# Identifying biases in cosmogenic nuclide production rate scaling models using in situ cosmogenic $^{14}C$ from surfaces at secular equilibrium

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Theoretical models currently used for scaling in situ cosmogenic nuclide production rates (e.g., Desilets and Zreda, 2003, EPSL 206, p 21; Stone, 2000, J. Geophys. Res. 105, p 23,753; Dunai, 2001, EPSL, 193, p 197) are based on modern measurements of cosmic ray variation with latitude and altitude. In situ cosmogenic $^{14}C$ (in situ $^{14}C$) in quartz provides a unique opportunity to test these theoretical models empirically using significant numbers of geologic samples. Unlike other commonly used in situ cosmogenic nuclides, $^{14}C$ has a short half-life that allows attainment of secular equilibrium, or "saturation," in approximately 20-25 ky. Also, $^{14}C$ loss from decay far outstrips loss from erosion in many geomorphic settings. Under such conditions, the measured concentration of in situ $^{14}C$ is only a function of its integrated average production rate.

We are analyzing samples from saturated surfaces along high-, mid- and low-latitude altitude transects to assess the altitudinal and latitudinal dependence of integrated late Quaternary in situ $^{14}C$ production rates. High-latitude samples from Antarctica range in altitude from near sea level to approximately 2.5 km. Sampling site altitudes for the mid-latitude transect range from near sea level in Death Valley, CA, to nearly 3.9 km in the Inyo-White Mountains, CA. Samples from the low-latitude transect, assembled from sites in Namibia, Australia and northern Chile, cover a similar altitudinal range.

No systematic difference is observed between the disparate low-latitude locations, suggesting a GAD adequately describes the effective geomagnetic field during exposure. We reduced the transect results to modern sea-level, high-latitude production rates using each scaling model, accounting for fluctuations in geomagnetic intensity and pole position, and using average sea-level pressures at each site per Stone (2000). Since the muogenic proportion of $^{14}C$ production has not been measured in geologic samples, we modeled both 100% spallogenic production and the experimental spallogenic/muogenic production proportions of Heisinger et al. (2002, EPSL 200, p 357). We then plotted the sea-level, high-latitude production rates against both sample latitude and altitude to evaluate whether each scaling model exhibits a bias in one or both of these parameters. Results suggest that, although scatter in the data is significant, biases can be identified in the models.