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Inherited monazite from Nazaré Paulista anatectic granite: implications for monazite age determinations and timing of high-grade metamorphism in the Socorro-Guaxupé Nappe (SE Brazil)

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The present study takes advantage of the ability of electron microprobe analyzer (EMPA) to combine high spatial resolution information on textures, chemical composition and ages of monazite to investigate the petrochronology of the Nazaré Paulista anatectic granite from the Socorro-Guaxupé Nappe (SGN) in SE Brazil and thus contribute to understand the timescales of partial melting in the continental crust. The approach is similar to that previously used by us to date the partial melting of a migmatitic paragneiss associated with this granite, where we identified a protracted history of melt production and crystallization spanning ca. 25 My (from 635 to 610 Ma) (Martins et al. 2009, Chem Geol 261: 271–285).

A wide compositional and textural variety of "Nazaré Paulista granites" exists in the SGN, forming countless small bodies closely associated with migmatitic garnet-bearing paragneiss. The most abundant varieties are: gray Grt-Bt granite (typically veined by Grt leucogranite 1) and Grt leucogranite 2, forming independent bodies. The two garnet leucogranites have distinct origin, with the first being interpreted as a product of decompression remelting of gray granite in a mushy state, and the second as independent low-temperature magmas directly extracted from the sources.

A dataset of 37 determinations in 9 monazite crystals from a gray Grt-Bt granite resulted in a mean age of 614.9±5.0 Ma (95% confidence level, MSWD = 1.6, probability of fit = 0.01). Twenty two determinations in 7 monazite crystals from associated Grt leucogranite 1 vein resulted in mean age of 605.4±5.4 (MSWD = 1.18 and probability of fit = 0.26). Although these results are within error of each other, they are consistent with the structural relations and may indicate a ~10 Ma age difference between the two granites. Detailed textural examination indicates that some crystals from both granites have irregular higher-Y cores (0.54-1.44 wt.% Y), similar to monazite inherited cores found in leucosome from associated migmatitic paragneiss. Taken separately, these cores yield a mean age of 632.9±7.1 Ma (N = 10, MSWD = 0.09 and probability of fit = 1.00). When these cores are excluded from regression, the ages obtained for both granites are lower, nearly identical, and statistically more consistent (gray Grt-Bt, 605.3±4.5 Ma, N=23, MSWD = 0.87 and probability of fit = 0.64; Grt leucogranite, 602.2±4.9 (N= 19, MSWD = 0.58 and probability of fit = 0.91). We conclude that the higher-Y cores are inherited and therefore the true ages of the studied granites are younger than those obtained from regression from the whole dataset, implying that the age difference between the vein and host gray granite is negligible. Preservation of inherited monazite in granites seems uncommon, but our results should caution against the use of monazite age without careful textural control, especially in anatectic granites. In our case the best-preserved inherited cores are found as inclusion in magmatic garnet from Grt leucogranite 1, where the reaction with melt was limited. The remaining cores are strongly resorbed and only can be dated at the high spatial resolution of EMPA.