

## NOBLE GASES IN HYDROTHERMALLY ALTERED MURCHISON (CM2) INSOLUBLE ORGANIC MATTER.

N. M. Allen<sup>1</sup>, M. E. I. Riebe<sup>1</sup>, D. I. Foustoukos<sup>2</sup>, H. Busemann<sup>1</sup>, C. M. O'D. Alexander<sup>2</sup>, G. D. Cody<sup>2</sup> and C. Maden<sup>1</sup>, <sup>1</sup>Institute of Geochemistry and Petrology, ETH Zürich, 8092 Switzerland (nicola.allen@erdw.ethz.ch), <sup>2</sup>Earth & Planets Laboratory, Carnegie Institution of Washington, Washington DC, 20015 USA.

**Introduction:** Alteration was an important process during the evolution of the early solar system. It occurred in the parent asteroids of chondritic meteorites due to heat generation from the decay of short-lived radioisotopes [1] and is separated into two main types. Thermal metamorphism leads to the recrystallisation of minerals and modification of crystal boundaries at temperatures of 250-900°C [2]. Aqueous alteration occurs when fluids interact with anhydrous minerals allowing for alteration at lower temperatures [3]. The effects of thermal alteration on noble gases in chondrites are well constrained; concentrations decrease with increasing metamorphic grade, and the release temperatures of Q gases increase [4,5]. The effects of aqueous alteration, however, are less well understood.

Noble gases are present in several phases hosted in the insoluble organic matter (IOM) of chondrites. Presolar nanodiamonds carry the components HL, P3 and P6, SiC grains carry Ne-E(H), and graphite carries Ne-E(L) [6]. Additionally, Q-gases are carried by the unidentified carrier Phase Q [7]. Previous investigations into the effects of aqueous alteration on noble gases indicated only small gas losses as significantly aqueously altered meteorites contained high concentrations in presolar grains and Phase Q [e.g., 8]. Loss of Ar and Kr relative to Xe in Phase Q was also identified [9]. Aqueous alteration also leads to loss of noble gases hosted in the soluble material of bulk CM chondrites, as well as the small losses of Q gases [10].

Tagish Lake (C2-ung.) provided an opportunity to investigate aqueous alteration within a single body. Analysis revealed only small variations in the noble gas concentrations for most carriers between the clasts, which experienced different degrees of aqueous alteration. Ne-E(L), however, was an exception, as it decreased in concentration in the more altered clasts, indicating it is lost from the presolar graphite carrier [11]. Apart from Tagish Lake and analysis of CM chondrites [11,10], most of our understanding of the variations with degree of aqueous alteration comes from matter from different parent bodies and is therefore complicated by different processes and conditions on distinct parent bodies. To address this, we performed a systematic study of noble gases in experimentally aqueously altered Murchison IOM. The samples were processed at different temperatures in water solutions with various  $\delta D$  to previously explore the H and N systematics in IOM during aqueous alteration [12].

**Methods:** The Murchison IOM samples were heated in pure water to a range of temperatures (250°C-400°C) at pressures of 50MPa. They reacted for between 27 and 163 days in solutions with  $\delta D$  values ranging from -345‰ to 3259‰ [12]. We analysed noble gases in three samples reacted at 300°C for 27-68 days, and one sample of unaltered IOM. The samples (0.0848-0.1383 mg) were packed in Pt tubes, and the compositions were measured on a noble gas mass spectrometer at ETH Zürich. The samples were extracted by infrared laser in one-step heating, with re-extractions to ensure complete degassing. Further samples altered at different temperatures will be measured to determine if noble gas characteristics depend on alteration temperature.

**Results and Discussion:** Preliminary results show alteration did not result in any significant changes to the Ne isotopic composition. This indicates that no major losses of Ne-E and other light noble gases occurred in presolar grains during the experiments. There are small but resolvable differences in the concentrations of the heavy noble gases; there is some mild loss of <sup>36</sup>Ar (12%), <sup>84</sup>Kr (14%) and <sup>132</sup>Xe (8%), and the elemental ratios of <sup>36</sup>Ar/<sup>132</sup>Xe and <sup>84</sup>Kr/<sup>132</sup>Xe decrease by ~5%. This suggests very mild degassing of Phase Q due to aqueous alteration. The differences between the light and heavy noble gases suggests that Phase Q is slightly less resistant to aqueous alteration than the above mentioned presolar grains. Reaction time does not affect noble gas concentrations, isotopic ratios, or elemental ratios. This suggests noble gas loss occurs during the early stages of aqueous alteration in IOM, consistent with previous Raman analyses indicating organic maturation in the early stages (~50 h) of IOM alteration [12].

In summary, our preliminary results indicate that experimental hydrothermal alteration leads to small alterations to the noble gases hosted in Phase Q, but no alteration to the noble gases in presolar grains.

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