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Osmium Transport During Dehydration Processes in the Subducted Slab: Experiments and Implications for the Os Isotopic Compositions of arc Magmas

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Suprachondritic $^{187}Os/^{188}Os$ in arc peridotites (Brandon et al., 1999), basalts and andesites (Alves et al., 1999; Suzuki and Tatsumi, 2000) indicates the mobilization of Os during subduction of oceanic crust. However, the mobilization mechanism of Os in subduction processes, dehydration or slab melting, is poorly constrained. In this study, high-pressure experiments have been conducted to evaluate osmium transport during the dehydration processes in subducted slab.

Aqueous fluids released from the subducting oceanic crust beneath the forearc region migrate upward and react with the overlying peridotite to form hydrous phases within the base of the mantle wedge (e.g., Tatsumi and Eggins, 1995). The major hydrous phase developed in the mantle wedge is serpentine, which is replaced by talc at temperatures of more than 60ºC. The dehydration reaction of serpentine is as follows:

serpentine -> olivine + orthopyroxene + H_2O

The reactions occurring within the down-dragged hydrous peridotite layer may be more complex, possibly due to solid-solution effects and the presence of minor hydrous phases. However, the apparent correspondence between the depths to the slab surfaces beneath dual volcanic chains and those of decomposition of amphibole/phlogopite provide rather compelling reasons for believing in the major role of such reaction in the formation of arc magmas (Tatsumi and Eggins, 1995).

We have used two types of starting materials for high-pressure experiments: A; natural serpentine (ca. 80%) from Ohesan (Kyoto, Japan), olivine (ca. 20%) and minor oxide (magnetite/chromite) and B; serpentine (>95%) and minor sulfide. The finely powdered samples were mixed and wrapped in perforated platinum foil to enable escape of any H_2O fluid liberated during the course of the experiments. The experiments were conducted at 1.0 GPa and 850ºC. in a solid-media, piston-cylinder high-pressure apparatus, using a piston-out technique. Reagent $Mg(OH)_2$ was used to check contamination from the materials such as the Pt foil.

Average Os concentrations in two starting material A and B were 2.88 and 0.32 ppb, respectively (Table 1). The mobility of an element during the dehydration experiments can be expressed as the percentage of an element removed by aqueous fluids during the dehydration reactions as follows:

$$\text{mobility} = (C_{STM} - C_{RP}) / C_{STM} \times 100\ (\%)$$

where C_{STM} and C_{RP} are the concentrations of Os in the starting material and in the run products, respectively. Any loss of Os was not observed in the sample B, while 13% Os escaped from the system during dehydration in the sample A. Since the Os concentration in the subducted material is much lower than that in the mantle, substantial amounts of Os derived from the subducting slab are necessary to elevate the Os isotopic compositions of arc magmas. However, observed 13% mobility in the dehydration process may be too low. Thus, slab melting rather than dehydration is possibly dominant for Os transport from the subducted slab into arc magmas.

Table 1. Osmium concentration and mobility of starting materials and run products.

	starting material Os (ppb)	run product Os (ppb)	mobility (%)
A	2.88	2.51	13
B	0.32	0.34	

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