Astrophy. **27,** 237. Prentice A. J. R. (1978) *Moon & Planets* **19,** 341. Prentice A. J. R. (1980) *Aust. J. Phys.* **33,** 623. Prentice A. J. R. (1984) *Earth, Moon & Planets* **30,** 209.

The MT. ADAMS, Washington fireball of January 25, 1989. Richard N. Pugh, Cleveland High School, Portland, OR 97202, USA.

The Northwest's brightest fireball occurred at 12:51 P.M., Pacific Standard Time, 25 January 1989. The meteroid entered the atmosphere over Puget Sound, Washington, producing a fireball. The object apparently skipped out of the atmosphere and re-entered the atmosphere down range producing a second fireball. This very bright fireball descended rapidly in an ever steepening path until it disrupted at 45 km producing a large dust cloud. A third fireball came out of this dust cloud moving 7 km down range before it exploded producing a second dust cloud.

The fireball was seen from Lewiston, Idaho to Coos Bay, Oregon. The area from which it was seen is nearly 250 000 km. Sonic booms were heard over an area of nearly 25 000 km. Anomalous sounds were heard from as far away as 125 km. Most of these sounds were at right angles to the path of the fireball.

The points of disruption were over the northwest flank of Mt. Adams, latitude 46°17′N, longitude 121°37′W, a 3660 m dormant volcano.

Aircraft, snowmobiles, and cross-country skiers were used in an attempt to locate meteoric dust on the snow. A fresh snowfall 36 hours after the fall ended these attempts.

Elemental and isotopic composition of solar flare noble gases in Kapoeta: Implications for charged particle acceleration from the sun. M. N. Rao,[1] D. H. Garrison[2] and D. D. Bogard. NASA Johnson Space Center, Houston, TX 77058, USA. [1]P.R.L Ahmedabad. [2]Lockheed-ESC.

We have measured mass-spectrometrically isotopic abundances of the noble gases in chemically etched pyroxene grain-size separates from the Kapoeta meteorite. Using three isotope correlation plots, ordinate-intercept techniques and two element isotope ratio plots, we have determined the long term average isotopic composition of solar flare Ne and Ar to be 20/22 = 11.6 ± 0.2 and 36/38 = 4.9 ± 0.1, respectively, and have shown that these ratios differ significantly from those of solar wind Ne (20/22 = 13.6 ± 0.1) and solar wind Ar (36/38 = 5.35 ± 0.1). By similar techniques we have also determined that the isotopic composition (long-term average) of solar flare He, 4/3 = 3800 ± 200, differs from that of solar wind He 4/3 = 2500. In the case of solar flare He, Ne and Ar, the heavier isotopes (4, 22 and 38) are enriched relative to lighter isotopes (3, 20 and 36) by ~34%, 16% and 8.5%, respectively, when compared to solar wind He, Ne and Ar. Further, in both heavily-etched 35–125 μm and 125–200 μm pyroxene size-fractions, we have determined the SF elemental ratios to be ^{4}He/^{36}Ar = 7545 and 5133; ^{20}Ne/^{36}Ar = 41.2 and 34.3; ^{22}Ne/^{36}Ar = 4.4 and 3.5, respectively. The SW values found in the corresponding unetched pyroxene-size fractions are ^{4}He/^{36}Ar = 1540 and 1170; ^{20}Ne/^{36}Ar = 35 and 30; ^{22}Ne/^{36}Ar = 2.8 and 3.0, respectively. A Z^2/A^2 dependance exists for the isotopic and elemental compositions between SW and SF. These Kapoeta results suggest that the SF particles are fully stripped of electrons and that a rigidity-dependant acceleration mechanism was operating in the flare regions on the surface of the ancient sun. Heavy noble gas data from the same Kapoeta samples have also been obtained.

Cosmogenic-nuclide production in small meteorites.* Robert C. Reedy. Space Science and Technology Division, Mail Stop D438, Los Alamos National Laboratory, Los Alamos, NM 87545, USA.

A large variety of nuclides are made by cosmic rays. In most objects, secondary particles (especially neutrons) generated by the high-energy (~GeV) particles in the galactic cosmic rays (GCR) dominate the production of cosmogenic nuclides. The lower-energy (~1–100 MeV) solar energetic particles produced as a result of large solar flares ("solar cosmic rays" or SCR) can produce nuclides within the outer few centimeters of solid material exposed to the SCR. In meteorites, most models have concentrated on GCR production in "normal" (pre-atmospheric radii ~10–50 cm) meteorites (Reedy, 1987a). For meteoroids with radii $\lesssim$10 cm, both GCR and SCR particles are important in nuclide production. To interpret cosmogenic-nuclide measurements in small meteoroids, such as Salem (Evans *et al.,* 1987; Nishiizumi *et al.,* 1990), good production rates by both GCR and SCR particles are needed but will not be easy to determine.

