NITROGEN AND HEAVY NOBLE GASES IN SANDS THAT HOSTED SAYH AL UHAYMIR 008 IN THE OMAN DESERT. S. P. Schwenzer1, R. K. Mohapatra1,2, S. Herrmann1, and U. Ott1, 1Max-Planck-Institut für Chemie, P.O. Box 3060, D-55020 Mainz, Germany, schwenze@mpch-mainz.mpg.de 2present address: University of Manchester, Department of Earth Sciences, Manchester, M13 9PL, United Kingdom.

Introduction: The Martian meteorite Sayh al Uhaymir (SaU) has been found in the desert of Oman. Up to now six stones, which are thought to be paired, have been discovered [1,2]. Terrestrial ages are estimated to be less than 10⁵ a [3,4]. Besides the petrological investigations, noble gas studies point to the Martian origin of the meteorite [5–7].

As these specimens spent a significant time in the desert, their indigenous elemental and isotopic compositions have been found to be affected by desert weathering [e.g. 5–8]. In order to understand the effects of terrestrial contamination on SaU in its nitrogen and noble gases, we have carried out a detailed study of various sample extracts (e.g., bulk, caliche and glass, [5–7,9]). These studies provide indications for the existence of an Elementally Fractionated Air (EFA, [10]) component in this meteorite which may explain the low-temperature component observed in Martian meteorites from hot deserts [11,12].

Adsorption of terrestrial nitrogen and heavy noble gases: Adsorption of terrestrial gases cannot be avoided during terrestrial residence and sample preparation. Preheating at 150 °C for several hours is usually adopted to remove such contamination. But signatures of terrestrial contamination induced by desert weathering have been shown to persist beyond such preheating and often to temperatures as high as 1000 °C [e.g. 12]. It has been shown that by using a carefully devised stepped heating experiment, it nevertheless is possible to isolate such terrestrial contamination from the indigenous signatures [5,6,12].

Take-up of heavy noble gases due to weathering and sample preparation procedures has been noticed in other types of meteorites as well. Incorporation of elementally fractionated Kr and Xe by chondrites due to weathering has been reported by [13]. Furthermore, [14] observed an increase of Kr and Xe during crushing and grinding of lunar samples with Xe uptake up to one order of magnitude greater than Kr uptake.

Still, processes responsible for the adsorption of heavy noble gases are poorly understood. Therefore we carried out studies on non-meteoritic material to investigate the elemental ratios of Kr and Xe in these samples. In an earlier study we investigated a caliche sample [9]. In the present study we have focused on a sample of the soil that hosted the meteorite in the Oman desert to further understand the nature of desert weathering of SaU.

Sample and experiment: The soil sample was collected by J. Zipfel, Mainz, directly at the point of discovery of SaU008. Two samples from different depths under the collecting point were taken. Part of the sample has been split into three grain size fractions (“coarse”, <500µm, <100µm) by sieving. For this experiment we used the grain size fraction <500µm of the surface sample.

9 mg of sandy material, wrapped in platinum foil, was measured in our laboratory using the procedure outlined in [6]. Gas extraction was carried out by stepped pyrolysis (at 250, 400, 1000, 1200, and 1600 °C) in an Ir crucible. An in line convectron® gauge was used to monitor gas pressures during each step. Pressure was highest during the 1000 °C step (similar to our earlier observation in the experiment with caliche from SaU005, [9]). This can be used as an indicator for the decomposition of the carbonate [15].

Results and Discussion: The amounts of gas released in the first two temperature steps were at blank levels (Fig. 1 and 2). Results obtained at temperatures of 1000 °C and 1200 °C are discussed below, because they are thought to originate mainly from the weathering products. In contrast to this, gas released at higher temperatures is likely to originate from the original mineral components of the sand itself.

$\delta^{15}N$ is 8.1±1.9 % and 17.9±1.5 % for the 1000 °C and 1200 °C temperature steps, respectively, which can be explained by terrestrial crustal values [16]. Negative values for $\delta^{15}N$, as found in our caliche experiment [9] and for desert nitrates by several authors [17,18] have not been observed in this experiment.
Only in the 400 °C step a slightly negative $\delta^{15}$N of -1.5±3.7 ‰ was observed, which is indistinguishable from air within error, however.

Kr and Xe data are summarized in Table 1. Isotopic ratios are identical to air values within errors. Amounts of Xe observed in the soil agree with what can be expected from the estimated amount of carbonate and the Xe concentration in the caliche [9]. $^{84}$Kr/$^{132}$Xe ratios in the 1000 °C and 1200 °C temperature step are 12.5 and 2.0, respectively, i.e. only 0.45 and 0.07 times the ratios in air.

**Table 1.** Kr and Xe data. All concentrations are given in $10^{-12}$ ccSTP.

<table>
<thead>
<tr>
<th></th>
<th>Soil 1000 °C</th>
<th>Soil 1200 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{84}$Kr</td>
<td>129±17</td>
<td>9.0±1.4</td>
</tr>
<tr>
<td>$^{132}$Xe</td>
<td>10.3±1.4</td>
<td>4.5±0.7</td>
</tr>
<tr>
<td>$^{84}$Kr/$^{132}$Xe</td>
<td>12.5±2.4</td>
<td>2.0±0.4</td>
</tr>
<tr>
<td>$^{129}$Xe/$^{132}$Xe</td>
<td>0.975±0.035</td>
<td>0.974±0.086</td>
</tr>
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Figure 3 shows a plot of $^{84}$Kr/$^{132}$Xe vs. $^{129}$Xe/$^{132}$Xe, as it is widely used in the study of Martian meteorites, using EFA [10] instead of Chassigny as an endmember. The plot also shows, as an example, data for 400 °C and 1600 °C temperature steps of SaU005 bulk sample measurements. The low temperature results fall onto a line between EFA and air whereas the high temperature step shows clear evidence for Martian atmospheric contribution. Also depicted are the results of our caliche experiment [9]. These data show elemental fractionation with $^{84}$Kr/$^{132}$Xe as low as ~5. Data for different water samples taken from the literature [19] vary between 13.4 and 15.9.

Our results on non-meteoritic material indicate that low Kr/Xe ratios in weathered martian meteorites are not necessarily of Martian/meteoritic origin, but can also be obtained by desert weathering processes. Fractionation below values that correspond to solubilities in water is possible. Therefore interpretation of low Kr/Xe ratios, especially in low temperature steps of meteorite investigations, has to be done with caution. In addition, our results raise the question if the formation of carbonates on Mars can lead to similar effects.

![Fig. 2. Cumulative release plot for $^{132}$Xe.](image)

**Fig. 2.** Cumulative release plot for $^{132}$Xe.

**Fig. 3.** $^{84}$Kr/$^{132}$Xe vs. $^{129}$Xe/$^{132}$Xe plot.

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**References:**