Formation and Fractionation of Metamorphic Sulfide Melts

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Formation of metamorphic sulfide-sulfosalt melts and subsequent fractionation and crystallisation of those melts can significantly change the distribution and composition of ore minerals within a deposit. At moderate metamorphic grades, formation of sulfide melt only occurs in ore assemblages with a significant proportion of sulfosalts and a low porportion of galena, or where certain native minerals coexist. Some types of gold deposits are the most likely to melt under these conditions. At higher metamorphic grades (mid-amphibolite facies), melting is favoured by massive sulfides that contain arsenopyrite + pyrite, as well as galena and chalcopyrite, the latter two becoming more important as temperature increases through the upper amphibolite facies. An extensive sulfide melt is likely to form within some massive Pb-Zn-Cu deposits at high temperatures.

Deformation plays an important role in both formation and fractionation of sulfide-sulfosalt melts. It promotes generation of greater melt volumes, increased chemical complexity in the melt, and fractional crystallisation through its role in driving mobilisation.

During segregation and fractionation, melts become progressively enriched in precious metals and the semi-metals, Sb, As and Bi. Sulfide melts segregated from Pb-Zn-Cu deposits are enriched in Pb, As, Cu, Ag, Sb, Tl, Bi, and Au, and depleted in Fe and Zn relative to the massive sulfide restite. Depending on the composition of individual mineral assemlages, sulfosalt melts segregated from gold deposits are enriched in Au, As, Sb, Bi, Hg, Tl and Te, and depleted in Fe, Mo and Zn relative to the restite (partitioning of Pb and Cu is highly dependant on bulk composition).

A range of gold deposits and Pb-Zn-Cu deposits metamorphosed at different grades have been investigated and sulfide melting at these sites is discussed. Melting and fractionation processes led to formation of rare and unnamed mineral phases in a number of different deposits.