GEOLOGY OF THE LOUSE CANYON-ROCK CREEK AREA, WASHINGTON COUNTY, IDAHO

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for
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Introduction

This report is based on mapping done for Bayhorse Silver in 2013-2014 (4 days) and in May and June, 2024, (10 days) and is written to describe the geology of the accompanying 1:12,000-scale geologic map. The report also benefits from the experience of the author working at the adjacent Bayhorse mine periodically over the past 11 years and from a NI 43-101 report of the Bayhorse mine by Ray (2014). The Louse Canyon-Rock Creek area is directly across the Snake River (Brownlee Reservoir) from the Bayhorse mine in Oregon. My work at the Bayhorse mine consisted of both underground mapping and structural analysis and of surface mapping in the vicinity of the mine.

Shortly after Bayhorse Silver USA acquired the Bayhorse mine property in 2013, I was asked to conduct a little reconnaissance mapping across the river in Idaho primarily to determine the presence and extent of what I will call here the 'Bayhorse rhyolite.' Silver mineralization at the Bayhorse is spatially associated with this rhyolite which was reported to extend eastward across the river. The rhyolite was found, and field relations were documented, but a report was not written nor a map made at that time as my efforts were re-directed to work at the Bayhorse mine.

Based on surface and underground relations determined at the Bayhorse mine, I made a case in several reports (Conway, 2013b; Conway and others, 2014) that the 'Bayhorse rhyolite' was intruded as a sill at the contact (regional unconformity) between the Triassic-Jurassic Huntington Formation and the overlying Jurassic Weatherby Formation. I also made a case that the locus of silver-copper mineralization was a low-angle fault, one of a series of southwest-ward dipping probable thrust faults. But mineralization only occurs along the faults where rhyolite is present. Thus, rhyolite is inferred to have a genetic connection to the mineralization.

Last fall, Hercules Silver (now Hercules Metals Corp) announced the discovery of a porphyry copper deposit at depth beneath historical silver mines (associated with rhyolite) some 30 miles northeast of Bayhorse in the Cuddy Mountain district. This has led Bayhorse Silver to renew interest in the area underlain by rhyolite on the Idaho side of Brownlee Reservoir. Bayhorse commissioned an aerial geophysical survey that has shown pronounced low-resistivity anomalies on both the Idaho and Oregon sides. A large block of claims was staked in Idaho and I was retained to expand the geologic mapping in Idaho.

I initiated this work by compiling the mapping I did in 2013-2014 (numerous GPS locations and extensive field notes) and submitting a detailed 1:360-scale map and report (Conway, 2023) of a small area in lower Louse Canyon. The current study incorporates and expands upon that work.

Accessibility, Logistics and Exposure

The study area is accessible from the east off Mineral Road only by 4-wheeler and dirt bike and then with difficulty. A trail on the high north-south ridge bifurcating the area is the only existing vehicular trail and is eroded and overgrown such that even jeep travel would be difficult and risky. Moreover, access to this trail is from the south of the area and requires crossing private property which access was denied us.

My 2013-2014 mapping was accomplished by taking a boat across Brownlee Reservoir from the Oregon side. The recent mapping was done mostly by helicopter drop-off and pick-up but also by boat for a few days work near the reservoir.

Elevations range from about 2000 feet to over 4000 feet. The terrain is very steep, notably on west slopes above the reservoir. On these west slopes bedrock exposure is locally good, but mostly fair to poor. On the east side of the north-south central ridge, slopes are not so steep, but exposure of bedrock is poor to very poor. Soil cover is thick nearly everywhere and on northern and eastern slopes grass and brush are thick. An exception is that the resistant rhyolite bodies tend to outcrop quite well. On the east, exposures are best along steep slopes of Rock Creek, including good exposures of Miocene Columbia River basalt on the north and east of Rock Creek.

