuric acid-ferrous sulfate (2). Such solvents are used as leach chemicals in large amounts and after prolonged contact with the ore the water insoluble copper oxides are converted into the water-soluble cupric sulfate form. Copper in the ore in the sulfide form is left undissolved by this treatment. Recent trends point to a combination of hydrometallurgical methods for the recovery of the oxide minerals, coupled with flotation methods for the recovery of the sulfide portion.

Electrolytic precipitation:

After the ore has been leached, electrolysis is the most widely employed method for the precipitation of copper from the sulfate solutions.

If zinc is also to be recovered, it is not the practice, nor does it appear feasible, to electroreduce this element simultaneously with copper in this process.

The current efficiency in the electrolysis of copper from a sulfate solution is adversely affected by the presence of ferric iron, nitrates, molybdenum, and chlorides. It is not uncommon for such efficiencies to be as low as 80%. In other words, twenty percent of the electrical power used in the electrolysis may be wasted in the sense that it does not contribute to the reduction of copper.

THE AMMONIA COMPLEXING AND ELECTROWINNING PROCESS

Recent studies in the Department of Chemical Engineering at Oregon State University* have indicated that it might be possible to process the low-grade copper and the zinc ores of Oregon with an ammonia complexing and electrowinning process.

Since this process (as described below) is best suited for ores in the oxide form, the first ore processing steps will undoubtedly have to be similar to the concentrating and roasting steps mentioned in the section on "Conventional Copper Processing of Sulfide Ores." In the roasting step, however, the temperature will only have to be high enough to form Cu_2O or CuO , since a reduction to metallic copper at this step of the process is unnecessary.

Leaching with Ammonia:

After the ore has been ground, concentrated and roasted, copper and zinc may be efficiently brought into solution by leaching the ore with a 15% solution of ammonia in water at room temperature and pressure. Such a leach results in the formation of various ammonia complexes with copper and zinc which, contrary to the case of the sulfides and oxides, are now soluble in the leach liquor or solution. In other words, this solution forms an effective "soap" for removing ionic copper and zinc from an oxide ore.

*Part of this material is extracted from the M.S. thesis of Mr. M. J. Bennett entitled, "A Study on Electrowinning Copper and Zinc from Low-Grade Ore."

To indicate the ability of this solution to leach copper, we may state the following experimental observations: a) In a small-scale laboratory experiment it was found that an ammonia leach could remove 91.5% of the copper from the ore in 1.5 hours. b) A comparison between an equal cost batch leach of ammonia in water and the conventional sulphuric acid leach showed that 77.6% of the total copper in the ore could be removed in six hours with the ammonia leach while, over the same period of time, the sulphuric acid leach removed only 55.1% of the copper. c) After the copper and zinc has been removed from the ammonia leach, the leach solution may be re-used as many as three times without noticeably losing any of its ability to extract copper or zinc from the ore.

Electrowinning:

The above solution, which now contains most of the copper and zinc in solution, is next made the electrolyte in an electrochemical process where these metals are electroreduced.

Experiments indicate that as long as cathode current densities of less than 5.5 amps/ft² are employed, bright copper can be plated out leaving all of the zinc behind in solution. At current densities in excess of the above figure both copper and zinc metal will be plated on the cathode in a loose spongy deposit which will flake off eventually from the base plate. Such a loose deposit will of course have an advantage in a continuously-operated process.

During this operation oxygen is given off at the anode and some ammonia gas (which represents an inefficiency) is liberated at the cathode at the higher-current densities. By the techniques of controlled current density mentioned above, it is thus possible to a) electrowin both copper and zinc separately in adherent form to base plates, or b) electrowin copper and zinc together as the constituents of brass in a loose flaky deposit.

A COMPARISON OF THE AMMONIA & SULFURIC ACID PROCESSES

- 1) Fewer difficulties are experienced in electrowinning zinc in the ammonia process as compared to the conventional sulfuric-acid process. These difficulties arise because of the presence of iron in the ore.
- 2) The power costs to electrowin a pound of copper by the ammonia process are estimated to be about 0.3 cents. This same cost for the sulfuric-acid process is about 0.2 cents.
- 3) To remove the same amount of copper and zinc from the ore, the leaching time is much less for the ammonia process as compared to the sulfuric-acid process.
- 4) The current efficiency for the ammonia process is approximately 90%. For the sulfuric-acid process the efficiency is between 80 and 90%.
- 5) The leach chemicals (sulfuric acid and ammonia) are both considered inexpensive. For the quantities required to produce equal amounts of copper, there is very little difference in the cost of these chemicals.
- 6) Little, if any, loss of sulfuric acid is experienced in the electro-winning process. At the higher current densities, in the ammonia process, some chemical make-up is required.
- 7) The sulfuric-acid leach solution is much more corrosive than the ammonia leach solution.

APPENDIX

COPPER AND ZINC DEPOSITS OF OREGON*

Nearly all of Oregon's metallic mineral production has come from three areas: northeast, centering around Baker; southwest, with Grants Pass the center; and the Cascade Mountains, with the Bohemia district accounting for most of the production. The only mines operating primarily for copper have been in the northeastern and southwestern districts where their ore occurrences and geology are generally similar. In the Cascade Mountains, copper and zinc production has been ancillary to gold and silver. The metal mining industry in Oregon has declined since the end of World War II because its mines have been of the fissure vein types that were not suitable for mass production methods that give high productivity per unit of labor.

Northeastern Oregon

Northeastern Oregon is dominated by the Wallowa-Blue Mountains belt that rises from the lava plateau in central Oregon and extends in a northeasterly direction to the Snake River. It is in these mountains that older rocks consisting of Paleozoic and Mesozoic sedimentary, metamorphic and igneous rocks are exposed. These older rocks yielded the metallic minerals of the region. Mining, mostly for gold, dominated the economy in this region from the discovery of gold in 1861 until the beginning of World

BY GOLD ORE

War II when most of the mines closed because of unavailability of labor and equipment.) Copper was associated with gold in many of these mines and was produced as a by-product of the gold. A few mines, as the Iron Dyke at Homestead and the Poorman near Keating, operated primarily for copper and produced between them about 10,000,000 pounds of copper from fissure vein deposits in the Clover Creek Greenstone. This formation crops out in a discontinuous belt along the south flank of the Wallowa Mountains between North Powder and Homestead contains numerous scattered outcrops that show copper mineralization. Production, however, aside from that of the Iron Dyke and Poorman mines, has been only a few tons at scattered prospects. There is a possibility that mineral exploration methods using modern techniques of geochemical and geophysical prospecting could uncover hidden ore bodies in this region as has been done in Canada and in the southwestern states.

Southwestern Oregon

The precious and base metal deposits of southwestern Oregon all occur in the Klamath Mountains, a region of steep hills, narrow canyons and dense timber cover. The Klamath Mountains are composed of tightly folded sedimentary and volcanic rocks that have been intruded by rocks ranging from granitic to ultrabasic in composition. Gold, since its first discovery in 1850, has been the principal incentive for mineral exploration in the area.

Many millions of dollars in gold and silver were taken from the lode and placer mines of the area until most were closed because of World War II ^{DIRECTIVES} shortages and post-war inflation. Aside from gold and silver, chrome was mined during both World Wars, and the only nickel mine in the United States is currently operating at Riddle.

Some copper has been mined intermittently with gold since the first lode mining was done in the region. The Waldo district has accounted for the bulk of copper production in southwestern Oregon. Total production has been about 6,000,000 pounds; most of it from the Queen of Bronze mine.

In this region many of the commercial copper occurrences are in bodies of massive sulfides where the copper sulfides chalcopyrite, covellite, and chalcocite are associated with pyrite (iron sulfide) and sphalerite (zinc sulfide). As in northeastern Oregon, greenstone (altered volcanic rock) is the host rock for most of the copper, but in southwestern Oregon it is more closely associated with later intrusive igneous rocks. Vein deposits of copper minerals in quartz and calcite associated with contact metamorphism are another type of occurrence, but these have not been as productive as the massive sulfide deposits.

Western Cascades

Along the western foothills of the Cascade Mountains, generally called the Western Cascades, are several mining districts that have produced

varying amounts of gold, silver, lead, copper, and zinc. From north to south the districts are: North Santiam, Quartzville, Blue River, and Bohemia.

The region is characterized by steep hillsides, narrow valleys, and dense forest cover. Access is provided by a few main highways that cross the Cascade Range and by many seasonal timber access roads.

The Cascades are composed mainly of volcanic rocks ranging in age from Eocene to Recent. The High Cascades, to the east, are capped by the large strata-volcanoes with Mt. Hood on the north and Mt. McLaughlin at the southern end of the chain. These volcanoes were built upon the older volcanic pile during the late Pleistocene and early part of the Recent epochs.

All of the mineral deposits are related to small dioritic intrusives. Most of the deposits are in quartz vein fissures that cut both the intrusive and country rocks. In some areas there is dissemination into the altered host rocks but the bulk of the production has come from the vein deposits. The Bohemia district, where the veins are as much as 20 feet wide and half a mile long, has accounted for most of the production.

Here again the principal incentive has been gold and silver, but at times when prices were favorable, copper, lead, and zinc have been shipped in small quantities. Because of high transportation and smelter charges, there has been little attempt to develop these mines for their base metal

content. Contributing to this has been the complex nature of the sulfide ores making smelting difficult and expensive. Because the ore has generally been restricted to narrow veins, the deposits found thus far have not been of a type amenable to low-cost mining methods such as open pit and block caving.

Mineral exploration techniques developed in recent years that have proven successful in finding covered ore bodies have been only superficially applied to this region. A detailed exploration program utilizing these geochemical and geophysical methods might indicate enough reserves to justify the development of a mine large enough to support a smelter.

*Report by: R. G. Bowen
Oregon Department of Geology and Mineral Industries

BIBLIOGRAPHY

- (1) "Metallurgy of Copper," J. Newton & C. L. Wilson, Wiley & Sons, (1942).
- (2) "Copper the Metal Its Alloys and Compounds," A. Butts, Reinhold Publishing Corporation, (1954).

September 5, 1975

Mr. John Blum
Branch of Contracts & Grants
U.S. Bureau of Mines
18th and "E" Streets, N.W.
Washington, D.C. 20240

Dear Mr. Blum:

In accordance with our telephone conversation this morning, I am very willing to change the date on the copper-zinc MAS project to begin on September 9, 1975, and end on September 8, 1976.

Would you please make the correction on the contract I sent to you and I will be very happy to initial it.

If you have any further questions, please feel free to call me.

Sincerely yours,

Raymond E. Corcoran
State Geologist

REC:jr
cc Donald Hull



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES
Washington, D.C. 20240

CONTRACT NO.

G0166013

Mo. Day Year

9 | 11 | 75

State of Oregon
Attention: Raymond E. Corcoran
Department of Geology and Mineral Resources
Portland, Oregon 97201

Gentlemen:

Enclosed is your fully executed copy of Grant Agreement Number
G0166013 entitled "Copper-Zinc Deposits in Oregon." Also enclosed
is the memo designating the Technical Project Officer.

Sincerely yours,

A. G. Young
Contracting Officer

Enclosure

TO THE CONTRACTING OFFICER:

Receipt of your contract on Sept. 16, 1975
is acknowledged.

By R. E. Corcoran
Signature

State Geologist
Title

1000 WILSON AVENUE, WASHINGTON, D.C. 20540



United States Department of the Interior

BUREAU OF MINES
WASHINGTON, D.C. 20240

JUL 24 1975

State of Oregon
Attention: Raymond E. Corcoran
Department of Geology and Mineral Resources
Portland, Oregon 97201

Gentlemen:

Enclosed are four copies of Grant Agreement Number G0166013 entitled "Copper-Zinc Deposits in Oregon," in the amount of \$23,807.

