Geophysical Research Abstracts,
Vol. 11, EGU2009-13183, 2009
EGU General Assembly 2009

Landscape evolution and erosion rates: advantages of incorporating cosmogenic 21Ne with 26Al and 10Be

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In situ-produced cosmogenic nuclides are now widely used to date geomorphic features and, when combined with landscape analysis, allows conclusions about climate events to be drawn. The commonly-used cosmogenic radionuclide pair 26Al and 10Be are measured in the same quartz fraction and the different half-lives allows Quaternary (and older) exposure ages and erosion histories to be quantified. However, 26Al and 10Be half lives differ by only a factor of two and they share the same spallogenic production profile. Typically analytical uncertainties mean that the 26Al/10Be ratio has only a limited ability to resolve erosion and exposure parameters. For example, the 26Al-10Be pair frequently does not allow simple exposure histories (i.e. zero erosion) to be resolved from complicated exposure histories involving erosion and/or burial.

Combining the stable cosmogenic nuclides (3He and 21Ne) with radionuclides offers the possibility of quantifying erosion rates (less than 80 cm/Myr) with higher resolution. Additionally this combination provides a better quantification of complex exposure histories. For instance, in stable landscapes where exposure-burial-exposure histories are on 100,000 year to million year timescales, the measurement of cosmogenic noble gas isotopes are required to allow surface process rates to be quantified.

Until very recently studies combining the stable and radioactive cosmogenic nuclides have been sparse. Using examples from glacial deposits and glacially-shaped bedrock from Northern Victoria Land, Antarctica, we will demonstrate how the incorporation of cosmogenic 21Ne with 26Al and 10Be can be used to refine and unravel the glacial history of the region. When 26Al- 10Be systematics rule out significant periods of burial they rarely allow erosion rates to be quantified. By combining 10Be with 21Ne, we show that erosion rates of 10 to 80 cm/Myr can be measured with a precision of 30%. In other cases we show that although there is no evidence of burial from 10Be and 26Al of erratics, 21Ne concentrations require a complex pre-exposure history, often with a few million years of burial prior to most recent exposure.