Nucleogenic neon-21 production rates for geochronology

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The (U-Th)/Ne chronometer is a potentially powerful technique for dating minerals that contain U and/or Th and oxygen and/or fluorine. For example, zircon, hematite, and apatite have sufficiently high nucleogenic neon fractions that ^{21}Ne chronometry is practical. Because neon is produced via α particle capture by oxygen and fluorine, dating accuracy depends on reaction cross sections and the calculated α stopping power in the material being studied. Despite being derived from the same cross section data, published ^{21}Ne production rates vary by tens of percent [1,2]. To reduce this uncertainty we implanted α particles in two materials with very different stopping powers, quartz and barium tungstate, to measure the production rate of ^{21}Ne from α particles in the ^{238}U, ^{235}U, and ^{232}Th decay series.

We find production rates that agree with predicted rates following the production model in [1], with uncertainties of 2-5%. Uncertainties are ~4% for ^{21}Ne/^{4}He ratios extrapolated to other minerals and are <2% for ^{21}Ne concentrations measured by isotope dilution, so (U-Th)/Ne age uncertainties will be <5% when nucleogenic fractions are high.

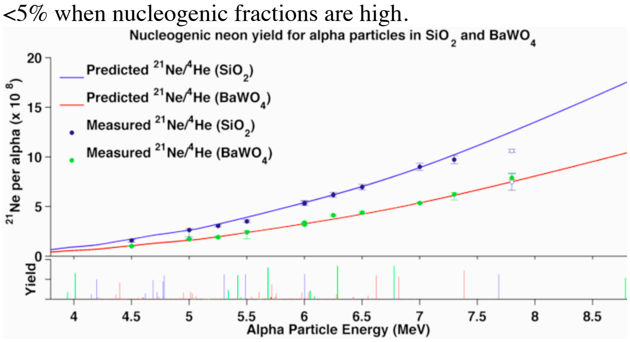

Figure 1: Ratios of nucleogenic neon to implanted helium in samples of quartz and barium tungstate compared to predicted yield following the approach of [1]. Open symbols showed evidence for helium beam contamination during implantation and are low for that reason. The lower plot shows alpha yields of the ^{238}U (blue), ^{235}U (red), and ^{232}Th (green) decay chains.

[1] Gautheron, Tassan-Got, & Farley (2006), *EPSL* **243**, 520-535. [2] Leya & Wieler (1999), *JGR* **104**, 15,439-15,450.

Which age is the true age? Unravelling within-flow ^{40}Ar/^{39}Ar age variations in Faroe Islands basalt lavas

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Previous dating of basaltic igneous rocks from the Faroe Islands by radiometric techniques (Ar/Ar and K/Ar) has proved problematic [1].

The Ar/Ar technique assumes that the rapid cooling rates of lavas is sufficient to close the argon system uniformly, preventing any loss or gain of argon from the lava during cooling. Therefore, an Ar/Ar age for a basalt should be independent of where in the lava a sample is collected. However, in practise, within-flow age variations of more than 10% have been found.

Forty-eight samples were collected from vertical transects through five basalt lavas from the Faroe Islands and radiometric ages were obtained by Ar/Ar step-heating analysis of whole-rock basalt, taking care to pick only visually fresh material and avoiding any signs of alteration (e.g. vesicle fills).

Surface exposure samples from two lavas yield average plateau-ages of ~46 Ma and ~51 Ma respectively (with individual samples ranging from 35 Ma to 55 Ma). Drill core samples from three lavas yield average ages of between ~56 Ma and ~57 Ma. The spread of ages for lavas analysed using drill core is considerably less than that for the surface exposure samples, suggesting that the highly variable Ar/Ar ages may reflect the effects of surface weathering.

We have performed a suite of geochemical analyses on all these samples which will ultimately allow evaluation of these post-emplacement alteration effects on the Ar/Ar system.

While we use a case study from the Faroe Islands Basalt Group, our results are important for accurately interpreting Ar/Ar ages from any basaltic system.

[1] Passey & Jolley (2009), Earth & Environmental Science Transactions of the Royal Society of Edinburgh, **99**, 127-158.

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