Towards determining cosmogenic ^{3}He exposure histories from old volcanic rocks

FINLAY M. STUART[1], ALICE J. WILLIAMS[1] AND HANNE H. CHRISTIANSEN[2]

[1]SUERC, East Kilbride G750QF, UK (f.stuart@suerc.gla.ac.uk, a.williams@suerc.gla.ac.uk)
[2]The University Courses on Svalbard, UNIS, P.O.Box 156, 9171 Longyearbyen, Norway (hhc@unis.no)

The presence of three He components (cosmogenic, radiogenic and magmatic) but only two isotopes has restricted ^{3}He exposure determinations to young (< 1 Ma) volcanic rocks, where radiogenic He is insignificant, and ancient rocks from stable landscapes which have long exposure histories. In an attempt to constrain <100 ka exposure histories from ancient volcanic rocks we have targeted microphenocryst and groundmass pyroxene in the expectation that it crystallised during eruption (after degassing) and has not trapped significant magmatic He.

In vacuo crushing 125-250 μm microphenocryst pyroxene from 5 Ma Roque Nublo volcanic breccias (Gran Canaria) released 0-2.5 % of the ^{3}He released by melting splits of the same sample. This compares to 99.7 % for > 1 mm pyroxene from cumulate pyroxenite clasts. The (<75 μm) powders which remain after crushing yield ^{3}He concentrations from melting which are indistinguishable from the microphenocryst fraction. After correction for radiogenic He less than 3 % of the ^{3}He of the microphenocrysts is magmatic in origin. The effect is small in comparison to production rate-scaling factor uncertainties, and the effect of erosion, partial shielding and inheritance.

Cosmogenic ^{3}He exposure ages of groundmass pyroxene, after correction for radiogenic He, from 6 boulders of early Tertiary basalts from the Faroe Islands are broadly consistent with the ages expected from glacial and periglacial geomorphological studies, and similar to ^{36}Cl exposure ages in a companion study. Replicate ^{3}He exposure age determinations have a standard deviation of 8 % despite a 10-fold variation in ^{3}He/^{4}He. A positive correlation between exposure age and ^{3}He/^{4}He indicates that post-exposure diffusive loss and/or a small magmatic He contribution may determine the accuracy of groundmass ^{3}He exposure ages. Exposure ages of less than 10 ka are sensitive to the ^{3}He/^{4}He used for the radiogenic He correction. An ongoing investigation of shielded samples is aimed at determining the magnitude of the magmatic He contribution and constraining the variability of the radiogenic He isotope composition.

Residence Time of Nubian Aquifer Water, Western Desert, Egypt

N. C. STURCHIO[1], M. SULTAN[2], Z. T. LU[3], X. DU[3], B. E. LEHMANN[4], R. PURTSCHERT[4], R. LORENZO[4], Z. EL ALFY[5], B. EL-KALIOUBY[6]

[1]University of Illinois at Chicago, Chicago, IL 60607 USA, (Sturchio@uic.edu)
[2]SUNY University at Buffalo, Buffalo, NY 14260 USA, (Sultan@amoun.er.anl.gov)
[3]Argonne National Laboratory, Argonne, IL 60439 USA, (Lu@anl.gov, Du@nwu.edu)
[4]University of Bern, Bern, Switzerland, (Lehmann@climate.unibe.ch, Purtschert@climate.unibe.ch, Lorenzo@climate.unibe.ch)
[5]Egyptian Geological Survey and Mining Authority, Abbassiya, Cairo, Egypt (Zinhsayd23@yahoo.com)
[6]Ain Shams University, Abbassiya, Cairo, Egypt (Belkaliouby@hotmail.com)

An immense reservoir (~50,000 km^{3}) of fresh water in the Nubian sandstone aquifer system underlies portions of Chad, Libya, and the Western Desert of Egypt. This water flows from southwest to northeast and discharges at oases. Recharge occurred during one or more humid climate episodes that prevailed during the late Pleistocene, but significant widespread recharge does not occur presently. D/H and ^{18}O/^{16}O ratios are much lower than those of modern precipitation in the region. We have obtained preliminary AMS data for ^{36}Cl and ^{14}C, providing new constraints on the residence time of the water. An expedition in May 2002 will sample for comprehensive environmental isotope tracer analyses including further ^{36}Cl and ^{14}C measurements by AMS, noble gases and other stable isotopes, as well as ^{85}Kr and ^{81}Kr measurements by magneto-optical atom-trapping methods (Chen et al., 1999). ^{36}Cl/Cl ratios vary from 33×10^{-15} to 228×10^{-15} and generally decrease along flow direction. Residence times calculated from these data can exceed 800 ka, depending on model assumptions, but conservative assumptions yield a range of about 100 to 400 ka. ^{14}C activities (0.08 to 1.84 pmC) are mostly at background, consistent with ^{36}Cl model ages, but two samples had measurable ^{14}C that may indicate some recent recharge. The ^{14}C in these two samples correlates with dissolved oxygen. Other recent work on the Nubian aquifer waters (Dabous and Osmond, 2001) indicates that the upper portion of the aquifer has a component of recent, relatively saline recharge. Therefore, our intercomparison of ^{36}Cl and ^{81}Kr will focus on water sampled from the lower portion of the aquifer, which represents the more ancient recharge component.

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