

Lithium isotope tomography of a subduction zone

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Lithium (Li) concentrations in mafic oceanic rocks inherit limited variations from igneous processes but progressively increase through low-temperature ocean floor alteration, acquiring high $^7\text{Li}/^6\text{Li}$ ratios as a consequence of isotopic exchange of seawater with secondary phases. By entering a subduction zone, fluids released from metamorphosed units preferentially carry ^7Li , leaving the residual dehydrated rocks isotopically lighter compared to unmetamorphosed protoliths. Serpentinites could entrap such escaping fluids but high-pressure metamorphosed rocks, in particular eclogites, may also accommodate fluids, e.g., in symplectites following the major metamorphic peak, whereby $^7\text{Li}/^6\text{Li}$ of eclogites could vary greatly.

To address the fate of Li during subduction and metamorphism, we performed a detailed survey of Li elemental and isotope systematics in variously metamorphosed lithologies (in particular eclogitized rocks and serpentinites at the base, all representing a dismembered oceanic slab) of the Mariánské Lázně metabasite complex at the triple junction of the Saxothuringian, Moldanubian and Tepla-Barrandian, three major lithospheric units in the Central European Variscan Belt. These rock associations also occur frequently in neighboring regions (e.g., Münchberg Massif, Frankenberg klippen, Krušné hory Mts., Saxonian Granulite Massif, Oberpfälzer Wald, Moldanubian Zone). Low-grade Neoproterozoic to early Cambrian MOR spilites from TBU accretionary wedge were also analyzed as a proxy for ocean floor units.

In serpentinites and serpentinized garnet peridotites, Li contents range 0.6–48 ppm and $\delta^7\text{Li}$ values vary from -15.5‰ to $+12.3\text{‰}$, displaying stark regional differences, which plausibly reflect the variable extent of prograde metamorphism during subduction of oceanic slab to different depths and partial rehydration during late stages of their exhumation. The eclogites reveal a narrower range of Li abundances, commonly between ~ 6 and ~ 30 ppm, with $\delta^7\text{Li}$ from -15.6‰ to $+15.1\text{‰}$ overlapping those of serpentinites. The isotopically light Li captured in eclogites from the Saxonian Granulite Massif and Münchberg Massif may indicate strong prograde metamorphism associated with deep (U)HP/HT conditions, different to less metamorphosed areas. Collectively, Li holds a great potential in revealing regional-scale differences in the extent of fluid flow during subduction-related metamorphism.

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