GEOCHEMICAL INVESTIGATIONS FOR GOLD, ANTIMONY, AND SILVER AT STIBNITE, IDAHO
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ABSTRACT

Several gold-antimony geochemical anomalies were outlined near Stibnite, Idaho, using the humus sampling technique. Several hundred reconnaissance humus samples were collected and analyzed by a combination fire-assay atomic absorption method. The results partially outlined several gold-antimony anomalies and are very encouraging for further work in this part of Idaho.

INTRODUCTION

Remote location, rugged topography, surface leaching of mineral values, and, in places, overburden or dense vegetation have hampered exploration for low-grade gold-antimony deposits in the Stibnite area of Valley County, Idaho. In 1968 the Bureau of Mines began studies to delineate favorable locations for gold, antimony, and silver deposits, using the humus sampling technique.

Several hundred samples were collected, ashed, and screened at the Bureau's Albany Metallurgy Research Center, and analyzed by a combination fire assay-atomic absorption method at the Bureau's Reno Metallurgy Research Center. Although more detailed geochemical work needs to be done, followed by physical exploration to determine more accurately the gold and antimony values at depth, it was felt that the humus sampling reconnaissance technique may be advantageous throughout central Idaho for the following reasons: (1) Humus samples are generally more representative than soil samples because the root systems cover a much larger and deeper area, (2) tree roots apparently penetrate below the zone of surface leaching, and (3) coniferous trees are relatively abundant throughout central Idaho and are apparently very efficient at accumulating gold, silver, and antimony.

LOCATION AND GEOGRAPHY

Stibnite is in the Yellow Pine mining district of Valley County, Idaho, about 37 airline miles east of McCall. Access from McCall is by 55 miles of fair to poor graveled and dirt roads through Yellow Pine to Stibnite (fig. 1).

A good airfield for small aircraft lies 3 miles south of Yellow Pine; the airfield at Stibnite is unattended although most of it is in good condition. The town of Stibnite is now deserted and most of the buildings have been torn down.

Stibnite is in the valley of the East Fork of the South Fork of the Salmon River within a mountainous region. Stream erosion and mountain glaciation have formed rugged topography with elevations ranging from about 6,000 feet to nearly 9,000 feet above sea level. The area is well forested with conifer timber, and ample water for large-scale milling operations is available. The annual precipitation varies from 20 to 30 inches, and a snow depth of 5 feet in the valley is common from late December to early April.

HISTORY OF MINERALS EXPLORATION AND MINING AT STIBNITE

Gold, silver, antimony, and mercury were discovered in the Stibnite area about 1900. The ores were relatively low grade, and the remoteness of the area discouraged extensive exploration or development for many years.

The mercury prospects east of Stibnite were operated intermittently from 1917 to the present, but production was significantly large only during World War II. The gold-antimony-silver ores were not mined extensively until 1932, when the Yellow Pine Mining Co., a subsidiary of Bradley Mining Co., began production at the Meadow Creek mine at Stibnite. Mining at Meadow Creek continued to 1938, when the company began to concentrate its production operations at the Yellow Pine quarry about 2 miles north of Stibnite.

Tungsten mining caused the most spectacular and profitable period of activity at Stibnite, although it was relatively short-lived. Early in the
1940's, the Bureau of Mines, drilling for antimony near the Yellow Pine mine, discovered a high-grade tungsten deposit suitable for open pit mining. Mining efforts were greatly accelerated throughout the war period, and the tungsten ore body was exhausted in 1945. Gold-antimony-silver mining continued until 1952, when rising mining costs combined with a fixed gold price and low antimony prices closed the Yellow Pine mine. The Meadow Creek mine yielded 303,766 tons of gold-antimony ore between 1932 and 1938, and the Yellow Pine mine produced 4,419,029 tons of gold, antimony, and tungsten ores during the 1939-52 period.

During 1955 and 1956, exploration for tungsten and antimony under DMEA projects met with limited success. Some exploration for mercury was conducted in recent years. Gold exploration was essentially nonexistent from 1957 until the Bureau began a reappraisal of the potential gold-antimony-silver resources in 1968.

GENERAL GEOLOGY

The geology of the Stibnite area was mapped and described in detail by the U.S. Geological Survey.\(^2\) Quartz monzonite or related rocks of the Idaho batholith apparently underlie the Stibnite area and crop out over most of it. However, large roof pendants of metamorphosed rocks crop out immediately east of the two principal gold-antimony and gold-antimony-tungsten mines and extend eastward past the mercury deposits. The metamorphic rocks are chiefly quartzite, schist, and limestone which were intensely folded and faulted before the intrusion of the quartz monzonite. Later faulting and shearing of the quartz monzonite appear to have been controlled, to some degree, by structures in the metamorphosed sedimentary rocks. Bedding within these rocks generally strikes northwesterly and dips 60° to 85° northeasterly.

Following the intrusion of the quartz monzonite, dikes of basalt, quartz latite porphyry, trachyte, and rhyolite were injected into many of the fault zones. A final period of movement along these faults occurred later.

Three periods of mineralizing activity, separated by episodes of fracturing, generated the following types of ore bodies: (1) Extensive gold-bearing pyrite and arsenopyrite replacement lodes, (2) less extensive scheelite replacement bodies within the gold lodes, and (3) stibnite and silver replacement ore bodies, some of which occur in the same fractures that localized the scheelite ores.

The two principal gold-antimony mines are located on the Meadow Creek fault, a major north-trending near-vertical shear zone up to hundreds of feet wide. Most of the former exploration was concentrated on this structure.

