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Partial melting and mantle-melts interactions at the Diamantina zone:insights on the mantle evolution during lithospheric break-up

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How continents break and how, when, and how much magma is produced during lithospheric breakup is yet little understood. A main reason is that answering to these questions requires direct access to rocks recording the magmatic processes during breakup, which is only the case for few places, among which the present-day Iberia and fossil Alpine Tethys ocean-continent transitions (OCT) are the best investigated. Studies from these sites showed evidence for partial melting, percolation and refertilization of inherited subcontinental mantle that allowed to develop a conceptual model to explain the magma-mantle evolution during lithospheric thinning and breakup at magma-poor rifted margins. Here we present bulk-rock and mineral major and trace element concentrations of mantle rocks and basalts dredged along the Diamantina OCT (SW Australia). Our results are interpreted in terms of mineral-melt exchanges in peridotites, element partitioning during refertilization and partial melting processes, and reconstruction of thermo-barometric equilibrium conditions in the subcontinental mantle of the Diamantina OCT.

Our preliminary results show that similarly to Tethys OCTs, two distinct mantle domains occur in the Diamantina zone: an inherited mantle formed of Sp-lherzolites equilibrated at $T_{REE}^{Cpx-Opx}$~1100°C, and a refertilized mantle domain of Pl-lherzolites with higher equilibrium temperatures ($T_{REE}^{Cpx-Opx}$~1300°C) highlighting the entrapment of percolating melts in the plagioclase stability field (~5kbar). The pyroxene speedometry indicates faster cooling rates than those calculated for the Tethyan subcontinental mantle (10^{-1} vs. 10^{-3}°C/yr, respectively). Basaltic rocks have tholeiitic to alkaline compositions (Na_2O+K_2O ~ 2-7wt% at SiO_2 < 52 wt.%). The REE-in-plagioclase-clinopyroxene thermometer indicates crystallization temperatures of ~1180°C.

These results suggest that lithospheric break-up in the Diamantina Zone is preceded by exhumation of subcontinental mantle from the Sp- to Pl-stability field in the presence of a high geothermal gradient. Thus, despite of the different inheritance and the proximity to the Kerguelen plume, the mantle evolution in the Diamantina zone is compatible with the Alpine model. We therefore consider that refertilization is a first order process that occurs at all magma-poor margins, independently of the pre-rift evolution. Nevertheless, how, and when partial melting occurred and how magmatic products evolved during exhumation remain unclear and need further investigations.