AN ANTARCTIC PERSPECTIVE ON *IN-SITU* COSMOGENIC NUCLIDE PRODUCTION

EDWARD J. BROOK,[1] ERIK T. BROWN,[2] MARK D. KURZ,[3] GRANT RAISBECK[4] and FRANÇOISE YIOU[4]

Long-term average production rates of some nuclides can be constrained by examining slowly eroding, old rock surfaces. At steady state with respect to production and radioactive decay, production rates are simply calculated from concentration data (*e.g.*, $P=N\lambda$), as long as erosion is negligible (Brook *et al.* 1995) The possibility that erosion is non-negligible makes these production rates minimum values. Examination of our and other published ^{26}Al data (half-life 7.2×10^5 yr) from a total of 15 Antarctic rock surfaces with ^{10}Be exposure ages older than 2 Ma (and therefore model erosion rates <~7 cm/Ma) yields ^{26}Al production rates that agree well with the published Sierra Nevada rates (Nishiizumi *et al.* 1989), assuming the altitude/latitude scaling of Lal (1991). The samples span an altitude range of 1380 to 2650 m and at each sample altitude the calculated production rates agree with the scaled Sierra Nevada rates within ~10%. The sea level production rate derived from the data (Lal 1991) is 35 ± 2 at/g/yr, close to the predicted value (Lal 1991) of 37 at/g/yr. These observations suggest that the long-term average ^{26}Al production rate is not higher than, and is probably close to, the value determined for glaciated bedrock in the Sierra Nevada exposed over the last ~11 ka[2]. The results also imply that the scaling factors (Lal 1991) are accurate within the latitude and altitude range considered here (excepting the possibility of compensating errors). As there is no reason to expect temporal variations in the ^{26}Al/^{10}Be production ratio, the long-term ^{10}Be production rate is also probably close to the Sierra Nevada rate (Nishiizumi *et al.* 1989). These conclusions are similar to those of Nishiizumi (this issue).

We have also collected two 1–1.5 m drill cores in Antarctic sandstone bedrock to examine the depth dependence of ^{10}Be, ^{26}Al, and ^{3}He production. ^{10}Be and ^{26}Al profiles from one core were reported previously (Brown *et al.* 1992). Both cores have exponential profiles; scale lengths are close to expected values and are 152 ± 5 and 145 ± 5 g/cm^2 for ^{10}Be and 153 ± 13 and 152 ± 5 g/cm^2 for ^{26}Al. Contrary to the calculations of Nishiizumi *et al.* (1989), these data indicate that muons produce <1–3% of total ^{10}Be and ^{26}Al at the altitudes and latitude of these cores, consistent with previous conclusions (Brown *et al.* 1995) based on a depth profile of ^{10}Be at low altitude near the equator.

The situation for ^{3}He is more complicated. One of the two cores exhibits an exponential decrease in cosmogenic ^{3}He with a scale length of ~150 g/cm^2. The second has a distinctly higher scale length, 227 ± 14 g/cm^2, over a similar depth interval. Studies of different size quartz grains in each core show that the discrepancy, which can be thought of as "extra ^{3}He" at depth, or loss of ^{3}He at the surface, is not an artifact of diffusion. It also does not appear to be caused by the presence of a non-cosmogenic ^{3}He component. Production of ^{3}He by muons is a remaining possibility. A model that includes the processes of erosion, diffusion, and ^{3}He production by neutrons and muons can approximately reproduce the observed profile with reasonable parameters, if exposure times are very long (*e.g.*, of order 20 Ma or greater), and if production of muons is ~10% of total production at 1700 m. While we are uncertain if this explanation of our data is correct, our observations suggest that further investigation of production rates of ^{3}He due to muon interactions is warranted.

[1]Graduate School of Oceanography, University of Rhode Island, Narragansett, Rhode Island 02882 USA
[2]LLO, University of Minnesota, Duluth, Minnesota 55812 USA
[3]Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543 USA
[4]CSNSM, Bâtiment 108, Campus Orsay 91405 France