Controls on the Partitioning of Ore Elements into Granitic Melts

M. WOLF[1*] AND R.L. ROMER[1]

[1]Deutsches GeoForschungsZentrum, 14473, Potsdam, Germany (*correspondence: mwolf@gfz-potsdam.de)

The distribution of metals between melt and restite during partial melting is a key parameter, whether later development of the magma (fractionation, fluid exsolution) eventually results in sufficient enrichment to form mineralization. Partitioning of ore elements into the melt is a function of protolith chemistry, melting temperature, and mode of melt extraction.

We compare the trace element distribution between melt and restite for a low-temperature and a high-temperature migmatite, respectively. For the low-temperature migmatite, most trace elements concentrate in the restite as they are hosted in minerals that remain stable during muscovite-dehydration melting, i.e., in biotite, zircon, and/or monazite. In contrast, for the high-temperature migmatites, that form by biotite-dehydration melting, trace elements are enriched in the melt relative to the restite due to the breakdown of the host phases during melt generation or higher solubility of the host phases in the melt.

Partitioning during low-temperature melting leads to a slight enrichment of most trace elements in the restite. If low-temperature melts are removed before biotite-dehydration melting starts, melting of the enriched restite at high temperature will generate a small volume of melt with markedly enhanced ore element concentrations. If low-temperature melts are not lost earlier, however, the ore element content of these high-temperature melts is diluted by these earlier melts. How much low-temperature and high-temperature melt may form depends on the protolith composition that controls the modal abundance of muscovite and biotite at melting conditions. Modeling shows that intensely altered siliciclastic sediments have a composition that favors the formation of a large volume of low-temperature melt and a relatively small volume of high-temperature melt. As these rocks also tend to have higher contents of some ore elements (in particular Sn, W, and Ta) due to residual enrichment, these rocks may in particular favor the formation of enriched high-temperature melts.

Multiple melt extraction from the same source may result in large volumes of depleted early melts and relatively small volumes of enriched late melts. This contrasting potential for ore element enrichment is also reflected in the temporal relation between barren and mineralized granites within a single igneous complex.