Surficial Geology

Quaternary alluvium is mapped as Qal in the wide Rock Creek drainage and in a small depression in the northern part of the area. The latter is a closed basin with thick soil. Deep weathering, particularly of the Weatherby Formation conglomerate unit, has resulted in widespread soil cover which is unmapped.

A probable landslide mass (Ql) lies on the western margin of the study area.

Intermittent talus is widespread in the study area but was broken out as a map unit (Qt) only where a prominent slope of basalt talus occurs in the central part of the area.

Columbia River Basalt

A thick section of basalt flows (Tcb) lies in central to eastern parts of the area. Multiple basalt flows are clearly seen on the eastern and northern slopes of Rock Creek. These flows, which dip moderately to the northeast, climb up westward to cap the central north-south ridge. Two small exposures of basalt in the north (Tcbi) are apparently intrusive and are possibly an intrusive phase of Columbia River basalt.

Bayhorse Rhyolite

Bayhorse rhyolite is used here as an informal map unit to include several distinct varieties of intrusive rhyolite in the Louse Canyon-Rock Creek area: an aphantic type (Jra) mainly in the west, and porphyritic (Jrp) and flow-banded (Jrf) types mainly in the east. The aphanitic type extends west across the Brownlee Reservoir to the vicinity of the Bayhorse mine and beyond. This rhyolite is described by Livingston (1925) as being a thick flow at the base of the Weatherby Formation. Livingston considered it to be a regional unit also occurring at the Mineral and Cuddy Mountain mining districts northward in Idaho. It has been generally considered in various mainly mine-related reports (Conway, 2013a) to be either a tuff or a flow. Ware and others (2022) consider it to be a tuff and to be the uppermost unit of the Huntington Formation in the Bayhorse mine area.

As these rhyolites intrude the Jurassic Weatherby Formation, they must be Jurassic or younger. They are arbitrarily and tentatively considered to be Jurassic in this report. All the various exposures of the aphanitic phase, as discussed below, are considered to be of the same generation. Alternatively, all three rhyolite types found east of the Louse Canyon fault could be of a different age/generation from the aphanitic type found west of the Louse Canyon fault. This less preferred alternative would contradict the suggestion below that the aphanitic phase cuts across the Louse Canyon fault.

Aphanitic rhyolite

Rhyolite type (Jra) is even grained and aphanitic in character, although it varies to very weakly porphyritic. It is typically light gray to tan in color. It is homogeneous and generally featureless, although rare weakly developed flow banding and columnar jointing can be found near lower (southern) contacts west of the Louse Canyon fault. It locally contains very tiny vapor phase cavities.

Rhyolite Jra is found largely in the western part of the area in one elongate exposure and as separate small exposures. Several small exposures are also found in the eastern part of the area along the Rock Creek drainage where it occurs both as isolated bodies and in intimate contact with porphyritic rhyolite (Jrp). Scarce <1-mm feldspar phenocrysts are found in this area.

This aphanitic rhyolite phase clearly intrudes the Weatherby Formation in a number of unconnected localities. It appears to cut across and thus post-date the Louse Canyon fault. A pre-fault alternative was evaluated (Conway, 2023) and considered less plausible. If pre-fault, the rhyolite would have been offset and be present along the Huntington-Weatherby on the east side of the fault. On close inspection of this contact only trace amounts of rhyolite were found and not near the Louse Canyon fault.

The question arises as to the direction of movement of the rhyolite. Did it cut across the fault from the east or from the west or in some complicated fashion from depth? It seems unlikely the rhyolite would have cut the fault from the east at exactly the position of the Weatherby-Huntington contact. More likely, the rhyolite was emplaced in the west and migrated

along the unconformity cutting across the fault and into the Weatherby, or it may have arisen from depth in the near vicinity.

Mineralization of aphanitic rhyolite is discussed below in the section on mineralization.

