1980LPI....11..971S

THE NEON ALPHABET GAME, D. D. Sabu* and O. K. Manuel**,
*Chemistry Department, Univ. of Missouri, Rolla, MO 65401
**U.S. Geological Survey, MS 963, Box 25406, Den. Fed. Ctr., Denver 80225

The discovery of nucleogenetic anomalies in other elements has revived interest in possible nucleogenetic anomalies of meteoritic neon. Over a decade ago, Pepin reported that meteorites contain isotopically distinct components of trapped neon with no evidence that diffusive fractionation is responsible for any of the isotopic variations [1,2]. Early studies of neon released by stepwise heating of bulk meteorites indicated only five isotopically distinct components of trapped neon, Ne-A, Ne-B, Ne-C, Ne-D and Ne-E [3-5], but diligent investigations of neon in minor meteorite phases have recently succeeded in identifying subdivisions of Ne-A and Ne-E, viz., Ne-A1, Ne-A2, Ne-E(L), and Ne-E(H) [6-11],and in uncovering evidence for an eighth neon component, Ne-O [7]. There are at least two other types of isotopically distinct neon in the Solar System, one in the solar wind [12] and the other in the Earth's atmosphere [13], and cosmic-ray-induced spallation reactions produce yet another in meteorites and in samples of the lunar surface. In spite of frequent interferences from the latter three components, there has been remarkable success in isolating new types of neon from meteorites. If these discoveries prove to be correct [1-11], then an element with only three stable isotopes may contain a wealth of information on the origin of nucleogenetic components in other elements of meteorites, e.g., xenon [14,15].

Attention has been focused primarily on Ne-E as a candidate for possible membership in the group of elements with nucleogenetic anomalies, prompted in part by reports that Ne-E accompanies s-products of xenon in the acid-etched residue, 1C10, of the Murchison chondrite [15] and that Ne-E is monoisotopically pure neon-22 [16]. These findings seem to support an earlier suggestion that Ne-E had an extra-Solar System origin [5] and thus slightly reduce the number of labeled, but unexplained, neon components.

In view of the relative ease with which light-weight, volatile elements like neon move from one site to another, it seems appropriate to reconsider the origin of these neon components in the light of an earlier study by Aston [17], who reported in 1913 that the atomic weight of neon was altered by its movement through clay pipe stems. In a more recent study [18], it was reported that fractionation effects in the isotopic composition of neon in lunar soils could be quantitatively represented by the following equation:

$$\partial \ln(^{21}Ne/^{22}Ne) \;/\; \partial \ln(^{20}Ne/^{22}Ne) \;=\; 0.50 \qquad (1)$$

Trapped neon in meteorites seems to consist primarily of Ne-A, or normal "planetary" neon, and it is the relative abundance of this neon [19] which correlates linearly with isotopic ratios of the heavy noble gases in plots such as Ne-20/Xe-132 vs Xe-136/Xe-132, Ne-20/Kr-82 vs Kr-86/Kr-82, etc. [20].

From a comparison of the isotopic compositions of meteoritic neon with the values predicted by Eq.(1), we have uncovered another neon component for which we propose the title of Ne-F. This title is befitting because Ne-F has the properties predicted by Eq.(1) when planetary neon is Fractionated. It could almost be argued that F was predestined to represent fractionated neon; previous participants in the neon alphabet game used up all earlier members of the alphabet series, then skipped Ne-F as a label, and began labelling

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

1980LPI....11..971S

new components of neon out of sequence, e.g., Ne-O, Ne-A2, Ne-E(L), etc.

Ne-F is very versatile for understanding variations in the isotopic compositions of neon in the Solar System in terms of binary mixtures of cosmogenic neon with Ne-F, as shown in Fig. 1. The upper left section of Fig. 1 shows the isotopic compositions of various neon components and recent experimental data which has been interpreted as evidence of Ne-E. The scale is expanded in the upper right section of Fig. 1, where the neon in different temperature fractions of Murchison residue, 1C10 [15], is compared with the isotopic compositions of neon which would be produced by fractionation of Ne-A. The 800° and 1000° fractions contain a slight excess of Ne-21 from spallation but neon in the other temperature fractions cannot be distinquished from Ne-F, as demonstrated in greater detail in the lower right section of Fig. 1. The lower left section of Fig. 1 shows the isotopic compositions of neon which are reported to be highly enriched in Ne-E and the trend which the data would be expected to follow if Ne-E were monoisotopic Ne-22.

