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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGY OF THE HALL MOLYBDENUM PROPERTY, NYE COUNTY, NEVADA

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Maps filed in a manila envelope in the rear

Abstract

The Hall molybdenum property has been extensively explored underground by the U. S. Vanadium Corporation, and sufficient exposures have been revealed to indicate 1,300,000 tons of inferred ore with a grade of 0.3-0.37 percent MoS_2. Desert Silver, Inc., agent for Metals Reserve Company, did additional exploration in 1943, obtaining more information on the extent of the ore body.

Mica schist and sericitic quartzite are unconformably overlain by limestone, locally silicified. The schist and limestone are intruded by a small alaskite stock. The border of the alaskite contains many barren quartz veins, at places with a persistent orientation. The mica schist and locally the limestone contain many quartz veins at the alaskite contact. The exposed molybdenite mineralization is limited to the quartz-veined schist at the alaskite contact, but some molybdenite occurs in random quartz veins at the border of the alaskite. Andesite dikes parallel the mineralized zone in part, but are definitely later than the mineralization. They are broken by later faults.

The alaskite-schist contact is the favored zone of molybdenite concentration, and favorable targets for additional exploration are indicated in sections east of the present underground workings where the contact is concealed under limestone or quartz.

Introduction

The Hall molybdenum property has received considerable attention in recent years both in underground exploration and in extensive sampling, and recently the Bureau of Mines, Department of the Interior, issued War Minerals Report 196 containing all of the pertinent assay data together with the results of check assays made by the Bureau. The grade and inferred tonnage reserves from present underground workings are given as well as data on water, power facilities and mine equipment.

C. A. Anderson and M. W. Cox worked on the preparation of a topographic and geologic map during the period September 2 to 20, 1943. S. C. Creasey visited the property on July 9, 1944. The climate is arid, and rock exposures are excellent except on the steeper slopes where there may be a thick mantle of slide rock.

Location and topography

The property is in the San Antonio Mountains (sometimes called the Liberty Mountains), Nye County, Nev., about 20 miles north of Tonopah. Except for 2 miles of paved highway west of Tonopah, the road north to the property is a graded gravel road, in rather poor condition at the time of study.

The collar of the shaft is located near the west margin of the San Antonio Mountains at an elevation of 5,900 feet, and the highest peak in the adjacent hills has an elevation of 6,524 feet. The drainage is essentially west in the canyons and washes.

Ownership and history

The property is owned by Lee F. Hand, W. C. Rigg, and C. H. Hall, and is divided into two groups of unpatented claims, the Chicago and

Treasure Hill groups. Six claims are included in the Chicago group, which covers the known molybdenite-bearing rocks; their locations are shown on pl. 1. The Treasure Hill group includes 23 or more claims, and these are located north and east of the Chicago group.

Shaft No. 1 was sunk a number of years ago when the property was being prospected for silver, and the first level was driven at that time. In 1935 the U. S. Vanadium Corporation became interested in the property, deepened the shaft to its present level, and drove a long southeast drift with crosscuts, ~~spending about $85,000 on the project~~. At the completion of this work, the company relinquished its option.

During the summer of 1942 and spring of 1943, the Bureau of Mines did additional sampling, the results leading to the publication of War Minerals Report 196.

From August to November 1943, Desert Silver, Inc., as agents for Metals Reserve Company did additional work to determine the depth of oxidation and width of the mineralized zone to the southeast above the lower level. Two shafts were sunk, two diamond drill holes were drilled, and a crosscut driven from the main shaft.

Development

To date all the underground work has been done on three claims, Chicago No. 1, Chicago Extension No. 1, and Chicago Extension No. 2. An inclined shaft (shaft No. 1, pl. 1) is 310 feet deep with an average inclination of 65° N., with three connecting levels. The first or 110 level is a north crosscut 103 feet long, essentially at the base of the oxidized zone. The second or 155 level is largely a north crosscut 130 feet long in the mineralized zone and a south crosscut and west drift, 165 and 85 feet long respectively, driven in barren rock. The third or 280 level consists of a drift 1,250 feet long with 6 main crosscuts to the north (see pl. II).

Shaft No. 2 was sunk 180 feet, with a north and south crosscut at 110 feet below the collar, 175 feet long, and a north crosscut at the bottom, 40 feet long. Shaft No. 3 was sunk 150 feet with a north crosscut at the bottom 65 feet long. Two diamond drill holes are 302 and 52 feet long (pl. IV).

