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^{10}Be, ^{10}C and OSL dating of alluvial sediments from the eastern Andes

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The mountain front of the eastern Andes in Argentina is characterized by alluvial fans and sequences of well-preserved fluvial terraces that were formed by incision of the fans. We applied different dating approaches (^{10}Be, ^{14}C, and OSL) to determine the age of these depositional surfaces at three sites. Site 1 is located on a small alluvial fan 35 km north of Mendoza. The age of the terraces T_2 to T_4 was determined by ^{10}Be exposure dating of sand samples from depth profiles and amalgamated pebbles. Both approaches allow correcting for the pre-depositional nuclide component and they yield similar ages within errors, which are consistent with the terrace stratigraphy. These ^{10}Be ages are 3–5 ka (T_2), 11–13 ka (T_3), and 16–20 ka (T_4) (Schmidt et al., in press). The age of T_3 is confirmed by a calibrated ^{14}C age of 12.61 $\pm$ 0.20 ka cal BP obtained from a wood sample. At site 1, ^{10}Be dating of sandstone boulders (n = 18) failed due to the presence of a high and variable inherited ^{10}Be component, which results in an overestimation of the depositional ages by up to $\sim$90 ka. This inherited component derives from pre-exposure of the boulders during an intermittent phase of storage in older alluvial fans that are currently reworked (Schmidt et al., in press). At site 1, OSL dating of quartz and feldspar was not successful. Infrared-stimulated luminescence (IRSL) on feldspar failed due to a high rate of anomalous fading, and the signal of post-IR IRSL measurements revealed a high proportion of incompletely bleached grains due to the stimulation of additional traps which need a longer light exposure for resetting. On the other hand, the quartz fraction was contaminated with feldspar, which did not allow receiving a clear luminescence signal from quartz even after a first stimulation with infrared light.

The sites 2 and 3 are located $\sim$5 km north of Mendoza in the distal part of a large alluvial fan. At both sites four terraces, T_1 to T_4 occur. At site 2, a depth profile on terrace T_3 yielded an imprecise ^{10}Be age of 2.9 $\pm$ 2.3 ka. The large error is caused by the young age of the terrace and a high inherited ^{10}Be component, equivalent to $\sim$13 ka of exposure. The age of T_3 is, however, precisely determined by a calibrated ^{14}C age of 3.84 $\pm$ 0.14 ka cal BP. At site 3, OSL dating of sediments exposed in a trench across the Cal thrust yielded reliable results. We used the post-IR OSL sequence on small aliquots of quartz and applied the minimum age model with different overdispersion values to bracket the burial ages. The sediments on terrace T_2, which are exposed in the highest part of the trench, were buried between 500 and 920 years. Three samples from folded sediments exposed beneath a major unconformity in the trench yielded consistent ages ranging from 8.5 to 14.0 ka. Three small wood samples from the trench yielded calibrated ^{14}C ages younger than 350 years, which we interpret as geologically meaningless.

Each of the applied dating methods has different requirements that need to be met. Owing to the large variability in erosion, transport history, and depositional environment at active mountain fronts, each method may fail. Therefore, combining different approaches is the best strategy for obtaining robust results when dating Late Quaternary surfaces and alluvial sediments.

Reference

Schmidt, S., Hetzel, R., Kuhlmann, J., Mingorance, F., Ramos, V.A. (in press). A note of caution on the use of boulders for exposure dating of depositional surfaces. Earth and Planetary Science Letters, doi: 10.1016/j.epsl.2010.11.039.