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Understanding complex exposure history of Mount Hampton, West Antarctica using cosmogenic 3He, 21Ne and 10Be in olivine

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Combining stable and radioactive cosmogenic nuclides is an established tool for revealing the complexities of long-term landscape development. To date most studies have concentrated on 21Ne and 10Be in quartz. We have combined different chemical protocols for extraction of cosmogenic 10Be from olivine, and measured concentrations in olivine from lherzolite xenoliths from the peak of Mount Hampton (∼3,200 m), an 11 Ma shield volcano on the West Antarctic rift flank. We combine this data with cosmogenic 3He (and 21Ne) in the olivines in order to unravel the long-term environmental history of the region.

The mean 3He/21Ne ratio (1.98 $\pm$ 0.22) is consistent with the theoretical value and previous determinations. 10Be/3He ratios (0.012 to 0.018) are significantly lower than the instantaneous production ratio (∼0.045). The data are consistent with 1-3 Ma of burial. The altitude of the volcano rules out over-topping of the peak by the West Antarctic Ice Sheet only possible burial could be generated by the growth of an ice cap although this contradicts the absence of evidence for ice cover. The 3He-10Be data can also be generated during episodic erosion of the volcanic ash over the last few million years. The data requires a minimum depth of 1 to 2.5 m for the samples during a minimum age of 5 Ma and maximum long-term erosion rate of ∼0.5 m/Ma with at least one erosive episode reflecting short-term erosion rate of ∼7 m/Ma that would have brought the samples into the surface during the last ∼350 ka. Erosion in this type of landscape could be related to interglacial periods where cryostatic erosion can occur generating an increase in the erosion rate. This study shows that episodic erosion can produce stable-radioactive cosmogenic isotope systematics that are similar to those generated by exposure-burial cycles.