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PRECIOUS METAL MINERALIZATION AT MT. HAMILTON, WHITE PINE COUNTY, NEVADA

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Abstract. Precious metal mineralization at Mt. Hamilton, Nevada is associated with a polymetallic, garnet-pyroxene skarn system developed in middle to upper Cambrian calcareous shales, limestones and dolomites. The skarn is developed around the Cretaceous Seligman and Monte Cristo calc-alkaline stocks. Gold is associated with intense retrograde alteration. Later epithermal quartz veins containing gold, silver, base-metal sulfides, and sulfosalts cross-cut skarn alteration. Westmont Mining Inc. is currently developing two mineralized zones containing a geologic resource of approximately 7.7 M.T., which averages 0.05 OPT gold and 0.5 OPT silver. The project will have an estimated mine life of seven years, with a planned annual production rate of 35,000 ounces of gold and 300,000 ounces of silver.

Introduction

The Mt. Hamilton Project is in White Pine County, Nevada, approximately 60 km west of Ely (Figure 1). The deposit occurs on the west flank of the White Pine Range in the White Pine Mining District. Extensive exploration by Phillips Petroleum in the late 1970's and early 1980's defined a small tungsten-molybdenum resource. Westmont Mining Inc. acquired the property in 1984 and has conducted intensive precious metal exploration since then.

Stratigraphy

Sedimentary rocks in the Mount Hamilton area range in age from middle Cambrian to Pennsylvanian. Stratigraphic units in the project area include the middle Cambrian Eldorado Dolomite, Geddes Limestone, and Secret Canyon Shale, and the upper Cambrian Dunderberg Shale. The Eldorado Dolomite is the oldest formation in the area and consists of gray to white, stromatolitic dolomite up to 200 meters thick (Sonnevil, 1979).

The Geddes Limestone overlies the Eldorado Dolomite. Deep drill holes in the vicinity indicate the contact with the Eldorado Dolomite is a breccia zone. The Geddes Limestone consists of dark gray, platy limestone and has a thickness in excess of 30 meters.

The Secret Canyon Shale accounts for the majority of the sedimentary sequence in the project area. This formation is at least 300 meters thick and consists of four units: a basal thin-bedded pale green shale, a thin-bedded limestone with shale partings, a thin-bedded greenish shale, and an uppermost unit consisting of interbedded limestone and shale.

The Dunderberg Shale disconformably overlies the Secret Canyon Shale and is 120 to 300 meters thick in the project vicinity. The formation consists of a basal greenish shale and mudstone with thin limestone interbeds. A middle unit, consisting of interbedded carbonaceous shale and limestone with shale partings, forms the bulk of the formation. The uppermost unit is a thinly bedded, nodular limestone with shale partings.

Intrusive Rocks

The sedimentary sequence has been intruded by two stocks of Cretaceous age. The Seligman stock is a medium-grained, hornblende-biotite granodiorite. The stock is elongate in a north-south direction along the axis of the Hoppe Springs anticline (Figure 2). The stock locally contains small silicified breccias containing molybdenite which are probably related to fault zones. Potassium-argon age dating on biotite from the Seligman stock yields dates of 106.6 +/-8 m.y. (Sonnevil, 1979) and 104.5 +/- 4 m.y. (Putney, 1985).

The Monte Cristo stock is a biotite granite-porphyry located 800 meters southwest of the Seligman stock. The stock displays extensive quartz stockworking and quartz flooding. Potassium-argon age dating on biotite from the Monte Cristo stock yields a date of 101.2 +/- 3.6 m.y. (Putney, 1985).

Several dikes and sills occur throughout the area and are generally 1 to 10 meters thick. They are quite similar, compositionally, to the Seligman and Monte Cristo stocks.

Structural Geology

At least two periods of major structural deformation have affected the area. Late Mesozoic to early Tertiary compressional tectonics resulted in the formation of broad north-south trending folds and thrust faults. Two major folds occur in the project area: the Hoppe Spring anticline along which the Seligman stock was intruded and the Silver Bell syncline to the west. High-angle faulting with northeast and northwest orientations developed during this period. Late Tertiary basin and range faulting has uplifted the White Pine Range along north-south trending, high-angle normal faults.