Certain physical characteristics of the region and of the ore mineralogy present problems in evaluating mineral potential. The Stibnite area is in a remote part of Idaho with substandard communication facilities and poor roads. The steep topography, short working season, thick underbrush, and heavy timber stands present problems in conducting an exploration program. An additional adverse factor is that the metallic minerals have been leached from the rocks to depths ranging from 10 to 50 feet. Therefore, sampling near the surface could yield erroneous results. Dozer trenches are generally too shallow to penetrate beneath the zone of leaching, and sample results from such trenches may not be definitive if negative. During the latest period of mining activity the only reliable exploration methods appear to have been drilling and driving underground mine openings. Diamond drilling has been plagued with problems of interpreting results because the nature of the rocks in or near the ore zones caused poor core recovery.

The high costs plus the possibility of unreliable results were strong deterrents to further Bureau core drilling and exploration adits in the Stibnite area. Therefore, some method of preliminary or reconnaissance exploration was needed to better define target areas before the more expensive methods would be appropriate. Geochemical soil sampling and trenching may be of dubious value because of surface leaching; geophysical methods available within the Spokane office of the Bureau of Mines were tested but gave non-definitive results. The geochemical humus sampling technique developed by the Geological Survey in the Empire district of Colorado appeared to be an exploration tool that could give definitive results.3

The humus geochemical method using conifer needles has many apparent advantages for application in the Stibnite area:

1. The trees' root systems sample a relatively large, deep area giving a more "representative" sample than soil samples.

2. The depth to which tree roots sample overcomes much of the problem of surface leaching.

3. Finally, coniferous trees, which apparently are very efficient at accumulating gold, silver, and antimony, are abundant in the Stibnite area.

The trees themselves were not sampled, but rather the conifer needle "pads" accumulating on the ground. Samples were taken of the lower portions of the "pads" where the needles are packed and turning gray from weathering. Soil from the underlying "A" horizon was not included in the humus sample although soil samples from the "B" horizon were taken at each humus sample location to make a comparison of the two methods.

Initially, a small group of soil and humus samples was shipped to the Geological Survey laboratory at Denver, where atomic absorption analyses were made to test the applicability of the humus sampling method in the Stibnite area. Later, a fire assay-atomic absorption method was developed at the Bureau of Mines laboratory in Reno, Nev., and all further samples were analyzed there. Most of the samples were ashed and screened by the Bureau's Albany Metallurgy Research Center prior to analysis at Reno.

An evaluation of the geology led Bureau of Mines personnel to consider the possibility that the northeast-trending, flat-dipping faults were the channels or feeders for mineralizing solutions emanating from a deep-seated source. Where these faults intersected north-trending faults, favorable structural conditions may have been present for the formation of major ore bodies. If this hypothesis were correct, major low-grade ore deposits may occur as flat-dipping disseminated bodies localized along the northeast-trending faults. This thinking influenced the location of the reconnaissance geochemical sampling program.

The anomalous areas outlined by humus sampling are shown in Figure 2. The gold content of the soil samples was generally too low to obtain a quantitative measurement, and the results were often very erratic; therefore, no attempt was made to outline anomalous areas from the soil samples.

The sampling was limited to several hundred samples of a reconnaissance nature and in some areas the sample lines were separated by several hundred feet. The interval between individual samples along the lines was generally 100 or 200 feet. Some sample lines were so far apart that it was impossible to construct isogeochemical lines. Sample lines and spacing were controlled by compass and cloth tape; in some of the brushy areas and across rugged terrain, the lines probably deviated considerably from the intended azimuth and sample interval. Figure 2 shows that most of the territory of probable interest around the Stibnite deposits remains untested, and that several possible anomalous areas are only partly outlined. Additional geochemical sampling on a more detailed grid system is recommended to cover these areas.

Approximately 35 humus samples were selected at random and tested for antimony by X-ray analysis. Previous reports such as Cooper's indicated that a probable correlation existed between antimony and silver; however, the X-ray analysis results indicated reasonably good statistical correlation of antimony with gold and essentially no correlation with silver. The coefficient of determination ($r^2$) value for silver-antimony correlation (excluding one highly erratic sample which was discarded) was 0.273 and for gold-antimony the coefficient was 0.723. About 75 percent of the changes in the antimony assay values are therefore related to changes in gold content of the humus; thus, the areas anomalous for antimony are expected to have a similar configuration to those anomalous for gold. The calculated percentage of antimony in humus ash equals 0.123 plus 0.576 times the gold content in parts per million (SN = 0.123 + 0.576 ppm Au).

*Work cited in footnote 2.*
FIGURE 2. - Gold and Antimony Anomalous Areas Outlined by Reconnaissance Geochemical Humus Sampling in the Stibnite Area, Valley County, Idaho.
CONCLUSIONS

The humus geochemical technique appears to have promise as an exploration tool at Stibnite and in much of the central Idaho region because it overcomes some of the problems associated with surface leaching and gold too fine to pan. Very little of the area in the immediate vicinity of the Stibnite mines has been tested; the initial geochemical reconnaissance efforts were limited to areas near flat-dipping northeast-trending faults. The entire map area of figure 2 should be covered by a detailed sampling program that hopefully would outline anomalies worthy of physical exploration.

The reconnaissance humus sampling program failed to provide conclusive evidence that the northeast-trending faults are the loci of large low-grade ore bodies, but the program added knowledge concerning the probable extent of the known deposits. The anomalies north and south of Garnet Creek indicate that the "Scout Ridge" deposit will extend almost to the surface, and that it is longer than originally thought. A few deep inclined diamond drill holes from the valley flat many years ago had indicated a relatively small, deeply buried deposit. The humus sampling results also indicate the West End Creek deposits to be more extensive.

Whether the anomalies near Fiddle Creek and west of Garnet Creek are related to mineralized northeast-trending structures or to weathered material migrating from the north-trending Meadow Creek Fault remains uncertain.