# CALCULATED PRODUCTION RATES OF NOBLE GASES IN THE SNC METEORITES.

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The chemistry, petrogenesis, and chronology of the Shergottites, Nakhlites, and Chassigny (the "SNC" meteorites) imply a unique origin, possibly from Mars (1-5). The noble gases and nitrogen trapped in the Shergottite EETA79001 most resemble gases in the atmosphere of Mars (6,7). However, there are dynamical difficulties in ejecting from Mars large meteorites that don't show strong shock effects (8). There is also the need to explain the three different exposure ages observed among these meteorites (9). Detailed production rates of cosmogenic noble gases in several SNC meteorites are reported here. These rates can be used to unfold the meteorites' cosmic-ray exposure histories and provide valuable clues to their origins.

The basic calculations of the production rates are the same as those done for the moon (10,11). The model for the fluxes of galactic-cosmic-ray (GCR) particles inside meteorites is described in Ref. 12. A spectrum of the GCR primary protons (13) was also used to calculate production rates in very small meteoroids. Production by solar cosmic rays was not considered but would be important near the preatmospheric surfaces and in small meteorites. The cross sections for the production of noble-gas isotopes are the same as used previously for the moon and which usually gave good agreement with observed production rates (10,11). The He-3 production rates have been multiplied by 1.4 to give good agreement with measured rates (11). The chemical compositions for the SNC meteorites studied here--Shergotty, ALHA77005, Nakhla, Chassigny, and the A and B lithologies of EETA79001--are averages of various measurements (1-5). (The values in Ref. 3 for CaO and $TiO_2$ in ALHA77005 were reversed.)

The production rates of He-3, Ne-21, and Ar-38, and the He-3/Ne-21 ratios are shown in Figs. 1-4 as a function of the meteoroid's radius and the sample's preatmospheric depth for the chemical composition of Shergotty. The production rates can vary considerably with radius and depth, and the production profiles for a high-energy product like He-3 are different than those for a low-energy product like Ne-21. These rates are usually not just twice the lunar (infinite radius) rate. The rates become fairly constant near the centers of spherical meteoroids (as for $R = 300\ g/cm^2$).

The production profiles for these nuclides in other classes of meteorites usually have similar shapes, but their magnitudes can vary considerably because of chemical variations. The He-3 production rates in all SNCs are similar and are about 1.04 times the rates calculated for L-chondrites. Production rates for Ne-21 and Ar-38 in the SNCs, relative to these rates in L-chondrites, cover a wide range. These production ratios are usually shielding-dependent. The ranges of the SNC/L-chondrite production ratios (Ne-21 and Ar-38) are (near-surface ratio-deep production ratio): Shergotty (0.76-0.53 and 3.4-5.1), Nakhla (0.75-0.58 and 4.7-7.3), Chassigny (1.18-1.24 and 0.6-0.4), EETA79001-A (0.91-0.76 and 2.5-3.6), EETA79001-B (0.74-0.48 and 3.7-5.6), and ALHA77005 (1.13 and 1.4-1.7).

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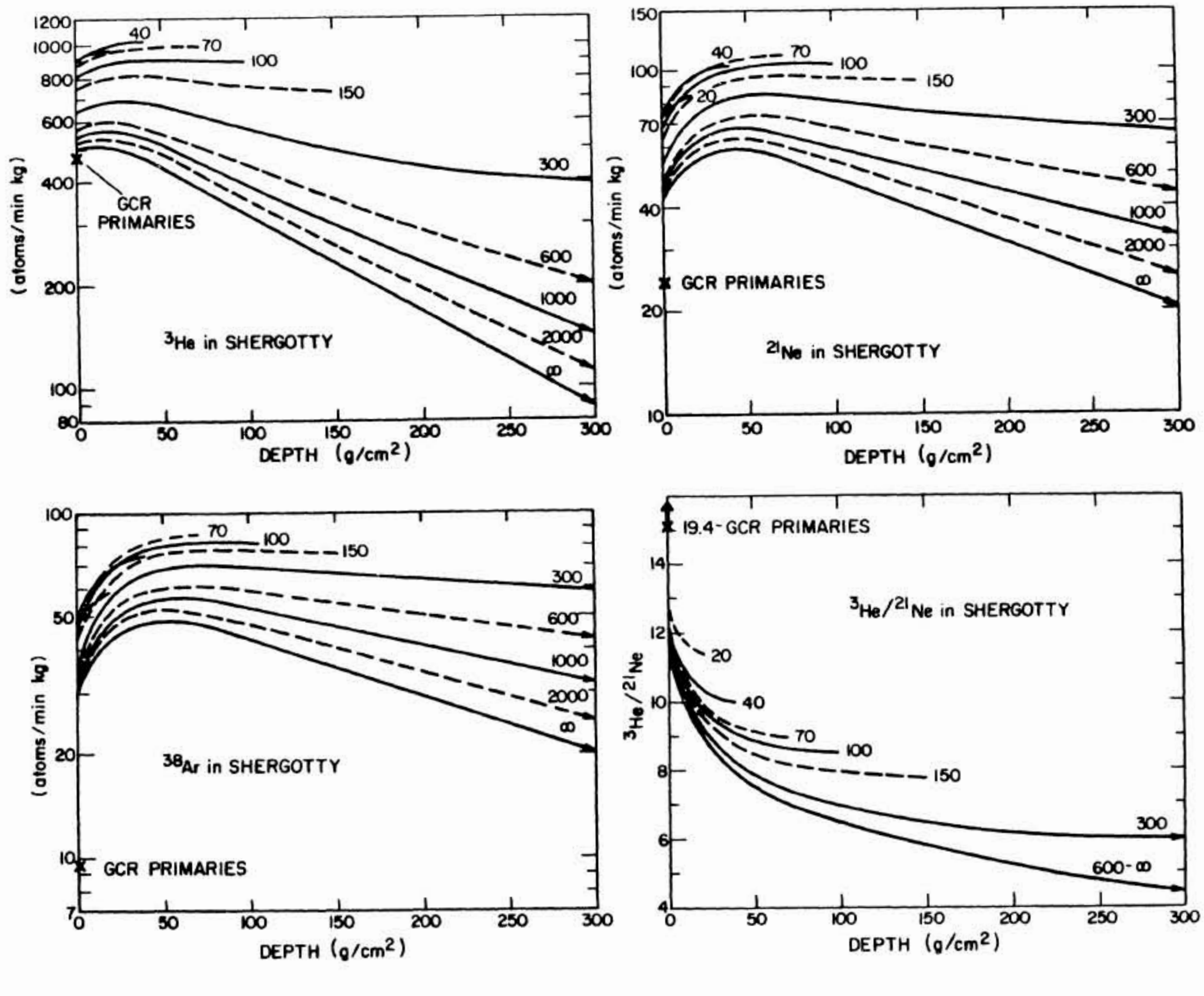


Figs. 1-4. Calculated GCR production rates and ratios for noble-gas isotopes as a function of radius and depth for Shergotty's chemistry. The x is for primary GCR protons only. Solar cosmic rays were not considered.