If this Grant Agreement is acceptable, please sign and return three copies with original signatures to this office, keeping one copy for your file. One fully executed copy will be returned for your records after final approval.

We ask that you not publicize this matter until you have received your fully executed copy.

Sincerely yours,

A. G. Young, Chief
Branch of Contracts and Grants

Enclosure

RECEIVED-PTLD
AUG 8 1975
DEPT OF GEOLOGY
MINERAL INDUS.

*Retained
3 copies
8-19-75
Chiff
one copy*

COPY

April 15, 1975

Mr. Robert D. Weldin
U.S. Bureau of Mines
E. 315 Montgomery Avenue
Spokane, Washington 99207

Dear Bob,

Enclosed is a copy of a letter I received recently from Mr. S.P. Wimpfen regarding our proposed copper-zinc study in Oregon. I am writing you simply to reiterate our interest in this project. We sincerely hope that MAS funds will be available for this work.

Sincerely,

Donald A. Hull

DAH/a

cc: R.E. Corcoran w/enclosure ✓



United States Department of the Interior

BUREAU OF MINES
WASHINGTON, D.C. 20240

In Reply Refer To:
EBM:AD/MMSDA-FEA

April 8, 1975

Dr. Donald A. Hull
Oregon Department of Geology and
Mineral Industries
2033 First Street
Baker, Oregon 97814

Dear Dr. Hull:

This is to acknowledge receipt of your proposal "Copper-Zinc Deposits in Oregon."

We are interested in the work that you suggest. At this point we are not certain about the availability of MAS funds for this fiscal year. Your proposal will be held until funds are available. We will keep you informed.

Sincerely,

Sheldon P. Wimpfen
Assistant Director--
Field Operations

Copper

August 12, 1965

Mr. B. P. McDonough
Coulee Lead and Zinc Mines Limited
Suite 902
55 Yonge Street
Toronto, Ontario
Canada

Dear Mr. McDonough:

We are pleased to hear your firm is planning on prospecting in Oregon. Unfortunately most of our publications dealing with copper deposits are out of print and no longer available. I am enclosing a copy of a report I made in 1961 concerning copper mineralization in northeastern Oregon. This describes an anomaly I found at that time that I believe warrants further investigation.

The copper mineralization in Oregon occurs in three different areas, northeastern Oregon, southwestern Oregon, and the Cascade Mountains. In northeastern and southwestern Oregon the copper is associated with Nevadian and pre-Nevadian intrusives in Paleozoic and Mesozoic greenstones. In the Cascade Mountains the mineralization is associated with late Tertiary diorite intrusives into andesites and pyroclastics. The best references to these areas are: U.S. Geological Survey Bull. 846-B, Geology and ore deposits of the Takilma-Waldo district, Oregon, by P. J. Shenon; and U.S. Geological Survey Bull. 893, Metalliferous mineral deposits of the Cascade Range in Oregon, by Callaghan and Buddington.

Our Department has the following publications that describe specific deposits throughout the State:

Oregon Metal Mines Handbook

- 14-A, Northeastern Oregon: Baker, Union and Wallowa Counties
- 14-B, Northeastern Oregon: Grant, Morrow and Umatilla Counties
- 14-C, Vol. 1, Southwestern Oregon: Coos, Curry and Douglas Counties
Vol. 2, Sec. 1, Josephine County
Vol. 2, sec. 2, Jackson County
- 14-D, Northwestern Oregon (including part of the Cascade Mountains)

These publications are all out of print except Bulletin 14-C, Vol. 2, Sec. 1, Josephine County, but are on file at the following places and presumed available for loan there:

Mines Branch Library

Dept. of Mines and Technical Surveys
555 Booth Street
Ottawa, Ontario

Library

Geological Survey of Canada
601 Booth Street
Ottawa, Ontario

We currently have under way a State-wide stream sediment sampling and are analyzing the samples for copper, zinc and molybdenum. This is similar to the program the GSC carried on in Nova Scotia. This program is not completed and we don't anticipate the first map of the series to be published before next summer. But the data is available for public inspection here in the Portland office.

When you come to Oregon it would be a good idea to stop at our offices as we could probably give you specific information on areas you might be interested in. We have field offices in Baker for northeastern Oregon and Grants Pass for southwestern Oregon, where the geologists can give you more detailed information on their areas. If you have any questions concerning particular occurrences I could probably answer them or refer them to the geologist who could.

Sincerely yours,

R. G. Bowen
Geologist

RGB:lk
Encl.

COULEE LEAD AND ZINC MINES LIMITED

(NO PERSONAL LIABILITY)

SUITE ~~1100-1110~~ :: 55 YONGE STREET
902 TORONTO

TELEPHONE

~~EMPIRE 4-2173-4~~

363-8184

July 15, 1965

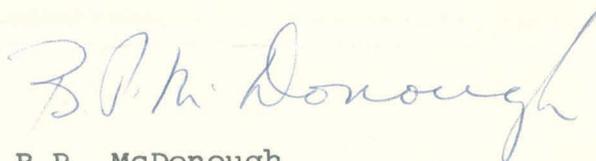
Department of Geology and Mineral Industries,
State Office Building,
Salem, Oregon.

Dear Sirs:

As we are planning some prospecting in your State, I was wondering if you could send us the most recent Bulletins on Copper deposits which might be of some assistance for our program. If there are any charges for such bulletins, please invoice us accordingly.

Sincerely yours,

COULEE LEAD AND ZINC MINES LIMITED



B.P. McDonough

/js

RECEIVED

JUL 20 1965

STATE DEPT. OF GEOLOGY
& MINERAL IND.



COPY

January 5, 1976

Mr. Richard N. Appling
U.S. Bureau of Mines
E 315 Montgomery St.
Spokane, Washington 99207

Dear Mr. Appling:

Please find enclosed four copies of our quarterly technical progress letter summarizing our study of copper and zinc deposits under grant number G0166013.

Sincerely,

DONALD A. HULL

DAH/a
enc.

dd: w/ enclosure - U.S. Bureau of Mines
Branch of Contracts & Grants
Interior Building
Washington, D. C. 20240

cc: " " - R.E. Corcoran ✓

RECEIVED-PTLD
JAN 6 1976
DEPT OF GEOLOGY

Quarterly Technical Report

Project: G0166013 - Copper - zinc deposits in Oregon

Period: September 9 - December 31, 1975

Grantee: State of Oregon: Department of Geology and
Mineral Industries

The study of Oregon's copper-zinc deposits was begun in September, 1975 with visits to copper properties in eastern Oregon. Field work to date has consisted mainly of geologic mapping and sampling in the vicinity of known copper prospects. Polished section studies of ore suites, geochemical analysis, literature review and coding of MAS record sets will continue during the winter. We have contacted several major mining companies in an attempt to secure data on Oregon's copper-zinc properties.

Geologic mapping was undertaken in September to define geologic controls over enigmatic copper mineralization in the Clover Creek Greenstone in Baker County. In October visits were made to the Almeda, Bolivar and Turner-Albright properties in southwestern Oregon. In November copper-bearing mercury prospects in the Pueblo and Steens Mountains in southeastern Oregon were examined and sampled. In December a visit was made to the U.S. Bureau of Mines office in Spokane to review procedures for compiling data on the MAS format.

RECEIVED-PTLD
APR 4 - 1977
Dep. of Geology
1218

March 30, 1977

Mr. Richard N. Appling
U.S. Bureau of Mines
East 315 Montgomery Street
Spokane, Washington 99207

Dear Mr. Appling:

Please find enclosed four copies of our quarterly technical report summarizing our study of Oregon's copper and zinc deposits under grant number G0166013 for the period January 1, 1977 to March 31, 1977.

Sincerely,

DONALD A. HULL

DAH/a
enc.

cc: w/enclosure - U.S. Bureau of Mines
Branch of Contracts & Grants
Interior Building
Washington, D.C. 20240

cc: w/enclosure - Ralph S. Mason

C
O
P
Y

Quarterly Technical Report

Project: G0166013 - Copper-zinc deposits in Oregon

Period: January 1 - March 31, 1977

Grantee: State of Oregon - Department of Geology and
Mineral Industries

We have been engaged in preparation of reports, assay maps and MAS record sets during the reporting period and no field work has been undertaken.

We have also worked on revisions, to record sets submitted earlier, as requested by the U.S. Bureau of Mines. We are awaiting assay data from industry groups on copper prospects drilled during calendar 1976. Due to the delays in receipt of these data, we anticipate that preparation of the final report will be delayed several weeks.



IN REPLY REFER TO:

United States Department of the Interior

BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

AUG 24 1976

State of Oregon
Attention: Raymond E. Corcoran
Department of Geology and Mineral Resources
Portland, Oregon 97201

Gentlemen:

Enclosed are four copies of Modification Number I to Grant Agreement Number G0166013 entitled "Copper-Zinc Deposits in Oregon."

If this modification is acceptable, please complete blocks 14, 15, and 16 of the Standard Form 30 and return three copies with original signatures to this office, keeping one copy for your file. One fully executed copy will be returned for your records after final approval.

If we may be of further assistance, please advise.

Sincerely yours,

A. G. Young, Chief
Branch of Contracts and Grants

Enclosure



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AUG 30 1976

DEPT OF GEOLOGY
MINERAL INDUS.

Antal
8-31-76

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT

1. AMENDMENT/MODIFICATION NO. I	2. EFFECTIVE DATE	3. REQUISITION/PURCHASE REQUEST NO.	4. PROJECT NO. (If applicable)
---	-------------------	-------------------------------------	--------------------------------

5. ISSUED BY U. S. Bureau of Mines Branch of Contracts and Grants 2401 E Street, N. W. Washington, D. C. 20241	6. ADMINISTERED BY (If other than block 5)
--	--

7. CONTRACTOR NAME AND ADDRESS <i>(Street, city, county, state, and ZIP Code)</i> State of Oregon Department of Geology and Mineral Resources Portland, Oregon 97201	8. AMENDMENT OF SOLICITATION NO. <input type="checkbox"/> DATED _____ (See block 9) MODIFICATION OF CONTRACT/ORDER NO. <input checked="" type="checkbox"/> G0166013 DATED 9/11/75 (See block 11)
---	---

9. THIS BLOCK APPLIES ONLY TO AMENDMENTS OF SOLICITATIONS

The above numbered solicitation is amended as set forth in block 12. The hour and date specified for receipt of Offers is extended, is not extended.

Offerors must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation, or as amended, by one of the following methods:

(a) By signing and returning _____ copies of this amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGEMENT TO BE RECEIVED AT THE ISSUING OFFICE PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If, by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided such telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

10. ACCOUNTING AND APPROPRIATION DATA (If required)

NO COST TIME EXTENSION

11. THIS BLOCK APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS

(a) This Change Order is issued pursuant to _____
The Changes set forth in block 12 are made to the above numbered contract/order.

(b) The above numbered contract/order is modified to reflect the administrative changes (such as changes in paying office, appropriation data, etc.) set forth in block 12.

(c) This Supplemental Agreement is entered into pursuant to authority of **P.L. 85-934 (72 Stat. 1793)**
It modifies the above numbered contract as set forth in block 12.

12. DESCRIPTION OF AMENDMENT/MODIFICATION

The termination date of the Grant Agreement is hereby changed to March 8, 1977, at no additional cost to the Government.

BY REASON OF THIS MODIFICATION; the term of the Grant Agreement is extended by Six (6) months, from September 8, 1976 to March 8, 1977. The total amount of the Grant Agreement remains unchanged.

Except as provided herein, all terms and conditions of the document referenced in block 8, as heretofore changed, remain unchanged and in full force and effect.

