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The connection between crustal reworking and petrological diversity in the deep crust: clues from migmatites

Bruna B. Carvalho (1), Edward W. Sawyer (1), and Valdecir de Assis Janasi (2)

(1) Département des Sciences Appliquées, Université du Québec à Chicoutimi, Chicoutimi, QC, Canada., (2) Instituto de Geociências, Universidade de São Paulo, São Paulo, SP, Brazil.

The deep levels of the continental crust have been extensively reworked as result of crustal differentiation. Migmatites are widespread in these high-grade metamorphic terrains, and provide valuable information on how processes such as partial melting, segregation of the melt from the residue and subsequent chemical exchanges lead to the petrological diversity found in the deep crust.

This study investigates processes that transformed a largely uniform, metagranodiorite protolith into a very complex migmatite that contains three varieties of diatexites (grey, schlieren and homogenous diatexites) and several types of leucosomes. The Kinawa Migmatite is part of the Archean TTG crust in the São Francisco Craton (Brazil), which has been reworked in a shear zone environment at upper amphibolite facies conditions (<730°C and 5-6 kbar); thus it may be typical of crustal reworking in the interior of old cratons [1].

Grey diatexites are residual rocks formed by the extraction of a water-fluxed melt created via the reaction Pl + Kfs + Qz + H_2O = melt. Diversity within the grey diatexites arises from different degrees of melt segregation (maximum $\sim$40% melt). Schlieren diatexites are very heterogeneous rocks in which residuum-rich domains alternate with leucocratic quartzo-feldspathic domains where melt accumulated. Homogeneous diatexites are coarse-grained leucocratic rocks and represent larger bodies of anatectic melt with minor amounts (<20%) of entrained residuum. Leucosomes display a wide range of compositions from tonalitic to alkali-feldspar granite. Leucosomes, homogeneous diatexites and the quartzo-feldspathic domains in the schlieren diatexites all show a sequence of microstructural stages from plagioclase-dominated to K-feldspar-dominated frameworks many of which show evidence for tectonic compaction. Thus, further segregation of melt from solids occurred during crystallization.
Minor amphibolite dykes in the metagranodiorite did not melt. They occur as angular to rounded fragments (schollen or rafts) in the diatexites and show strong evidence for mechanical and chemical interaction with their melt rich hosts. Typically, the diatexites and the leucosomes around the schollen contain higher proportion of amphibole and/or biotite than that farther away; a number of features suggest that this is due to disaggregation that contaminated the melt rich rocks.

Our data indicates that in the deep levels of the crust petrological diversity is produced by melt segregation, both during partial melting and crystallization, and by interaction of the anatectic melt with unmelted material in the source. During melting, segregation produced residuum plus anatectic melt and all intermediate stages, whereas during crystallization it resulted in crystal fractionation and generated diverse plagioclase-rich rocks and fractionated melts. Finally, crystals disaggregated from the amphibolites entrained and interact with anatectic melt producing leucosomes and diatexites with the compositional signature of contamination.

[1] Carvalho, B.B; Sawyer, E.W.; Janasi, V.A. (2016). Crustal reworking in a shear zone: transformation of metagranite to migmatite. Journal of Metamorphic Geology DOI: 10.1111/jmg.12180