Isotopic Disequilibrium during Partial Melting

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We present Sr, Nd, and Pb isotope data from leucosomes and melanosomes of low-temperature and high-temperature migmatites. Leucosomes and melanosomes have different Sr, Nd, and Pb isotopic compositions, which implies that (i) metamorphism and partial melting do not inevitably result in isotopic homogenization and (ii) the isotopic composition of partial melt and protolith differ.

The various rock-forming minerals have contrasting Rb/Sr, Sm/Nd, and U,Th/Pb ratios and, therefore, develop with time different Sr, Nd, and Pb isotopic compositions. The Sr, Nd, and Pb compositional range increases with time depending on their parent-to-daughter element concentration. During partial melting, some minerals contribute to the melt, other to the restite. The Sr, Nd, and Pb budget and the Sr, Nd, and Pb isotopic composition of the melt is controlled by the melting minerals, although there may be some redistribution between melt and restite.

Micas, as important hosts for Rb, have a high Rb/Sr and, thus, develop higher $^{87}Sr/^{86}Sr$ ratio than feldspar or amphibole. Involvement of these micas and feldspar, as for instance during muscovite or biotite dehydration melting, leads to distinctly radiogenic isotopic Sr compositions in the resulting melts. The prefered incorporation of LREE in the accessory phases apatite and monazite leads to a smaller increase in $^{143}Nd/^{144}Nd$ with time than for zircon, xenotime, or garnet, that prefer the HREE and therefore have high $^{147}Sm/^{144}Nd$. The Nd and Sr isotopic composition of leucosome and melanosome depends, however, not only on the phases involved in the melting process, but also on their age (as time is needed to develop isotopic differences). Our leucosome-melanosome pairs show differences of up to six ε_{Nd}-units and up to 0.005 in $^{87}Sr/^{86}Sr$.

If the leucosome has lower ε_{Nd} and higher $^{87}Sr/^{86}Sr$ than the melanosome, multiple melt extractions will result in distinct differences in ε_{Nd} and $^{87}Sr/^{86}Sr$ among the various melt batches extracted from the same source. This difference in isotopic composition, however, may incorrectly be interpreted as evidence for a different source or as mixed signal from two sources.