A search for cosmogenic nitrogen in a terrestrial rock

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^{15}N produced by cosmic rays has been identified in lunar rocks and meteorites. Production occurs through reaction on ^{16}O directly via $^{16}O(p,2p)^{15}N$ and indirectly via $^{16}O(p,pn)^{15}O$ (e.g., [1]). Due to ubiquitous occurrence of oxygen in terrestrial rocks and the fact that ^{15}N is stable, the use of cosmogenic ^{15}N appears attracting for evaluating surface exposure durations on the long range. However, nitrogen is very abundant at the Earth's surface, mostly as atmospheric N_2, as organic N, or as ammonium substituting to K in crustal rocks, so that its detection requires techniques able to identify precisely $^{15}N_c$ from contamination or structural nitrogen. We have analysed nitrogen and noble gases in a pyroxene separate from a dolerite boulder sampled at an elevation of 2550 m at Mt Feather in the Dry Valleys, Antarctica [2]. Ne and He minimal exposure ages are 5.3-5.6 Ma, respectively [2]. Gases were extracted by stepwise heating using both a CO_2 laser and a combination of an externally heated quartz tube and an induction furnace. Nitrogen, neon and argon amounts and isotopic ratios were analysed together by static mass spectrometry in CRPG, Nancy, France. $^{21}Ne_c/^{38}Ar_c$ in the range 2.3-3.1 are comparable to values observed in lunar samples (e.g., [1,3]). The highest $^{15}N/^{14}N$ ratios were observed during the highest temperature extractions, consistent with the release pattern of $^{15}N_c$ from extraterrestrial material. Assuming that these high $^{15}N/^{14}N$ ratios are due to release of cosmogenic $^{15}N_c$, computed $^{15}N_c/^{21}Ne_c$ and $^{15}N_c/^{38}Ar_c$ ratios of 13 (range : 2-23) and 48 (range : 7-88) encompass lunar soil values (4 and 14, respectively). The corresponding $^{15}N_c$ production rate at sea level, scaled to a ^{3}He production rate of 115 atom/g.yr at sea level for the sampling latitude [2], is ~ 200 (possible range : 73-460) atoms/g.yr. Further work is under way to refine this value.

References

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