Letter of Interest for the
Homestake Deep Underground Science and Engineering Laboratory
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Role of Iron Formations in The Making of Giant Gold Deposits: Homestake Mine, Lead, South Dakota

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Objective: The role of iron-bearing units in destabilizing the gold bi-sulfide/chloride complexes and yielding to a giant gold deposit.

Introduction

Precambrian gold mineralization in the Homestake mine consists of pyrrhotite, arsenopyrite, +/- pyrite, and native gold associated with chlorite group minerals, quartz, siderite, ankerite, and biotite. This mineralization is intimately associated with a specific stage of quartz veining and ductile shear zones. Individual ore bodies are relatively undeformed, pipe-like to tabular bodies that vary from sparse to densely clustered, depending on a variety factors that include shear intensity, quartz vein development, rheologic contrasts, and host rock mineralogy. Ninety-five percent of the gold mineralization is hosted in the Homestake Formation with the remainder in the Poorman Formation and to a much lesser extent, the Ellison Formation.

Fluid Inclusion studies

Dr. Duke has performed microthermometry on over 1600 inclusions from 18 quartz vein samples. The vein samples were provided by Homestake Mining Company geologists and were considered to represent the three main stages of quartz veins: stage I (pre-mineralization), stage II mineralized), and stage III (post-mineralization) (Only one stage III sample was examined).

Inclusion types included (1) nearly pure gas, (2) water-gas, and (3) nearly pure water. Within these three general types, 16 sub-types were recognized on the basis of composition and density variations in the H2O-CO2-CH4-NaCl model system. Overall results are consistent with trapping of the earliest inclusions at near-peak metamorphic conditions of 370 deg - 580 deg C, 3.5 - 5.0 kbar. These were high-density H2O-CO2 inclusions (XH2O ~ 0.95). Subsequently, a variety of inclusion types were trapped along a clockwise, retrograde P-T-t path at temperatures and pressures below the H2O-CO2-CH4-NaCl solvus, although the exact mechanisms, timing, and origin for these is unclear.

Suggested Work :

- Direct in situ analysis of inclusion fluids to understand gold and sulfide and/or chloride speciation and chemical composition of mineralizing fluids.
- Determination of initial chemical composition of the iron formation (in this case the Homestake Formation) using samples from drill core and underground exposures.
- Assessment of the physical and chemical changes during metamorphism and its influence on Homestake mineralization, using samples from drill core and underground exposures.
- Using obtained data to establish a genetic model for giant gold deposits associated with iron formations, which would be a tool to explore for similar deposits elswhere.

Space Requirement and Technical Issues:

Initially, emphasis will be on the mine database composed of geologic maps and cross-sections, Homestake Core Repository and diamond drill hole logs, and the Vulcan digital data base

Selection of key areas will be based on preliminary analysis, and on currently accessible locations underground mainly from Homestake Formation.

Access to the underground facility:

No access required for the initial phase of this study. Initial phase samples will be selected from currently available Homestake Core Repository, mainly from the Homestake Formation.

Other general requirements:

Collaborator institution with a geoscience lab., (and/or a geoscience lab. within DUSEL) capable of extracting and analyzing inclusion fluid and performing isotope analysis.