Alteration

Early potassic alteration in the Seligman stock is indicated by the occurrence of secondary bronze, shreddy biotite replacing original black, euhedral biotite. Propyllitic alteration is common and is expressed by the alteration of the mafic minerals, and occasionally plagioclase, to chlorite, epidote, and calcite. Sericitic alteration is common throughout the Seligman stock and is concentrated along the northwest side of the stock. The sericitic alteration is associated with pervasive silicification and consists of sericite after plagioclase, and locally up to 40% pyrite. Several areas along the stock periphery have significant amounts of localized argillic alteration. Kaolinite occurs as patchy replacements of potassium feldspar and plagioclase and as thin veinlets (Putney, 1985).

Many of the dikes and sills are altered to endoskarn consisting of plagioclase, quartz, and pyroxene with minor retrograde alteration to actinolite or chlorite. Many of these dikes and sills have very narrow garnet-pyroxene haloes up to hundreds of meters from the massive skarn zones.

A hydrothermal alteration aureole is present in the sedimentary rocks concentrically about the Monte Cristo and Seligman stocks. The alteration aureole is approximately 5 km long and 2 km wide. Alteration is complex and has an early, dominantly metamorphic, isochemical stage which resulted in the formation of hornfels. A cross-cutting, dominantly metasomatic stage resulted in the formation of skarn.

The early alteration stage has altered shales and calcareous shales to fine-grained, pale green diopside (diop 80-90, hd 10-20, jo 0) + quartz + potassium feldspar hornfels proximal to the intrusives. This alteration grades outward to fine-grained biotite + quartz hornfels distal to the intrusives. The shales have been bleached and silicified up to several hundred meters beyond the biotite hornfels. The limestone layers within the shales have been altered to medium-grained marble with occasional fine-to-medium-grained tremolite or wollastonite, often with garnet, developed along limestone-shale contacts. The more argilliceous limestone layers contain some fine-grained, istropic garnet (gr 60-80, ad 20-40).

The transition from dominantly metamorphic processes (hornfels) to dominantly metasomatic processes (skarn) is marked by the increasing iron content in the pyroxene and the formation of andraditic garnet. The hedenbergitic pyroxene (diop 45, hd 50, jo 5) is dark green. The andraditic garnet (gr 30-60, ad 40-70) ranges from apple green to dark red-brown with well developed growth banding and alternating isotropic and anisotropic zones.

Retrograde alteration is limited in extent and consists of two periods. The earliest and most common retrograde alteration (type 1) is garnet altered to quartz, calcite, and pyrite. The later retrograde alteration (type 2) is represented by the alteration of garnet and pyroxene to quartz, epidote, iron oxide, actinolite, chlorite, and Mn-enriched epidote. The more extensive, type 1, retrograde alteration is dominated by quartz, possibly reflecting the increased quartz content of the shaley protolith. Type 2 retrograde zones are generally limited to cross-cutting zones or veins, probably related to permeability controlled by the major northeast and northwest trending high-angle fault zones. Pink, Mn-enriched epidote is most common in the more shaley protoliths and probably reflects the original composition of the shale. Minor amounts of Mn-enriched epidote also occur in the altered intrusives.

Mineralization

Tungsten, molybdenum, copper, and gold are associated with garnet-pyroxene skarn. Fine-to-medium-grained scheelite is disseminated in thinly-bedded skarn zones within calc-silicated Secret Canyon Shale and Dunderberg Shale and in massive garnet-pyroxene skarn. Minor amounts of tungsten are associated with retrograde skarn zones and are of higher grade than that associated with prograde skarn. This is thought to represent remobilized tungsten as seen in other tungsten skarn systems (Newberry, 1982).

Molybdenite is also associated with prograde skarn, most commonly with pyroxene dominant skarn, and later retrograde alteration (Putney, 1985). Molybdenite-bearing, silicified breccias cut both the Seligman Stock and the calc-silicate hornfels. Molybdenite commonly occurs in chlorite, epidote and actinolite-rich altered areas in garnet-pyroxene skarn and in quartz-pyrite-epidote veinlets (Jones, 1984). The association of molybdenite with retrograde alteration and cross-cutting veins suggests molybdenum mineralization was, in part, later than tungsten mineralization.

Copper occurs as disseminated chalcopyrite in garnet-pyroxene skarn southeast of the Seligman stock. The paragenetic relationship of copper with tungsten-molybdenum has not been studied.