13. CONTRACTOR/OFFEROR IS NOT REQUIRED TO SIGN THIS DOCUMENT CONTRACTOR/OFFEROR IS REQUIRED TO SIGN THIS DOCUMENT AND RETURN **3** COPIES TO ISSUING OFFICE

14. NAME OF CONTRACTOR/OFFEROR BY R. E. Corcoran (Signature of person authorized to sign)	17. UNITED STATES OF AMERICA BY _____ (Signature of Contracting Officer)
--	--

15. NAME AND TITLE OF SIGNER (Type or print) R. E. Corcoran State Geologist	16. DATE SIGNED 8-31-76	18. NAME OF CONTRACTING OFFICER (Type or print)	19. DATE SIGNED
---	-----------------------------------	---	-----------------



DEPARTMENT OF
GEOLOGY AND MINERAL INDUSTRIES

RECEIVED-PTLD
APR 15 1976
DEPT OF GEOLOGY
INDUS

2033 FIRST STREET • BAKER, OREGON • 97814 • Phone (503) 523-3133

ROBERT W. STRAUB
GOVERNOR

April 13, 1976

Mr. Richard N. Appling
U.S. Bureau of Mines
E 315 Montgomery Street
Spokane, Washington 99207

Dear Mr. Appling:

Please find enclosed four copies of our quarterly technical progress letter summarizing our study of Oregon's copper and zinc deposits under grant number G0166013 for the period January 1 - March 31, 1976.

Sincerely,

DONALD A. HULL

DAH/a
enc.

cc: w/enclosure - U.S. Bureau of Mines
Branch of Contracts & Grants
Interior Building
Washington, D. C. 20240

cc: w/enclosure -- R. E. Corcoran

Quarterly Technical Report

Project: G0166013

Copper-zinc deposits in Oregon

Period: January 1 - March 31, 1976

Grantee: State of Oregon: Department of Geology and
Mineral Industries

Field work on the study of Oregon's copper-zinc deposits resumed in March with visits to mining districts in the Western Cascade Range and discussions with property owners. Major exploration efforts by mining companies are underway at several properties including the Iron Dyke, Meadow Lake, Almeda, Turner-Albright, Bolivar, and Queen of Bronze; and the company personnel have been extremely helpful in furnishing data on reserves and core samples for microscopic study.

We plan to continue field checking of existing file data and to resume geologic mapping in the vicinity of some of the properties in Baker County as the weather improves. Geochemical and ore microscopic studies are continuing.

RRS

(Sent 11-30-67)

COPPER, LEAD, AND ZINC

Copper, lead, and zinc follow iron and aluminum in tonnage and value of all metals produced. These three are used extensively in all phases of modern civilization. Copper ranks first in tonnage and value followed by zinc and lead.

The world-wide production of copper is at an all-time peak; $5\frac{1}{2}$ million tons in 1965, almost double what it was in 1950. In the U.S., mine production of copper was over $1\frac{1}{4}$ million tons in 1965 and has been in excess of a million tons for several years. The total U.S. production from the earliest available records through 1965 has been almost 53 million tons.

This increase in the production and demand for copper is attributed directly to the development of electric power and expansion of the brass and bronze industry. In the U.S. the consumption of electricity has doubled every decade during this century, and we hear every day of the urgent need for increased generation and transmission facilities to meet our near-future needs. World wide, with the industrialization programs now in progress in the hitherto underdeveloped nations, the present and projected future demands for copper can only increase.

The United States is the largest consumer of copper in the world and since 1883, when it displaced Chile as the world leader, has also been the largest producer. Prior to World War II our production exceeded our domestic demands, but since then we have become net importers and now look to foreign sources for about a quarter of our needs. Based on projected industrial demands in relation to population increase and per capita consumption, the outlook is that we can anticipate importing from foreign sources from now on.

Most of the United States production comes from ores of lower grade than worked elsewhere, but by using methods such as open pit mining and large scale underground breakage where thousands of tons of ore are mined and milled daily, unit costs are reduced to the point where U.S. ores are competitive with the rest of the world. Copper is a widely occurring metal but only five principal producing areas contain 93 percent of the world's measured and indicated reserves. These are: (1) Chile and Peru, (2) western United States, (3) Zambia and Congo, (4) Russia, and (5) Canada. Of these, Chile has the largest known reserve figured at 46 million tons as of 1958. The U.S. is next with 32.5 million; less than a 30-year supply at our current production.

The production of copper in Oregon has been small but its potential is probably greater than the production figures would indicate. The total recorded production from the State is 24,000,000 pounds; by present-day standards this is quite minuscule when considered alongside the daily copper production from, for example, the largest mine in the world, Utah Copper's West Mountain mine, which produces approximately 1,400,000 pounds per day. Oregon's copper production has come from vein and irregular replacement bodies along shear and fault zones, largely from one mine, the Iron Dyke, located on the Snake River near Homestead in Baker County. Next in importance and producing about half as much ore was the Queen of Bronze, located in Josephine County in the opposite corner of the State. These two mines accounted for a little over 21,000,000 of the 24,000,000 pounds of copper produced in Oregon from 1902 to 1965. Both the Iron Dyke and the Queen of Bronze were operated primarily as copper mines. The remaining production came as ancillary to gold and silver mining.

The Iron Dyke deposit is in Permian greenstones. Mineralization is associated with a broad shear zone in which the rocks have been brecciated, hydrothermally altered, and locally silicified. The ore minerals, consisting mainly of pyrite and chalcopyrite with very little quartz as gangue, occur as tabular replacement bodies up to 6 feet thick along shear planes and as stringers and small irregular masses disseminated through the intervening country rock. The ore zone in the lower levels of the mine was about 140 feet wide and 210 feet long. The mine operated almost continuously during 1915-1928. The 239,075 tons of ore produced averaged 3 percent copper, 0.14 ounces gold, and 1.07 ounces silver per ton.

The Queen of Bronze mine is located in Triassic greenstones near serpentine contacts. The ore occurs in shear zones in the greenstone that are filled with quartz and sulfides. The main period of activity at this mine was from 1903 to 1910 when about 20,000 tons of ore running $8\frac{1}{2}$ percent copper was mined. Later lessees shipped about 15,000 tons of ore. The mine closed in 1930.

Other properties that shipped more than 100,000 pounds of copper are: the Balm Creek mines in the Keating district of Baker County, Silver Peak mines in Douglas County, the Champion mine in the Bohemia district of Lane County, the Standard mine of the Quartzburg district of Grant County, and the Almeda mine in the Galice district of Josephine County. Table 1 gives the principal producers of base metals.

Lead and zinc follow behind copper in production and consumption. Lead is particularly vital to the transportation industry where it is used in storage batteries, bearing metals, and tetraethyl gasoline. Smaller amounts are used as type metal, solder, and in the glass and chemical industry. Zinc's main use is in galvanizing, followed by die castings, photoengraving plates, and dry-cell battery cases.

The United States is the largest consumer of lead and zinc, and at one time was also the largest producer of these metals. The U.S. is now the fourth largest producer of lead and the second largest producer of zinc.

Oregon's recorded production of these two metals has been small, only 1,320,000 pounds of lead and 380,000 pounds of zinc. These production figures represent the lead and zinc reported by the smelters and are only a minimal figure as most of the Oregon ore has gone to the A.S. & R. Smelter in Tacoma which is primarily a copper smelter and does not report zinc. Consequently there was no recorded zinc production unless the ore was shipped to a zinc smelter.

Complex sulfide ores containing significant percentages of lead, zinc, and smaller amounts of copper are found in the Cascade Mountains of Oregon in addition to the other mining areas in northeastern and southwestern Oregon. The bulk of the lead and zinc production has come from the Bohemia district where it occurs in quartz-bearing veins and shear zones where diorite and quartz diorite intrusives have invaded the Tertiary lavas and pyroclastic rocks.

It is not unreasonable to assume that Oregon has the potential to produce a larger amount of base metals. Most of the copper, lead, and zinc found was in Oregon during the search for gold between the years 1850 and 1900. At that time there was little interest in base metals unless the deposits were extremely rich. Those found were vein type deposits and with the low-cost labor of the period they could be profitably worked by underground mining. Current exploration trend is to look for areas of disseminated mineralization and large tonnages making it possible to mine lower grade ore than is acceptable in vein or podiform type deposits. These

disseminated deposits have been found in other areas by using exploration techniques that will uncover hidden mineralization. Many of the new deposits found in other areas in recent years have been the result of a diligent exploration effort in areas of known mineralization to find extensions or blind ore bodies (not outcropping) associated with known deposits.

The geologic literature of Oregon describes places where relatively large areas of sulfide dissemination have been reported. At the time of the reporting the metal values were often too low for exploitation by underground methods, but using today's techniques of exploration and mining a new look should be taken at many of these properties. Examples of properties where potential disseminated deposits have been reported by competent geologists are: the Quartzburg district of Grant County, where Gilluly, Reed and Park (1933) report a replacement body of quartz, tourmaline, and chalcopryrite which extends along a fracture zone over a distance of about 1,000 feet long by 75 feet wide on the Copperopolis property. Reports by Lindgren (1901) and Gilluly (1931) on the Keating district of Baker County describe "widespread" copper prospects in the Triassic greenstone in the foothill belt of the Wallowa Mountains from North Powder to Homestead, a distance of about 55 miles. Lindgren (1901, p. 630) describes an ore body of disseminated chalcocite and native copper in altered basalt at the Cooper Union (Burkemont) property. Libbey's (1967) report on the Almeda mine in Josephine County summarizes several reports of investigations on that property that point out the likelihood of a good sized body of base metals that may be of sufficient grade to be worked by today's methods. Shenon (1933a) points out the possibility of sulfide mineralization that was not developed in the Silver Peak area in Douglas County.

Figure 1 is an index map showing the areas of copper, lead, and zinc production and significant occurrences of these elements. Areas considered significant but having little or no production are shown in Table 2.

Table 1

Principal Copper, Lead, and Zinc Occurrences in Oregon

<u>County & Dist.</u>	<u>Production in pounds</u>		<u>Remarks*</u>	<u>References</u>
	<u>Copper</u>	<u>Lead</u>		
<u>Baker</u>				
Homestead	14,417,920		Iron Dyke mine. Massive pyrite and chalcopyrite in shear zones in Permian(?) chloritized lava flows.	Lindgren, 1901; Swartley, 1914; Parks & Swartley, 1916; Oregon Dept. Geology and Min. Ind. Bull. 14-A
Keating	1,047,000 700,000 (Est.)		Balm Creek Mining Co. Pyrite and chalcopyrite veins in shear zones in Permian greenstones.	Lindgren, 1901 Gilluly, 1931
<u>Josephine</u>				
Takilma-Waldo	6,882,274	72,295	Queen of Bronze mine. Copper sulfides in irregular deposit associated with greenstone-serpentine contacts.	Diller, 1914; Shenon, 1933
Galice	259,800	71,200	Almeda mine. Massive copper sulfide replacement and fissure fillings. Associated with dacite sills near greenstone-slate contact.	Shenon, 1933a; Libbey, 1967
<u>Douglas</u>				
Riddle	593,000 (Est.)		Silver Peak mine. Massive and disseminated sulfides in schist associated with shears along the contact between Jurassic(?) and Dothan and Galice and Rogue Formations.	Shenon, 1933a

Table 2

Areas of Significant Base Metal Occurrences

County and District	Type of Occurrence	Reference
<u>Eastern Oregon</u>		
<u>Baker County</u>		
Homestead	Replacement and shear zone fillings in Permian greenstones. Mainly chalcopyrite and pyrite.	Lindgren, 1901 Parks & Swartley, 1916
Keating	Pyrite and chalcopyrite impregnate and replace Permo-Triassic greenstones along shear zones and fractures. Secondary minerals include copper oxides, minor native copper, chalcocite, and bornite.	Lindgren, 1901
<u>Grant County</u>		
Quartzburg	Quartz-tourmaline sulfide replacement in pre-Tertiary greenstones.	Gilluly, Reed & Park, 1933
Granite	Quartz and calcite filled fissure veins carrying pyrite, chalcopyrite, sphalerite, and galena. Host rock is argillite and granodiorite.	Koch, 1959
<u>Wallowa County</u>		
Imnaha	Fissure fillings in granodiorite of hematite and chalcopyrite.	Libbey, 1943
<u>Malheur County</u>		
Pueblo Mts.	Siliceous "reefs" up to 25 feet wide in Tertiary and pre-Tertiary volcanic rocks contain small amounts of chalcopyrite, schwartzite, and cinnabar.	Williams & Compton, 1953

Central Oregon

Jefferson County

Ashwood

Cavity filling and replacement in breccia zones in Tertiary volcanic and volcanic sediments. Variety of sulfides including cinnabar.

