Geophysical Research Abstracts
Vol. 17, EGU2015-11160, 2015
EGU General Assembly 2015

Production and distribution of melt in domainal migmatite deciphered by micro-mapping the local effective bulk compositions

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Migmatites are fantastic targets to study the evolution of melt compositions, because they represent levels in the crust where partial melting has occurred. However, migmatites commonly have a complex history because they are the products of different transformation processes, such as (i) melt producing reactions, (ii) melt migration, and (iii) retrograde reactions. Evidence of such processes is preserved in the minerals and microstructures of rocks that outcrop in deeply exhumed orogens. The complexity of migmatites is due to their chemical and textural heterogeneity visible in different domains with various mineral assemblages. Partial melting of pelites involves reactions that are predictable using thermodynamic models. However, a forward modeling approach based on rock-specific equilibrium phase diagrams (P-T sections) requires the knowledge of local bulk composition for each equilibrium assemblage. This study demonstrates that suitable local effective bulk (LEB) compositions can be derived by means of standardized microprobe X-ray images, using the program XMAPTOOLS. For chemically heterogeneous samples, such as domanial migmatites, these LEB compositions allow the stable mineral assemblages to be modeled for each domain and to obtain reliable P-T estimates.

A metapelite sample studied in detail derived from a metasedimentary xenolith in the Marcabeli pluton, El Oro Complex, Ecuador. This sample shows complex mineral patterns due to local melt redistribution (at mm to cm-scale), involving major changes that affected the local chemical composition observed today. Four domains are identified: A residuum domain made of cordierite + biotite + plagioclase + spinel, which is a metamorphic assemblage stable at P-Tmax conditions of 750 $\pm$ 50°C and 2 $\pm$ 1 kbar. In the leucosome (plagioclase + Kspar + quartz + biotite + orthopyroxene) three sub-domains show different mineral assemblages. Domain-specific equilibrium assemblages in the P-T sections demonstrate that these three assemblages reflect three interconnected melt-rich domains, each with different melt fractions (from 29 to 93 vol-%), yet all coexisted at equilibrium near P-Tmax conditions.