Fluids at continental margins: What we can learn from [129]I results

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The close association of iodine with organic material and the presence of the long-lived radio-isotope [129]I ($T_{1/2}$ = 15.7 Ma) make this isotope system an interesting tracer for fluid movements at continental margins. The system was applied to studies of volcanic fluids associated with subduction zones [1] as well as to methane-rich fluids at passive [2] and active margins [3]. Volcanic fluids are characterized by iodine concentrations close to 10 μM, i.e. only moderately higher than in seawater (0.4 μM) and by CO_2 as their dominant carbon species. Results for volcanic fluids show [129]I/I ratios which are site-dependent and are consistent with derivation from subducting marine sediments. In contrast, fluids associated with gas hydrates or emanating from mud volcanoes along continental margins are enriched in iodine by factors of 500 or more compared to seawater and are dominated by the presence of CH_4. [129]I/I ratios in these methane-rich fluids predominantly fall into a narrow range between 200 and 400×10^{-15}, regardless of site or age of subducting slab present in active margins. Because the [129]I results show neither relation to the age of the host sediments nor to the ages of subducting slabs or other tectonic features, a significant proportion of iodine in the fluids in these locations probably is derived from sources in the upper plates of active margins. More specifically, the iodine age distribution suggests that organic sources of Eocene age or older have contributed to the iodine present in these fluids. These sources are found in the deeper sections of passive margins and in the continental parts of subduction zones. The [129]I/I results demonstrate that different processes are active in fore arc and main arc areas: volcanic fluids in the main arcs show the recycling of volatiles from subducting marine sediments but fluids in fore arc areas are predominantly derived from sources in upper plates, i.e. the terrestrial parts of continental margins.

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Silicon self-diffusion in forsterite, revisited

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The plastic deformation of minerals in the mantle is believed to be controlled by diffusion. Si is the slowest diffusion species in most mantle minerals, and therefore expected to limit the creep rates [1]. Jaoul *et al*. [2] measured the Si self-diffusion coefficient (D_{Si}) in forsterite (*Fo*) at ambient pressure, showing $\log[D_{Si}\ (m^2/s)]$= -22.1 at 1600 K. Such a value is approximately 3 orders of magnitude lower than that expected from the deformation experiments [3]. Moreover, measurement of D_{Si} at high pressures [4] showed very high D_{Si}, i.e., $\log D_{Si}$ = -19.8 at 1600 K. In order to solve these discrepancies, we revisited D_{Si} in *Fo* in this study.

Fo crystals were polished in colloidal silica solution, deposited with 300-500 nm of [29]Si enriched Mg_2SiO_4 films coverd by 100 nm of ZrO_2 films. They were annealed at 1600 K and 0, 1 and 8 GPa for diffusion. The diffusion profiles were obtained by SIMS.

Surface roughness is a serious error source for SIMS analysis. Although the roughness just after deposition was less than 10 nm, that after annealing become as large as 250-300 nm. Hence, the samples were polished again in colloidal silica solution after diffusion. The final roughness was thus reduced to be less than 50 nm.

$\log D_{Si}$ was determined to be -19.3±0.5 at 0 GPa and 1600 K in this study, which is 2.8 orders of magnitude higher than that by Jaoul *et al*. [2]. Their low D_{Si} could be obtained due to the bad contact of the coating layer with the host. The present D_{Si} is consistent with the high dislocation climb rates in deformation experiments. Our data also indicates a small activation volume as $3.0\times10^{-6}\,m^3/mol$.

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