Paper ID: 10391
oral

SPACE LIFE SCIENCES SYMPOSIUM (A1)
Radiation Fields, Effects and Risks in Human Space Missions (4)

Author: Dr. Kyeong Ja Kim
Korea Institute of Geoscience and Mineral Resources, Korea, Republic of

Dr. Robert C. Reedy
Planetary Science Institute, United States

COMPARISON OF THE EXPERIMENTAL DATA AND NUMERICAL SIMULATION FOR THE PRODUCTION OF COSMOGENIC NUCLIDES ON THE LUNAR SURFACE

Abstract

The production rates of spallogenic Be-10, C-14, Cl-36, and Mn-53 and neutron capture-induced Ca-41 in the Apollo drill core were investigated using the MCNPX code. The concentrations of these cosmogenic nuclides in the Apollo 15 deep drill core have been studied [1-6]. These measured data allow us to test the numerical simulations by the MCNPX code for rates of cosmic-ray-induced reactions. The MCNPX (Monte Carlo N Particle eXtended) code combines the latest versions of the LAHET code for high-energy particle transport and the neutron code MCNP that were used by Masarik and co-workers [3,7,8]. The spectral shape of the incident galactic-cosmic-ray (GCR) protons was the same as that of [7]. The fluxes of protons and secondary neutrons were calculated using a spherical shell of a radius 1.78E+3 km and a density of 1.71 g/cm3, and an incidence flux of 1 p/s/cm2 of galactic-cosmic-ray protons [7]. We compared our calculated production rates using both Bertini (BER) (default model) and the CEM (Cascade-Exciton Model) option of MCNPX. The production rates of cosmogenic nuclides were then calculated using these calculated neutron and proton fluxes, compositions of the Apollo 15 drill core samples, and our most-recent sets of neutron and proton cross sections for all target-product combinations. Effective proton flux for each radionuclide was determined by the measured data and model calculations. The average effective proton flux for spallation reaction is determined to be 4.50 and 4.94 p/cm2/s for CEM and BER model, respectively. The profiles of our calculated production rates agreed well with the measured concentrations [1-6] and previous calculations. This work also confirms that numerical simulation of secondary particle production on planetary surfaces using MCNPX code is reliable.

[1] Nishiizumi K. et al., (1984), Earth Planet. Sci. Lett. 70, 157-163. [2] Nishiizumi K. et al., (1984), Earth Planet. Sci. Lett. 70, 164-168. [3] Nishiizumi K. et al., (1997), Earth Planet. Sci. Lett. 148, 545-552. [4] Rancitelli L.A. et al., (1975), Proc. Lunar Sci. Conf. 6th, 1891-1899. [5] Imamura M. et al., (1973), Earth Planet. Sci. Lett. 20, 107-112. [6] Imamura M. et al., (1974), Proc. Lunar Sci. Conf. 5th, 2093-2103. [7] Masarik J. and Reedy R.C., (1994), Geochim. Cosmochim. Acta 58, 5307-5317. [8] Reedy R.C. and Masarik J. (1994), Lunar Planet. Sci. 25, 1119-1120.