Isotope cosmochemistry of gallium: insights into planetary volatile depletion

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Gallium is a moderately volatile element with a 50 % condensation temperature of 968 K [1]. The Earth and the Moon are depleted in volatile elements, including Ga, compared to the primitive meteorites that represent the solar system element abundance [2]. The origin of this depletion is a long-standing debate. Furthermore, while Ga behaves as a siderophile element during metal/silicate partitioning [3], its over-abundance in the Earth's mantle is puzzling. In order to understand the Ga behavior in the solar system, and more generally the behavior of moderately volatile elements, Ga isotope ratio analysis at high precision was developed and applied to terrestrial, carbonaceous chondrites and lunar samples [4].

Samples were analyzed using a Neptune Plus MC-ICP-MS at IPGP. The $\delta^{71/69}$Ga was analyzed with a precision ~0.05 ‰ (2SD). We will present data for a variety of terrestrial igneous rocks, carbonaceous chondrites (CI, CM, CO, CV), and lunar samples (mare basalts, highlands, Mg suite, green glass, regolith).

Terrestrial samples have a narrow range of isotopic composition with statistically similar values (average δ^{71}Ga = 0.00 ± 0.06; 2SD, n = 18). The δ^{71}Ga of carbonaceous chondrites is lower compared to the one of terrestrial samples, and decreases in the order of CI > CM > CO > CV which is inversely correlated with the Al/Ga ratio. Lunar samples varied in isotopic composition, and a correlation between Ga and Zn isotopes was observed.

Despite the difference in degree of partial melting, the δ^{71}Ga value was homogeneous for terrestrial samples, which represent the BSE value [4]. Carbonaceous chondrites represent a two component mixing of a volatile rich/isotopically heavy with a volatile poor/isotopically light phase. Lunar samples are enriched in the heavier isotopes of Ga, similarly to Zn suggesting a global scale evaporation for the origin of the Moon volatile depletion.

[1] Lodders (2003), *Astrophys. J.* **591**, 1220–1247. [2] Drake & Righter (2002) *Nature* **416**, 39–44. [3] Blanchard *et al.* (2015) *Earth Planet. Sci. Lett.* **427**, 191–201. [4] Kato *et al.* (2017) Chem. Geol. **448**, 164–172.