Probing water-rock interactions in martian meteorites: Preparing for Mars Sample Return

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Description: The topic of the history of water on Mars is currently of great interest, as evidenced by a number of ongoing and forthcoming missions (e.g., MSL, ExoMars, Mars 2020). The next major step in martian exploration includes an internationally coordinated MSR programme [1]. Meanwhile, martian meteorites are ideal material available for developing robust analytical protocols for MSR-related investigations.

It is becoming ever clearer that surface samples have experienced complex histories, and that the amounts of sample returned will be limited and therefore it is of fundamental importance that we continue to improve and advance our technical expertise through the study of existing martian meteorites in order to ensure we are able to answer the scientific questions the returned samples are designed to address.

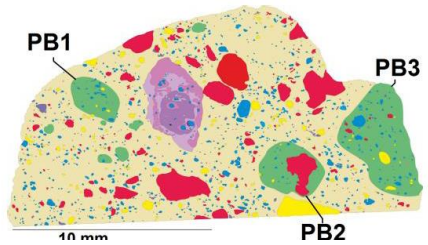

Fig. 1: A false-coloured X-ray elemental map of a slice of NWA 7034 highlighting the diversity of breccia in breccia clasts (PB1, PB2, PB3).

Measurement of H and O stable isotopic compositions in minerals associated with water-rock interactions provide a key tool for determining the origin of water in a given context [2-3]. The martian meteorites comprise a number of different lithologies with distinct geological histories that span most of the age of the planet. Determining the isotopic composition of the fluids associated with this alteration has the potential to record the evolution of the isotopic reservoirs in the martian atmosphere and hydrosphere through time. The increasing diversity of martian meteorites, e.g. the clast-rich breccia NWA 7034 and its pairs (Fig. 1), potentially containing records of sedimentary processes on Mars [4], now presents us with unique opportunities to investigate fluid-rock interactions on Mars.

In this project the PhD student will perform two inter-linked studies: (1) Refine analytical techniques for in situ measurements of the abundance and isotopic composition of H and O in alteration phases in a select set of martian meteorites to explore the water-rock interactions on Mars through time; (2) Develop micro sampling strategy for carrying out high-precision triple O isotope study on bulk-samples and a range of phases from these martian meteorites, which would help in understanding the evolution and magnitude of the isotopic disequilibrium between the crust and atmosphere and how atmospheric signatures are incorporated into the rock samples.

Results from this study will help identify contributory sources of waters on Mars based on their isotopic signatures that will then allow us to develop insights into the history of low-T aqueous alteration on Mars.

Continued

References:

[1] Beaty et al. (2019) Meteorit Planet Sci 54, S3-S152. **[2]** Piercy et al. (2020) Geochim Cosmochim Acta 280, 26-45. **[3]** Lee et al. (2015) Geochim Cosmochim Acta, 154(1), pp. 49-65. **[4]** McCubbin et al. (2016) J Geophys Res: Planets, 121(10) 2120–2149.

Qualifications required:

BSc (hons) in Geosciences, 2:1 or higher (a first class Master's degree in Geosciences or equivalent with some independent research experience would be preferred).