In conclusion, Ne-F seems to be very common in the Solar System, but there appears to be no evidence of alien nucleogenetic products in meteoritic neon.

REFERENCES

1. Pepin, R.O.(1967) Earth Planet. Sci. Lett. 2, 13-18.
2. Pepin, R.O.(1968) In Origin and Distribution of the Elements (Ed. by L. H. Ahrens) p. 379-386. Pergamon Press, New York.
3. Black, D. C. and Pepin, R. O. (1969) Earth Planet. Sci. Lett. 6, 395-405.
4. Black, D. C. (1972) Geochim. et Cosmochim. Acta 36, 347-375.
5. Black, D. C. (1972) Geochim. et Cosmochim. Acta 36, 377-394.
6. Alaerts, L., Lewis, R. S., Matsuda, J. and Anders, E. (1979) Programme of 42nd Annual Meeting of the Meteoritical Society, Abstract 146, p.93.
7. Eberhardt, P. (1978) Proc. Lunar Planet. Sci. Conf. 9th, 1027-1054.
8. Alaerts, L., Lewis, R. S. and Anders, E. (1979) In Lunar and Planetary Science X, p. 12-14. Lunar and Planetary Institute, Houston, TX.
9. Eberhardt, P., Junck, M. H. A., Meier, F. O. and Niederer, F (1979) In Lunar and Planetary Science X, p. 341-343. Lunar and Planetary Institute, Houston, TX.
10. Lewis, R. S., Alaerts, L., Matsuda, J. and Anders, E. (1979) Astrophys. J 234, L165-L168.
11. Eberhardt, P., Junck, M. H. A., Meier, F. O. and Niederer, F. (1979) Astrophys J. 234, L169-L174.
12. Geiss, J., Buhler, F., Cerutti, H., Eberhardt, P. and Filleux, Ch. (1972) Apollo 16 Prelim. Sci. Rept. NASA SP-315, p. 14.
13. Nier, A. O. (1950) Phys. Rev. 79, 450-454.
14. Manuel, O. K., Hennecke, E. W. and Sabu, D. D. (1972) Nature 240, 99-101.
15. Srinivasan, B. and Anders, E. (1978) Science 201, 51-56.
16. Junck, M.H.A. and Eberhardt, P. (1979) Meteoritics 14, in press.
17. Aston, F. W. (1922) Isotopes, Edward Arnold & Co., London. Diffusion experiment on p. 39-40 was presented to British Assoc. at Birmingham, 1913.
18. Srinivasan, B. (1973) Proc. Lunar Sci. Conf. 4th, 2049-2064.
19. Reynolds, J. H., Frick, U., Neil, J. M. and Phinney, D. L. (1978) Geochim Cosmochim. Acta 42, 1775-1797.
20. Manuel, O. K. and Sabu, D. D. (1975) Trans. Missouri Acad. Sci. 9, 104-122.

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

1980LPI....11..971S

THE NEON ALPHABET GAME

Sabu, D. D. et al.

