Cosmogenic helium and neon extracted by crushing: A technique for discriminating between mantle and cosmogenic helium

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The helium and neon isotopic compositions of olivines coming from a 11Ma old xenolith sampled at Mt. Hampton (West Antarctica) were analyzed by crushing and heating. The $^4He/^3He$ isotopic ratio obtained by crushing varies between 1340 and 6300 (R/Ra between 115 and 539) with ^4He content around 3-5 10^{-10} ccSTP/g confirming that cosmogenic helium can be extracted by crushing [Scarsi, 2000; Yocochi et al., 2004]. The neon also shows a clear cosmogenic origin ($^{20}Ne/^{22}Ne$ down to 7.7 and $^{21}Ne/^{22}Ne$>0.32) indicating that some cosmogenic neon can also be extracted by crushing out of the olivines. This result indicates that for samples that had been exposed for a long time (e.g. few Ma to Ga), a step crushing procedure may not give the mantle ratios without ambiguity and that measurement of neon can discriminate between cosmogenic and mantle origin of the ^3He. Melting of the powder left after the crushing experiment gives $^4He/^3He$ ratio as low as 51±5 (R/Ra=14 230) and $^{21}Ne/^{22}Ne$ as high as 0.78, close to the cosmogenic end-member. Our results show that ~0.4% of the cosmogenic helium and ~0.3% of the cosmogenic neon can be extracted out of olivines by crushing

References

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Grain size dependency of ^{10}Be concentrations in alluvial sediments in the Great Smoky Mountains

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Analysis of multiple grain-size fractions from alluvial sediment samples in the Great Smoky Mountains (GSM), show, in five of the six samples tested, higher nuclide concentrations and by inference, slower model erosion rates, in smaller grain sizes than in larger ones. ^{10}Be concentration in the < 2 mm fractions correlate to erosion rates that range between 25±3 and 50±6mm ky^{-1}. in contrast, erosion rates 20%-40% higher are calculated for the >2 mm fractions in each sample. Field evidence for mass wasting is minimal, therefore, differences in cosmogenic nuclide concentrations between grains of different sizes cannot be explained by differences in transport mechanism. We interpret the difference in concentrations as a result of the large elevation distribution of the source and longer exposure periods on the slopes for the smaller grains compared with the narrow and relatively low source elevation of the large grains and their shorter exposure history.

Large sandstone clasts disaggregate into sand-size grains rapidly during down slope transport so only clasts from the lower parts of slopes reach the streams. A positive correlation between maximum relief in the basin and the difference in normalized ^{10}Be concentrations in the different grain size fractions suggests that our explanation is valid. We use the sampling location production rates to calculate erosion rates from ^{10}Be concentrations in the larger clasts. When site production rates are used, large grain size fractions yield erosion rates that range between 18±2 and 45±6 mm ky^{-1}, similar to those calculated from the small grain size fractions. These results support our assertion that clasts are derived from the lower parts of the slopes, that clasts are not transported long distances downslope, and that different grain sizes are generated at similar rates in the GSM.