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Regional Setting of Rattlesnake Hills Alkaline Complex

Alkaline igneous complex hosted gold deposits are rare, but potentially substantial type of gold deposit. From Canada to Mexico, the inland margin of the Cordilleran orogenic belts, the Rocky Mountains are scattered with alkaline-igneous complexes. A number of centers in the Montana, Black Hills and Colorado Provinces are known to be gold bearing. Cripple Creek, Colorado has produced the most gold and is one of the best known world class alkaline rock gold deposits. While Cripple Creek is one of the largest gold alkaline systems in the world, gold enrichment in these systems is still not well understood. Cripple Creek is a large explosive volcanic diatreme complex, and is the largest diatreme complex in the alkaline trend. Rattlesnake Hills in Wyoming is a recently discovered prospect and is currently being actively explored by Evolving Gold Inc. It shares similarities with Cripple Creek including extreme alkalinity.

Distribution of alkaline magmatism in western United States based on time of formation. Numbered localities represent areas of economic importance. Map adapted from Jensen and Barton 2000.

Rattlesnake Hills Local Map
QEMSCAN® and Ore Microscopy Sample Locations

The three largest and most extensively drilled bodies of the Rattlesnake Hills alkaline complex: North Stock, South Stock, and Antelope Basin; however, South Stock is not currently being explored by Evolving Gold Inc. North Stock is dominated by explosive diatreme breccias, phanorite, and porphyritic bodies, both containing gold mineralization. Antelope Basin is a large quartz monzodiorite body that has intruded schist basement and remains a target for gold mineralization. Localized faulting with regional faulting aligning with foliation shows a NW-SSE to WNW-ESE trend dipping steeply. These structures provide structural controls for the gold mineralization.

Topographic map of Rattlesnake Hills. Evolving Gold Inc. 2008 and 2009 drill hole traces are represented by thin black lines, while holes with ore microscopy (red dots) and QEMSCAN® (blue dots) are thick purple lines.
Hydrothermal Fluid and Ore Paragenesis of the Gold-Bearing Rattlesnake Hills Alkaline Complex, Wyoming

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Introduction

Rattlesnake Hills gold mineralization is hosted in alkaline igneous rocks and diatreme breccias, and is currently being explored by Evolving Gold Corp. During the 2008 and 2009 drill seasons, Evolving Gold Corp drilled 93 holes totaling 36,190 meters. The local geology consists of Archean mica-rich schist basement rocks and 15 Tertiary intrusive bodies with varying lithologies of phonolite to quartz monzodiorite. The age of Rattlesnake Hills alkaline complex is 43-44 Ma. Gold mineralisation occurs in at least two styles: high grade gold-carbonate veins and low grade disseminated gold in altered rocks.

Cripple Creek, CO is analogous many alkaline centers in the Colorado Mineral Belt (Rocky Mountains) and throughout the world, especially Rattlesnake Hills, WY. The Cripple Creek system has multiple generations of hydrothermal events overprinting all phases of volcanics. It is still uncertain which magmatic event(s) is/are responsible for the hydrothermal alteration, early or late. However, it is known that mineralization is associated with the later stages of magmatism. Rattlesnake Hills Alkaline Complex shares these characteristics. Ore microscopy, QEMSCAN®, and fluid inclusion analysis show a complex fluid and thermal history.

Comparison of Rattlesnake Hills to Cripple Creek

Rattlesnake Hills Alkaline Complex is comparable to Cripple Creek, and has several similarities. Both complexes lie along a trend of alkaline complexes that extend from Mexico to Canada. However, Rattlesnake Hills is Eocene in age, and slightly older than Oligocene alkaline complexes of Cripple Creek. Rattlesnake Hills and Cripple Creek have similar rock types ranging from diatreme breccias, phonolite, and felsic porphyries. Gold mineralisation styles at both complexes occur in high grade veins with low grade disseminated halos of mineralization in altered wallrock. Cripple Creek has less intense potassic alteration, and there are no known zones of tellurides at Rattlesnake Hills.

Maps showing the similarities between Rattlesnake Hills, WY and Cripple Creek. Rattlesnake Hills Alkaline Complex intrusive and extrusive volcanics range from phonolite, felsic porphyry, and quartz monzodiorite. Cripple Creek major alkaline igneous lithologies range from phonolite to tephriphonolite to phonotephrite. However, lamprophyric dikes are present in the Cripple Creek Complex but have not yet been recognized at Rattlesnake Hills. Both complexes are hosted in granites and schists. Maps adapted from Evolving Gold Inc.

Fluid Inclusions

There is a rarity of fluid inclusions throughout the system. Most inclusions are extremely small (1-10 μm) and dark, making inclusion work challenging. Additionally, fluid inclusions recognized to date are associated with later carbonate generations, which do not carry gold.
Ore Microscopy

Gold most commonly is associated with sulfide rich carbonate veins in porphyry intrusions or “green” potassically altered schist. Ore microscopy of 30 thin sections shows the main ore minerals are: gold, pyrite, marcasite, chalcopyrite, and sphalerite. There are multiple fluid events in the deposit, making paragenesis difficult to determine. Petrographic results show gold occurs in pseudomorphic pyrite after bladed marcasite, blocky marcasite, and pyrite. Gold-bearing pyrite and gold-bearing marcasite do not occur together; however, nonmineralized marcasite and pyrite can be intergrown, but where there are stringers of the two, marcasite is generally earlier than the pyrite. Based on color variations of gold grains, it is probable that the composition of gold varies from grain to grain with some enrichment in copper.

Paragenesis:
- Leucosene replacing mafic minerals (Titanite).
- Pyrite and marcasite nucleate on leucosene cores.
- Difficult to determine sequence of marcasite and pyrite, because there are multiple generations of pyrite and marcasite, some intergrown, but generally without any contact.
- Gold associated with pyrite and marcasite.
- Goethite replacing gold associated with pyrite and leucoxene replacing pyrite.
- Pyrite nucleating on leucosene cores. Sample is unaltered schist with white carbonate vein (RSC 168 2587.5°).
- Pyrite nucleating on leucosene cores. Sample is unaltered schist with white carbonate vein (RSC 168 2587.5°).
- Marcasite growing on a leucosene center (Marcasite is partially to completely pyrite).

Gold occurs as:
- Euhedral, anhedral, pseudomorphic pyrite after marcasite. Marcasite has several forms: bladed, radial, snowflakes, and pseudomorphic marcasite after pyrite.

Pyrite occurs as:
- Anhedral, pseudomorphic pyrite after marcasite.
- Goethite replacing goethite.
- Large pyrite grain, with smaller marcasite grain with gold.
- Pyrite containing alluvial gold.
- Gold is hosted in pyrite and marcasite.

Gold, silver, and arsenic most frequently occur in both pyrite. The results confirm the petrographic analysis. QEMSCAN images show several features: 1. Strong K-feldspar alteration in all samples, by percent volume ~40%. 2. Pyrite with arsenian pyrite rims is associated with muscovite-silicate alteration zones. 3. There are generally two generations of carbonate in veins (In calcite-rich veins early calcite is rimmed by Mg and Fe-bearing calcite, and dolomite-rich veins show early dolomite with late Mg and Fe-bearing dolomite). 4. Pyrite associated with gold mineralization is at the vein contacts with wallrock or is associated with early carbonate vein generations. 5. Most gold, silver, and electrum grains range from 30-25 μm.

QEMSCAN® analysis of 11 thin sections using electron back scatter imaging produces false-colored images with a 2D-micro resolution. The main ore minerals are gold, silver, electrum, pyrite, and arsenian pyrite.