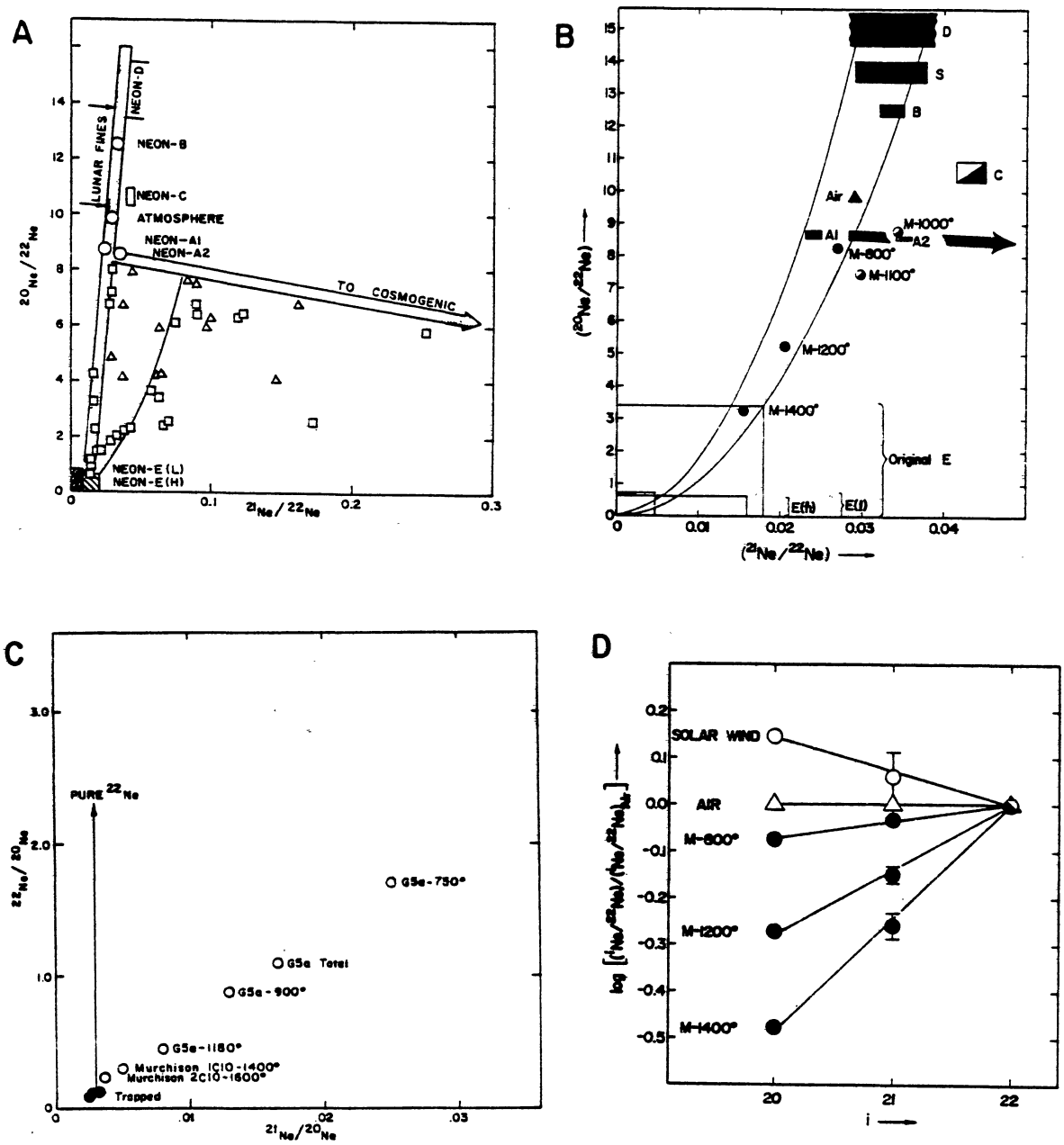

Fig. 1,A: The isotopic composition of Ne-F, represented by the almost vertical area that encompasses atmospheric Ne, is compared with the isotopic compositions of Ne in temperature fractions of supposedly Ne-E rich phases of Orgueil, G4j, and other carbonaceous chondrites [7,8,15]. Addition of cosmogenic Ne will shift isotopic compositions to the right of Ne-F. Fig. 1,B: The isotopic composition of mass fractionated Ne-A, represented by the area enclosed by curved lines, is compared with components Ne-A1, -A2, -B, -C, -D, -E, -E(l) and -E(h) [1-11] and with neon in the solar wind [12], in air [13], and inthe 1C10 Murchison residue [15]. The addition of cosmogenic neon may explain data to the right of fractionated Ne-A, e.g., Ne-C. Fig. 1,C: The isotopic compositions of Ne in reputedly Ne-E rich fractions of Orgueil and Murchison [8,9,15] are compared with isotopic compositions expected in mixtures of monoisotopic ^{22}Ne and trapped Ne. Fig. 1,D: Neon in the solar wind [12] and in the 800°, 1200° and 1400° fractions of Murchison 1C10 residue [15] have isotopic compositions expected in fractionated Ne defined by Eq.(1).

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System