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Unraveling Melt Loss: Metamorphic Modeling of Granulites via S-type Granite and Leucosome Melt Reintegration

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Granulites are essential for constraining the tectonic and metamorphic evolution of orogen. Their formation involves melting reactions where high-temperature mineral assemblages are preserved through melt extraction, leaving behind residual rocks. Modeling these processes is challenging because the extracted melt is often lost; therefore, it must be reintegrated into the bulk composition to accurately define metamorphic trajectories. This study optimizes metamorphic modeling by comparing the integration of chemical compositions from S-type granites, leucosomes, and melt modeled using MAGEMin software[1]. The research focuses on the Anápolis-Itauçu Complex, the Southern Brasília Orogen metamorphic core, Central Brazil. Metapelitic granulite samples consist of quartz, plagioclase, K-feldspar, garnet, biotite, kyanite, sillimanite, rutile, monazite, apatite and zircon. Modelling was based on local bulk composition acquired from quantitative microprobe maps. The first approach, adding leucosome composition, indicates a clockwise path, onset at approximately 812°C, 7.75 kbar in the prograde path, reaching peak metamorphic at 1137.5°C, 15.7 kbar; the retrograde path is marked by biotite and substitution of kyanite to sillimanite, at 500 °C, 5 kbar. A second approach, adding S-granite composition, indicates a metamorphic peak condition of 890 °C and 13.6 kbar and retrograde conditions of 720˚C and 7.8 Kbar. A third approach, using software-estimated melt, indications prograde conditions at 818°C and 8.12 kbar, peak at 950 °C and 15 kbar. The conditions of the metamorphic peak were also calculated by Bingo-Antidote[2] and the results was 867 °C and 16.33 Kbar. This work successfully constrains the metamorphic path of the granulites. All approaches yielded similar P-T conditions within the granulite facies field. However, certain aspects warrant further discussion: in the S-type granite reintegration approach, plagioclase remained stable over a broader P-T range due to the granite's specific composition. Furthermore, the leucosome integration resulted in slightly higher peak conditions compared to the other methods.

[1] Riel, et al. (2022), Geochemistry, Geophysics, Geosystems 23, e2022GC010427.

[2] Duesterhoeft, Lanari, (2020), Journal of Metamorphic Geology 38, 527-551.