Libbey & Corcoran, 1962

Lake County

Brattain

Replacement and cavity fillings with chalcopryite, galena, and sphalerite in Tertiary volcanics and quartz diorite stock.

Oregon Dept. Geology & Mineral Industries files

Cascade Mountains

Marion County

North Santiam

Vein deposits of complex sulfides in Tertiary volcanics in and adjacent to diorite intrusive bodies.

Callaghan & Buddington, 1938

Linn County

Quartzville

Similar to North Santiam.

Callaghan & Buddington, 1938

Lane County

Bohemia

Cavity fillings and replacement in shear and breccia zones of complex sulfides carrying variable amounts of gold. Tertiary volcanics associated with diorite intrusives.

Taber, 1949
Callaghan & Buddington, 1938

Blue River

Complex sulfides in breccia zones of Tertiary volcanics adjacent to diorite intrusives.

Callaghan & Buddington, 1938

Jackson County

Al Serena
(Buzzard)

Altered and bleached volcanic rocks containing veins of complex sulfides in the altered rock, little quartz.

Callaghan & Buddington, 1938

Southwestern OregonJosephine County

Waldo-Takilma Copper sulfides in irregular bodies and lenses associated with greenstone-serpentine contact. Diller, 1914
Shenon, 1933

Galice Podiform barite and complex sulfide masses near greenstone and meta-sediment contact with associated porphyritic dikes. Diller, 1914
Shenon, 1933a
Libbey, 1967

Curry County

Chetco Podiform sulfides at the contact between greenstone and serpentine. Parks & Swartley, 1916

Coos County

Mt. Bolivar
(Thompson mine) Mineralized shears along a major serpentized fault zone between sediments and metavolcanics. Diller, 1914
Parks & Swartley, 1916

Jackson County

Gold Hill Gold bearing quartz veins in meta-sediments and metavolcanics associated with diorite intrusives. Parks & Swartley, 1916

Douglas County

Riddle Massive and disseminated sulfides in shear zones along contact of metavolcanics and metasediments. Shenon, 1933a

Tiller-Drew Quartz veins and shear zones in metavolcanics and metasediments adjacent to dioritic intrusives. Parks & Swartley, 1916
Shenon, 1933a

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(Map missing
Dick has copy.)

Principal Areas of
Copper, Lead & Zinc
Occurrences in Oregon

List, & Mine

THE WORLD

Coos Bay, North Bend

Empire, Eastside

SERVING THE GREAT EMPIRE WHICH IS SOUTHWESTERN OREGON

Printed and Published in Coos Bay, Oregon

THURSDAY, JUNE 25, 1959

26 PAGES

COngress 7-2133

FIVE CENT

Mining Planned For Powers Area

Roseburg Firm To Seek Copper, Gold, Silver

POWERS—Bolivar Copper Co. of Roseburg plans to mine copper, gold and silver from Bolivar mountain, 34 miles southeast of Powers starting about Aug. 15, according to an announcement today by R. L. Carr of Roseburg, company president.

D. C. Morgan, appointed production manager June 16 by the board of the Oregon corporation, said today in Roseburg the company started this week assembling mining machinery at a camp at the foot of the mountain. Purchase of more equipment is necessary before work can proceed on pit mining of the copper concentrate found there

by prior core drilling and assaying, he said.

Both said the company is four years old, has a small number of stockholders, but has sufficient funds to go ahead.

The president said the firm has built roads and bridges in the four years it has explored the mountain, located off the Powers-Glendal road. Core drilling has disclosed "large volumes" of copper, Carr added, and the firm has procured a market in Tacoma Smelt Co., Tacoma, Wash.

Pit mining will be employed, taking the "overburden" from terraces of about 20 feet, Carr stated. Plans are to use a steam shovel.

"The payroll will be small, at least at the beginning," said Carr. "You've got to creep before you walk. But we expect this will do Powers a lot of good."

The company anticipates that gold, silver, and other minerals besides copper that it may obtain on the mountain will go far toward paying the cost of getting the copper out.

Salem Statesman
1-17-60

Copper Ore to Go to Japan^{DB} From Oregon

ROSEBURG, Ore. (AP) — Copper ore concentrates will begin moving from Oregon to Japan under an agreement announced in Roseburg Saturday between the Bolivar Copper Co. and Mitsui Co., Ltd., of Seattle, and Japan.

Bolivar stockholders, for the most part Roseburg area residents, have ratified a contract negotiated earlier with Mitsui representatives. It calls for shipping a minimum of 800 tons of copper concentrates to Japan every two months. At present prices, the contract will amount to two million dollars over the two-year period.

The copper is coming from a remote Coos County area 34 miles from Powers. It borders Douglas County. The site of the mine is about 23 air miles from the Hanna Mining Co.'s nickel operation near Riddle.

Clearing of timber and construction of a mill has begun. The flotation method will be used to extract the ore. Bolivar officials said strip mining will be used on a hill 1,800 feet above the mill.

The first shipment of the ore is scheduled to move to Japan by way of Portland in August.

State of Oregon
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Branch Office
239 S. E. "H" Street
Grants Pass, Oregon

9 January, 1964

To: Ralph

From: Len

You may add another placer to the list of active mines we sent up:
The Aphir placer at the mouth of Nagle Gul. on Josephine Creek being
operated by H.E. Smith, Kerby.

I checked with Lloyd Frizzell about mentioning their activity in the
Takilma area and he said it would be OK. They had an induced polarity
type geophysical survey done by McPhar which outlined some large
anomalies which are supposed to be sulfides. Ray Hageman of Medford
Diamond Drilling put down four holes without finding anything to be
excited about. Frizzell became concerned and called McPhar back.
They are now in the process of resurveying (detailing) the anomalies.
This apparently should have been done in the first place before any
drilling was done. The large anomalies may turn out to be several sm-
all ones. We still have hopes for them of finding something of value.
Their most encouraging shows are on the old Lilly and Waldo properties.

Please don't mention the details; just that you'd be interested in
a little background. Thanks for sending the antimony info.

Len

COPPER

ADDITIONAL COPPER PROPERTIES

OREGON

Jackson County

1. Squaw Creek District.

Pacific States Mines Co.

LOCATION: Sec. 5, T. 41 S., R. 8 W., along Squaw Creek about 32 miles SW. of Medford.

Douglas County

2. Drew District.

South Umpqua Mining Co.

LOCATION: 5 miles SW. of Drew on Drew Creek.

3. Drew District

Pennell & Farmer

LOCATION: On South Umpqua River about 5 miles above Tiller.

Ref.: U.S.G.S. Circular 2 (reference for first three)
Philip J. Shenon, 1933

Grant County

4. Quartzburg District

Copper Mountain property
V.E. Ryan, Mgr., Prairie City, Oregon.

LOCATION: About 8 miles from Prairie City in sec. 1, T. 12 S., R. 33 E.

Ref.: Gilluly, Reed & Parks, U.S.G.S. Bull. 846-A, 1933.

5. Quartzburg District.

Copperopolis property
Owner: ?

LOCATION: Just west of the east fork of Dixie Creek, 8 miles by road from Prairie City, in sec. 6, T. 12 S., R. 34 E.

Ref.: Gilluly, Reed, & Parks, loc. cit.

COPPER PROPERTIES
Grant County

6. Quartzburg District.

Standard property (copper & cobalt)

Owner: Mercantile Commerce National Bank, St. Louis, Mo.

LOCATION: About 7 miles from Prairie City on the east fork of
Dixie Creek, in sec. 12, T. 12 S., R. 33 E.

Ref.: Gilluly, Reed, & Parks, loc. cit.

PRINCIPAL COPPER PRODUCERS

American Smelting & Refining Co.
Western Mining Department, SW Division
813 Valley National Building
Tucson, Arizona 85713

Inspiration Consolidated
Copper Company
25 Broadway
New York 4, N.Y.

Bagdad Copper Corporation
P.O. Box 245
Bagdad, Arizona

Kennecott Copper Corporation
Ray Mines Division
Hayden, Arizona

*(P.O. Box 1650
Salt Lake)*

Banner Mining Company
P.O. Box 5605
Tucson, Arizona

Magma Copper Company
P.O. Box 37
Superior, Arizona

Cyprus Mines Corporation
523 W. 6th Street
Los Angeles 14, California

Phelps Dodge Corporation
Western Operations
Douglas, Arizona

Duval Corporation
1906 First City National Bank Building
Houston, Texas 77002

CODDER

COPY

RECEIVED
SEP 6- 1967

Harris

STATE DEPT. OF GEOLOGY
& MINERAL IND.

Sept. 1, 1967

*Ralph
Mine file
EMD*

Mr. Richard Van Blaricom
American Smelting and Mining Company
3422 S. 700 W
Salt Lake City, Utah 84119

Dear Mr. Van Blaricom:

This is in reply to your telephoned request last week for a run-down concerning copper-gold areas in eastern Oregon.

One of our more publicized copper areas extends at interrupted intervals through northern Baker county from near the base of the Elkhorn Mountains on the west to the Snake river in the vicinity of Homestead where the Iron Dike mine was an active producer for a time, intermittently, between around 1914 through the twenties. There was also extensive promotional development during the late 1920's, including some production during the 1930's at various properties (Mother Lode and Poorman) on Balm Creek in the vicinity of Keating.

This "belt" was recognized back in the last century and has been under investigation periodically ever since by both flamboyant promoters and the most respected mining companies in the business. The list of the latter includes practically all the majors in the business and the pattern during the twenty-five years that I have been in Baker is that several of these companies have made several repeat visits to the area. They have come, secured claims and options, done much geologic mapping, some sampling, a little drilling and/or geophysical work, and then pulled out only to come back four or five years later for another look. In other words, the prospects throughout this belt class pretty much as teasers -- not strong enough and large enough to precipitate immediate development yet still interesting enough to command continuing re-appraisal.

As it stands today, Kennecott has taken nearly 40 claims in one portion of this belt this past summer, at Burkemont, that is, and they have optioned several properties in another portion near Sparta. Two other majors have been nosing around much of the summer but the extent of their activities is less well publicized.

COPY

-2-

For the background on this Baker County copper belt the most comprehensive single report is that by Gilluly, U.S.G.S. Bulletin 830. It is also the most up-to-date excepting for some of the largely unpublished geologic work that George Koch and Dick Bowen did some five or six years ago on the Permian-Triassic formations which are the host bedrock for the copper. Our Sparta map by Prostka covers part of the belt is also new.

