Metasomatic mobilization of PGE in the suboceanic mantle: an implication from sub-μm-sized sulfides from Tahitian peridotite xenolith

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Platinum-group elements (PGEs: Os, Ir, Ru, Rh, Pt and Pd) are strongly partitioned into metallic phases. Hence PGEs are thought to have been mostly sequestered in Earth's core during core–mantle differentiation. In spite of such preferential distribution of PGEs into the core, investigations of natural mantle peridotites have revealed that PGE concentrations of the mantle are enriched, i.e. supra-chondritic PGE patterns that are not simply predicted from modeled pristine mantle left after the core separation (Mann et al., 2012 *Geochim. Cosmochim. Acta.*). With devoting efforts to compile bulk-rock PGE data of worldwide mantle peridotites in the past decades, metasomatic PGE inputs have been postulated (e.g., Lorand and Luguet, 2016 *Rev. Mineral. Geochem.* and references therein). Recent approaches of *in-situ* analyses for base metal (Fe-Ni-Cu) sulfides (one of the representative PGE-host minerals) along with bulk-rock analyses supported such PGE mobility during metasomatic events (e.g., Alard et al. 2011 *J. Petrol.*, Delpech et al., 2012 *Lithos*). However, direct petrographic evidence for the metasomatic mobilization of PGE has not yet been documented because the samples are imposed on 'multiple' metasomatic events (e.g., Lorand et al., 2004 *Chem. Geol.*). Here we introduce sub-μm-scale investigations of 'armored' sulfide inclusion array of metasomatic origin within silicate mineral in a lherzolite xenolith. With employing analyses by a field-emission transmission electron microscope with energy dispersive X-ray spectroscopy (FE-TEM-EDS), we introduce direct evidence of PGE mobilization in response to a metasomatic event and delineate the mechanism of PGE migration in the mantle.
The lherzolite xenolith we use here was collected at Tahiti island. Since the lherzolite contains (1) vein-like clinopyroxenes in equilibrium with carbonaceous melt, (2) secondary CO_2 fluid inclusions, and (3) secondary carbonaceous silicate glass inclusions, we suppose that the lherzolite was subject to carbonatite metasomatism. Our intense investigations into sub-μm-sized sulfide inclusion array in a clinopyroxene crystal revealed that they partly coexist with carbonaceous aluminosilicate glass, implying that immiscible sulfide melt and carbonaceous aluminosilicate melt filled microcracks before hearing of the host clinopyroxene. From the fact that the sulfides contain appreciable amounts of Ir–Pt–Rh (~20 atomic%), we conclude that Ir, Pt and Rh were mobilized through carbonatite metasomatism. We speculate that the PGEs were transported via miscible carbonatite–silicate–sulfide melts, which reached a new immiscibility field owing to a decrease in pressure and temperature. Although immiscible sulfide melts were minor in volume, most of the PGE were partitioned into the sulfide melts.

Keywords: PGE, Metasomatism , Mantle xenolith, Sulfide, Carbonatite, TEM