Drying and dying of a subducted slab: Li and B isotopes in Western Anatolia Cenozoic Volcanism

S. AGOSTINI1, S. TONARINI1, J.G. RYAN2 AND F. INNOCENTI1,3

1 CNR – Istituto di Geoscienze e Georisorse, Pisa, Italy; s.agostini@igg.cnr.it; s.tonarini@igg.cnr.it
2 Department of Geology, University of South Florida, Tampa, USA; ryan@shell.cas.usf.edu
3 Dipartimento di Scienze della Terra – Università di Pisa, Pisa, Italy; innocen@dst.unipi.it

The transfer of the light elements Li and B from solid to fluid phases is accompanied by isotopic fractionation, with the heavier isotopes (Li and B) concentrated in fluid phases. In the context of subduction, low-temperature fluids released from slabs are strongly enriched in both 7Li and 11B, and progressive dehydration of slabs releases fluids with lower and lower δ7Li and δ11B. Interestingly, Li isotopes in most arc lavas show modest variation and are similar to MORB values, while δ11B shows remarkable variability.

Western Anatolia orogenic magmatism took place during the Neogene in an extensional but subduction-related context and shifted over time from calc-alkaline to shoshonitic to ultrapotassic in character. From Late Miocene onward OIB-type magmas occurred, and the transition from orogenic to intraplate products is marked by eruptions of mildly alkaline K-rich basalts. Values of δ7Li for calc-alkaline lavas vary widely (from +8 to -4 ‰) while younger ultrapotassic lavas show overall lighter δ7Li, partially overlapping the values of calc-alkaline rocks (+3 to -7 ‰). The variations observed in the calc-alkaline/U-K association are positively correlated with δ11B (varying between 0 and -15‰) and with 87Sr/86Sr (0.70866-0.70720). These data fit a model in which both Li and B isotopes are fractionated during progressive slab dehydration, and the geodynamic setting of the study area leads to melting of a supra-slab mantle that records this Li depletion. In this model, U-K magmatism originates via melting a mantle metasomatized by residual fluids coming from a dying slab. Pleistocene OIB-type Na-alkali basalts are characterized by δ7Li ≈ +3 ‰ and δ11B ≈ -2 ‰. Late Miocene potassic basalts have comparable δ7Li, but their δ11B varies from -13 to -4 ‰. The B isotope systematics of these lavas have been explained via melting of sub-slab mantle modified by small amounts of residual slab derived fluids [1]. The decoupling of B and Li isotopes in K-basalts may result from markedly different B and Li mantle contents. The mantle is essentially bereft of B (<<0.1 ppm), but contains significant Li (1-2 ppm), so that small slab fluid additions cannot shift Li isotopic compositions, but will significantly modify δ11B.

References