Rhyolite porphyry

Excellent bold exposures of rhyolite porphyry (Jrp) are found along and near Rock Creek in the eastern part of the Louse Canyon study area. This rhyolite (possibly rhyodacite) type has a dark red-brown to gray-brown matrix with up to 5% 0.5-2-mm tan feldspar phenocrysts. It is massive and homogeneous; no flow features were observed. Tiny vapor phase cavities are locally present.

Rhyolite of this type was found as very scarce float in the elongate Jra exposure area in the lower Louse Canyon area; no outcrop was found.

Flow-banded rhyolite

Rhyolite (Jrf) with locally pronounced flow layering was found at one locality in the eastern part of the study area. The consistent layering strikes northwest and dips shallowly to the northeast (see attitude on map). In the lower parts, the layering is pronounced and the rock is fragmental - basically a flow breccia. Flow foliation dies out entirely upward in the section that is on the order of 100 feet thick. Upper parts have an inhomogeneous texture with pale aphanitic splotches in an irregular crystalline mosaic.

The flow breccia parts of this unit have some resemblance to ash-flow tuff. It seems unlikely it is actually ash-flow tuff considering its geologic setting and its very limited extent. Ash-flow tuffs occur in a pronounced volcanic environment and have great lateral extent. On the other hand, the flow attitude would apparently be consistent with the overall bedding/foliation attitude of the host Weatherby rocks. Very little time was spent examining this unit. An intrusive origin seems preferable although it remains somewhat enigmatic.

Gabbro/basalt unit

The gabbro/basalt unit (Jg) is included here with the rhyolite because of close spatial association with rhyolite. A small basalt dike is shown on the map in the northwestern part of the area. A rhyolite selvage is found on the north margin of this dike suggesting possible co-magmatism. Near this occurrence, small exposures of units Jg and Jra are shown in close proximity on the map. Rocks of the Jg unit are shown nowhere else on the map but are found here and there in apparently small intrusive bodies that do not crop out. These rocks range from basalt (aphanitic) to fine-grained gabbro. The latter commonly weathers dark brown, rarely forming small spheroidal weathering boulders. Weathered brown blocks and spheroids superficially appear to be sandstone.

Weatherby Formation

The Jurassic Weatherby Formation belongs to the Izee terrane (or Izee basin) of the Blue Mountains suspect terrane complex of east-central Oregon and western Idaho (Ware and others, 2022). It lies unconformably on the Triassic-Jurassic Huntington Formation.

Conglomerate, schist and limestone

This unit (Jwc) is highly variable but is characterized by being conglomeratic and schistose. It is a soft lithology due to its high content of low-grade metamorphic clay/sericite minerals and is thus typically deeply weathered and poorly exposed. It is therefore not readily amenable to the defining of mappable lithologic sub-units. Limestone is common in many parts of the unit and is locally abundant. The limestone is not typically massive, but thin-bedded, impure, and commonly interbedded with the schist. It weathers deeply as does the schist. The limestone is locally punky, almost gossanous; it possibly was mineralized with sulfides.

Time did not permit mapping separately some massive limestone beds within this unit on the north bank of Rock Creek.

A prominent feature of this unit is coloration. The slaty to schistose layers, with or without clasts, are variably in light purplish and greenish hues. This was also noted (Conway and others, 2014) in basal Weatherby at the Bayhorse mine across the river in Oregon. It is common for fine-grained distal volcanic rocks (tuff beds) to have wide color variation. This suggests a possible volcanic origin of the fine-grained material in the Jwc unit. Moreover, cursory examination of the pebbles and cobbles in this unit indicates they are largely of volcanic origin. Thus, one source area of these strata of the Izee Basin may have been an active volcanic terrane. Likely also, some clasts were derived from the underlying Huntington Formation.

This unit is basically bi-modal clastic in character, with pebbles and cobbles in various proportions within the (pre-schist) shaly matrix. There are, however, notable grit and sandstone interbeds as well.

