COLD DESERT'S FINGERPRINTS: TERRESTRIAL NITROGEN AND NOBLE GAS SIGNATURES, WHICH MIGHT BE CONFUSED WITH (MARTIAN) METEORITES SIGNATURES.

S. P. Schwenzer[1], M. Colindes[1], S. Herrmann[1] and U. Ott[1], [1]Max-Planck-Institut für Chemie, Joh.-J. Becherweg 27, D-55128 Mainz, Germany; schwenze@mpch-mainz.mpg.de.

Introduction: Among the 36 Martian meteorites known to date 12 (or 26.2 kg) are finds from Antarctica, with their number constantly increasing. Moreover, some individuals belonging to the rarest groups stem from Antarctica, like the only orthopyroxenite ALHA84001. Terrestrial weathering can be expected and has been observed [2], as the Antarctics Martian meteorites have terrestrial ages in the range of some 10^3 to 10^4 years [2]. Furthermore we previously argued that terrestrial weathering might account for the differences observed between ALHA84001 noble gas signatures and those of the nakhlites [3]. Here we focus on the cold desert environment; in our accompanying paper [4] the hot desert environment's influence is discussed and a brief literature summary is given. The aim of both papers is to evaluate possible terrestrial contamination of (Martian) meteorites. Thus we focus on gases released at low-temperatures, mainly ≤ 800 °C.

Sample: During the 2003/2004 ANSMET season three terrestrial samples were collected for our study from a moraine at Sandford Cliffs: 1) a boulder of about 15 cm diameter, 2) a half-fist-sized piece of rock and 3) gravel plus fines from a freezing-thawing zone. Here we used two pieces from the interior of the boulder (samples fresh 1 and 2) as material with minor terrestrial influence, three samples from the "weathering crust" of the boulder (weathered 1–3), and separated the 100–500 µm fraction from the gravel and fines by dry sieving; this sample is called "moraine".

Petrography: The original rocks are dolerites, which appear fresh with some patches of brownish color. When crushed, parts of the outer 1–3 mm chip off the boulder easily. This outer portion is named "weathering crust" here. It contains the original minerals but shows far more intense brownish staining than the interior. The "moraine" sample contains ~ 78 % dolerite fragments, in addition 11 % milky grains of light yellowish-white color and 11 % of a third component, most likely quartz, which is intensely covered with Fe-oxides-/hydroxides. Detailed petrographical and mineralogical investigations are under way.

Results: Nitrogen and noble gas results are given in Table 1 and Figs. 1–3. Using the ^{40}Ar/^{36}Ar ratio as a guide, we regard all T-steps below 900 °C to release adsorbed atmospheric and secondary mineral gases in the samples from the boulder. The picture is somewhat different for the moraine sample, which degassed significantly radiogenic Ar (^{40}Ar/^{36}Ar=4180) from the 600 °C-step on. On the other hand, the moraine sample releases 78 % of ^{36}Ar in the 400 °C-step, while the other samples only release between 28 and 52 % in this step. The same holds true for ^{132}Xe, where the moraine sample releases 72 % at 400 °C, the other samples between 26 and 52 %. The amount of ^{36}Ar and ^{132}Xe correlate in the low-T-steps of our five samples. No clear distinction can be made between fresh and weathered samples from the amounts released. In contrast, the ratios ^{36}Ar/^{132}Xe and ^{84}Kr/^{132}Xe clearly discriminate between the three sample types. The fresh samples are identical in their low-T-steps' ratios: ^{36}Ar/^{132}Xe is 815±80 and 848±81for fresh 1 and fresh 2, respectively, and ^{84}Kr/^{132}Xe 14±1 for both. For the weathered samples ^{36}Ar/^{132}Xe varies between 247 and 381, mean ^{84}Kr/^{132}Xe is 10.2±1, the moraine shows ^{36}Ar/^{132}Xe=27 and ^{84}Kr/^{132}Xe is 1.8. The δ^{15}N values are varying in a wide range for samples from the boulder. "Moraine" and weathered 1, however, are the only samples showing air ratio within error, all other δ^{15}N values are higher. Except for "moraine", the differences smoothen or vanish in the sums as the contribution from high T-steps is added.

Discussion: Ratios of ^{36}Ar and ^{84}Kr to ^{132}Xe become lower with increasing degree of weathering, which might be due to repeated adsorption/desorption cycles. Due to its higher heat of adsorption [5] Xe is favoured when adsorbed, while Kr is favoured when desorbed. No such effect can be seen for the nitrogen isotopes in the samples from the boulder. The "moraine", however, shows clearly negative δ^{15}N in all T-steps ≥ 500 °C, of which especially the 900–1200 ones might be related to the decompostion of some secondary phases. Negative δ^{15}N values have been observed in soils, plants and some natural gases [6]. Some of the lowest values have been found in samples from Antarctic dry valleys [7].

As a result, influence on the nitrogen and noble gas budget of meteorites due to Antarctic weathering is obvious. The weathering signature shows low ^{36}Ar/^{132}Xe and ^{84}Kr/^{132}Xe elemental ratios, which can easily be mistaken as Martian interior singnatures [8]. While the direction of fractionation seems to be clear, the degree of changes in the noble gas budget, and even more the nitrogen signature and budget, as well as their correlation to other weathering features need more investigation.

References: [1] http://curator.jsc.nasa.gov/antmet/marsmets/samples.cfm. [2] http://curator.jsc.nasa.gov/antmet/mmc/contents.cfm. [3] Schwenzer S.P. et al. (2006) *LPSC XXXVII*, Abstr. # 1614 [4] Schwenzer et al., this volume [5] Ozima M. & Podosek F. A. (2002) Noble gas geochemistry, Cambridge University Press. [6] Coplen T.B. (2002) *Pure applied Chem*, *74*,: 1987–2017 [7] Wada E. et al. (1981) *Nature*, *292*, 327–329 [8] Swindle T.D. (2002) *Reviews in Mineralogy & Geochemistry 47*, 171–190.

Acknowledgements: We are grateful to Nancy Chabot, Ralph Harvey, John Schutt and the ANSMET team for collecting the samples. We thank Niels Hoppe for assistance with parts of the data reduction. This study is funded by DFG grant SCHW 1232/1-1.

Table 1. All samples of this study, total amounts. ^{36}*Ar in* 10^{-8} *ccSTP,* ^{132}*Xe in* 10^{-12} *ccSTP,* N_2 *in ppm.*

sample (weight)	^{36}**Ar**	^{132}**Xe**	^{84}**Kr/**^{132}**Xe**	**δ**^{15}**N**	**N**$_2$
fresh 1	0.549	8.06	12.8	9.5	3564
(67.7 mg) ±	0.019	0.42	0.7	1.4	144
fresh 2	0.389	5.00	16.3	13.1	1658
(81.3 mg) ±	0.018	0.36	1.2	0.5	9
weathered 1	0.611	24.13	8.4	3.9	3991
(60.3 mg) ±	0.022	0.61	0.3	2.5	180
weathered 2	0.648	17.39	10.6	9.7	3925
(126.0 mg) ±	0.016	0.32	0.3	1.2	174
weathered 3	0.572	13.11	16.5	---	2923
(99.2 mg) ±	0.018	0.45	0.6		134
moraine	0.826	332.6	1.8	-8.4	3445
(79.8 mg) ±	0.022	6.3	0.1	1.3	98

Fig. 1-3 Cumulative release plots for ^{40}*Ar/*^{36}*Ar,* ^{84}*Kr/*^{132}*Xe and* δ^{15}*N for three selected samples.*