

Trace element data and fluid regime during HP-LT metamorphism of basic rocks, Ile de Groix, France

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Trace element contents in whole-rock samples and minerals of the metamorphic rocks of the Ile de Groix - part of a Hercynian HP/LT metamorphic belt - were analyzed in massive and banded eclogites and blueschists. Geochemical data indicate that the protoliths of the massive lithologies represent MORB-type basalts. The banded lithologies are of volcano-sedimentary origin.

Trace elements contents for metamorphic assemblages were determined by LA-ICP-MS. GR03 is a banded blueschist containing an assemblage of grt-ep-Fe³⁺ rich gln-pheng-rt-mt-qtz. The bulk rock incompatible element abundances in this specimen generally exceed those for its constituent minerals. Only in garnet are the HREE contents higher than in the bulk rock, reflecting the high compatibility of the HREE within the garnet crystal structure. The epidote REE contents match those for the bulk rock in the central parts of the grains and decrease rimwards. All other minerals are REE and HFSE depleted compared with the bulk rock composition. Epidote and, to a lesser extent, phengite and rutile display a positive Pb anomaly in the multi-element patterns. The bias between the whole rock and the mineral trace element patterns observed in several specimens could be explained by a fluid that only partly left the rock system during the metamorphic process and was trapped in the rock interstices (Shatsky *et al.*, 1990). It is suggested that the fluid-mineral interface processes play a crucial role during the trace element mobilization during blueschist facies metamorphism, with some blueschists representing an assemblage of metamorphic minerals and fluid components that did not completely escape the system.

The comparison of massive and banded rocks indicates that the massive rocks were less affected by the fluid/element transfer than the banded rocks. Epidote in massive eclogites is REE enriched compared to the bulk rock. The distribution of REE in epidote is highly variable in all rock types. This seems to be constrained by the local equilibrium associated with the appearance and disappearance of new stable mineral phases (garnet, apatite or titanite) during the various stages of metamorphism. We suggest that the massive rocks were less rich in fluid components before the onset of high-P metamorphism, and that during fluid escape the REE mostly remained trapped in the newly forming mineral phases.

Reference

Shatsky VS, Kozmenko OA, Sobolev NV (1990). *Lithos* **25**, 219–226.

Diffusively driven Li isotope fractionation

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The cycling of Li at the Earth's surface results in marked isotopic fractionations (~40‰) that lead to the subduction of isotopically heavy Li. This scenario suggests that Li isotope ratios should provide a distinctive tracer of subducted components in oceanic basalts. Such promise is based on the tacit assumption of equilibrium, in which only low temperature processes can significantly fractionate stable isotopes. However, several recent experimental and observational studies have highlighted that Li isotopes are readily fractionated in magmatic processes by diffusion. In order to use Li isotopes as a tracer of recycled material it is thus critical to understand the role of diffusion on Li isotopes at different length scales.

We have examined Li isotopic profiles in phenocrysts of lava flows. Except in glassy samples, we commonly find zoned crystals. Such isotopic zoning appears to be the natural consequence of cooling, during which the partition coefficient of Li in phenocrysts increases. We have reproduced the forms of isotopic profiles in a self-consistent model driven only by cooling. Deriving absolute cooling rates depends on several parameters which are currently poorly constrained (e.g. the diffusivity of Li in olivine), but the data plausibly imply temperature drops of a few hundred degrees in hours.

The influence of diffusion on the Li isotopic composition of a whole lava flow, rather than its redistribution during final cooling, is more difficult to determine. The general over-lap of (unzoned) olivines from peridotitic xenoliths with many mantle derived melts suggest that whole rock compositions are not ubiquitously fractionated by diffusion. As an empirical assessment of possible diffusively driven differences in bulk Li isotopic compositions, we have analysed a suite of samples from the East Pacific Rise (9–10°N). These samples show near homogeneity in long-lived radiogenic isotope tracers but contrasting U-series disequilibria, suggesting their derivation from different depths of the melting regime. This should give rise to differential chemical gradients between the melts and mantle through which they finally ascend, potentially driving different diffusional loss of Li. Although the sample suite shows a significant range in $\delta^7\text{Li}$ related to disequilibrium, its magnitude is small (0.7‰), suggesting that the role of diffusion in influencing these lava compositions is minor.