In contrast to the little deformed massive volcanic and volcaniclastic rocks of the Huntington Formation, the conglomeratic schist of the Weatherby is generally strongly foliated. Clasts are somewhat flattened and elongated. As far as I was able to determine, the foliation is parallel to the bedding as is common in the limbs of a fold. These strata are likely in the eastern limb of major anticline plunging, possibly moderately, to the north (see structure section below).

Gypsum and conglomerate

Pure to impure gypsum is interbedded with conglomeratic schist (Jwg map unit) in the lower part of the Weatherby Formation adjacent to the Brownlee Reservoir. Gypsum was mined at one location and trenched and pitted at several other locations. The actual nature of the stratigraphy in this unit was not determined, but gypsum likely is considerably less abundant than conglomerate in this unit. It's presence and extent southeast of the Louse Canyon fault is speculative.

Limestone and dolomite

A thick, massive limestone bed is well exposed in the northwestern part of the area. It is a cliff-former in this location and is perhaps 75 feet thick at maximum. The map unit Jwl is composed of this massive bed as well as slabby thin-bedded limestone both above and below it. The latter are similar to thin poorly cropping limestone beds scattered within the main conglomerate unit (Jwc).

The only other mapped body of this unit forms a resistant layer on the ridgetop central to the study area. This exposure contains both massive (up to about 5 feet thick) and thin slabby beds. Its boundaries are poorly defined.

In field notes from my 2013-2014 reconnaissance mapping of the northwestern Jwl exposure, I noted the presence of probable dolomite and also carbonate-looking rock that would not react to acid even when powdered. I speculated the latter might be anhydrite. I failed to confirm this in the current field season's work.

Huntington Formation

The Huntington Formation has long been considered to be Triassic (Brooks, 1979) and has been divided into lower and upper members. From recent U-Pb zircon dating, Ware and others (2022) report a Triassic age (ca. 220 Ma) from the lower member and a Jurassic age (ca. 187 Ma) from the upper member.

Rocks of the upper member of the Huntington Formation were examined in the triangular exposure area northwest of the Louse Canyon fault and along the Huntington-Weatherby contact southeast of this fault. Additionally, I spent a number of days mapping Huntington rocks across the Brownlee Reservoir near the Bayhorse mine (Conway and others, 2014). In both areas the rocks are very dark-weathering mafic volcanics and volcaniclastics. They are intruded by rhyolite dikes in the Bayhorse mine area. In the Bayhorse mine and adjacent to the Bayhorse rhyolite, the mafic rocks are extensively and variably hydrothermally altered. These hematite-rich altered rocks are dark reddish brown and commonly contain irregular pale green to white clay-rich blobs. Primary features such as conglomerate clasts and thin-bedded clastics are recognizable in these highly altered rocks.

In contrast to the younger Weatherby, the Huntington rocks are massive and show little or no foliation.

The Huntington-Weatherby contact in the Louse Canyon area and on to the southeast is shown as a thrust fault in Figure 2 of Ware and others (2022). I saw no evidence for faulting along this contact and consider it to be unconformable as per the regional picture.

Structure

The Huntington-Weatherby contact in the larger area around Bayhorse mine and the Louse Canyon area is roughly arcuate and convex to the north as shown in Figure 2 of Ware and others (2022). This suggests a northerly plunging anticline. Supporting this, Weatherby beds dip

northwesterly west of the Bayhorse mine then to the north at the Bayhorse mine and to the northeast in the Louse Canyon study area. The Weatherby beds in the Louse Canyon area are roughly parallel to foliation and would be in the easterly limb of this hypothetical anticline.

A reversal of foliation attitudes in the far northwestern part of the area suggests the presence of a small syncline.

The Louse Canyon fault is shown on the map as having a normal down-to-the-east displacement. It could, as well, have a right-lateral component of motion. The attitude of the fault plane was not determined. If the preferred interpretation given above is correct, that the rhyolite (Jra) intrudes the fault, then the faulting is of Jurassic age, post-dating deposition of the Weatherby and pre-dating intrusion of the Jurassic(?) rhyolite.

