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Mantle-melt interactions related to lithospheric break-up: insights from the Diamantina zone (SW Australia)

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How continents break, separate, and how, when, and where magma is produced during breakup is yet little understood. Studies of exhumed mantle rocks from the N-Atlantic and the fossil-Alpine Tethys ocean-continent transitions (OCT) show that partial melting, percolation and refertilization of inherited mantle are intimately related to lithospheric thinning and tectonic exhumation during final rifting. Here we present new petrological and geochemical data from mantle peridotites dredged along the Diamantina OCT (SW Australia), show modelling results of mineral-melt exchange and discuss element partitioning related to refertilization and partial melting and compare the results with those described from the OCTs in the Alps.

The major and trace element concentrations of minerals composing spinel and plagioclase lherzolites were measured by µ-XRF and LA-ICP-MS. Spinel and clinopyroxene show two distinct populations that, consistently with those observed in the Alpine Tethys ophiolites, are representative of two mantle domains: i) the inherited subcontinental mantle, showing equilibration temperatures of 900±30°C; and ii) the refertilized domain characterized by higher equilibration temperatures (1100°C±100°C) highlighting the entrapment of MORB-type melts in the plagioclase stability field (~5kbar). Interestingly, few spinels found in inclusions in large pyroxene porphyroclasts in samples from the refertilized domain display the same chemical compositions as those from the inherited domain, thus representing the missing link between the two mantle domains.

Geochemical modeling and pyroxene thermo-barometry suggest that the lithospheric break-up in this region is preceded by exhumation of subcontinental mantle from the spinel stability field to the seafloor. The mantle peridotites follow a hot exhumation path that is due to the percolation at low pressure of MORB-type melts that formed in the garnet stability field. These observations are similar to those documented previously in the Alps. Thus, we assume that the nature of the inherited subcontinental mantle that is different at the two places has little impact on the magmatic processes during final rifting and breakup.