Our other copper area, and my favorite, is located in the Quartzburg District of Grant County. This begins just north of Prairie City and is roughly bounded by Dixie Mountain and Dixie Creek on the east and west, respectively. The bedrocks include a complex of greenstones and intrusive crystallines that in all probabilities are the correlative counterpart of the formations present in the Baker County copper belt. However, this can not be stated as being authoritatively final because the Quartzville geology has not received anywhere near the same amount of study that the Baker rocks have had, nor has the intervening terrain between the two areas received any great amount of recent attention.

The mining history of this district is one of major promotional development between 1900 and 1910. Since then there has been very little activity excepting for periodic development at the Dixie Meadow gold mine, some small-scale output of sorted shipping grade copper from the Standard each year for the past seven or eight years, an abortive attempt to reactivate milling at the mine on shoe-string capital during the Korean war and the activities of a few pocket gold entrepreneurs over the years. Jim Kinsella has made the sorted copper shipments to Tacoma so you should be able to get all his settlement records. The Standard Milling Company, Verne Jacobson and Don Olling, made the Korean war shipments (both sorted ore and some concentrates), these also to Tacoma.

Where this district differs from the Baker copper "belt" is that here sulphide mineralization is notably developed in disseminated form over some observably wide areas while in the Baker area such mineralization is far less evident. The Quartzburg sulphides are copper, cobalt and iron sulphides mostly, with associated gold which could conceivably exist as a pleasantly abundant by-product in areas where the cobalt is best developed. At least in the old days when the Standard was stoped strictly on a fissure-vein basis, the encountered cobaltite lenses were reportedly good for from 3 to 7 ounces of gold per ton as a general rule and comparable samples of massive cobaltite secured today bear this out. At any rate, the disseminated condition of mineralization noted in the area is described in Gilluly's U.S.G.S. Bulletin 846. There are several instances.

There is also another factor which makes the Quartzburg area more than ordinarily attractive as a candidate for investigation in my estimation. This is that during the years I have been in eastern Oregon none of the established old-line mining companies have done one iota of field work in the area. The reasons for

COPY

3-

this stem from a series of overlapping or inter-related factors which are difficult to explain in a few words, but one contributing factor behind the disregard for the area has been the mediocre turn-of-the-century production record as reported by Gilluly. Another has been that the turn-of-the-century workings were all confined solely to development of ore shoots along narrow fractures -- so much so that the dominant reaction a reader obtains from a hasty scanning of Gilluly's description is that shears and veins constitute the prevailing mineral setting. Lost in the background, and overlooked accordingly, are his references to the dissemination tendency. I myself have scanned this bulletin many times over the years without especially noting this aspect of his remarks and only recently did I have occasion to really scrutinize it carefully enough for the full impact of his remarks to register relative to the dissemination angle. As a result I now consider the area deserves some careful up-to-date re-investigation whereas heretofore I would have discounted the district along with everyone else, and for that matter have done so on more past occasions than I now like to remember.

Another factor contributing to the past disregard of the area stems from the make-up of Bulletin 846 -- a series of thumbnail descriptions of prospects at large as commonly presented in the old Mines Handbooks of the time while the Baker County Bulletin, U.S.G.S. 830, is a comprehensive report devoted solely and totally and expressly to copper prospects and related geology. Then too, Gilluly was under a handicap, being in the Quartsburg area during the depression and on a short-term project when all the old turn-of-the-century mines were shut down and mostly inaccessible and the operators and their records gone from the country. This is why he secured such scant and incomplete history for some of the prospects, while I, in turn, have had several decades during which to scrounge miscellaneous bits of historical data from many places and hence have been able to put together a somewhat more rounded record of some of the early activities. Not that the early record is good from the standpoint of dollar production, but it does serve to show that even at the Standard gold was the prime mining objective in the early days and cobalt next -- with copper not the prime objective as the Bulletin 846 report infers.

For your further information concerning this district, I am enclosing a copy of a portion of a report I made recently for the Grant County Planning Commission. In this my newly acquired recognition of Gilluly's remarks concerning the existence of disseminated mineralization is described in more detail. Whereas this report was prepared for the Planning Commission's guidance in appraising the county's mineral occurrences, I have nonetheless been liberal in passing out copies to people for the sake of drawing attention to the fact that the area might be a sleeper meriting far different treatment than it has been accorded during recent decades. In other words, this is not a report that we as a department will ever publish because it is written somewhat informally in places, etc., but otherwise I do handle it as a sort of an "open file" report for interested takers such as yourselves.

COPY

Trusting this information will provide you with the perspective and the references you wanted, I am

Yours very truly,

NORMAN S. WAGNER

NSW/aw

enc. Ore-Bin, Historical Notes on the Standard Mine.
Copper Section of Grant County Planning
Commission report.

COPPER MINERALIZATION IN NORTHEASTERN OREGON: A PROGRESS REPORT

By

George S. Koch, Jr., Assistant Professor of Geology
Oregon State University

and

Richard G. Bowen, Geologist
State of Oregon Department of Geology and Mineral Industries

For Presentation
at
Geology Session
1961 Northwest Mining Association Meeting

Spokane, Washington, December 1, 1961

Presented at December, 1961 Meeting
Northwest Mining Association

COPPER MINERALIZATION IN NORTHEASTERN OREGON: A PROGRESS REPORT *

by

George S. Koch, Jr., Assistant Professor of Geology, Oregon State University, and Richard G. Bowen, Geologist, State of Oregon Department of Geology and Mineral Industries.

For several years the State of Oregon Department of Geology and Mineral Industries has been investigating copper mineralization in northeastern Oregon as part of a long-range project to study the copper resources of the state. Because no copper mining is being done at present in northeastern Oregon and because the known copper mineralization is distributed sporadically over a wide area, it was felt that a knowledge of the basic geology of the copper-bearing rocks was of primary importance. As a result, we have initiated the study by making reconnaissance investigations of the copper-bearing rocks and are presently mapping the exposures of these rocks in four 15-minute quadrangles.

In northeastern Oregon, the copper-bearing rocks are complexly folded volcanic and sedimentary rocks of Permian and Triassic age. In most of the region, these older rocks have been covered by Tertiary formations, particularly the Columbia River basalt flows of Miocene age, but wherever the older rocks crop out copper mineralization is found. The copper deposits have been extensively prospected for many years and prospect pits and shallow shafts abound. In a few places, extensive underground workings have also been driven, particularly at the Fargo prospects near the junction of the Snake and Imnaha Rivers; at the Standard Mine, in Grant County near Prairie City; and at the Iron Dike Mine on the Snake River near the town of Homestead. In modern terms, however, only a small amount of copper has been mined thus far, most of it from the Iron Dike Mine, where about 15 million pounds of copper were produced, mainly between 1900 and 1927.

One of the most actively prospected areas is within the four quadrangles indicated on the index map (Figure 1): the Medical Springs, Keating, Sparta, and Durkee quadrangles. The geology of these quadrangles, which are north and east of Baker, Oregon, in Baker and Union Counties, is the subject of this article.

Previous Work

The first published geologic work in this area was done by Lindgren (1901), who made an excellent reconnaissance geologic map. Later, Gilluly (1931, 1937) and associates mapped the Baker 30-minute quadrangle and the adjacent Keating area in the Sparta quadrangle, in which mining exploration was active in the early 1930's. Gilluly's time was limited and he characterized his work in the Baker quadrangle as a "detailed reconnaissance." Nonetheless, the mapping by Gilluly and his associates was accurate and it was of great value in the present investigation.

We have also used previously published reports, particularly those by Ross (1938) and Smith and Allen (1941), and unpublished reports on the geology of the Telocaset 30-minute quadrangle (of which the Medical Springs quadrangle is a part) by Wagner (1952) and a report on the Durkee quadrangle by Fitzsimmons (1949).

Present Work

This preliminary report is based chiefly on field work done in the summers of 1959, 1960, and 1961 by Koch, Bowen, and Harold J. Prostka. Subsequent laboratory work and field mapping in adjacent areas will add to and undoubtedly modify conclusions of this report. Responsibility of the geologic mapping has been divided as follows: Koch and Bowen are mapping the copper-bearing rocks in the Medical Springs and Keating quadrangles, and Prostka is mapping the Sparta and Durkee quadrangles. In addition to geologic mapping, Bowen is making a geochemical investigation of the area.

Mapping was done on aerial photographs and compiled on maps at a scale of one inch to one mile. New topographic maps by the U. S. Geological Survey are available for the Sparta and Durkee quadrangles. The southeast one-quarter of the U. S. Geological Survey Telocaset 30-minute quadrangle, when published, will be the Medical Springs quadrangle and the northeast one-quarter of the Baker 30-minute quadrangle will be the Keating quadrangle. Planimetric maps of these areas, designated as the Telocaset 4 and Baker 1 quadrangles, respectively, have been made by the U. S. Forest Service and were used as base maps.

*This preliminary report has been prepared in limited quantity for a special purpose and should not be included in reading lists and periodicals as generally available.

In the present investigation, the emphasis has been placed on the pre-Tertiary rocks, since these are the copper-bearing ones. Although outcrops of pre-Tertiary rocks are reasonably abundant and are rarely more than a mile in distance from a passable road, geologic mapping has been hindered by the substantial degree of weathering, by the complexity of the geology, and by the similarity of rocks of diverse origins and ages. About 1,000 samples of pre-Tertiary rocks have been collected and studied under a binocular microscope on flat, fresh surfaces prepared by sawing the samples with a diamond saw. This procedure has facilitated the investigation greatly, because it makes it possible to identify many rocks which otherwise could not be determined. In addition, about 200 thin sections have been studied under the microscope.

Nonetheless, owing to the complexity of the geology many problems have not yet been solved. Because of the importance in future exploration, we wish to emphasize that more detailed geologic mapping could be done readily. Because the soil cover in the pre-Tertiary rocks is in most places thin, measured in inches or at most a few feet, it would be feasible in detailed investigations of critical areas to obtain samples of rock with a minimum of trenching.

Geology

General: In the four quadrangles described, the rocks fall into two groups separated by a profound unconformity. The older rocks are of pre-Tertiary age, whereas the younger rocks are of Tertiary and Quaternary age (Figure 2). The oldest pre-Tertiary rocks consist of Permian sedimentary and volcanic rocks intruded by a plutonic complex of albite granite, quartz diorite, and gabbro. These are unconformably overlain by bedded upper-Triassic sedimentary and volcanic rocks whose lithologies are in some places different from the Permian rocks but in other places are so similar that distinction between the two is difficult.

The Tertiary rocks consist of basalts, lake sediments, diatomite, and welded tuff. They have been gently warped and tilted and are cut by northwest-trending normal faults. Quaternary deposits are terrace gravels, slide rock, and younger alluvium occupying present-day valleys. Because these younger rocks are related to the copper-bearing ones only in that they cover and conceal them, they are not described further in this article.

Because of the complexity of the pre-Tertiary rocks, formation names are not well defined. The accompanying correlation chart indicates the names that we have used and lists the analogous terms of previous workers. It must be emphasized that the present interpretation is provisional and subject to change, particularly when additional paleontological studies have been made.

Correlation Chart

<u>Present Work</u>	<u>Gilluly (1937)</u>	<u>Ross (1938)</u>
Tertiary and Quaternary rocks	Tertiary and Quaternary rocks	Tertiary and Quaternary rocks
Hurwal formation		Younger Mesozoic sedimentary rocks
Martin Bridge limestone		Martin Bridge limestone
Lower sedimentary series		Carboniferous sediments
?	?	?
Clover Creek greenstone (Tr)	Clover Creek greenstone (Pm)	Clover Creek greenstone (Pm)
Harsin Ranch formation (Pm)		
Relation unknown	Relation unknown	
Elkhorn Ridge argillite (Pm & Tr)	Elkhorn Ridge argillite (Pa?)	
Relation unknown	Relation unknown	
Burnt River schist (Probably Tr)	Burnt River schist (pre-Carboniferous?)	

