The SP basalt flow: A new primary calibration site for cosmogenic nuclide production rates

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The SP lava flow and its cinder cone (SP Crater) are located in the northern part of the San Francisco volcanic field, about 55 km north of Flagstaff, AZ (USA). The basaltic cinder cone and flow both have extremely youthful, unweathered geomorphic appearances, which retain a well-defined rim and crater, and lava-flow levee, aa, and agglutinate features. No soils have formed on the flow, and the flow surface has a well-developed desert varnish. Previous studies report $^{40}Ar/^{39}Ar$ and K-Ar ages of the flow that suggest the cone erupted 70±4 ka, in contrast to preliminary OSL ages (~2-4 ka) reported for quartz xenoliths in the same flow. Preliminary surface exposure data suggest that the flow is indeed ~70 ka. Co-existing olivine and pyroxene separated from whole-rock samples collected near the head and at the toe of the flow were analyzed for cosmogenic ^{3}He and ^{21}Ne. Fenton *et al.* [1] report good 1:1 age agreement between these nuclides in co-existing olivine and pyroxene when using the following production rates for ^{3}He and ^{21}Ne: 118 and 49 at/g/yr in olivine and 114 and 23 at/g/yr in pyroxene. Using these rates and measured nuclide concentrations in this study, preliminary ^{3}He and ^{21}Ne ages of the SP flow yield an average age (±std. dev) of 68±5 ka. Adjusting these rates to the specific chemical compositions of SP olivine and pyroxene, using a modification of Masarik's [2] elemental production rates, yields an average age (±std. dev) of 70±5 ka, in perfect agreement with the $^{40}Ar/^{39}Ar$ and K-Ar ages. The SP flow has undergone negligible erosion based on initial cosmogenic nuclide analyses and this is supported by the unweathered appearance of its surface. This is thus an excellent location for calibrating production rates of multiple cosmogenic nuclides in co-existing olivine, pyroxene, and quartz. Based on the $^{40}Ar/^{39}Ar$ age and ^{21}Ne concentrations in SP pyroxenes, we already report a weighted-mean production rate ($P^{21}Ne$) of 25±2 at/g/yr. This agrees with, but is much more precise, than the $P^{21}Ne$ of 25±8 at/g/yr initially reported by Fenton *et al.*

[1] Fenton *et al.* (2009) *Quat. Geochron*, submitted.
[2] Masarik (2002) *Geochim. Cosmochim. Acta* **66**, A491.

^{40}Ar-^{39}Ar age for gabbroic lunar meteorite Northwest Africa 5000

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Lunar meteorite Northwest Africa 5000 is a feldspathic breccia with predominantly monolithologic composition of metal-bearing leucogabbroic to gabbroic clasts in a partly glassy matrix, with some shock melt-injection veins [1]. The high metal content observed in the clasts has been attributed to the impactor, suggested to be processed material from the inner Solar System [2]. The existence of exotic metals within the otherwise apparently igneous-textured gabbroic clasts may signify large-scale impact melting and differentiation. Initial ^{40}Ar-^{39}Ar age spectra for three bulk subsamples of a gabbroic clast are highly discordant and suggest a partial re-setting of the K/Ar system manifest in the initial ~70% of the ^{39}Ar released. This was likely the result of a thermal event such as an impact at ~500 Ma, and possibly when the material composing this meteorite was excavated and became exposed on the lunar surface. This interpretation is in agreement with cosmogenic radionuclide results [3]. The following ~30% of ^{39}Ar release shows more consistent apparent ages, though not meeting standard plateau criteria, suggestive of an age of 3.2±0.1 Ga, possibly the age of the larger impact that created a substantial melt sheet which then differentiated. The $^{38}Ar/^{36}Ar$ for all temperature steps shows the typical cosmogenic value of ~1.54 indicating negligible contribution from trapped or solar argon. Similar re-setting ages of 3.2-3.3 Ga have been observed for Apollo 16 soil samples collected from the North Crater ejecta [4,5], and also coincide with a peak in Apollo 14 [6] impact melt spherule ages.

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[1] Irving *et al.* (2008) *39th LPSC*, abst.#2168. [2] Humayun & Irving (2008) *GCA* **72**, 12S, A402. [3] Nishiizumi *et al*. (2009) *40th LPSC*, abst.# 1476. [4] Fernandes *et al*. (2008) *Workshop ESSIB*, abst.#3028. [5] Shuster *et al*. (2008) *Eos Trans. AGU* **89(53)** Fall Meet. Suppl., Abs.# V51H-05. [6] Culler *et al*. (2000) *Science* **287**, 1785-1788.