COSMO-CALIBRATE-

A Program for Calibrating Cosmogenic Exposure Ages

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In order to account for geomagnetically-induced changes in cosmogenic nuclide production rates in situ, and thereby increase the potential accuracy of exposure age dating, we have developed a numerical model which generates geomagnetically-calibrated exposure ages. Currently accepted, model-age calculations are based on time-averaged production rates. Use of time-averaged production rates may introduce systematic errors >20% in exposure ages causing cosmogenically dated events to be correlated incorrectly with events dated by other means (Clark et al., *Quat. Res.*, 44, Nov, 1995). Applying our model to existing nuclide abundance data generally increases calculated exposure ages (Fig. 1), supports the ^{10}Be-based assertion of Gosse et al. (*Geology*, 23, p. 877-880, 1995) that a glacial advance in the Rocky Mountains may have occurred during Younger Dryas time, and most importantly, reconciles three apparently disparate production rate estimates for ^{26}Al and ^{10}Be.

We have created a computer program (COSMO-CALIBRATE) which uses generally accepted geomagnetic paleointensity records (Meynadier et al., *Earth & Planetary Science Letters*, 114, 39-57, 1992; and McElhinny & Senanayake, *J. of Geomagnetism & Geoelectricity*, 34, 39-51, 1982) and empirical relationships to account for cosmogenic isotope production rate variations over the last 140 ky. Magnetic field strengths are converted to apparent paleolatitudes using the formulation of Nishiizumi et al. (*JGR*, 94, 17907-17915, 1989) after which instantaneous production rates are calculated using the third degree polynomial of Lal (*Earth & Planetary Science Letters*, 104, 424-439, 1991). Muon contribution is currently assumed to be minimal as suggested by Brown et al. (*GRL*, 22, 703-706, 1995). Samples exposed at lower latitudes and higher altitudes will have experienced greater production rate variation (Fig. 2).

Our program calculates instantaneous ^{10}Be and ^{26}Al production rates at any given sample site (altitude and latitude) and outputs both geomagnetically-calibrated and uncalibrated exposure ages from sample isotopic abundance data. Calibration, such as we propose, will likely increase the accuracy of exposure ages and once verified by additional data, may allow for more robust cosmogenic dating and correlation of relatively brief geomorphic and climatic events. Our program (COSMO-CALIBRATE) is available as user-friendly, compiled Macintosh code by anonymous ftp from beluga.uvm.edu.

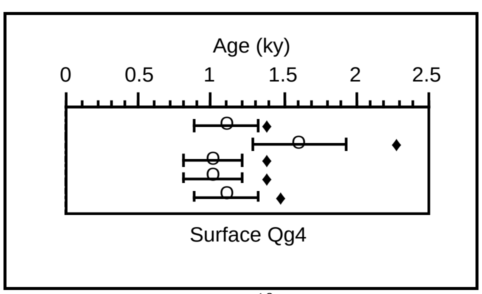
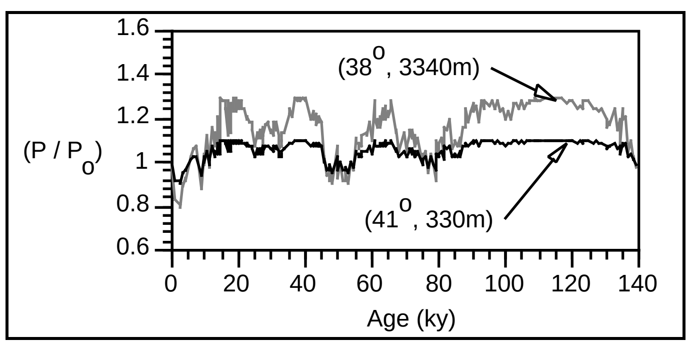


Figure 1. Calibrated ^{10}Be exposure ages from COSMO-CALIBRATE 1.7 (diamonds) and uncalibrated ^{10}Be exposure ages (Bierman et al., *Science*, 270, 447-450) calculated using production rates of Nishiizumi et al. (*JGR*, 94, 17907-17915, 1989), 11 cal ky BP (open circles).



Relative instantaneous production rates calculated by COSMO-CALIBRATE for two study sites: Sierra Nevada (38º, 3340 m), and the Laurentide Terminal Moraine (41º, 330 m).