Cosmogenic nuclide production rates from ancient Antarctic surfaces

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We have measured multiple cosmogenic nuclides in a set of 12 ancient quartzite and granite erratic samples from the Transantarctic and Prince Charles Mts, Antarctica. The data comprise ^{21}Ne measurements on quartz, ^{10}Be and ^{26}Al on quartz and ^{36}Cl on K-feldspar and biotite. Simple exposure ages for the samples based on ^{21}Ne range from 1.6 - 10.2 Myr; the combined ^{21}Ne, ^{26}Al and ^{10}Be data suggest that actual ages are ca. 4-16 Myr with erosion rates of 0.05-0.5 m/Myr. The long exposure ages of these samples allow us to determine ^{36}Cl production rates from concentrations close to saturation values. K-feldspars from the granite samples have low Cl concentrations (6-26 ppm), allowing us to calculate limits on the ^{36}Cl production rate from K largely independent of other contributing target elements. The value derived from these data is close to values previously determined from lateglacial calibration sites in Scotland (159-166 atom/g K/yr). Biotite samples are comparatively rich in Cl (75-290 ppm), and correspondingly more sensitive to ^{36}Cl production by neutron capture on ^{35}Cl; calibration results from these samples are broadly compatible with current estimates of the n-capture production rate, but corrections for K-, Ti- and Fe-derived ^{36}Cl are significant and limit the precision of the calculation. Beryllium-10 and ^{26}Al in quartz were measured with a precision and reproducibility better than +/- 1%. These data, combined with the independent evidence of long exposure times from the ^{21}Ne data, allow us to estimate saturation values for ^{10}Be and ^{26}Al, which place a geological limit on the ratio of the ^{10}Be half-life to that of ^{26}Al. Using the best estimates of production rates for these nuclides from new CRONUS calibration data, the Antarctic data suggest a value for the ^{10}Be half-life comparable to, or higher than, the results of recent physics-based re-determinations.

New approaches to the development and growth of Hadean and Archaean crust

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A critical consideration in the evolution of Earth's continental crust is the timing of generation and composition of Hadean and Archaean crust. In recent years much of what we know has been through Hf and U-Pb isotopes in zircon, particularly the Jack Hills detrital zircons with their unique suite of >4 Ga ages. Data from these zircons have implied that the Hadean crustal source for the zircons was at least partly evolved and that the Earth's surface already had free water. Whilst this information is invaluable, it is difficult to validate by other methods. What would be useful is a complementary method that is capable of either providing similar independent information or other information not possible from zircon.

The mineral titanite is robust, with a fairly high closure temperature for Pb and O and very high for the REE. It contains these elements in abundances that are readily measured in small volumes and potentially by *in situ* techniques, in an analgous way to zircon. We present a combination of *in situ* (LA-ICPMS and SIMS) and solution (ID-TIMS) U-Pb data from titanites within tonalitic and granodioritic gneisses from around the Isua region of SW Greenland. These ages are as old as 3.65 Ga and demonstrate that old igneous titanite can survive later reworking, even this far back in time. We also present *in situ* O and Nd isotopic data and demonstrate that this data is achievable from within single parts of the same grain. The O data are mantle-like and do not require reworked sedimentary material within the protoliths, also verified by O data from zircons. The Nd data suggest, similar to *in situ* Hf data in zircon, that the protoliths have reworked older igneous crust with model ages in the region of c.4 Ga. The data from Greenland do not, therefore, sample the potential very early vestiges of Earth's crust.