

Time-space migration of melting within the E-Atlantic plume and magmatism in Portugal: U-Pb ages and Pb-Sr-Hf isotopes

M. GRANGE¹, U. SCHARER¹, J. GIRARDEAU² AND G. CORNEN²

¹Université de Nice - Sophia Antipolis, Geosciences Azur (UMR 6526), parc Valrose, F-06108 Nice, France (grange@unice.fr; scharer@unice.fr)

²Université de Nantes, Laboratoire de Planétologie et Géodynamique (UMR 6112), 2 rue de la Houssinière, F-44322 Nantes cedex 3, France (vpcs@univ-nantes.fr; guy.cornen@univ-nantes.fr)

To examine time-space relations between gabbroic to granitic alkaline magmatism in Portugal and seamount formation in the central east Atlantic region we have undertaken (1) U-Pb dating on zircon and titanite, (2) U-Pb and Rb-Sr isotope analyses on grain-by-grains selected feldspars and (3) Hf isotope analyses of the dated zircons. Ages are 68.9 ± 0.3 (2σ) and 70.0 ± 1.0 Ma for the Monchique complex, and 77.2 ± 0.2 , 77.1 ± 0.4 and 75.8 ± 0.2 Ma for the Sines massif. For the Sintra magmatic complex four ages of 82.1 ± 0.1 , 83.4 ± 0.7 , 80.2 ± 0.6 , and 81.7 ± 0.4 Ma are obtained. An older age of 88.2 ± 0.5 Ma is defined for the Ribamar complex. These ages define a period of at least 19 million years for alkaline magmatism showing a systematic increase in ages from south to north. For intrusional-subvolcanic rocks exposes more than 100 km to the north, much older ages of 146.5 ± 1.6 , 142.3 ± 1.0 , and 145.3 ± 1.4 Ma were determined.

Corrected for in-situ decay of U and Rb (isotope dilution) Pb_i in the Cretaceous rocks lie at 18.522-19.299 for $^{206}Pb/^{204}Pb$; at 15.555-16.007 for $^{207}Pb/^{204}Pb$, and at 38.482-39.350 for $^{208}Pb/^{204}Pb$, and Sr_i are 0.70274 to 0.70481. For Hf isotopes, ϵHf_i range from +4.3 to +9.6. Most sources are less radiogenic in ^{206}Pb than the Cretaceous seamounts but they partly overlap with data from younger seamounts and the Madeira Archipelago. Examined in the Pb_i vs. ϵHf_i correlation diagrams all data plot in or adjacent to the field of worldwide OIB sources, being significantly different from any Atlantic MORB source. Cretaceous anorogenic alkaline magmatism in Portugal therefore requires melting of OIB-like mantle sources possibly followed by melting of the Iberian subcontinental mantle, as well as small contributions from old crust. The large spectra of lithologies seems to reflect differences in degrees of melting in possibly both, the plume and the subcontinental mantle. Emplacement of the 88 to 69 Ma alkaline complexes including the 77 Ma old Ormonde seamount is younger than Cretaceous seamount formation along the continent-ocean transition in the central east Atlantic. On the other hand, it is much older than Oligo-Miocene and Quaternary seamount emplacement. This pattern allows to establish that melting within the plume migrated in time from West (104-81 Ma) to East (88-69 Ma) and South (< 69 Ma).

Lithium incorporation in olivine

K.J. GRANT AND B.J. WOOD

GEMOC, Macquarie University, Sydney, Australia (kgrant@els.mq.edu.au; bwood@els.mq.edu.au)

The relative concentrations of the two stable isotopes of lithium are increasingly being used to investigate chemical homogeneity and evolution of the upper mantle. The principal host for lithium in the mantle is olivine, but how univalent species, such as Li and Na, are incorporated into the crystal structure remains poorly understood. Here, we describe the results of isobaric crystal-melt partitioning experiments which, together with thermodynamic modelling, provide insight into the mechanisms of incorporation of Li in forsterite and natural olivine of mantle composition.

The results of partitioning experiments conducted on end-member forsterite doped with varying concentrations of lithium and trivalent cations show that the dominant substitution mechanism depends strongly on the concentrations of dopant elements. At relatively high concentrations (>20 ppm Li in the crystal), lithium is principally incorporated into near end member forsterite via coupled substitution with trivalent cations such as Al and Fe^{3+} . At <20 ppm Li in the crystal, however, there is no correlation between Li partitioning and trivalent element concentration and results indicate charge-balance via vacancy or interstitial defect formation.

The lithium contents of natural olivine from the spinel stability field were measured using LA-ICPMS. The amount of Li in olivine is low (<5 ppm) and, unlike Na, does not correlate with the concentration of any trivalent cation species. We therefore conducted a series of additional experiments in order to investigate Li incorporation in natural, Fe-bearing olivine. In these experiments, crystals were grown at 1 atm from a natural basanite melt, at a range of oxygen fugacities. The results demonstrate that the partitioning of lithium between iron-bearing olivine (approximately Fo89) and melt is strongly dependent on oxygen fugacity (fO_2). The concentrations of lithium in mineral-melt pairs from our experiments show that $D_{Li}^{olivine-melt}$ decreases from 0.3 at IW to 0.15 at NNO. This negative dependence on fO_2 suggests that lithium is incorporated into Fe-bearing olivine either through formation of oxygen vacancies or coupled to tetrahedral Fe^{2+} . The consequences are that partitioning and diffusion of Li in natural materials is strongly dependent on the activities of major components in the medium.