Because essentially all the copper mineralization in the mapped area is in the Harsin Ranch and Clover Creek greenstone formations, only these two formations are described in the present paper. Together, they comprise the Clover Creek greenstone as described by Gilluly (1937) and we have distinguished them for the following reasons:

Gilluly (1937, p. 21) named the Clover Creek greenstone for exposures along Clover Creek in the northeast part of the Keating quadrangle in sections 24, 25, 26, and 35, T. 7 S., R. 42 E. and stated that it "consists of altered volcanic flows and pyroclastic rocks, with subordinate conglomerate, limestone, and chert." But unfortunately, the age assignment to the Permian was made from fossils collected near Big Creek, some six miles northwest of the type locality. During the present investigation it has been found (Bostwick and Koch, 1961) that limestones associated with the rocks of the type locality are of Triassic age and that it is possible to subdivide the Permian and Triassic rocks. Therefore, we believe that the best way to resolve these difficulties is to restrict the name Clover Creek greenstone to the Triassic rocks found at the type locality and to assign the new name Harsin Ranch formation to the Permian rocks found at the Harsin Ranch and along Big Creek.

Harsin Ranch formation. The name Harsin Ranch formation has been provisionally assigned to a group of Permian sedimentary and volcanic rocks well exposed on the Harsin Ranch and along Big Creek in the north-central part of the Keating quadrangle.

Gilluly's (1937) description of the bulk of the Clover Creek greenstone as quartz keratophyres, meta-andesites, keratophyre tuffs, and spilites described most of the rocks that we assign to the Harsin Ranch formation. The keratophyres and quartz keratophyres are dacitic to rhyolitic volcanic rocks. They are light greenish-gray and porphyritic with phenocrysts of albite and quartz set in a microcrystalline groundmass of quartz, albite, chlorite, and a little magnetite. The meta-andesites are dark-green rocks; they have abundant phenocrysts of altered feldspars, pyroxene, and sporadic hornblende set in a chloritic groundmass that is commonly trachytic. The keratophyre tuffs are dense porcelaneous rocks which sometimes show depositional banding. Upon weathering, many of the tuffs become mottled, sometimes emphasizing their fragmental origin. The spilites are basaltic rocks that by hydrothermal or deuteric alteration have had their normally calcic feldspars altered to albite and the basic minerals usually altered to chlorite. They are differentiated from the meta-andesites principally by their relict textures, the andesites commonly having trachitic and the basalts having intersertal textures.

All of the volcanic rocks are albitic and contain other low-temperature minerals such as chlorite, prehnite, and epidote. Gilluly (1935) pointed out their textural, mineralogical, and chemical similarity to known spilitic rocks.

Other than fossils, the associated sedimentary rocks are the chief basis for distinguishing the Harsin Ranch from the Clover Creek greenstone. The limestones on Harsin Ranch, where Gilluly found Permian fossils, are intimately associated with the spilitic volcanic rocks. They are very impure and grade from a lime-cemented arkose to an arenaceous limestone. All of the known Permian limestone is in thin, tabular bodies, is brown in color, and is fossiliferous. Although no Permian fossils have been found in rocks other than limestone, these other sediments are believed to be Permian because of their similar attitudes and their juxtaposition to the limestones. The arenaceous sediments range from nearly pure quartzite to arkosic wackes that in general lack volcanic debris. A few conglomerates are present in the Harsin Ranch formation, but not enough work has been done to differentiate them in lithology from the Clover Creek formation conglomerates.

Clover Creek greenstone. The bulk of the rocks in the Clover Creek greenstone, as restricted in this paper, appear to be clastics rather than lavas, but because of their greater resistance to weathering the lavas are more prominent. The igneous rocks have essentially the same composition as the Permian ones but with minor differences that are probably due mainly to the intrusion of the plutonic complex into the Permian rocks. In general, lavas in the Clover Creek greenstones are a little less silicified, sheared, and indurated than those in the Harsin Ranch formation.

Again, the sedimentary rocks have proven the best means for differentiation on the basis of lithology. The limestones range from lime-cemented volcanic breccia to pure, massive, crystalline limestones. They are variable in fossil content and always appear in disconnected lenses or pod-shaped bodies. Gilluly (1937, p. 26) thought these discontinuities were due to deformation and regional metamorphism producing plastic flow in a formerly continuous limestone bed. We believe these pods and lenses are primary features and that the limestones were reef deposits in a shallow sea.

The noncalcareous clastic rocks in the Clover Creek greenstones are less quartzose and more volcanically derived than those of the Harsin Ranch formation. Both the wackes and conglomerates contain a high percentage of volcanic rock fragments. A search in the shales and finer wackes, where well exposed in stream beds, has frequently yielded impressions of Halobia, an upper Triassic mollusk.

In the Sparta quadrangle, the copper-bearing rocks are evidently all of Triassic age and are assigned to the Clover Creek greenstone, according to our restricted usage of this name. In the Durkee quadrangle, copper mineralization has thus far never been important. It must be emphasized that fossils are extremely sparse in these quadrangles and that it is possible that Permian rocks assigned to the Harsin Ranch formation crop out in these areas.

Structure: The relations between the Clover Creek greenstone and Harsin Ranch formations are highly uncertain in the Keating and Medical Springs quadrangles. Overthrusting on a rather large scale, with or without a substantial angular unconformity, appears to be required to explain the outcrop patterns observed. Large-scale thrusting of greenstones over Hurwal, Martin Bridge, and Clover Creek greenstone rocks has been demonstrated in the Sparta quadrangle by Prostka (1960).

Geochemical Testing

To supplement the basic geologic studies, Bowen has done geochemical sampling for copper in water and soils. In addition to looking for anomalies, the sampling was done to establish a background measurement for others wishing to do more detailed work.

Geochemical testing has been limited to two types of tests: heavy metals (zinc, lead, and copper) in water using dithizone extraction (Huff, 1948), and copper in soils using 2, 2' biquinoline extraction (Conney and Hawkins, 1958).

During the summer of 1960, most of the streams draining the Clover Creek greenstone in the vicinity of Keating were tested for their heavy metal content. In general we had negative results from the stream testing; the only place metals were detected was where mine waters were known to be emptying into the streams. This testing was done at a time of extremely low stream flow, a probable reason for the failure to detect heavy metals in more places.

The test for copper in soils was more successful. In this test only a partial extraction of the copper is made, as a measure of the readily available copper is just as indicative of mineralization as is total copper. This eliminates, to some extent, the problem of large variation of background in rock types, ranging from about 25 ppm in granites to 150 ppm in basalts.

So far about 400 soil samples have been tested using the biquinoline method. Most of the traverses were made across structure in order to detect the variation, if any, of the different units within the "greenstones." The bedrock underlying the soils tested was albite granite, metabasalt, keratophyre, chert, and wacke. There were no significant variations in background, all being 4 to 6 ppm.

During the testing in 1960 one anomaly, shown in Figure 3, was uncovered. As a check on our methods, this area was re-run in 1961 with little variation in the results.

Conclusions

Thus far we are unable to state whether or not the Harsin Ranch formation or the Clover Creek greenstone is more favorable for the emplacement of copper. Lithologies and mode of deposition of both formations are very similar and it is possible that the best controls for mineralization were beds of characteristic lithologies, regardless of age or of proximity to later intrusive bodies.

We wish to emphasize that, while the work has elucidated some aspects of the general geology, it has raised many more problems than it has answered. It is interesting to note, however, marked similarities between these deposits in northeastern Oregon and copper deposits in the Appalachian Mountains, particularly in the Catoclin greenstones of Maryland and adjacent states (Brophy, 1960) and New Brunswick (Cheriton, 1959).

