Iron-Rich and Iron-Poor Mississippi Valley-Type Mineralization, Metaline District, Washington

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Abstract

Two texturally and mineralogically distinct types of Mississippi Valley-type mineralization are hosted by the upper Cambrian Metaline Formation in northeastern Washington. Josephine-type mineralization is iron poor and coarse grained, whereas Yellowhead-type mineralization is iron rich, fine grained, and commonly botryoidal. Josephine mineralization is found largely in the Josephine lithofacies, a fragmental unit near the contact between dolomites of the Metaline Formation and shales of the overlying Ledbetter Formation. Yellowhead mineralization forms several planar zones several hundred meters below, largely in the light-gray bedded dolostone lithofacies of the Metaline Formation. About 12.7 million tonnes (Mt) of Josephine-type ore (1.3% Pb, 3.0% Zn) and 730,000 t of Yellowhead-type ore (4.5% Zn, 0.5% Pb) were produced from the district before 1977, and about 5.5 Mt of ore (7.2% Zn, 1.3% Pb) remain, largely in the Yellowhead zone.

Ore textures in both types of mineralization indicate a complete lack of equilibrium among adjacent minerals, and this is confirmed by geochemical measurements. Although fluid inclusion homogenization and freezing temperatures are similar for both types of ore, fluid inclusion leachate and gas analyses differ for each mineral. Compositions for Josephine minerals appear to form a cluster that differs from compositions for Yellowhead minerals, suggesting that ore minerals were deposited from two parent brines that changed composition slightly to deposit each mineral. Isotopic analyses indicate that sulfur in both types of mineralization was probably derived from the same source whereas lead definitely came from two distinct sources. These observations indicate that ore formed when two parent metal-rich brines mixed with the same source of sulfur. Abundant pyrite that retains the form of marcasite suggests that the original brine in at least the Yellowhead ores was moderately acid. Geochemical speciation calculations indicate that relatively high temperatures are needed to dissolve enough iron to make iron-rich Mississippi Valley-type deposits. Furthermore, moderately acid brines with relatively low sulfur contents are enriched in iron whereas those with high sulfur contents lack iron, suggesting that the variations in iron content of these deposits reflect variations in the dissolved sulfur content of the parent brines.