TRAPPED SOLAR WIND GASES IN LUNAR FINES AND A BRECCIA. P. Eberhardt, J. Geiss, H. Graf, N. Gröger, M. D. Mendia, M. Mörgeli, H. Schwaller, A. Stettler, Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland, and U. Krähenbühl, H. R. von Gunten, Institut für anorganische, analytische und physikalische Chemie, University of Bern, Freiestrasse 3, 3012 Bern, Switzerland

The noble gases He, Ne, Ar, Kr and Xe were measured in:
- Four ilmenite grain size fractions separated from the Apollo 11 breccia 10046.
- Seven bulk grain size fractions obtained from Apollo 12 fines 12001.
- Five ilmenite grain size fractions separated from Apollo 12 fines 12001.
- Two olivine fractions separated from Apollo 12 fines 12001.

In addition Sr, Zr, Ba, were measured in five and La, Ce, Sm, and Eu in three bulk grain size fractions.

The salient results are:

1) The \((\text{He}^4/\text{Ne}^{20})_{\text{tr}}, (\text{Ar}^{36}/\text{Kr}^{86})_{\text{tr}}\) and \((\text{Kr}^{86}/\text{Xe}^{132})_{\text{tr}}\) ratios in the four ilmenite fractions of 10046 are grain size independent and similar to the ratios found in the 10084 ilmenite (Eberhardt et al. 1970). The \((\text{Ne}^{20}/\text{Ar}^{35})_{\text{tr}}\) ratio, however, is highly grain size dependent, increasing from 10 for the coarsest fraction to 29 for the finest one. This may be due to an impurity (glass?) containing large amounts of Ar, Kr and Xe, but no He and Ne. This impurity may have been degassed from He and Ne during the breccia formation.

2) The average \((\text{He}^4/\text{He}^3)_{\text{tr}}\) ratio in the 10046 ilmenite is 3060 \pm 160. This value is distinctly higher than the corresponding ratio of 2720 \pm 90 found in the 10084 ilmenite (Eberhardt et al. 1970). The similarity of the \((\text{He}^4/\text{Ne}^{20})_{\text{tr}}\) ratios in the 10046 and 10084 ilmenites suggests that long time variations in the solar wind \text{He}^4/\text{He}^3 ratio exist.

3) The \((\text{Ne}^{20}/\text{Ne}^{22})_{\text{tr}}, (\text{Ne}^{22}/\text{Ne}^{21})_{\text{tr}}, \) and \((\text{Ar}^{36}/\text{Ar}^{38})_{\text{tr}}\) ratio in the 10046 ilmenite are very similar to the 10084 ilmenite. The \((\text{Ar}^{40}/\text{Ar}^{36})_{\text{tr}}\) in the 10046 ilmenite is a factor of two higher than in the 10084 ilmenite, probably reflecting time variations in the outgassing behaviour of the moon.

4) The isotopic composition of trapped Kr and Xe was evaluated from the five finest 12001 bulk grain size fractions using the \((\text{Kr}^M/\text{Kr}^N)_{\text{m}}\) versus \([\left(\text{Sr} + 0.8 \text{ Zr}\right)/\text{Kr}^N]_{\text{m}}\) and \((\text{Xe}^M/\text{Xe}^N)_{\text{m}}\) versus \((\text{Ba}/\text{Xe}^N)_{\text{m}}\) correlation.
method (cf. Eberhardt et al. 1970). The inclusion of a correction for the variable target element chemistry in the different grain size fractions was important for the 12001 fines and led to improved values for the isotopic composition of trapped Kr and Xe (cf. Figure 1).

5) The isotopic composition of the trapped Kr in the 12001 fines (BEOC 12) is slightly different from the composition derived from the Apollo 11 fines 10084 (Eberhardt et al. 1970, Pepin et al. 1970). The BEOC 12 krypton agrees with slightly fractionated atmospheric Kr (- 4.6% per mass unit fractionation), except for a possible excess of Kr$^{86}$ in atmospheric Kr. Such an excess of Kr$^{86}$ in atmospheric Kr could be due to fission Kr.

6) The isotopic composition of the trapped Xe in the 12001 fines (BEOC 12) agrees, within the error limits, with the composition derived from the Apollo 11 fines (BEOC 11) (Eberhardt et al. 1970). The precision of the BEOC 12 determination is superior to the BEOC 11 values. BEOC 12 xenon agrees with the SUCOR Xe isotopic composition obtained by Podosek et al. (1971) from a limited set of measurements. The abundance of the light isotopes agrees with average carbonaceous chondrite Xe (AVCC-Xe) (Eugster et al. 1967) and trapped chondritic Xe (Marti 1967) (cf. Figure 2). The heavy isotopes are less abundant and the difference can be explained as a fission component in AVCC-Xe with Xe$^{131}$ : Xe$^{132}$ : Xe$^{134}$ : Xe$^{136}$ = (52 ± 25) : (88 ± 33) : (77 ± 19) : 100.

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References


Figure 1. \( \frac{Xe^{126}}{Xe^{132}} \) vs \( \frac{1}{Xe^{132}} \) and \( \frac{Xe^{126}}{Xe^{132}} \) vs \( \frac{Ba}{Xe^{132}} \) correlations. Plotting against \( \frac{Ba}{Xe^{132}} \) corrects for the variable chemical composition of the grain size fractions.

Figure 2. \( \delta \) values, relative to average carbonaceous chondrite Xe, of the trapped Xe in Apollo 11 and Apollo 12 fine material.