Testing 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; Lal, 1991, EPSL 104, p 424; 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 mid- and low-latitude altitude transects to assess the altitudinal and latitudinal dependence of integrated late Quaternary in situ ^{14}C production rates. 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 comparable altitudinal range. In using samples from disparate locations, we are testing the assumption that the geomagnetic field averages to a geocentric axial dipole (GAD) over the exposure period of these samples.

Results from both transects are well-described by simple exponential functions. No systematic difference is observed between the low-latitude locations, suggesting a GAD adequately describes the effective geomagnetic field during exposure. Results from the mid-latitude transect are consistent with published scaling models, which do not differ significantly along the transect. However, the Lal (1991) and Dunai (2001) models for spallogenic production mechanisms predict higher production rates than those measured for the low-latitude transect. This suggests in situ ^{14}C production may have a significant muogenic component – consistent with the predictions of Heisinger et al. (2002, EPSL 200, p 357). Interestingly, the Desilets and Zreda (2003) model, which includes spallogenic and muogenic scaling factors, also overestimates the measured low-latitude production rates.

Burial of terrigenous and marine organic carbon in the Yangtze river delta and adjacent shelf sediments

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River delta and shelf system are one of the most important environment for organic carbon burial and may have a major contribution to the fate of carbon. However, organic carbon deposition in the delta and shelf sediments and their contribution to the carbon cycle were not well studied. Organic carbon $\delta^{13}C$, grain sizes, carbonate contents in sedimetns as well as the organic carbon burial rates of the Yangtze River Delta and adjacent East China Sea shelf were determined in order to understand sources of organic carbon, marine and terrigeouns materials burial flux and their relative contribution to the study delta and shelf depositional system.

Large spatial variations of organic carbon, grain sizes and burial flux were observed in this study. Most terrigenous organic carbon were found in the Yangzte River Delta and inner shelf region. Away from the Delta and inner shelf in the west/east direction, organic carbon progressively shifted from mostly terrigenous in origin to predominant marine with organic carbon $\delta^{13}C$ varied between approximately –26 and -19. Similar spatial variations of organic carbon concentrations in sediments and %fine-grained sediments were also found, with higher concentrations of organic carbon, and fine-grained sediments located mostly in the Delta and inner shelf. Organic carbon $\delta^{13}C$ increased linearly with decreasing organic carbon concentrations. Organic carbon concentrations also increased linearly with the fine-grained sediment contents. Large amount of detritus from the Yangtze River are controlling the distribution of terrigenous organic carbon distribution in the study region.

Approximately 80% of the terrigegenous organic carbon exported from the Yangtze River were deposited in the Delta and inner shelf region with very limited amount of terrigenous organic carbon capable of depositing in other region. A great percentage of marine organic carbon were unaccounted and may be decomposed in the water column or escaping outside the Delta and shelf system.