of interest, mainly at energies below 20 MeV. More cross sections are needed for terrestrial cosmogenic nuclides, especially for neutron energies above 20 MeV.

Neutron-transport codes, such as the Monte Carlo N-Particle (MCNP) code, can be used to study nuclides made by neutron-capture reactions and have shown that rates for the $^{35}\text{Cl}(n,\gamma)^{36}\text{Cl}$ reaction depend on the rock's composition and water content. The LAHET Code System (LCS) and similar codes have been used very successfully for studying cosmogenic nuclides in extraterrestrial matter. LCS was recently to study production of nuclides in the Earth (Masarik and Reedy, this workshop).

REFERENCES


WORKSHOP ON SECULAR VARIATIONS IN THE RATES OF PRODUCTION OF COSMOGENIC NUCLIDES ON EARTH: PALEOMAGNETIC AVERAGES OF GEOMAGNETIC LATITUDE

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The production rate of cosmogenic nuclides depends on the geomagnetic cutoff rigidity, which in turn depends upon geomagnetic latitude. The geomagnetic dipole moment axis moves over time, one of the characteristic patterns of secular variation. Over the past 300 yr, the latitude of the northern end of the dipole axis has decreased from ca. 83°N to 78°N, while longitude has drifted westward from 320°E to 290°E (Merrill and McElhinny 1983). On the other hand, a critical assumption of paleomagnetism is the geocentric axial dipole field hypothesis, whereby the magnetic direction at any locality will average over several millennia to that of an axial geocentric dipole.

Data of Ohno and Hamano (1992) were used to model the effect of dipole secular variation on average geomagnetic latitude. This compilation gives average pole positions at 500-yr increments for the past 10,000 yr, based on archaeomagnetic and sediment paleomagnetic data. For several sites on the Earth’s surface, the average pole position was integrated back in time from the present to 10,000 yr ago. Differences between geomagnetic and geographic latitudes (here called the latitude difference) were calculated for the time-integrated average pole positions at 500-yr increments. Averaging from the present back to 1–4 ka gives a median difference of 1.7°; from 4–7 ka, it is 1.4°; from 7–10 ka, it is also 1.4°. A similar analysis was carried out using pole positions of Merrill and McElhinny (1983: Table 4.1) at 100-yr increments back to 2000 yr BP. Averaging from the present back to 200–800 BP gives a median difference of 4.2°. Thus, for exposure times longer than several centuries, the latitude error is typically 1.5°.

The Laschamp excursion, involving anomalous paleomagnetic directions and intensities, has been observed in some but not all data sets between 30 and 50 ka (Thouveny and Creer 1992). If such an excursion were due to a tilt of the dipole axis, its effect on average geomagnetic latitude could also be calculated. If the pole moves linearly to a latitude of 45° and back during a 5-ka long excursion (ignoring changes in dipole moment), the integrated average latitude difference is down to 2° after 50,000 yr; for a short 200-yr excursion (Thouveny and Creer 1992), the difference is down to 2° after 200 yr.