Acknowledgements

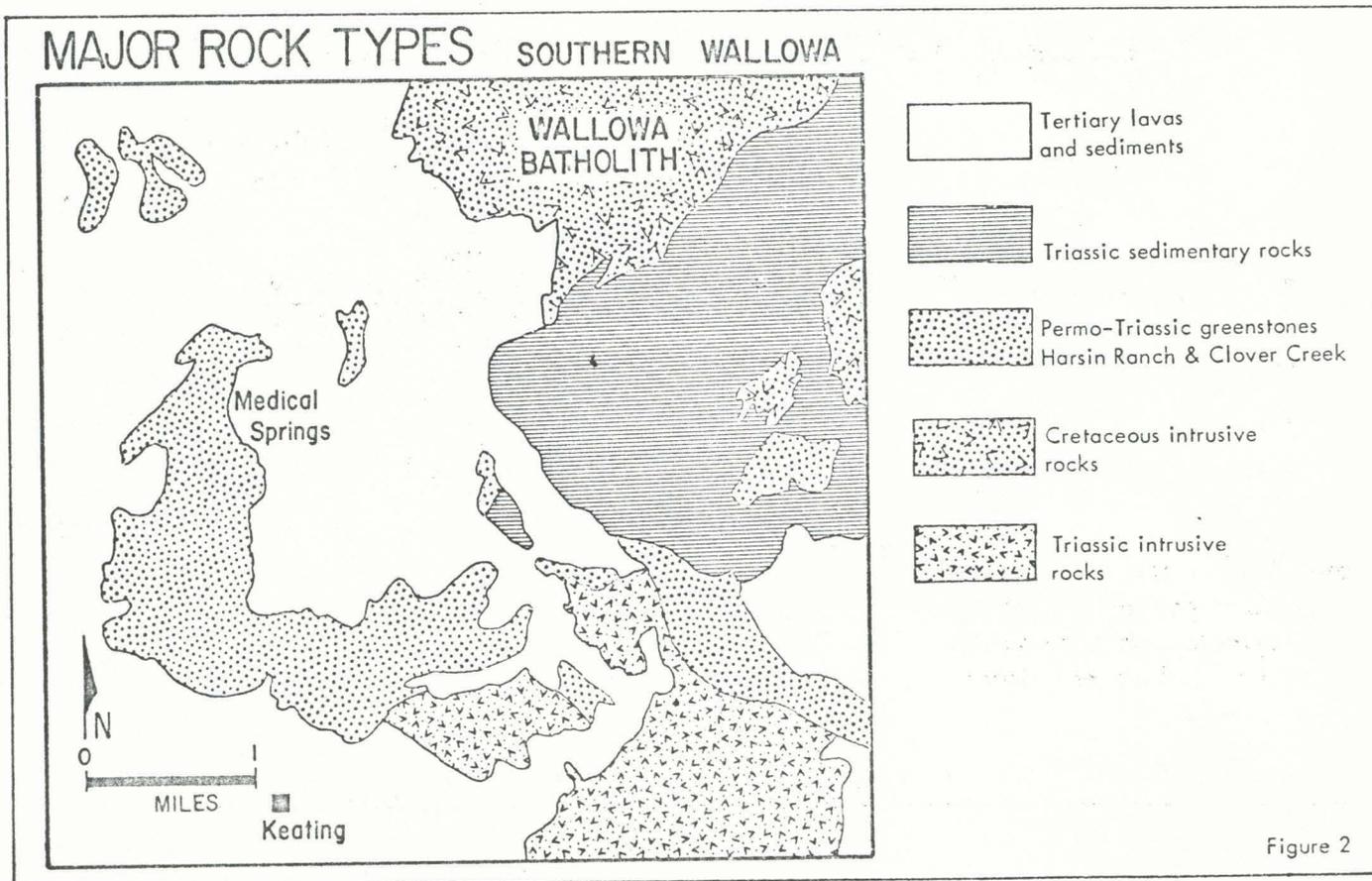
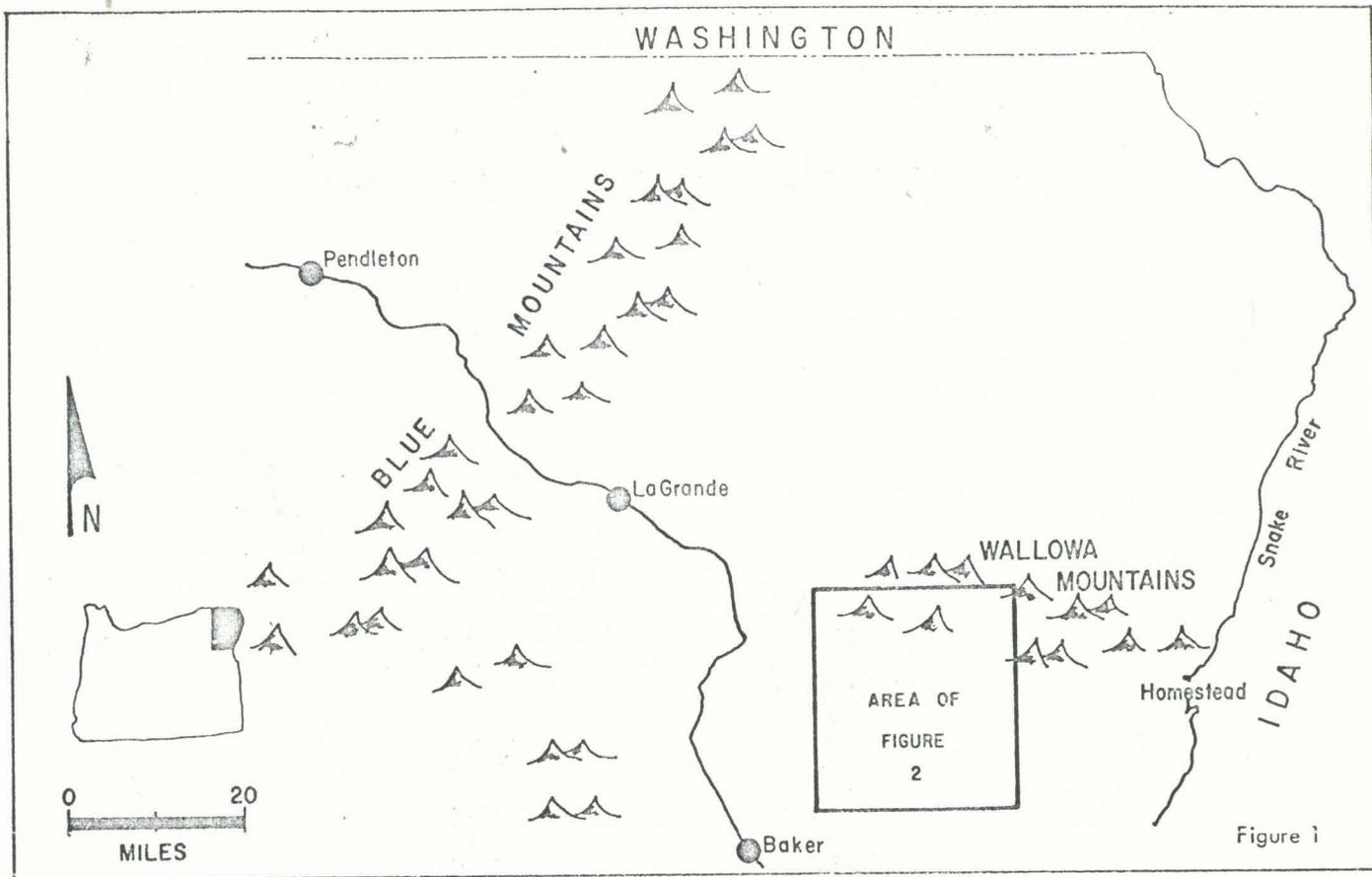
In particular, the writers thank Harold J. Prostka, who mapped two of the quadrangles described in this article, and who has contributed many useful ideas regarding the origin of copper-bearing rocks. They also thank David A. Bostwick, Assistant Professor of Geology at Oregon State University, who identified all of the fossils and made age assignments which were essential to the mapping. The writers thank Richard L. Bateman, who mapped most of the Tertiary rocks, and James K. Lukanuski, who assisted in mapping pre-Tertiary rocks in 1960.

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* * * * *



GEOCHEMICAL TRAVERSES

Run near Burkemont property

Sect. 28, T.7 S., R.42 E., Baker County

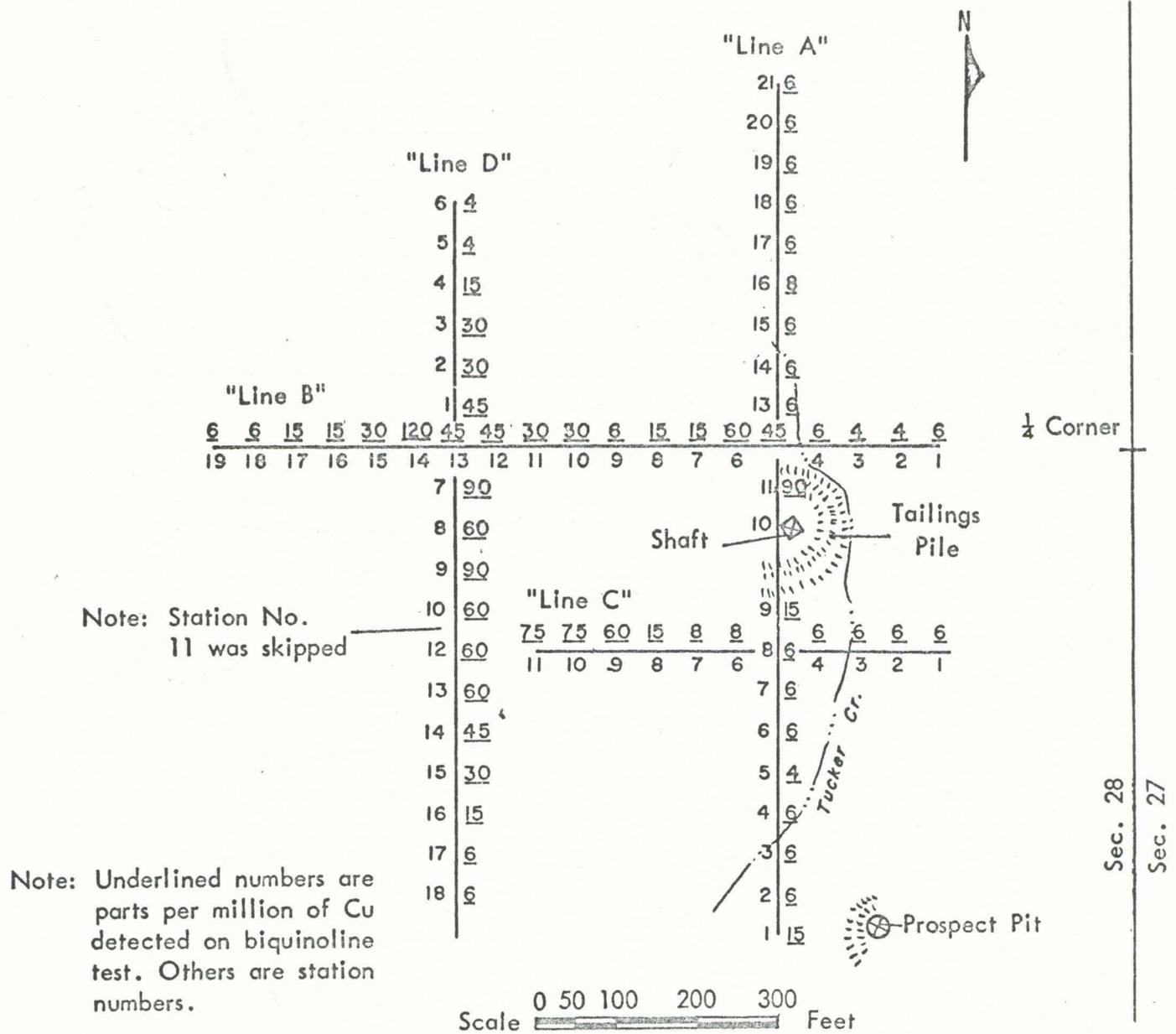


Figure 3

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RECEIVED
DEC 17 1969
STATE DEPT. OF GEOLOGY
& MINERAL INDU.

*Andy
Rudolph-*

December 12, 1969

Mr. Robert J. Chapman
Duval Corporation
4715 E. Ft. Lowell Road
Tucson, Arizona 85716

Dear Mr. Chapman:

I have before me a copy of Ralph Mason's letter to you of December 4 in which he says that he is asking us at the Baker office to prepare a "memo" for you concerning the copper deposits in the Sparta area near Baker.

What Ralph had in mind when he said, "memo", I don't exactly understand as the topic is one that could be good for an entire text. And even with a text there would be much left un-said. In essence, however, the story is that these prospects, and others geologically similar, extend in a generally east-west "belt" along the foothills of the southern flank of the Wallowa Mountains from a point north of Baker bordering the Elkhorn Range and thence eastward into the Seven Devils country of Idaho. This is a distance of 75 or so miles; however the term, "belt" is not to be construed as being an unbroken succession of prospects. Quite to the contrary, the surface evidence of mineralization is localized and discontinuous to the extent that it can be described as a "belt" only in the broad sense of there being alignment of repetitious exposures at random intervals of the particular host formations with which the prospects identify. In other words, the term "belt" has crept into published literature as a carry-over from the days of the more loquacious promoters.

In the Clover Creek area of Oregon (north of Keating) one prospect commanded attention as early as the 1870's, at which time a "smelter" of a sorts was built. How early the Idaho prospects first commanded attention I don't know, but by the turn of the century a major promotion was underway in the

COPY

- 2 -

Snake River area in both States. This went sour in a big way with some of the promoters ending up in the pen as I understand it; nevertheless, interest in the prospects didn't terminate either in the Snake River (Homestead-Cuprum) area or in the instance of the more outlying prospects in the Sparta, Keating and Medical Springs areas of Oregon. Instead, there has been a succession of activities of one sort or another at one prospect or another in the so-called "belt" in both states throughout the present century. This has included the shipment by individuals, or teams of individuals, of many carload lots of sorted highgrade ore beginning with World War I and during all emergency situations which have existed since. It has also included several attempts to mine on a higher level of mechanization and financing. In Oregon there were two such operations, the largest being at the Iron Dike mine at Homestead beginning about 1915 through 1928 with a recorded production of 14,417,920 pounds of copper, 34,967 ounces of gold and 256,489 ounces of silver. The general consensus, if I am informed correctly, is that this operation was financially rewarding. It is also my understanding that Thayer Lindsley was on the management team for at least part of the time.

The other Oregon operation was at the Mother Lode mine on Balm Creek, near Keating, and only a mile or two distant from the site of the 1870's period activity mentioned previously. Here at the Mother Lode an 800, or thereabouts, foot deep shaft was sunk during the latter part of the 1920's. Then under a different corporate set-up there was a period of production of two or three years duration, ending 1938. A truly ambitious undertaking which brought outside electric power to the Baker Valley for the first time (from Idaho), this operation was nevertheless not a success from a financial standpoint; albeit it is my understanding that by the time the smoke cleared away and the mill was sold off, the investors didn't end up hurting too severely. Unfortunately, however, only fragmentary records exist concerning the amount of production that was made. Those that do, though, indicate that the gold content of the ore contributed substantially towards saving the bacon. Incidentally, both this and the Iron Dike operation were strictly drift and stope propositions although at the Iron Dike they did have a surface gossan-type development of sufficient proportions to glory-hole.

