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Potential input of light elements into subduction zones—Insights from ODP leg 209

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Altered oceanic mantle potentially contains the major input of light elements (Li, B, and Be) into subduction zones. In order to constrain the enrichment of oceanic mantle in light elements by hydrothermal alteration, we studied altered spinel harzburgites from ODP Leg 209 (sites 1272A and 1274A) at the Mid-Atlantic Ridge (MAR; 15 °20′ fracture zone). In the studied samples, the degree of serpentinisation varies between 50% and 100%, and primary olivine, orthopyroxene and clinopyroxene are preserved. This allows us to constrain the Li, Be and B budget before and after serpentinisation.

Analysis of Li, B and Be by secondary ion mass spectrometry shows Li contents of olivine and orthopyroxene of 0.45–1.3 ppm and 0.38–1.0 ppm, respectively. This is fairly consistent with values for normal unaltered mantle minerals (Eggins et al., 1998; Woodland et al., 2004). Li contents of clinopyroxene (0.44–2.8 ppm) are slightly higher than in depleted mantle (Savov et al., 2005) and higher than in olivine, a trend opposite to what is commonly observed in non-metasomatised mantle (e.g., Woodland et al., 2004). This reverse Li partitioning could be explained by a reaction with a mafic silicate melt in the mantle (supported by textural data).

B and Be abundances (e.g., orthopyroxene: 1–100 ppb B and 0–4.2 ppb Be) are near the detection limit but comparable to depleted mantle (Savov et al., 2005). Obviously, the serpentinisation process did not considerably change the light element budget of the primary anhydrous mantle minerals. The average concentrations in serpentine minerals are 0.17 ppm Li, 0.4 ppb Be and 30 ppm B. Compared to the primary mantle assemblage, they are similar in Be, depleted in Li and strongly enriched in B. Strongly serpentinised oceanic mantle is thus a major carrier of B into subduction zones (but not of Li and Be) and hence plays an important role in the light element cycle. The different behavior of the light elements can be explained by the very different mineral–fluid partition coefficients of Li and B, by the higher (20 times) availability of B in seawater compared to Li, and by the very limited fluid mobility of Be.

References

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