GCR Production. In very small (radii $\lesssim$1 cm) objects, primary particles dominate nuclide production as few secondary particles are produced. Production rates for very small objects have been calculated by integrating over energy particle flux times cross section and are usually quite different from those in normal meteorites (Reedy, 1987b). As the size of a meteoroid gets larger, production of secondary particles increases and primary particles are attenuated, so the "mix" of nuclide-forming particles changes from almost pure primaries to predominantly secondaries. Neutron production per incident GCR particle increases with meteoroid radii until ~1000 g/cm^2, where it approaches the value in very large objects (Spergel *et al.,* 1986).

Most models for GCR production of nuclides don't work well for meteoroids with radii $\lesssim$10 cm, in part because they don't consider this changing mix of nuclide-producing particles. For most semi-empirical models that rely on meteorite measurements, there are not much data to fit, and often the contributions from SCR production are poorly known. There are a few nuclides where SCR production is unimportant, such as ^{10}Be (Nishiizumi *et al.,* 1990), that can be used in modeling GCR production in small objects. Monte Carlo calculations, like those of Reedy (1988), coupled with selected measurements should help to establish GCR production rates in small meteorites.

SCR Production. The production of nuclides by the SCR at depths of a few centimeters in small meteoroids is much higher than at the same depth in a big object like the Moon as SCR particles coming from all directions can reach that depth, whereas in the Moon only particles entering nearly vertically can reach such depths (Reedy, 1987c; Michel *et al.,* 1982). For most nuclides in small meteoroids, SCR production rates can be similar to or greater than GCR production rates down to depths of several centimeters, especially if the meteoroid's radius is less than ≈5 cm (Reedy, 1987c).

A serious problem in calculating or interpreting SCR production in meteorites is that the flux of SCR particles is poorly known. Orbits for meteorites can vary greatly and result in a wide range of possible SCR fluxes that are most likely quite different from those determined for the Moon. As for the Moon, the SCR flux producing short-lived radionuclides can vary much depending on the solar-particle events during the radionuclide's last few half-lives that hit the meteoroid (*cf.* Evans *et al.,* 1987). References: Evans J. C. *et al.* (1987) *Lunar & Planet. Sci.* **18,** 271. Michel R. *et al.* (1982) *Earth Planet. Sci. Lett.* **59,** 33. Nishiizumi K. *et al.* (1990), this meeting. Reedy R. C. (1987a) *Nucl. Instrum. & Methods* **B29,** 251. Reedy R. C. (1987b) *J. Geophys. Res.* **92,** E697. Reedy R. C. (1987c) *Lunar & Planet. Sci.* **18,** 822. Reedy R. C. (1988) *Lunar & Planet. Sci.* **19,** 966. Spergel M. S. *et al.* (1986) *J. Geophys. Res.* **91,** D483. *Work supported by NASA and done under the auspices of the US DOE.

The SIMPSON Desert Depression—An intracratonic basin or a large multi-ring impact basin of proterozoic age? W. U. Reimold[1] and M. J. Duane.[2] Econ.[1] Geol. Res. Unit, % Dept. of Geology, and Schonland Research Centre, University of the Witwatersrand, P. O. Wits 2050, Johannesburg; [2]Dept. of Geol. and Appl. Geology, Univ. of Natal, Durban 4001, RSA.

The Australian craton, excluding the region east of the Tasman Line, is a complex mosaic of basins and crustal blocks (Rutland, 1976), which appear to have shared similar geological histories over the past 1.8 Ga (*cf.* Spec. Iss. Tectonophysics, v. 158). The components of this ancient plate did not rotate and were not accreted by conventional plate collisional processes (Veevers and McElhinny, 1976). In contrast to other Proterozoic orogens, the central Australian blocks share similar geochemical affinities and have a characteristic lack of ophiolitic facies (in contrast to conventional collisional orogens).

We focussed on the Simpson Desert Depression (Duane and Reimold, 1989, 1990), because of its pivotal role as a Central Australian Proterozoic basin within a plate that was unfragmented until at least 1.0 Ga (Lindsay *et al.,* 1987). The period spanning 2.0–1.0 Ga is unresolved in Australian geological understanding and we attempt to offer an alternative hypothesis to the current plate tectonic scenarios for the Early Proterozoic Australian continent.

The central Australian geological "oddities" that distinguish the region from other Proterozoic regions are: