

## Li Behaviour During Serpentinisation of Oceanic Peridotites

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The two most important sources of Li in the ocean are rivers and hydrothermal fluids with  $\delta^6\text{Li}$  values of -23 and -9 per mil, respectively (Huh et al, 1998). As the Li content and isotopic composition of sea water are constant (respectively 0.19ppm and -32.3 per mil, Chan et Edmond, 1988), some processes which preferentially remove the light isotope ( $^6\text{Li}$ ) from sea water are required to balance the inputs. Alteration of basalt at low temperature preferentially removes  $^6\text{Li}$  from sea water. However, this process is probably not sufficient to balance the Li isotopic budget of the ocean (Chan et al, 1992). Other processes which preferentially remove  $^6\text{Li}$  from the ocean have been proposed (e.g. high temperature alteration of basalt, uptake during marine sedimentation (Seyfried et al., 1984), but their mechanism are not well-known. In this study, we examine the behavior of Li during serpentinisation in samples dredged over EDUL Cruise (Marion Dufresne, 1997) along the South West Indian Mid Oceanic Ridge. The aims of this study were : (1) to determine the distribution of Li content and isotopic composition in primary and secondary minerals depending on the conditions of alteration, (2) to determine the effect of the serpentinisation process on the Li budget in the ocean.

**Samples and methods descriptions** Although peridotites are intensively serpentinised (more than 70%), relicts of primary phases are still present and include olivine, enstatite, diopside and spinel. The degree of serpentinisation especially depends on temperature and the water/rock ratio. The  $\delta^{18}\text{O}$  values of our samples range between 1.6 and 5.8 per mil suggesting temperature of alteration between 100 and 300°C.  $^{87}\text{Sr}/^{86}\text{Sr}$  ratios range between 0.708382 and 0.709345 indicating high water/rock ratios. In situ analyses were performed with the ion microprobe ims3f (CRPG-Nancy), and the isotopic values were calibrated using mineral standards including olivine, pyroxene and amphibole. Bulk rocks were measured by TIMS following James and Palmer, in press at the Bristol University.

**Li behavior during serpentinisation process** In situ analyses in thin sections allow to precise the Li distribution in serpentines. Li content is higher (up to 20ppm) than in relict minerals (less than 1ppm). This Li content depends on the serpentinisation conditions, with the sample altered at the highest temperature containing the lowest Li content. The mapping of Li isotope variations in minerals shows  $\delta^6\text{Li}$  ranging from -25 to -3 per mil

for primary minerals (olivine, opx, cpx), and from -19 to +15 per mil for serpentine. All minerals are highly heterogeneous, and in most crystal, altered zones have less negative  $\delta^6\text{Li}$  values than relict zones, indicating that serpentine preferentially incorporate light Li isotope. The  $\delta^6\text{Li}$  values measured by TIMS on whole rock samples range from -3 to -14 per mil for eight samples, in good agreement with the in situ values obtained on each samples. These variations are correlated with those of  $\delta^{18}\text{O}$  values, suggesting that Li isotopic fractionation is depending on temperature or that fluid isotopic composition become more and more negative as it circulates in oceanic crust.

3) Implications on the Li balance in ocean Considering the whole rock  $\delta^6\text{Li}$  values, the fluid composition should range from -9 to -20 per mil, enriched in  $^6\text{Li}$  compared to sea water. This suggests that Li in serpentine is provided by the high temperature alteration of the oceanic crust. The whole rock Li contents in our serpentinised samples (1-8ppm) are more concentrated than primary peridotites. For a proportion of serpentinised peridotite of 15%, this sink of Li is 10 time smaller than altered basalts, and would not balance the Li mass excess in ocean. The isotopic composition range for serpentinised peridotite is comparable to the one measured for altered basalts (-5 to -11 per mil, Chan et al, 1994). Moreover, serpentines do not represent a Li sink with negative values and can not isotopically balance the Li sources in ocean. The effect of serpentinisation is also to remove  $^6\text{Li}$  from fluids which previously interacted at higher temperature with the oceanic crust. Therefore this process would lower the Li transfer to the ocean.

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