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STEPS TOWARDS PRECISE Ar/Ar CHRONOLOGIES FOR FLUID-ROCK INTERACTION THROUGHOUT THE SOLAR SYSTEM

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Introduction: Determination of ages for pre-terrestrial fluid-rock interaction has only been carried out on two of the twelve known nakhlites (Lafayette and Yamato 000593). The only K-Ar ages for the K-bearing “iddingsite” range from $0-670 \pm 91$ Ma [1]. Within the nakhlites fine-grained iddingsite is present in discrete veins and as grain coatings. The low K-content and fine-grain size of the iddingsite hinder the Ar/Ar approach as: (1) only small amounts of material are available for isotope extraction, and (2) potential recoil of ³⁹Ar and ³⁷Ar from the fine-grained clays during irradiation. This contribution will focus on novel approaches for Ar/Ar dating of fine-grain K-bearing clay in meteorites using cutting edge mass spectrometer technology (high-sensitivity high-resolution HELIX Split Flight Tube noble gas mass spectrometer), a range of irradiation protocols (e.g., *in vacuo* encapsulation, D-D fusion neutrons and irradiation of thin sections), and a variety of Ar extraction tools (e.g., CO₂ and UV lasers, bulb furnace). Analogue materials from the Isle of Arran (Scotland) have been collected to aid initial investigations. After testing of our approaches we will target K-bearing clay in both the nakhlites (e.g., Nakhla) and carbonaceous chondrites (e.g., Murchison).

Arran analogues: Samples for a ‘proof of concept’ study were sourced from the east coast of Arran, where a highly altered Carboniferous basaltic lava flow is exposed. The flow consists of grains of plagioclase and olivine that show similarities to olivine crystals from the nakhlites. Veins and patches of iddingsite are evident. These alteration products are been utilized to test and refine sample preparation methods, detection limits and achievable spatial resolution prior to analysis of the meteorites. This analogue material is especially useful as its age (c. 330 Ma) falls mid-way between the estimates for alteration of Lafayette (i.e. 0-670 Ma), its K-content is comparable to that of the nakhlite iddingsite, and veins of alteration products are 2-20 μm wide, also similar to the average size of veins in the nakhlites (4-16 μm [2]).

Analytical methodology: SUERC has taken delivery of the first two Thermo Fisher HELIX SFT noble gas mass spectrometers. We have built a custom designed low volume extraction line, which is dedicated to Ar/Ar dating of extraterrestrial materials. Attached to this system is a New Wave UP-213 UV laser that enables *in situ* analysis of material with a spatial resolution (spot size) of 4 μm. The HELIX SFT is able resolve isobaric interferences at mass 36 allowing for the first time a true ³⁶Ar measurement and accurate atmospheric correction. Ion counting electron multipliers and high-sensitivity resistor Faradays will allow for precise measurement of small ion beams, facilitating determination of precise Ar/Ar ages.

References: [1] Swindle T.D., et al. (2000) *MAPS*, 35, 107-115. [2] Changela, H.G. and Bridges J.C. (2011) *MAPS*, 45, 1847-1867.