Constraining paleotemperatures of planetary surfaces with cosmogenic neon in feldspars

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Cosmogenic noble gases often exhibit open system behavior at planetary surface temperatures in common rock-forming minerals like feldspars. This open system behavior can be exploited to reconstruct the paleotemperatures of planetary surfaces, provided that the production and diffusion systematics of a particular cosmogenic noble gas–mineral pair are understood. Paleotemperatures on the moon have been reconstructed from cosmogenic and radiogenic isotopes of argon measured in multiple solid phases [1]. Here, we test whether cosmogenic neon isotopes in feldspar minerals can also be used to quantify lunar surface paleotemperatures using anorthite from lunar troctolite 76535. Measurements of cosmogenic ^{38}Ar in 76535 indicate that this sample has a minimum exposure age of 142 Ma and did not experience temperatures greater than 170 °C during its exposure. Argon isotope measurements in other lunar samples indicate that effective diffusion temperatures (*EDT*s) of the lunar surface are ~70–80 °C [1].

We quantified the diffusion kinetics of neon in 76535 anorthite through step-degassing experiments on neutron-irradiated anorthite fragments. Linear behavior in an Arrhenius plot was observed for 98% of ^{22}Ne released, indicating an activation energy (E_a) of 116 ± 3 kJ/mol and a pre-exponential factor ($ln(D_0/a^2)$) = 9.5 ± 0.5 ln(s^{-1}). Given these diffusion kinetics and lunar *EDTs* of ~70–80 °C, we predict that cosmogenic neon concentrations will have reached a steady state between production and diffusion during the 142 Ma exposure duration of 76535. Forthcoming measurements of the cosmogenic neon present in 76535 anorthite grains will provide a direct test of this prediction allow us to assess the viability of cosmogenic neon-in-feldspar paleothermometry on the moon and other planetary bodies.

[1] Shuster & Cassata (2015), *GCA* 155, 154-171.