The other fault on the map, roughly parallel to the Louse Canyon fault, is inferred based on interpretation of Google Earth imagery. That section of the inferred fault between its two intersections with the Huntington-Weatherby contact is a sharp line between dark rocks on the northwest and light rocks on the southeast. This is reasonably interpreted as dark Huntington rocks juxtaposed with light (as is typical) Weatherby rocks.

The Rock Creek lineament is somewhat enigmatic. Because it is so pronounced one would expect it to reflect the presence of a fault. If it is a fault, it is likely of the same generation as the Louse Canyon fault because it appears to be cut by rhyolite (Jrf and Jrp). This is under the assumption that these cross-cutting rhyolite bodies are Jurassic in age.

The puzzle, however, lies in the apparent continuity of the lineament southward into the Columbia River basalt. This might suggest that a fault reflected in the lineament cuts the basalt. If indeed that is the case, any rhyolite cutting the fault would have to be post-basalt.

A third possibility is that the rhyolite does not cut the fault, contrary to what I have shown on the map. In this case, the fault might be Tertiary, would cut the basalt and also cut the rhyolite but with very little, virtually undetectable, offset of the rhyolite.

My preferred alternative is that the lineament reflects a Jurassic fault and is intruded by Jurassic rhyolite. The apparent extension of the lineament into basalt would likely represent preferential erosion uphill along the fault eating into the overlying basalt.

Mineralization

Gypsum ‘mineralization’ is not pertinent to this study and is therefore not discussed except in the description of the Jwg map unit.

A number of prospect pits and trenches are shown on the map in the aphanitic rhyolite (Jra) and in the conglomerate unit (Jwc) of the Weatherby Formation. Material excavated includes altered, weakly brecciated and micro-veined rhyolite, mineralized sediments, and quartz veins. Some of the latter have gossanous cavities. Small amounts of malachite and azurite were found in some of these excavations.

Two short (5-10 feet) adits are shown on the map in the Huntington rocks near the Brownlee Reservoir shoreline. The northernmost is into a 4" wide gossan zone within an east-west fault. I have nothing in my 2013 field notes regarding mineralization at the other adit.

From detailed mapping (scale 1:360) in the lower Louse Canyon area, Conway (2023) gives the following description of mineralization in the Jra unit. *"The most important takeaway from this field work is that the bulbous east end of the Bayhorse Rhyolite is mineralized. As indicated above in the waypoint notes, quartz veining is ubiquitous in the rhyolite of this area. Hydrothermal activity may have caused the local crackling and metasomatic silicification. Locally the rhyolite is vuggy which likely indicates the original presence of sulfides. Copper oxide coatings are present although scarce. Several prospect trenches and pits are shown on the map; other small workings are present."*

Features described above were also found in the current study in other exposure areas of aphanitic rhyolite. Notably, a gossanous sample from a prospect pit (see map) near the crest of the central north-south ridge contains anomalous gold, silver, copper, arsenic and antimony.

Silver and copper mineralization (tetrahedrite and copper sulfides) at the Bayhorse mine is structurally controlled by the Sunshine thrust fault (Conway, 2013b). However, mineralization along this fault occurs only in the presence of the aphanitic phase of the Bayhorse rhyolite (Conway and others, 2014). In complex fault slices within the fault zone, mineralization is preferentially in rhyolite.

No evidence for mineralization was found in the porphyritic (Jrp) and flow-banded (Jrf) units of the Bayhorse rhyolite.

Regional correlation of mineralization

The following section is to be considered preliminary. The main purpose of this report is to describe the geology and mineralization of the Louse Canyon-Rock Creek area. Further research into the regional relations would be required to make any definitive statements about the silver vs porphyry copper mineralization in the area.

