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Melting and melt segregation processes controlling granitic melt composition

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Abstract

Several important processes in the petrogenesis of granite are still debated due to a poor understanding of complex interactions between minerals during the melting and melt segregation processes. To promote an improved understanding of the mineral-melt relationships, we present a systematic petrographic and geochemical analysis for melanosome and leucosome samples from the Triassic Jindong migmatite, South China. Petrographic observations and zircon U-Pb geochronology indicate that the Jindong migmatite was formed through water-fluxed melting of the Early Paleozoic gneissic granite (437 ± 2 Ma) during the Triassic (238 ± 1 Ma), with the production of melt dominated by the breakdown of K-feldspar, plagioclase, and quartz. The Jindong leucosomes may be divided into lenticular and net-structured types. Muscovite, plagioclase, and K-feldspar in the net-structured leucosome show higher Rb and much lower Ba and Sr contents than those in the lenticular leucosome. This may be attributed to the elevation of Rb and decreasing Ba and Sr abundances in melts during the segregation process due to early fractional crystallization of K-feldspar and plagioclase. These leucosomes show negative correlation between $\varepsilon_{Nd}(t)$ and P_2O_5, reflecting increasing dissolution of low-$\varepsilon_{Nd}(t)$ apatite during the melting process. The continuous dissolution of apatite caused saturation of monazite and xenotime in melt, resulting in the growth of monazite and xenotime around apatite in the melanosome. This process led to a sharp decrease of Th, Y, and REE with increasing P_2O_5 in the leucosome samples. This complex interplay of accessory mineral reactions in the source impacts REE geochemistry and Nd isotope ratios of granites. As the granites worldwide exhibit similar compositional and isotopic patterns to the Jindong leucosomes, we suggest that both the melting and melt segregation processes strongly control the granitic melt compositions.

Keywords: Migmatite, crustal anatexis, disequilibrium melting, chemical fractionation, granite