Perspectives on dating with multiple cosmogenic nuclides

DARRYL E. GRANGER

Department of Earth and Atmospheric Sciences, Purdue University, West Lafayette, IN 47907, USA (dgranger@purdue.edu)

The method of dating sediment burial using the differential decay of ^{26}Al and ^{10}Be in quartz has been used since the earliest days of terrestrial cosmogenic nuclide measurements. Techniques were readily adapted from the meteoritic field, where multiple cosmogenic nuclides were routinely measured to date complex histories of exposure and shielding in space and on earth. However, because the ^{26}Al-^{10}Be pair is sensitive only on a million-year timescale, with uncertainties of 10's to 100's of thousands of years, it initially proved to be of limited use for dating earth surface processes, which tend to occur much more rapidly. More recently, a flurry of new applications has developed to date rock and sediment burial over the past 5 My, providing dates to investigate long-term river incision, marine terrace uplift, glacial histories, and biologic evolution, as well as measurements to investigate paleo-erosion rates. I will present examples of these applications from published work as well as from marine terraces and caves of central Italy.

Accurate burial dating with ^{26}Al and ^{10}Be is hampered by a large discrepancy in the half-life of ^{10}Be. Although most published ^{10}Be measurements implicitly assume a half-life of 1.5 My, an alternative measurement of 1.34 My was derived from the same parent solution; these values have never been resolved. A compilation of surface exposure data from the literature reveals that ^{26}Al/^{10}Be ratios near saturation are consistent with either half-life, but that they are more closely described by the shorter half-life.

Ongoing and future work with different mineral systems may employ different cosmogenic radionuclides. For example, feldspar and quartz in the same rock can be analyzed for ^{36}Cl, ^{26}Al, and ^{10}Be to reveal more complex or recent exposure and burial histories. Carbonate rocks may also prove useful for the ^{36}Cl-^{10}Be pair. Preliminary results from a Roman marble quarry show that ^{10}Be can be measured to high precision in this rock, although care must be taken to avoid secondary calcite which may contain large amounts of meteoric ^{10}Be, even many centimeters beneath the surface.

Preservation of (Early) Miocene landscapes in the Atacama Desert, northern Chile

T.J. DUNAI[1], G.A.GÓNZALEZ-LÓPEZ[2], J. JUEZ-LARRÉ[1] AND D. CARRIZO[2]

[1]Faculty of Earth and Life Sciences, Vrije Universiteit, Amsterdam, Netherlands (dunt@geo.vu.nl; juej@geo.vu.nl)

[2]Departamento de Ciencias Geológicas, Facultad de Ingeniería y Ciencias Geológicas, Universidad Católica del Norte, Antafogasta, Chile (ggonzale@ucn.cl)

Depositional surfaces of early Miocene sediments surfaces are preserved in the Coastal Cordillera, Atacama Desert, northern Chile. Measurement of cosmogenic ^{21}Ne in clasts from erosion-sensitive sediment surfaces show that these surfaces have been barely affected by erosion since 25 Ma. Predominantly hyperarid conditions since 25 Ma are required to create and preserve these oldest continuously exposed surfaces on Earth. The next oldest continuously exposed surfaces, in the Dry Valleys region, Antarctica, have about half this age. Occurrence of younger exposure ages indicate that brief pluvial episodes occurred since the Early Miocene did occur, which caused limited, localized erosion and material transport, only marginally affecting the large scale landscape.

We present new data from other, similarly old surfaces, from the coastal portion of the Atacama Desert. These data demonstrate that the exceptional landscape stability in this coastal desert is widespread, as would expected from the large scale regional factors controlling climatic conditions in this area.

The dominantly hyper-arid conditions we infer for the Coastal Cordillera since ~25 Ma ago are compatible with the hypothesis that the onset of aridity in the Atacama Desert is the cause, rather than the result of the uplift of the high Andes.

Only exceptional global climatic disturbances have occasionally permitted humidity transfer across the Andes into the driest regions of this Coastal Desert since ~25 Ma.

References

Dunai T.J., González López G.A. and Juez-Larré J., (in press), *Geology*.

Lamb, S. and Davis P., (2003): *Nature*, **425**, 792-797.

Schäfer, J.M. et al., (1999) *Earth Planet. Sci. Lett.* **167**, 215-226.

van der Wateren, F.M. et al., (1999) *Global Planetary Change* **23**, 145-172.