Gold is most commonly associated with type 2 retrograde skarn zones. A retrograde assemblage of iron-oxides (hematite and geothite) and quartz veining with minor epidote and calcite is closely associated with up to 90 percent of the ore grade material. The intensity of the retrograde alteration correlates positively with gold grades. The grade of skarn related gold mineralization averages 0.05 ounces per ton but values in excess of 0.25 ounces per ton are common in areas of the most intense retrograde alteration. Minor amounts of gold occur in prograde skarn zones containing up to five percent, fine-grained, euhedral pyrite with trace amounts of arsenopyrite.

Sulfosalt-bearing quartz veins cut skarn, retrograde skarn, and intrusive rocks. The veins vary in thickness from one-half to ten meters and are continuous over an area measuring 700 by 1400 meters. Veins commonly contain sphalerite, galena, pyrite, covellite, bornite, stibnite, chalcopyrite, and minor tetrahedrite, bournonite, and jamesonite. Anomalous gold (0.01-0.5 OPT) and silver (0.3-30.0 OPT) values occur throughout the vein system, locally overprinting skarn related mineralization to produce the highest grade ores in the deposit.

Conclusions

Intrusion of the Cretaceous, calc-alkaline Monte Cristo and Seligman stocks into the middle to upper Cambrian Secret Shale and Dunderberg Shale resulted in the formation of a precious metal bearing poly-metallic skarn system.

Alteration exhibits a paragenesis from an early, dominantly meteoric, hydrothermal system to a later, dominantly magmatic hydrothermal system. The earlier, lower temperature alteration resulted in the formation of an extensive biotite-diopside hornfels aureole. The later, higher temperature alteration formed an extensive garnet-pyroxene skarn. Two stages of retrograde alteration occur in the skarn. An early assemblage of quartz with minor calcite forms an extensive zone of alteration around the stocks. A later, more intense retrograde assemblage of iron-oxide, quartz, and minor epidote is restricted to northeast and northwest trending, high-angle fault zones.

Precious metal mineralization at Mt. Hamilton occurs in three phases. The majority of the gold mineralization is associated with retrograde alteration typified by quartz and iron-oxide. Low grade pyritic zones in garnet-diopside skarn account for less than five percent of the ore grade material. Sulfosalt bearing quartz veins with high gold and silver values cross-cut the skarn related mineralized zones.

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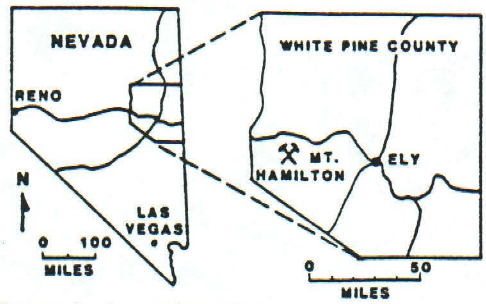

Figure 1. Location Map

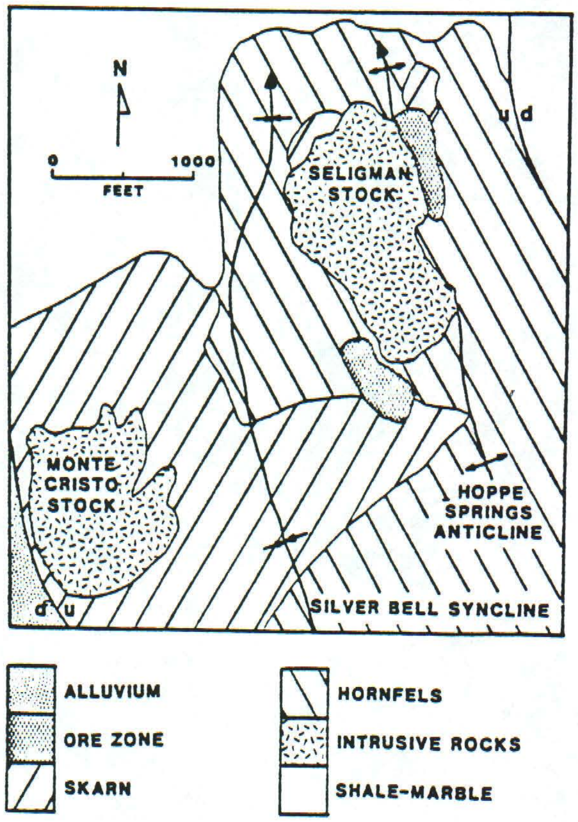

Figure 2. Generalized Geologic Map