(U-Th)/Ne chronometry

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Nuclear production of ^{21}Ne, like ^{4}He, in U and Th rich minerals such as apatite, zircon, monazite and titanite can potentially be used for chronometry. To test the possibility, a review of the available cross section data was done, permitting a reevaluation of the ^{21}Ne production from this reaction. The important factors of the simulation are the cross section and the stopping distance values for a mineral characterized by its chemical composition and density. Additionally, ^{21}Ne has a stopping range of about 1 µm compared to about 20 µm for α particles; thus the (^{21}Ne/^{4}He) production ratio also depends on crystal size when the crystals are small enough that α ejection is important.

We also present measurements of the (^{21}Ne/^{4}He) ratio on few mg aliquots of well-dated volcanic apatites and zircons. The measured (^{21}Ne/^{4}He) are in agreement with the theoretical values for apatite and zircon. Based on our production rate estimates the Durango apatite and Fish Canyon Tuff zircon give Ne ages of 34.2±8.6 Ma and 28.0±12.2 Ma respectively, which are in agreement with independently known ages. Additionally, the ^{4}He and ^{21}Ne content of zircons from the deeply exhumed crustal section in Gold Butte, Nevada (crystallization age of 1.4 Ga) imply (U-Th)/Ne ages of 963±164 and 777±122 Ma, far older than their He ages of 16.7±1.3 and 19.1±1.5 Ma respectively. To explain the age difference, a neon closure temperature for zircon around 400°C is derived.

This study demonstrates that (U–Th)/Ne chronometry can be a powerful new tool permitting access to a higher closure temperature than with (U–Th)/He. Additionally, the physical and mineralogical properties of the minerals of interest can be a great advantage and can help when K-Ar or Ar-Ar dating is difficult.