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THE NEED FOR ISOTOPIC DATA ON REFRACTORY ELEMENTS IN THE SOLAR WIND

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The sun accounts for the bulk of material in the solar system. Information on the isotopic composition of elements in the solar wind is therefore essential for an understanding of the contribution made by each nucleogenetic component that has been identified in meteorites. Recent work ~~in our group~~ suggests that isotopic data on the solar wind may also help us understand the physical process that is concentrating light elements at the solar surface. THIS HYPOTHESIS IS BRIEFLY DISCUSSED.

The present data base on isotopic abundances of elements in the solar wind consists mostly of volatile elements that could be easily resolved from indigenous lunar material. The possibility of alterations in the isotopic composition of these elements by mass dependent fractionation may limit their utility in resolving nucleogenetic from physical effects.

Recently we noted (Manuel and Hwaung, 1983) that the isotopic composition of noble gases in the solar wind can be understood as a mixture of the two major planetary noble gas components (Sabu and Manuel, 1980): He, Ne and Ar in the sun are type-X, Xe is type-Y, and solar Kr is a mix of these two planetary noble gas components. Resolution of solar-wind-implanted gases into these two components required correction for a velocity-selection, mass fractionation process that spans several orders of magnitude across the mass range (3-136 amu) represented by the stable isotopes of the five noble gases.

Previously, isotopic fractionation in noble gases has generally been assigned to a planetary process, e.g., diffusive gas loss. Planetary fractionation fails to explain several features in the elemental and isotopic abundance patterns of planetary and solar-wind-implanted noble gases. The relationship between planetary and solar-wind-implanted gases instead suggests a solar fractionation process that enriches lighter nuclei at the sun's surface.

Such a process is not entirely unexpected. Abundances of elements at the solar surface display a steep decrease in abundance over the mass range spanned by the noble gas isotopes. Chapman and Cowling (1952) note that lighter nuclei will tend to diffuse towards the cooler region of an ionized gas. Further, they point out that, "This must happen in the sun and the stars, where thermal diffusion will assist pressure diffusion in concentrating the heavier nuclei towards the hot central regions."

Refractory and volatile elements would behave alike under the conditions of solar fractionation. Prolonged exposure of foils at 1AU from the sun would be a relatively inexpensive way to collect the quantity of solar-wind-implanted refractory elements needed to test this hypothesis.

S. Chapman & T. G. Cowling, The Mathematical Theory of Non-uniform Gases, Cambridge University Press, section 14.72, p. 255 (1952).

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