Geology

The oldest rocks include sericitic quartzite and quartz-mica schist; the former is limited to the northern part of the mapped area and the latter to the southern part (see pl. I). Presumably both belong to the same general sequence of rocks, as both have somewhat parallel foliation and have the same unconformable relationship to younger limestone. The chief interest lies in the mica schist, for it contains the bulk of the known molybdenite mineralization. The schist is well foliated with muscovite, the dominant mica, but biotite is accessory; the foliation in general dips steeply northeast with northwest strikes. However, the southwestern exposures of the mica schist have foliation planes dipping to the southwest.

The schist and quartzite are overlain unconformably by dark-gray massive limestone, the foliated schist and quartzite striking into the depositional contact. The limestone is appreciably silicified and some chert beds may be present. Irregular blotches of dense gray quartz have replaced the limestone, usually erasing the bedding planes so that the structure is difficult to determine. Only in a few exposures were definite bedding planes recognized, and these have been plotted on pl. I.

The mica schist and limestone were intruded by an alaskite stock, roughly circular as exposed, and having a diameter of approximately 2,500 feet. Presumably the stock has a west extension under the alluvium, but the appearance of several scattered pendants of limestone in the northwest part of the exposed stock may imply proximity to the west margin. The texture of the alaskite is variable, ranging from aplitic to porphyritic, with orthoclase phenocrysts imbedded in a medium-grained groundmass of orthoclase, milky plagioclase, quartz, and rare muscovite. Locally some biotite is present.

A feature of considerable interest is the appearance of many narrow quartz veins 1 to 4 inches wide in the alaskite, mica schist, and limestone. In places the alaskite contains at least 50 percent by volume of these veins. The orientation of the veins in the alaskite may be completely at random, or, with a persistent strike and dip of the majority and the remainder at random orientation. The attitude of the veins with persistent strikes and dips have been plotted on plate I. The veins with persistent attitude are more common in the eastern part at the stock, in part striking into the alaskite contact. In this quartz-veined alaskite facies there are many small masses of quartz too small to plot on the geologic map, particularly in the northern part of the stock. The evidence at hand indicates that the quartz-veined alaskite forms a hood over the stock conforming essentially to the contact, as shown in section F-F', plate III. At the southwestern margin of the alaskite stock, the area of exposed quartz-veined alaskite on the west of the north-south fault is small. This is on the up-throw side of the fault, where deeper levels are exposed. This relation would suggest that a deep vertical extension of the quartz-veined alaskite would not be expected.

The schist bordering the alaskite also contains numerous quartz veins, usually essentially parallel to the foliation in the schist. Quartz veins in the limestone are more erratic in distribution, and much of the limestone even at the contact is essentially free of veins, but along the east margin and in the narrow roof pendant across the northern half of the stock, numerous quartz veins are at random orientation in the limestone.

The contacts between quartz-veined rocks and non-quartz-bearing rocks are transitional, for scattered quartz veins are found in the areas mapped as quartz-free. In the main, the rocks were mapped as quartz-vein-bearing where quartz veins approached 30-40 percent by volume.

There are several large masses of pure quartz or quartz containing only traces of alaskite or schist. They have the appearance of having formed largely by replacement, as shown by the transitions into the host rock. They do not extend to great depths, as shown by their absence on the 280 level even though exposed at the surface. Some of these masses are brecciated, cemented by quartz and, locally, by iron oxides. The origin of all of the quartz-breccia masses is not evident, but several clearly owe their origin to later faulting. This strongly implies that faulting is responsible for all, but the faults may have a displacement of such small magnitude that they were not recognized by offsets of contacts in the mapping.

In the south-central part of the mapped area, there is a dike-like mass of rhyolite (?) tuff, composed of fragments of quartz, indeterminate feldspar and volcanic ash, the latter two locally altered to sericite. At the western end of this dike, the dip is 15° to the north and at a marked angle to the bedding of the limestone. As the dike is followed to the east, the strike changes appreciably, and the dip is nearly vertical. Where the dike is widest, quartz veins appear parallel to the west margin, mineralized with sulfides now altered to iron oxide.

