Isochron burial dating with ^{26}Al and ^{10}Be: Applications from landscape evolution to human evolution

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Burial dating of sediment by the radioactive decay of cosmogenic ^{26}Al and ^{10}Be in quartz has proven useful for dating caves, river terraces, glacial tills and paleosols over the Plio-Pleistocene. However, it has remained limited by the great depths required to shield samples from cosmogenic nuclide production, typically >10-20 meters. Here we present a new isochron method that circumvents this problem and allows accurate dating at much shallower depths.

Isochron burial dating relies on analyzing a set of samples sharing the same burial history, but with different pre-burial concentrations. In this case, a plot of ^{26}Al *vs.* ^{10}Be will yield a line whose slope is dependent on the burial age, and whose intercept depends on the amount of postburial production. As with other isochron methods, a successful date requires samples that have a wide range of inheritance.

Samples that maximize variability in inheritance could come from (a) individual clasts, which commonly show tenfold variability in alluvial settings, (b) the sediment/bedrock interface, (c) buried paleosols, where inheritance varies exponentially with depth, or (d) different grain size fractions.

We will present results from ongoing work dating sediments in a wide range of environments, illustrating strengths and limitations of the method. Field studies include river incision in the Colorado Plateau, and hominin evolution in China.

The nitrogen and oxygen isotope composition of nitrate in the environment: The systematics of biological nitrate reduction

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The nitrogen (N) and oxygen (O) isotope ratios of nitrate (^{15}N/^{14}N, ^{18}O/^{16}O, respectively) in environmental samples provide an integrated signal of the physical transport and concurrent biological nitrogen transformations of nitrate. Interpretation of nitrate isotope distributions requires *a priori* knowledge of the isotopic signature associated with distinct biological processes. We present work that informs our current understanding of the physiological mechanisms underlying the expression of nitrate N and O isotope effects during its biological reduction. Both assimilation by unicellular plankton and bacterial denitrification impart equivalent N vs. O isotope effects on nitrate. This unexpected coupling originates during enzymatic nitrate reduction, such that nitrate reductase enzymes emerge as the dominant driver of the organism-level isotope effects. *In vitro* measurements of the enzymatic isotope effects of assimilatory and dissimilatory nitrate reductases are compared to *ab initio* computations of putative transition state structures of the enzyme-substrate complexes to identify rate-limiting steps in enzymatic catalysis. These biological sytematics of nitrate isotope fractionation are contextualized with reference to their utility in interpreting nitrate isotope distributions in the environment.