Origin of pallasites from chemical and isotopic composition of siderophile and volatile element

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Pallasites are meteorites with a simple mineralogy of Fe-Ni metal, silicate (olivine ± pyroxene) and ± FeS that has been for a long time interpreted as reflecting metal-silicate equilibrium at the core-mantle interface of early differentiated planetesimals. Several arguments based on chemical disequilibrium in olivine [1], variable and elevated cooling rate of the metal phase [2], remnant magnetisation of Fe–Ni olivine inclusions [3], have suggested pallasite formation through impact and mixing of olivine and metal from differentiated bodies. To test these hypotheses, we have investigated, in olivine and metal phases of pallasites, the chemical and isotopic composition of germanium (Ge), a siderophile and volatile element, which fractionates upon high-temperature impact processes [4].

Metal and olivine of Main-Group Pallasites (Imilac, Esquel, Brahin, Seymchan) and Eagle Station have been mechanically separated, then purified by hand-picking. These phases have been analyzed for Ge and metal trace element (Ni, Cr, Co) contents by ICP-MS, and chemically processed to isolate Ge for isotopic measurements by HG-MC-ICPMS (relative to NIST3120a Ge standard) (CRPG-Nancy) [5].

Ge contents in metal ranges from 45 to 65 ppm in MG pallasites and 63 ppm in Eagle Station, and in olivine from 40-70 ppb in MG pallasites and ≈135 ppb in Eagle Station. Values for olivine are of one order of magnitude lower than those of mantle rocks from Earth and Mars, but closer to Ge contents in HED. First δ^{74}Ge values in MGP olivine (+0.05 to +0.21±0.1‰, 2SD) are also significantly lower than those of the terrestrial mantle (δ^{74}Ge = +0.46 to +0.50‰, [5]). δ^{74}Ge values in MGP metals are homogeneous (+1.01±0.04‰). We can calculate a positive isotopic fractionation $\Delta^{74}Ge_{metal\text{-}olivine}$ of +0.8-+0.96‰ that is in the same direction than the Earth system [4]. Interpretations of low [Ge] and δ^{74}Ge in olivine of pallasites will be investigated in the light of (1) new results for CI chondrites (δ^{74}Ge=+0.90±0.06‰) and silicate mantles of Mars, Vesta, (2) processes of isotopic fractionation during injection of liquid metal in olivine mantle following impact.

[1] Hsu W. (2003) *MAPS* **38**, 1217-1241. [2] Yang J. and Goldstein J.I. (2006) *CGA* **70**, 3197-3215. [3] Tarduno J.A. et al. (2012) *Science* **338**, 939-942. [4] Luais B. (2007) *EPSL* **262**, 21-36. [5] Luais B. (2012) *Chem. Geol.* **334**, 295-311.