Andesite dikes cutting the quartz-veined schist are poorly exposed at the surface, the widest exposures being about 20 feet, but underground widths as great as 50 feet have been exposed. The rock is greenish-gray with a relict-porphyritic texture, the phenocrysts largely altered to sericite or chlorite, with a few plagioclase crystals remaining. In the absence of quartz phenocrysts, the designation as andesite is probably appropriate. On the 280 level where the andesite is best exposed, the intrusive contact with the schist is parallel to the foliation in the schist with but one exception. However, several of the contacts with the schist are faults, and only a small width of andesite is exposed as in the 222 crosscut (see pl. II), indicating that the dike has been broken into segments. For this reason it is not certain whether one or two dikes are exposed on the 280 level, for the andesite at the south end of the 210 drift may be faulted into its present position instead of being a separate dike. The andesite was cored twice in the diamond drill hole (section J-J', pl. IV), and two explanations are possible: (1) there are several dikes each parallel to the foliation in the schist, or (2) there is one dike that has been broken into segments as illustrated in section J-J'. This latter interpretation is favored because of the visible faulting on the 280 level. However, there is considerable offset from the projected surface position of the dike from the 280 level and its outcrop north of the collar of the diamond drill hole. This may be the result of a series of faults; or it may be the result of the dike's also cross-cutting the foliation of the schist; or two dikes may be present as suggested in section F-F', plate III.

The age of the rhyolite and andesite dikes is unknown, but both are younger than the alaskite. Presumably they are related to the volcanic rocks that make up the major part of the San Antonio Mountains and are exposed only a short distance to the east of the mapped area.

Structure

The few measurable stratification planes in the limestone, plus the distribution of the limestone, are suggestive of an anticlinal structure plunging to the northeast. This structure, however, may be caused by the doming action of the alaskite stock.

There are numerous faults of small displacement underground, but only those that have resulted in displaced contacts could be plotted with certainty on the geologic maps. These can be roughly divided into two sets, northwest and northeast faults, with one north-south fault. In all examples where the direction of dip can be determined accurately, the faults are high-angle reverse. Four of these are later than the quartz veining in the alaskite; the one fault which crosses the mineralized zone is later than the molybdenite mineralization, for the ore zone is displaced southward (see pl. II). The andesite dikes are later than the molybdenite mineralization, and they have been broken by faulting. There is no evidence contrary to the supposition that all of the faults are somewhat contemporaneous. The evidence is clear, moreover, that the mapped faults have no bearing on the molybdenite mineralization, except possibly to displace the mineralized rock.

The andesite is absolutely barren of quartz veins as well as of molybdenite. On the 221 crosscut (see pl. II) some molybdenite is indicated in the andesite on the assay map prepared by the Bureau of Mines, but the molybdenite is related to mineralized schist inclusions in the andesite. It is true, however, that the better mineralization lies to the north of the andesite dike on the 280 level, but this condition bears no relation to the dike, since the andesite is younger. In the 223 crosscut south of the andesite (see pl. II) there is a wide zone containing better than 0.2 percent MoS_2.

On the 280 level, the mineralized zone with a grade of 0.28 percent MoS_2 or better (see War Minerals Report 196) ranges from 40 to 75 feet in width. There is no positive evidence available yet as to whether the ore zone is essentially tabular and parallel to the foliation in the schist and to the bulk of the quartz veins in the schist, or whether it follows the alaskite-schist contact. There is an indication of a combination of both from the information at hand, as shown in section C-C', plate III. The upward extension from the 280 level is parallel to the foliation and also follows the contact, forming a wedge shape rather than a tabular ore zone. However, the information obtained by Desert Silver, Inc., in shafts 2 and 3, indicated that the ore zone essentially follows the alaskite contact (pl. IV).

The work by Desert Silver, Inc., indicates that the molybdenite has been oxidized to a depth ranging from 85 to 120 feet. No molybdite could be positively identified at the surface over the known mineralized rock, but assays by Desert Silver, Inc., show a molybdate in the oxidized zone. An ultra-violet lamp was used on the surface exposures, and powellite was detected in rather erratic distribution, but with no apparent relationship

Mineralization

The known molybdenite-bearing rock is limited to the southwest contact of the alaskite stock and is only exposed in the underground workings. The surface rocks have been deeply weathered and their sulfide minerals oxidized. Molybdenite was found in two prospect cuts in the limestone to the east of the alaskite stock, but only as small scattered crystals in widely spaced quartz veins, with no indication that the mineralization is of economic importance. Rather it indicates that molybdenite is probably widespread in the surrounding rocks, but of very low grade, and in the dense, hard quartz veins may escape oxidation.

