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Evidence for microdomain formation and preservation in ultra high temperature granulites: Implications for the behaviour of melt in the lower crust.

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Migmatites indicating extreme metamorphism are commonly generated in late stages of orogenesis. Understanding the formation of microdomains preserved in partially molten and restitic rocks plays a key role in deciphering the properties and rheological behaviour of the lower crust.

The investigated sample belongs to the Antananarivo Block in northern Madagascar. It is an undeformed, highly restitic rock that underwent ultra high temperature (UHT) metamorphism culminating at 8-10 kbars and 900 - 1050˚C. Nevertheless, the rock still preserves three microdomains having different textural, chemical and petrological characteristics. (i) Domain A has an equigranular (ca. 200 μm) texture composed of 30% plagioclase, 30% biotite and 30% orthopyroxene with minor spinel, illmenite, rare quartz and local sillimanite occurence. (ii) Domain B is composed of mm-size crystals of biotite (40%) and orthopyroxene (45%) with locally plagioclase (10%), cordierite and illmenite. In both domains, plagioclase-rich pockets are evidence of local crystallisation of a former melt. (iii) Domain C shows inclusions of orthopyroxene and biotite in a cm-size porphyroblastic garnet closely associated to an aggregate of mm-size biotite.

The different domains reflect bulk chemistry heterogeneities and show the situation of effective melt segregation as well as related backreactions. The contacts between the domains are often well-defined. This aluminium-rich sample has an unusual chemical bulk composition. As expected at such temperature, garnet chemistry is homogeneous indicating fast diffusion. The preserved mineral compositions (e.g. "Al-in-Opx" thermometry, stability of the biotite by mineral equilibrium modelling) indicate a high solidus for this rock. The unusual bulk composition can only be explained by melt

segregation from a sedimentary precursor. The different domains associated to the special bulk chemistry composition offer a good opportunity to test thermodynamic models. Available consistent thermodynamic databases predict the stability of biotite under these conditions but do not predict the solidus properly. The model forecasts the formation of much more aluminium-rich phases compared to what is observed.

The observation of this UHT granulite can be summarized as follows: (1) melt segregation can be very effective in the lower crustal section; (2) despite of very high temperature textural and chemical microdomains are preserved and (3) the solidus of such restitic granulites is high (in the order of $\sim$800˚C). These interpretations have major consequences for the lower crust of granulitic composition. These crustal parts produce melt, which is transported away and leaves behind a solid restite. The effective melt segregation inverts the strength of such layers at ultra high temperature (from partially molten to solid rocks). The formation and preservation of heterogeneities independent from deformation shall be taken into account for unravelling the behaviour of melt in the lower crust.