

GEOLOGY OF THE RUBY CREEK COPPER DEPOSIT, SOUTHWESTERN BROOKS RANGE, ALASKA*

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ABSTRACT

At Ruby Creek, Alaska, a 1-km-diameter body of hydrothermal dolostone cuts through over 500 m of Middle to Late Devonian carbonate sediments and contains in excess of 100 million tons of 1.2 percent copper. It is one of several similarly mineralized dolostone bodies in the Cosmos Hills which occur near the boundary between a carbonate platform and a shale basin. A complex alteration sequence is recognized in the Ruby Creek body which shows distinct variations with depth. The alteration sequence is separated into two major stages: an early period of dolomitization with minor base metal mineralization (A and B dolostones) and a later period of fracture-controlled copper mineralization (C assemblage). Clasts of A dolostone in sedimentary breccias indicate alteration began during early diagenesis.

Early alteration resulted in progressive dolomitization of the host limestone and produced a zonal arrangement of low iron dolostone (A dolostone) around a ferroan dolostone (B dolostone) to siderite core. Siderite-bearing assemblages are either adjacent to, or replace, argillaceous lithologies. Alteration in footwall shale (now phyllite) is not recognized but may have been structurally displaced. Sulfide mineralogy also exhibits spatial and temporal variations. Sulfides are sparse in the A and upper, low iron B dolostones. Pyrite is a common accessory with later ferroan B dolostone and is commonly associated with minor sphalerite, barite, and barium silicates. In the core of the system, pyrrhotite, chlorite, and barium silicates are present with the siderite-bearing assemblage. A zone of discontinuous massive to semimassive iron sulfide separates the siderite-bearing zone from overlying ferroan B dolostones. Late assemblages of massive pyrite, often cobaltiferous, with minor sphalerite, occur in the middle and upper portions of the system adjacent to unaltered argillaceous beds. Conversion of dolomite to calcite accompanied pyrite deposition in these zones. Sulfur isotope studies suggest that temperatures in the core of the system during the early alteration stage exceeded 300°C. Reflectance studies of organic material contained within the various dolostones indicate that the alteration was produced by several fluid pulses, at least one of which carried hydrocarbon.

Dolomite veins (C veins) associated with the second major stage of mineralization show a distinct zonation. Veins are most abundant just above the massive iron sulfide layers separating ferroan dolostones from siderite-bearing assemblages. Vein density decreases toward the periphery of the system. Mineralogy also displays distinct spatial variations. Deep in the system the veins contain dolomite with sparse quartz, in the middle of the system dolomite, chalcopyrite with minor calcite, and pyrite are present. On the edge of the system the veins contain dolomite and calcite with minor sphalerite, pyrite, and fluorite. Massive copper sulfides are, in large part, restricted to former zones of massive pyrite. Chalcopyrite, replacing earlier pyrite, is the dominant copper-iron sulfide but is in turn replaced by bornite and finally chalcocite-digenite. Bornite- and chalcocite-rich assemblages display dolomite-destructive alteration and concurrent calcite precipitation. These copper-rich zones contain carrollite apparently formed from the breakdown of cobaltiferous pyrite. Fluid inclusion studies indicate decreasing temperatures of the system give temperatures of approximately 125°C. Zones of massive copper sulfides formed at temperatures between 100° and 120° C. The copper mineralization predates a Jurassic-Cretaceous period of deformation and metamorphism and appears to be a continuation of A and B dolostone alteration.

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GEOLOGY AND SULFIDE MINERALOGY OF THE NUMBER ONE OREBODY, RUBY CREEK COPPER DEPOSIT, ALASKA

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ABSTRACT

The Number One orebody is the largest and most sulfide-rich ore zone (at least 200,000 tons containing 8.4 wt % Cu) at the Ruby Creek copper deposit, in the southwestern Brooks Range of Alaska. Pyrite and copper-bearing sulfide minerals are concentrated within the matrix of a dolostone breccia body, which is enclosed by phyllite and calcic marble of Middle to Late Devonian age. The Number One orebody has three mineralogical zones that grade into each other: (1) an outer zone, widest toward the hanging wall, containing mostly pyrite with minor amounts of chalcopyrite and traces of carrollite and sphalerite; (2) an intermediate zone containing major chalcopyrite and pyrite, minor tennantite-tetrahedrite, bornite, carrollite, and sphalerite, and traces of galena; and (3) a core zone containing major bornite, chalcopyrite, pyrite, and chalcocite, minor carrollite, digenite, and sphalerite, and traces of galena, covellite, and the termanium-bearing sulfides renierite and germanite. Small clots of anthracitelike organic material (anthraxolite) are found throughout the ore. Much of the pyrite is fine grained and was deposited before the other sulfides, being increasingly replaced by Cu-bearing sulfides from the outer zone to the core. Some of this pyrite recrystallized into coarser grains having cobaltiferous rims, and these grains were generally not replaced. The sulfide minerals are commonly pseudomorphous after lath-shaped crystals within the dolomite clasts; no unreplaced examples were found, though the crystals closely resemble those of marcasite. The abundant fine-grained, porous pyrite also may represent replacement of marcasite. The origin and timing of brecciation and ore deposition remain unknown, though dolomitization and ore deposition appear to have occurred in preexisting carbonate breccia. Close mineralogical and geologic similarities are noted with the Kipushi Cu-Zn-Pb deposit in Zaire and with several other carbonate-hosted copper-rich organic-bearing deposits. The common concentration of the rare metals Co, Ge, and Ga in these structurally and mineralogically complex ores should increase their economic attractiveness.

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