Beginning 1943 to now I can state as a matter of first-hand knowledge that there have been very few years, if any, during which there wasn't some responsible company here looking at one prospect or another in the "belt". Either here in Oregon, that is, or in the adjacent parts of Idaho. And by responsible companies, I mean the majors in the field such as A.S. & R., Kennecott, Phelps Dodge, Hecla Copper Range, Norandex, etc. In fact, over the years most of them have made a series of repeat visits although not necessarily to the same combination of properties as those examined previously.

COPY

During the first several years of this period these examinations entailed, for the most part, only superficial mapping and reconnaissance-type sampling; however, seven or eight years ago Phelps Dodge put in a season of geophysical exploration in the Keating-Clover Creek area. Then beginning early in 1965 Cyprus optioned most of the same ground plus additional acreage at nearby Sparta and ended up drilling 18 exploratory tests over a two-season period with several holes extending to depths in excess of 500 feet. Concurrently, Bear Creek, likewise did some drilling in the old Burkemont area a mile or two west of the Cyprus Clover Creek ground. In Idaho the story has been much the same with various companies notably Hecla, Noranda and Bear Creek expending exploratory dollars on evaluation endeavors of the sort that go a couple steps beyond the appraisal of exposed surface geology.

To the best of my knowledge, all companies in all instances relinquished their options without following through with any additional explorations or attempts to make any test production and this applies in the instance of the Idaho explorations as well as to those in Oregon. Nevertheless, the trend during the past several years has been that as soon as one company pulls out on a given combination of options, another has moved in soon afterwards. Thus Cyprus took over after Phelps Dodge in the Keating-Sparta area and today the same land is held by an independent outfit from Vancouver, B. C. And so far, this group has completed a very thorough-going, close-interval soil sampling program covering some 140 claims and have expressed the intent of following through with an areal mag. survey. Again, the same holds true in Idaho in that the ground released by Norandex last year is now reportedly under option to someone else.

Thus it has gone and is still going -- all of which means that there is sufficient evidence of widespread mineralization to command interest even though no sufficient tonnage has as yet been found to demonstrate open-pit potential to anyone's satisfaction at any one place. Nevertheless, the copper mineralization is present and widespread in its occurrence; otherwise it wouldn't be generating the play it has received. Unless it is, to put it facetiously, that industry is more concerned about not being caught napping while a competitor picks up a sleeper than they are impressed by the prospects themselves.

Geologically, the mineralization relates primarily with a complex of Permo-Triassic volcanics and less clearly with certain intrusives. The volcanics have been classified locally as the Clover Creek greenstone although for all practical purposes they can be regarded as being an extension of the more abundantly publicized Seven Devils formation of Idaho. In any event, they consist lithologically of both lava flows and sediments comprised predominantly of material of volcanic derivation. And interestingly enough, it has recently been established quite authoritatively that, in Oregon at least, the Permian members of the formation

COPY

date Upper Permian while the Triassic members date high in the Upper Triassic -- this with an absence of any strata of any kind representing deposition during the interim. Generally speaking, the ratio of lava flows to sediments is perhaps greatest in the Permian fraction while with the Triassic it is the other way around with the volcanic sediments dominating. But since both contain sub-lithologies which are strikingly similar in appearance, identification of one from the other in the field is far from easy.

Diverse opinions exist as to whether the copper mineralization occurs more universally in association with the sediments than with the flows but I believe that the majority of geologists who have studied the mess incline to the feeling that it is the Triassic sediments that are most mineralized. However, this question is largely incidental compared to the question of whether the mineralization is widely disseminated in the porphyry copper sense, or instead, is limited in its occurrence primarily to development in and along shear zones. Until recently, the shear zone concept is the one that has been favored and this is the one I am personally inclined to favor even yet. But then it is to be noted that as a long-time resident of the community I have experienced such a disproportionate amount of contact with the visionary promoting element that I could very well have become prejudiced in my thinking, or in other words, it is to be recognized that some justification must exist for thinking otherwise or else industry wouldn't have moved in and undertaken the explorations they have. In any event, it is clear beyond a shadow of doubt that all of the ore mined so far in the area has originated from localized enrichments and that the question of whether ore bodies exist in the form of potential open-pit reserves remains to be resolved.

Beyond this point, geologic considerations give rise to more questions than there are answers for at the present stage of developments; therefore, I will terminate this "memo" with the hope that the foregoing comments will provide the type of background that may serve to prove helpful to you in evaluating the nature of the interest that has been shown in our northeastern Oregon copper occurrences during recent years. At least, I am supposing that this constitutes the sort of background perspective that Ralph had in mind for me to relay.

Sincerely,

NORMAN S. WAGNER
Geologist

NSW/aw

P.S: Gilluly's "Copper Deposits near Keating, Oregon" (USGS Bull. 830) contains the most comprehensive description of the bedrock geology of any single specific published report I can refer to your attention. However, even this has now been in part up-dated by the more recent work by Koch and Bowen which has resulted in the recognition of the Upper Triassic age for much of Gilluly's mapped "Clover Creek".



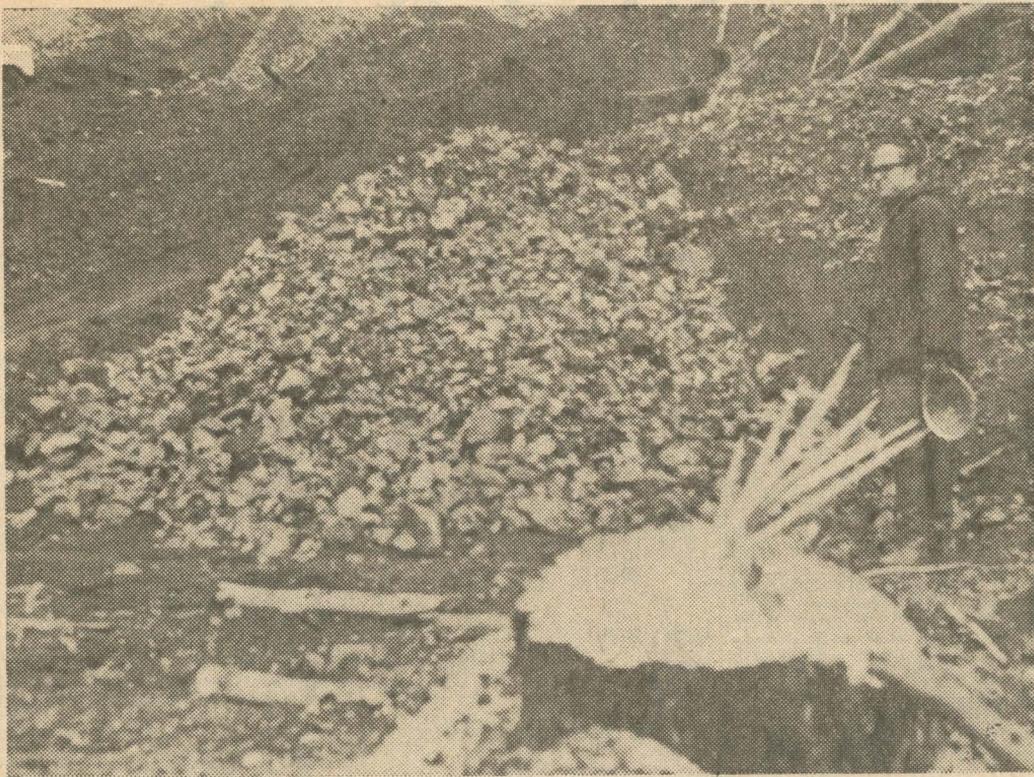
A SMALL PART of a working face at pit No. 1, the first of three in the open-pit portion of the Brass Ledge Mines, Inc., operation near Peavine Lookout. Copper ore, desig-

nated by state geologists as chalcopryrite, is exposed at right center of photo, but may be difficult for the untrained eye to detect.



ROAD BUILDING? Well, not quite, although the small "Cat" and front-end loader used by Ben Kilpatrick is of a type commonly used in some kinds of road work and other construction and maintenance. But the

material being loaded on the dump truck is estimated to be worth \$180 a ton. It is copper ore, of a type known as chalcopryrite, from pit No. 1 of the Brass Ledge Mines, Inc.



TONS AND TONS of copper ore, an estimated 150 of them, are shown at pit No. 1 of the Brass Ledge Mines, Inc., operation near Peavine Lookout, awaiting shipment to the AS&R smel-

ter at Tacoma. The size of Ben W. Kilpatrick of Grants Pass emphasizes hugeness of the ore pile. The stump in foreground is from a big tree felled a short time earlier. — Courier Photo

A Return to Copper Mining

By **GEORGE CURTIS**

Higher prices for copper, now at 60 cents a pound FOB at the American Smelting and Refining smelter in Tacoma, has made it possible for the Brass Ledge Mines, Inc., to open up the old Brass Ledge Mining Claims, located in the Galice country hills, about a mile from the Peavine Look-out.

The last time anyone tried operating the same mine, but on a different basis, was in 1960, when the price, according to Steve McTimmonds, vice-president and secretary - treasurer, was 18 to 22 cents.

It didn't work.

McTimmonds and other officers of the corporation, Dr. Don N. Cline, Grants Pass dentist, president, and Gene L. Brown, lawyer, director, believe their ore will run 10 to 15 per cent copper. The three men own all the voting stock.

The ore is described by the local geologists of Oregon's Department of Geology and Mineral Industries, as "vein type cooper ore. The mineral is chalcopyrite in quartz."

"If it will run 15 per cent, that would be 300 pounds of copper per ton," McTimmonds comments. "At 60 cents a pound, that would be \$180 a ton, without counting the gold, silver and nickel.

"On top of that, this is bonus ore, containing silica, which the smelter can use in its fluxing processes. The miners get credit for that.

"We can make money at \$100 a ton, which gives us plenty of margin to work out a profit, even if the ore percentages don't quit hold up according to estimates.

"The \$100 a ton would be roughly comparable to 8 per cent ore, while the break-even point is about 4 per cent.

"The first shipment of ore, about 60 tons, or approximately a carload, will leave Merlin by rail, some time next week. About 30 to 35 tons are stock-piled there now," he said.

Work at the mine now includes felling and bucking of trees, which will be sold as sawlogs or peelers, and stripping overlay off the copper vein.

year-around stream near the mine, because the water will be needed for the ball mill.

"Shortages in copper, were caused at least in part by foreign nations kicking out American companies, to keep ore for their own mining, and by the war and other increasing industrial demand," McTimmonds said.

"Men holding non-voting stock in the company include Larry Evans, miner; Ron Wilson and Ray Varner. Dr. Cline's address and telephone number will be used until further notice," he added.

McTimmonds said a small amount of additional non-voting stock will be issued soon.

"We believe the mine can produce 100 tons a day, he said, but added, "We're only after 100 tons a week, for a longer lasting operation."

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Meanwhile, some ore has been mined at the main pit, one of three which will be operated, 1,000 feet apart, all on the same ore vein. McTimmonds estimates that 5,400 tons of ore will be mined from the main pit, to a depth of 600 feet.

In addition, early mining will include work in one tunnel, also into the same vein, at a depth of 300 feet below pit No. 1. The tunnel was bored in the 30's, for gold.

Some of the ore will be shipped "as is," but lower grades will be put through a ball mill and refined before shipping to the smelter, McTimmonds said.

The corporation expects to employ about 10 men at the No. 1 pit and more as others are opened up.

The vein averages 15 to 20 feet wide thus far, of high grade ore," says McTimmonds. "The mill, which probably will be one with a capacity of about 25 tons per 8-hour day, or larger, will make it possible to get more tonnage, by widening the operating width and working with lower grade ores, as well as the higher.

The vein has been spotted in four places over a distance of 6,400 feet. The other two pits will speed up production by tapping the vein from the surface at more locations.

"In addition, the company is in the market to buy other copper claims."

The company plans to dam