Volatiles in the Earth-Moon system: A chlorine isotope perspective

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Description: Recent work focusing on hydrogen isotope systematics of lunar samples have indicated a common origin for water in the Earth-Moon system (e.g., Tartèse and Anand, 2013; Saal et al., 2013). On the other hand, chlorine isotope composition of lunar samples have been used to argue for an anhydrous Moon (Sharp et al., 2010) in apparent contradiction to the growing database of measured water contents in a variety of lunar rocks requiring a significantly wetter lunar interior (e.g., Tartèse et al., 2013). Much of the H isotope work in lunar samples have been carried out on apatite or volcanic glasses. In contrast, most of the chlorine isotope work has focussed on bulk-rock measurements with a very few analysis on apatites. Interestingly, except for lunar samples, Cl isotopic composition of pristine planetary materials measured to date, including terrestrial samples, display a very restricted variation (average $d^{37}\text{Cl} = -0.3 \pm 0.3 \%$). This characteristics has been used to argue for a homogeneous Cl isotope reservoir in the inner solar nebula (e.g., Sharp et al., 2013).

Lunar samples display more than 20 fold variation in their Cl isotopic composition ($d^{37}\text{Cl}$ ranging from -0.7 ‰ to 24 ‰), a characteristics considered to be a result of Cl isotope fractionation in absence of H (or water) and claimed to be consistent with sample measurements; a hypothesis currently becoming untenable in light of latest data. It is therefore imperative to evaluate other processes and scenarios that might give rise to extreme Cl isotopic fractionation as seen in lunar samples. Currently, there is a debate regarding some of the analytical protocols employed in bulk-sample Cl isotope measurements and hence the reliability of the bulk-rock data. Thus, it is desirable to apply a different technique for Cl isotope measurements which could provide an independent method to assess Cl isotope systematics of planetary samples.

Apatite and magmatic glasses are the major Cl-bearing phases in almost all planetary samples and are therefore suitable target for in-situ Cl isotope measurements by ion-probe techniques. The proposed project will build upon recent protocols developed at the Open University for measuring H and Cl isotopic composition in apatites and glasses using a NanoSIMS. The work will involve Cl isotope measurements in apatites and glasses in a range of lunar, terrestrial and other meteoritic materials to build a database with which to evaluate the processes and sources involved in imparting a specific Cl isotope composition in each case and help in developing a better understanding of the origin of volatiles in the Earth-Moon system.

We seek a highly motivated candidate with an interest in cosmochemistry and willingness to participate in developing and applying new analytical protocols for analysis of planetary materials. The successful applicant will work in a dynamic research team consists of several PhD students post-doctoral researchers.

References:

Qualifications required: A first class or upper second class MSci/BSc degree in Earth Sciences or related discipline. Any previous experience in using micro-analytical instruments such as EPMA or SEM would be an advantage.