

Utilising U-series disequilibria of calcic soils to constrain the surface age of Quaternary deposits: a comparison with ^{10}Be , ^{26}Al age data from Patagonian glacial moraines

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Calcic soils mantle ~20% of the Earth's land surface, generally forming where mean annual precipitation is <750mm. The timing of mid Pleistocene to Holocene calcic pedogenesis in gravelly deposits can be precisely established by mass spectrometric $^{230}\text{Th}/\text{U}$ dating of carefully selected, mg-size samples of dense soil carbonate pebble coats. Moreover, if the onset of calcic pedogenesis is rapid, $^{230}\text{Th}/\text{U}$ dating of early-formed soil carbonate may provide useful age estimates for glacio-fluvial terraces and other Quaternary surfaces and strata of interest in paleoclimatic, neotectonic and geomorphologic studies.

We have examined soil carbonate from Pleistocene moraines and outwash gravels near Lago Buenos Aires, Patagonia, where a detailed chronology for the last two glacial cycles has previously been determined using ^{10}Be , ^{26}Al and $^{40}\text{Ar}/^{39}\text{Ar}$ dating techniques. $^{230}\text{Th}/\text{U}$ dating of calcic soils developed in Last Glacial Maximum outwash gravels that post-date the Fenix V moraine yield ages between 20.6 ± 1.6 ka and 16.6 ± 0.5 ka (median $\text{U}=1.7\text{ppm}$, $^{232}\text{Th}=0.3\text{ppm}$, $^{230}/_{232}\text{AR}=31$; all errors at 2σ). Comparison between maximum ^{10}Be and ^{26}Al ages for the Fenix V moraine (23.7 ± 4.8 ka) with maximum $^{230}\text{Th}/\text{U}$ age data for associated outwash (20.6 ± 1.6 ka) indicates a brief interval (<3ka) between surface stability and the onset of calcic pedogenesis during glacial conditions.

For the penultimate glaciation, ^{10}Be , ^{26}Al and $^{40}\text{Ar}/^{39}\text{Ar}$ ages constrain deposition between 190 - 109 ka for the Moreno II moraine [1]. $^{230}\text{Th}/\text{U}$ analyses of soil carbonate formed in outwash gravels correlated with Moreno II suggest onset of calcic pedogenesis between 170 ± 8.3 ka and 146 ± 4.8 ka (median $\text{U}=1.6\text{ppm}$, $^{232}\text{Th}=0.2\text{ppm}$, $^{230}/_{232}\text{AR}=17$), concurrent with MIS 6. In addition, a prominent interval of subsequent pedogenesis is constrained between 80.3 ± 1.8 ka and 38.9 ± 1.9 ka (median $\text{U}=1.8\text{ppm}$, $^{232}\text{Th}=0.2\text{ppm}$, $^{230}/_{232}\text{AR}=13$), broadly corresponding to MIS 4 and synchronous with increased dust influx as recorded in the Vostok ice record.

[1] Kaplan M.R., Douglass D.C., Singer B.S., Ackert R.P., Caffee M.W. (2005) *Quat. Res.* **63**, 301-315.