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BOUNDARY CONDITIONS ON THE EARLY SUN FROM ANCIENT COSMOGENIC NEON IN METEORITES. C. M. Hohenberg, M. W. Caffee and T. D. Swindle, McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130 USA; and J. N. Goswami, Physical Research Laboratory, Navarangpura, Ahmedabad 380 009, India.

Isotopic analysis of neon from individual grains of the meteorites Murchison (CM) and Kapoeta (howardite) shows large enrichments of cosmogenic neon in grains with solar flare tracks. The quantity of this component is incompatible with GCR or SCR irradiation under present conditions and is attributed to irradiation by energetic flares from an early active sun [1]. Handpicked grains from each meteorite were grouped according to the presence or absence of solar flare heavy ion tracks, and these four samples (an irradiated and an unirradiated group from each meteorite) were analyzed with an ion-counting noble gas mass spectrometer.

While galactic cosmic ray exposure ages for the unirradiated grains yield the nominal values reported for the recent, well-documented, exposure histories of the meteorites, the irradiated grains contain large excesses of cosmogenic Ne-21. If these excesses were attributed to GCR irradiations, minimum pre-compaction exposure ages of 28 m.y. and 56 m.y. are obtained for Murchison and Kapoeta, respectively, irradiated as individuals in free space (4π geometry and at the peak of the production curve). The required GCR exposure times for regolith settings are several hundred million years, far longer than the 1 m.y. or so allowed by most models for the irradiation of gas-rich meteorites [2]. The other possible source of the cosmogenic neon is irradiation by solar cosmic rays. However, irradiation under present conditions would again require 100 m.y. of exposure at 3 A.U. [1].

This seems to leave two possibilities: 1) models for the irradiation of gas-rich meteorites are wrong, and exposure periods (presumably in regoliths) lasted up to two orders of magnitude longer than predicted; or 2) gas-rich meteorites were irradiated by an early sun with a flux of energetic protons up to two orders of magnitude higher than the present-day flux. If the latter is the case, further constraints can be set on the early solar system. First, the postulated active early sun would seem to have had a harder energy spectrum than at present, since the isotopic composition of the cosmogenic neon is closer to that produced by galactic cosmic rays than that produced by present-day, lower-energy solar cosmic rays [1]. Second, there is an apparent lack of solar wind neon (an upper limit of less than 20 years exposure, compared to 100 years or more predicted by most models), perhaps indicating shielding by nebula gas or thin coatings on the grains themselves. One difficulty is, of course, the fact that Kapoeta is a differentiated meteorite, with evidence of formative activity or impact metamorphism as late as 3.6 b.y. [3, 4]. Thus, if these grains were irradiated by an active early sun, they must not have been seriously affected by these later processes.

References: [1] M. W. Caffee, J. N. Goswami, C. M. Hohenberg and T. D. Swindle (1983). Proc. Lunar Planet Sci. Conf. 14th, in press. [2] J. N. Goswami, D. Lal and L. L. Wilkening (1983). Space Sci. Rev., in press. [3] D. A. Papanastassiou, R. S. Rajan, J. C. Huneke and G. J. Wasserburg (1974). Proc. Lunar Sci. Conf. 5th, 583-584. [4] R. S. Rajan, J. C. Huneke, S. P. Smith and G. J. Wasserburg (1979). Geochim. Cosmochim. Acta, 43, 957-971.