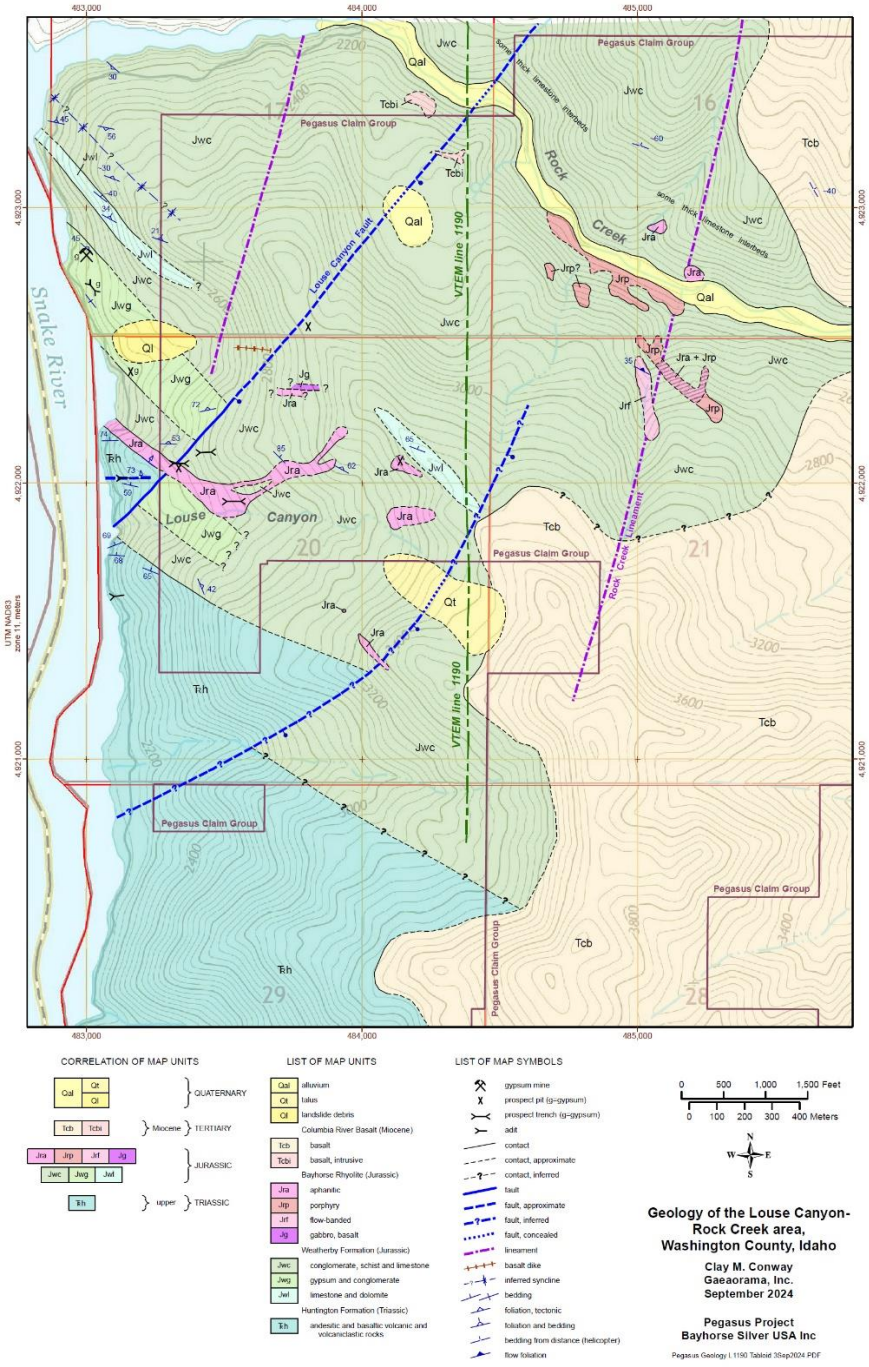
Mineral deposit settings and relations at Bayhorse have similarities to those in the Mineral and Cuddy Mountain districts. At each, silver mineralization is associated with rhyolite which is found at or near the Huntington-Weatherby contact. Thus, silver mineralization at all three is potentially coeval - generated in the same regional magmatic episode. The newly discovered porphyry copper mineralization at Hercules is in shallow intrusions beneath the silver deposits and may or may not be of the same generation.