In the potential ore zone, molybdenite and associated pyrite with a little chalcopyrite occur in quartz veins and pods cutting both the alaskite and intruded schist. In the latter, the veins are largely parallel to the foliation planes, but in the former the better sulfide mineralization occurs where the quartz veins are at random orientation. There are no sharp boundaries to the mineralized zone. The quartz veins are present in the same quantity away from the zone, but the sulfide content decreases so that assay walls will determine the width of any ore zone. Underground where the quartz veins have a parallel strike and dip in the alaskite, the MoS_2 content is very low, indicating that only the random veins were favorable hosts for molybdenite deposition. The molybdenite occurs largely along the margin of the quartz veins, whereas the pyrite is present throughout the quartz. Where there has been subsequent minor faulting, the molybdenite has been smeared out along the fault surfaces.

to the grade of the underlying mineralized rock. The schist far to the south of the projected ore zone was barren of powellite, but the alaskite to the north of the schist contact, known to be practically barren on the 280 level, showed as much powellite as the rocks over the known mineralized rock. The distribution of the powellite is apparently too erratic to be used as a reliable guide in prospecting for extensions of the mineralized zone.

Grade of the deposit

About 600 samples have been taken in the underground workings by engineers of the U. S. Vanadium Corporation, and these have been plotted on an assay map prepared by the Bureau of Mines. The samples taken by Emigh for U. S. Vanadium Corporation were from wide deep channels cut with a jack hammer, each sample weighing one ton or more per 10 feet. These were hoisted to the surface and crushed and quartered. These samples gave lower returns than those taken by other engineers. The Bureau of Mines engineers took 51 check samples, and these agreed with the Emigh returns rather closely. For our purposes in showing the distribution of the molybdenite, all Emigh assays of 0.2 percent MoS_2 or higher are indicated on plate II. The width of the ore zone as given by the Bureau of Mines engineers and their estimate of the grade for each crosscut is also given, except for crosscut 201 which was calculated from Emigh's assays and Bureau check samples.

In War Minerals Report 196, the Bureau of Mines engineers suggest that the average grade for the zone as outlined is 0.376 percent MoS_2.

Desert Silver, Inc., sampled the four crosscuts east of the fault on the 280 level, blasting down a muck sample and taking every tenth shovelful; 9,600 pounds were collected and mixed according to the ratio of width of ore. This sample was split to 1,200 pounds and divided into four equal parts. One sample submitted to the Southwest Engineering Laboratory, Los Angeles, ran 0.3 percent MoS_2, 0.13 percent Cu, and traces of Au and Ag. The weighted average of the Bureau of Mines estimates for the same crosscuts is 0.368 percent MoS_2. Since the molybdenite is not uniformly distributed, the exact determination of grade is difficult to determine, but it undoubtedly lies between 0.3-0.37 percent MoS_2.

Ore reserves

In the computation of reserves, the Bureau of Mines engineers used the widths of the mineralized zone on the 280 level as indicated on plate II and assumed a vertical range of 300 feet below the oxidized zone. This gave a reserve of 1,310,000 tons of inferred ore. From the data now available this estimate is as accurate as can be given. It does not take into account the possibility of the widening of the ore zone in the higher levels, but again that may be counter-balanced by narrowing in depth.

Conclusions

The available information indicates that the alaskite-mica schist contact is the favored zone of molybdenite concentration, with the bulk of the mineralization in the schist. However, where quartz veins are at random in the alaskite at the contact, molybdenite mineralization can be expected.

A greater part of the quartz-veined alaskite, particularly where the quartz veins have a persistent strike and dip, and the large masses of quartz appear to be essentially barren and do not provide encouraging targets for additional exploration.

The favorable zone for the extension of the mineralized belt is along the southeastern extension of the schist-alaskite contact, and the approximate location of this contact is projected eastward and shown on sections A-A', G-G', and H-H', plate III. The exact location of the contact is difficult to project because it is concealed by the mass of quartz and quartz breccia, and by limestone. The scarcity of quartz veins in the limestone in sections A-A' and H-H' indicates it to be unfavorable for molybdenite mineralization.