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Cross-calibration of cosmogenic ^{3}He and ^{21}Ne production rates in olivine, pyroxene and quartz

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A recent investigation of cosmogenic He, Ne, and Ar in pyroxene separates from Antarctica [1] has revealed an inconsistency between different methods currently available for assessing ^{3}He and ^{21}Ne production rates in mafic minerals. E.g., using a normalized ^{3}He production rate of 115 atoms $g^{-1}a^{-1}$ as derived from various experimental determinations, exposure ages turn out 30-40% higher than if the method of [2] based on elemental composition is applied. Likewise, several methods to calculate the ^{21}Ne production rate yield disagreeing results, which however are consistent with either of the two He age values. A rock of basaltic-andesitic composition sampled from a Pleistocene lava flow on the Puna plateau (NW Argentina) contained a quartz xenocryst from crustal contamination $\sim$3 cm in size, along with olivine and pyroxene phenocrysts, and was used for a direct comparison of cosmogenic ^{3}He and ^{21}Ne concentrations in those minerals. The results show that cosmogenic ^{3}He concentrations (corrected for magmatic He with ^{3}He/^{4}He = 7.9 R_a as determined by crushing extractions) are equal at 32×10^{6} atoms/g in olivine and pyroxene, while cosmogenic ^{21}Ne is 12.8, 7.2, and 3.8×10^{6} atoms/g, respectively, in olivine, pyroxene, and quartz. The resulting ^{3}He(ol)/^{21}Ne(qz) ratio of 8.25 $\pm$ 0.79 is considerably higher than that obtained by comparing established production rates of $\sim$115 and $\sim$20 atoms g^{-1} a^{-1} (5.75). The difference is similar to that resulting from different He and Ne production rate assessment methods, and implies either an $\sim$30% higher ^{3}He production rate in olivine or an $\sim$30% lower ^{21}Ne production rate in quartz compared to values most widely used at present. A somewhat higher ^{3}He production rate in olivine has recently been advocated [3]; a lower ^{21}Ne production rate is quite possible as well given the difficulties in the one experimental determination it is based on.

[1] S. Niedermann et al., manuscript submitted to EPSL, 2006. [2] F. Kober et al., EPSL 236, 404-418, 2005. [3] P.-H. Blard et al., EPSL 247, 222-234, 2006.