In Hercules Metals' news releases, I have found no geochronology and have not checked the published literature for the Cuddy Mountain area. However, NevGold states in an 18 April 2024 news release that the silver mineralization at Hercules is Jurassic and that Triassic plutonic rocks are present at both Hercules (no age given) and Mineral (204 and 200 Ma) where NevGold has its Zeus project. NevGold suggests that the Triassic plutons may be the source of porphyry copper mineralization. [The Triassic-Jurassic boundary is 201.4 Ma.]

Rhyodacite (or trachyte) flows and an overlying rhyolite tuff at Mineral are considered by Ware and others (2022) to belong to the upper member of the Huntington Formation. They yielded Jurassic U-Pb zircon ages of 188.45 ± 0.05 Ma, 186.96 ± 0.07 Ma, and 187.03 ± 0.04 Ma. This requires the overlying Jurassic Weatherby Formation to be younger than about 187 Ma. Northrup and others (2011) have dated a rhyolite tuff in the lower part of the Weatherby Formation in the Mineral district to be 180.7 Ma. These numbers would require that the rhyolite intrusion of the Bayhorse-Louse Canyon area cannot be older than 187 million years and likely no older than 180 million years. The younger age limit of rhyolite magmatism is not at present constrained, but it is most likely Jurassic. The same age constraints would apply to the mineralization which at the Bayhorse mine and in the Louse Canyon area is clearly spatially associated with rhyolite and is therefore likely genetically related to the rhyolite

Based on the above relations, one might hypothesize that Jurassic silver mineralization in the region (the three areas discussed) would be about 15 million years or more later than late Triassic porphyry copper mineralization. This might imply either an extended period of magmatism - if the copper and silver mineralization are genetically related - or two unrelated magmatic/mineralizing events. Alternatively, the copper mineralization is not related to the Triassic plutons, but occurred later in different shallow intrusives along with the silver mineralization at higher levels.

An exploration model, or hypothesis, arises that magmatism produced both copper-bearing shallow intrusives and silver in higher levels associated with rhyolite emplacement. This model would suggest the possible presence of porphyry copper intrusives beneath the intrusive rhyolites of the Bayhorse-Louse Canyon area.



CORRELATION OF MAP UNITS

Qal, Qt, Ql		QUATERNARY
Tcb, Tcbi	Miocene	TERTIARY
Jra, Jrp, Jrf, Jg; Jwc, Jwg, Jwl		JURASSIC
Trh	upper	TRIASSIC

LIST OF MAP UNITS

- Qal alluvium
- Qt talus
- Ql landslide debris

Columbia River Basalt (Miocene)

- Tcb basalt
- Tcbi basalt, intrusive

Bayhorse Rhyolite (Jurassic)

- Jra aphanitic
- Jrp porphyry
- Jrf flow-banded
- Jg gabbro, basalt

Weatherby Formation (Jurassic)

- Jwc conglomerate, schist and limestone
- Jwg gypsum and conglomerate
- Jwl limestone and dolomite

Huntington Formation (Triassic)

- Trh andesitic and basaltic volcanic and volcaniclastic rocks

LIST OF MAP SYMBOLS

- gypsum mine
- prospect pit (g-gypsum)
- prospect trench (g-gypsum)
- adit
- contact
- contact, approximate
- contact, inferred
- fault
- fault, approximate
- fault, inferred
- fault, concealed
- lineament
- basalt dike
- inferred syncline
- bedding
- foliation, tectonic
- foliation and bedding
- bedding from distance (helicopter)
- flow foliation

0 500 1,000 1,500 Feet
0 100 200 300 400 Meters

N W E S

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