TRAPPED SOLAR GASES IN THE ALHA81005 LUNAR(?) METEORITE.

D. D. Bogard and P. Johnson, SN4/NASA Johnson Space Center, Houston, TX 77058

We have measured the isotopic abundances of the noble gas elements He, Ne, Ar, Kr, and Xe in a primarily matrix sample of Antarctic meteorite ALHA-81005, which may have had an origin from the Moon. This sample contained very large concentrations of what are obviously implanted solar wind gases (Fig. 1). Absolute concentrations and relative abundances of these trapped gases are quite similar to typical solar gas-rich soils and breccias returned from the Moon. Isotopic compositions of the trapped gas in ALHA81005 are also identical to solar gas trapped in lunar samples - e.g., trapped 4-He/-3-He = 2600, 20-Ne/22-Ne = 12.5, 40-Ar/36-Ar = 1.8. Isotopic ratios of Kr and Xe plot on the mass-fractionation trends for lunar soils (1), and there is no obvious evidence of excess radiogenic 129-Xe or fission-produced Xe.

Fayetteville and Pesyanoe (Fig. 1) are the two regolith-derived meteorites with the largest known concentrations of solar wind gases. Although the 4-He concentration in Pesyanoe is as high as ALHA81005, the other noble gas concentrations in Pesyanoe are much lower, and consequently Pesyanoe shows a much less fractionated noble gas abundance pattern compared to ALHA-81005 and to lunar fines and breccias. Meteorites rich in solar gases typically show considerably less mass fractionation of their gases (e.g., much larger 4-He/132-Xe) compared to lunar samples. This fact is probably due to the much higher levels of regolith gardening and ion re-implantation, with accompanying mass-fractionated gas loss, of lunar regolith compared to regoliths on meteorite parent bodies.

A preliminary value for the potassium concentration of the matrix of ALHA81005 (J.C. Laul, Pers. Comm.) indicates that $\sim 1.4 \times 10^{-5} cm^3/g$ of radiogenic 40-Ar should be produced in 4 Gy time. The measured 40-Ar concentration in ALHA81005 is $\sim$20 times this value, which strongly suggests the presence of an atmosphere-implanted 40-Ar component such as that which has occurred on the Moon throughout much of its history (2). Presumably for an asteroid parent body the much shorter gravitational escape time for 40-Ar, the much smaller cross-section of the parent body surface, and the likely weaker solar wind fields would greatly reduce the effectiveness of the atmospheric-implantation process. In fact, the 40-Ar/36-Ar ratios in Pesyanoe and Fayetteville are much larger than in ALHA81005 and lunar soils and much of the 40-Ar in the first two meteorites is due to in situ decay of K.

Even those noble gas isotopes with low relative abundances (e.g., 3-He and 38-Ar) are primarily of solar wind origin in ALHA81005. However, if we adopt a trapped 21-Ne/22-Ne ratio of 0.030, we estimate that about 17% of the measured 21-Ne, or $\sim 26 \times 10^{-8} cm^3/g$, is cosmic ray produced. For a lunar surface irradiation this value would represent at least 100 MY of cosmic ray exposure.

The presence of large concentrations of solar gases in ALHA81005 clearly indicate that the matrix was finely spread on a surface exposed to the solar wind for a period of time before breccia formation. The large concentrations of solar gases with a mass fractionation pattern like lunar regolith samples, the excess concentrations of radiogenic 40-Ar and the suggestion of an old cosmic ray exposure age are all consistent with an origin of ALHA81005 from the lunar regolith. Such characteristics are dissimilar to known meteorites and may be hard to reconcile with an origin from the regolith of an asteroid.

TRAPPED GASES IN ALHA81005?

Bogard, D. D. and Johnson, P.

References:
1. Bogard, D. D., Hirsch, W. C., and Nyquist, L. E. (1974) Proc. Lunar Sci. Conf. 4th, p. 1975.
2. Manka, R. H. and Michel, F. C. (1970) Science 169, p. 278.
3. Marti, Kurt (1969) Science 166, p. 1263.
4. Bogard, D. D. and Nyquist, L. E. (1973) Proc. Lunar Sci. Conf., 4th, p. 1975.

Figure 1: Measured noble gas concentrations in a matrix sample of ALHA81005, in the solar gas-rich meteorite Pesyanoe (3), and in lunar fines 65501 (4). Also shown are the typical range of 36-Ar concentrations in ordinary chondrites, OC, and in Type 1 carbonaceous chondrites, C1.