Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06808, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06808
EGU General Assembly 2008

Towards an experimental determination of element-specific production rates for cosmogenic ^{3}He, ^{21}Ne and ^{38}Ar

S. Niedermann (1), P. Pilz (1), M. Goethals (1,2), C.R. Fenton (1) and F. Kober (3)

(1) GeoForschungsZentrum Potsdam, Germany, (2) Westfälische Wilhelms-Universität Münster, Germany, (3) ETH Zurich, Switzerland (nied@gfz-potsdam.de)

The production rates of terrestrial cosmogenic nuclides in rocks exposed at the surface depend not only on the geographical location of the sampling site, but also on the elemental composition of the irradiated minerals. So far, only model calculations have been available for these “element-specific” production rates of cosmogenic ^{3}He and ^{21}Ne, while experimental determinations have focused on specific minerals such as olivine and quartz. However, except for quartz most minerals display a considerable range in elemental composition, which may substantially affect the total production rate. In addition, it has recently been shown [1] that model calculations yield discordant results in terms of ^{3}He and ^{21}Ne exposure ages of pyroxenes. Therefore, a direct experimental determination of element-specific production rates would be desirable.

We have started such an investigation, based on a comparison of cosmogenic ^{3}He, ^{21}Ne and ^{38}Ar concentrations in different minerals of the same rocks. Our sample material includes a basaltic-andesitic lava flow from the Puna plateau (NW Argentina), where a quartz xenocryst from crustal contamination was found in one specimen along with olivine and pyroxene phenocrysts; the Bishop Tuff (California) ignimbrite containing both quartz and pyroxene; the olivine- and pyroxene-bearing Bar Ten lava flow, Arizona; and the Oxaya ignimbrite from the Arica area (Chile) where quartz and sanidine can be compared.

Relating the cosmogenic ^{21}Ne concentration in olivine or pyroxene to that in coexisting quartz provides information on the ratio P_{21}(Mg)/P_{21}(Si). From the samples studied so far, we obtain a weighted mean of 4.62 ± 0.36, or $P_{21}(Mg) \approx 188$ at (g Mg)$^{-1}$ a^{-1} when combined with the experimental ^{21}Ne production rate in quartz of 19 at g^{-1} a^{-1}, i.e. 41 at (g Si)$^{-1}$ a^{-1} [2]. The value for Mg is very close to that predicted by the Kober et al. [3] model.

Cosmogenic ^{3}He production rates vary much less among different elements, but still some influence does exist. According to models, the production rate in pyroxene should be a few percent lower than in olivine due to lower Mg content. However, four measurements of coexisting olivine and pyroxene in the Puna and Bar Ten samples consistently yielded slightly higher ^{3}He concentrations in pyroxene. Since the pyroxene is Ca-rich (14-16%), this may indicate that the ^{3}He production rate from Ca is at least as high as that from Mg, while model calculations predict a smaller rate by a factor of 2.

The ^{38}Ar production rate from Ca has been determined earlier based on ^{3}He and ^{21}Ne ages of pyroxene separates from Antarctica [1]. We now address the other important target element for ^{38}Ar production, i.e. K. Preliminary results from sanidine separates of the Oxaya ignimbrite, cross-checked against ^{21}Ne in coexisting quartz, indicate an ^{38}Ar production rate from K $\sim$2-3 times higher than that from Ca. If confirmed, this would be clearly different than the ratio of $\sim$1 expected based on model data for the lunar surface [4].

[1] S. Niedermann et al., Earth Planet. Sci. Lett. 257, 596-608, 2007.

[2] S. Niedermann, Earth Planet. Sci. Lett. 183, 361-364, 2000.

[3] F. Kober et al., Earth Planet. Sci. Lett. 236, 404-418, 2005.

[4] C.M. Hohenberg et al., Proc. Lunar Planet. Sci. Conf. 9, 2311-2344, 1978.