INFORMATION OF ASTROPHYSICAL INTEREST IN THE ISOTOPES OF SOLAR WIND IMPLANTED NOBLE GASES. Oliver K. Manuel and Golden Hwaung, Department of Chemistry, University of Missouri, Rolla, MO 65401.

Natal material of the Solar System was chemically and isotopically heterogeneous and contained short-lived radioactivities (1-3). These inescapable conclusions of numerous meteorite analyses demonstrate the need for cooperation and unambiguous communications between experimentalists and astrophysicists if the experimental findings are to be resolved into useful information on the formation of the Solar System.

There has been surprisingly little attention given to the information that the isotopic ratios of solar wind implanted noble gases might provide the astrophysics community on (a) the relative abundances of various nucleogenetic components in natal material of the Solar System, and (b) the occurrence of nuclear reactions in the Sun. Notable exceptions include attempts to explain high values of the He-3/He-4 ratio in the solar wind by an early deuterium-burning stage of the Sun (4-6), and attempts to assign high values of the Ne-20/Ne-22 and Ne-21/Ne-22 ratios in the solar wind to one of many isotopically distinct (and alphabetically labeled) types of Ne in the early Solar System. References to the discovery of each of these Ne components are given elsewhere (7).

It has been suggested (7) that there was, in fact, only one type of Ne in the early Solar System and that fractionation is responsible for variations observed in the isotopic composition of spallation-free Ne. It has also been suggested (3) that protoplanetary matter contained basically two types of noble gases: Type-Y gases from a stellar interior contained isotopically "normal" Ar, Kr and Xe but no He or Ne, and Type-X gases from the outer layers of a supernova contained all of the He and Ne mixed with isotopically "anomalous" Ar, Kr and Xe. We use the conclusions of these two studies (3,7), together with isotopic data on solar wind implanted gases in lunar material, to seek information on (a) the relative amounts of Type-Y and Type-X noble gases in the surface of the Sun, and (b) the occurrence of nuclear reactions in the Sun that might have altered the isotopic composition of the five noble gases there.

To correct for possible fractionation effects in the isotopic composition of Ne and other noble gases in solar wind implanted elements of Apollo lunar fines 12001 (ref. 8), we calculate a fractionation factor f,

$$f = f(\Delta m,\ m_i/m_j,\ T,\ \Phi,\ \Theta) \qquad (1)$$

where $\Delta m = m_j - m_i$, T is the temperature in K, Φ is the gravitational potential, and Θ characterizes the other physical parameters of the fractionation process. The isotopic ratios of He and Ne in Type-X (9) and in solar wind implanted gases (8) are used to evaluate the parameters in Eq. (1). The results of these calculations are shown in Table 1, together with the isotopic ratios of Type-X gases in Allende mineral separate #58 (ref. 10).

It can be seen from Table 1 that the isotopic compositions of fractionation-corrected, solar wind implanted He, Ne, Ar and Kr in lunar fines 12001 are remarkably similar to those of Type-X gases. When a proportionate correction is made to the isotopic composition of solar wind implanted Xe in lunar fines, the resultant composition is very much like that seen in air and clearly does not show the W-shaped isotopic anomaly pattern of Type-X xenon.

Table 1. A Comparison of the Isotopic Composition of Fractionation-Corrected Noble Gases in 12001 with Type-X and Atmospheric Type Gases

Isotope	Fractionated 12001	Type-X Gases	Atmospheric Gases
He-3	1.425×10^{-4}	$(1.425 \pm 0.2) \times 10^{-4}$	1.4×10^{-6}
He-4	≡1.000	≡1.000	≡1.000
Ne-20	8.2	8.2 ± 0.4	9.8
Ne-21	0.025	0.025 ± 0.003	0.029
Ne-22	≡1.000	≡1.000	≡1.000
Ar-36	4.0	4.50 ± 0.02	5.32
Ar-38	≡1.000	≡1.000	≡1.000
Kr-78	2.4	1.7 ± 0.2	3.0
Kr-80	17.3	19.1 ± 0.1	19.6
Kr-82	≡100.0	≡100.0	≡100.0
Kr-83	106.0	117.7 ± 0.9	99.7
Kr-84	557.9	562.4 ± 3.9	494.6
Kr-86	190.3	202.6 ± 10.1	151.1
Xe-124	2.30	4.93 ± 0.06	2.35
Xe-126	2.22	3.44 ± 0.02	2.21
Xe-128	46.6	57.7 ± 0.2	47.0
Xe-129	611.4	688 ± 4	648.0
Xe-130	≡100.0	≡100.0	≡100.0
Xe-131	518.4	540 ± 2	519.1
Xe-132	654.8	644 ± 3	659.1
Xe-134	261.2	372 ± 3	255.9
Xe-136	229.1	397 ± 4	217.4

In conclusion, it appears that the surface of the Sun may contain predominately terrestrial-type Xe and Type-X He, Ne, Ar and Kr. The absence of any excess of He-3 from the fusion of H-2 seems to be compatible with a recent suggestion that the Sun's radiant energy is generated, not by fusion, but by radiation from a hot SN core in the Sun's interior (11).

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