A MODEL FOR GCR-PARTICLE FLUXES IN STONY METEORITES AND PRODUCTION RATES OF COSMOGENIC NUCLIDES. R. C. Reedy, MS-J514, Los Alamos National Laboratory, Los Alamos, NM 87545.

The production rates of cosmic-ray-produced nuclides in meteorites vary with the meteorite's size and shape and with the sample's location. The isotope ratio Ne-22/21 has been used for shielding-corrected production rates determined empirically (1), but this ratio does not uniquely determine the sample's exact exposure geometry or a nuclide's production rate. Some production rates in stony meteorites as a function of size and depth have been calculated previously using thick-target results (2) or cross sections and models for the cosmic-ray fluxes (3-5). However, these calculations have only considered a few nuclides (2) or several sizes of meteorites (3-5). Reported here is a model for the fluxes of galactic-cosmic-ray (GCR) particles in spherical meteorites of any radius that can be used to calculate the production rates of many cosmogenic nuclides.

My meteorite GCR-particle flux model, based on the model developed by Reedy and Arnold (6) for the moon, uses two variables: a flux normalization and a spectral-hardness parameter \( \alpha \). For spherical stony meteorites, the flux normalization is calculated using the interaction parameters of Ref. 6 and an omnidirectional flux above 1 GeV of 1.87 protons/cm\(^2\) s (4). An expression for the spectral-hardness parameter as a function of meteorite radius \( R \) and sample depth \( d \), \( \alpha(R,d) \), was developed by interpolating between four cases: \( R = 0, 70, \) and 300 g/cm\(^2\) and an infinite radius. A value of \( \alpha = 944 \) MeV gives a very crude approximation to the primary GCR spectrum (or \( R = 0 \)). The \( \alpha \) curve for St. Severin (4) was used for \( R = 70 \) g/cm\(^2\). The lunar \( \alpha \) curve (6) was used for an infinite radius. The \( \alpha \) curve for \( R = 300 \) g/cm\(^2\) was determined by fitting the Na-22 activities for the outer 50 cm of Jilin (7), which are fairly constant. The interpolation expression for \( \alpha(R,d) \) is \( \alpha(R,d) = f(R) \alpha_{RA}(d) + b(R) \alpha_{RA}(2R-d) \), where \( \alpha_{RA}(d) \) is the lunar \( \alpha \) curve (6) and \( f(R) \) and \( b(R) \) are parameters for particles coming from the "front" and "back." For \( x > 80 \) g/cm\(^2\), \( \alpha_{RA}(x) = 324.44 \times \exp(-0.004838x) \). The parameter \( f(R) \) is 0.78 for \( R < 64 \) g/cm\(^2\) and \( 1 - \exp(-0.0085R - 0.97) \) for larger radii; \( b(R) \) is 0.73 for \( R < 40 \) g/cm\(^2\) and 0.65 + 0.002R for greater radii. For very large radii, \( \alpha(R,d) \) is assumed to be the same as \( \alpha_{RA}(d) \). Several spectral-hardness curves are shown in Fig. 1. When compared to the curves in Ref. 5, my \( \alpha(R,d) \) values are all similar in shape but are higher than the Ref. 5 values (R of 15 cm and greater).

Calculated production rates as a function of \( R \) and \( d \) are shown in Figs. 2 and 3 for Al-26, a low-energy product, and Be-10, a high-energy product. For Be-10, new cross sections that give good fits to experimental profiles were used (8). These two plots show the effects of the buildup of secondary neutrons and the attenuation of primary and, eventually, secondary particles. The points plotted for pure GCR primary protons (9) are about 0.5 of those calculated with \( \alpha(0,0) \). This model is probably not good for \( R < 20 \) g/cm\(^2\) as it most likely overestimates the number of secondary neutrons. I also suspect that the radii for this model really refer to meteoroid radii that are about 5 g/cm\(^2\) greater than the nominal \( R \). Plots of the calculated Ne-22/21 ratio versus a calculated production rate look similar to those of Ref. 1 for \( R < 200 \) g/cm\(^2\), but for larger radii, almost any production rate is possible for the smallest values of Ne-22/21. My calculated production profiles for H-3 and Na-22 are similar to those of Ref. 2 for \( R < 100 \) g/cm\(^2\), but for larger radii, my profiles drop much slower with increasing depth than do theirs.

Fig. 1. The spectral-hardness parameter \( \alpha(R,d) \) as a function of sample depth for several meteoroid radii (in g/cm\(^2\)). The values of \( \alpha \) for the centers of spheres with intermediate radii are indicated by X.

Figs. 2-3. Calculated production rates of Al-26 and Be-10 as a function of sample depth in L-chondrites of several radii. The x marks the production rates calculated for pure GCR primary protons.