Constraining landform erosion and ages from surface exposure age distributions on old Patagonian moraines

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Applying surface exposure dating to moraines older than the last glacial maximum is challenging. For these older moraines, boulder erosion and landform degradation become important, resulting in a wide distribution of cosmogenic nuclide concentrations. Extracting meaningful exposure ages from these moraines requires accurate erosion and exhumation rates.

To better understand the evolution of exposure age distributions with time, we have started an investigation of cosmogenic ^{3}He and ^{36}Cl from a large suite of basalt boulders collected from the Telken IV (760-1016 ka; [1]) and Deseado (109-760 ka; [1]) moraines at Lago Buenos Aries (LBA), Argentina. The moraines at LBA are ideal for this study because they are the longest, best preserved glacial record outside of Antarctica. Surface exposure dating has established that the youngest moraine complex at LBA ranges in age from 16 to 26 ka (stage 2) and records millennial scale fluctuations of the ice margin during the LGM [2]. Exposure ages on the next oldest moraine complex suggest that they date to the penultimate glaciation (stage 6) but the effects of boulder erosion and exhumation are evident with many young outliers in the exposure age distribution.

We have obtained ^{3}He exposure ages of 178, 190, and 133 ka on three boulders from the Telken IV moraine, which are similar to ages obtained using ^{10}Be and ^{26}Al on nearby granitic boulders of older moraines (Telken V and VII moraines [2]). Our ^{3}He exposure ages calculated with an erosion rates of 2mm/kyr are almost twice as old, 287 and 326 ka, but still significantly less than the minimum age of the Telken IV moraine, clearly indicating the importance of boulder exhumation and erosion. Using our preliminary data, the maximum deflation rate of the moraine surface is 7 mm/kyr. We plan to obtain additional ^{36}Cl and ^{3}He data to constrain the process of boulder exhumation and erosion and thereby 1) improve the chronology of glacial history in Patagonia, 2) understand landform development and preservation in the dry Patagonian steppe, and 3) infer landform age from exposure age distributions in areas where independent chronology is not available.

References

[1] Singer, B. S., et al., GSA Bull 116, 434, 2004.
[2] Kaplan, M. R. et al., GSA Bull 116**,** 308, 2004.

^{3}He exposure ages of boulder armored terraces in the northwestern Colorado Plateau

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In the Capitol Reef and Escalante areas of the northwestern Colorado Plateau (south central Utah) there are tens to hundreds of individual basaltic-andesite armored terraces throughout the landscape. These armored terraces are former valley floors that are now 10-200 m above the local drainages. All of these armored terraces are capped with coarse basaltic-andesite boulder deposits derived from the high (>3400 m) volcanic plateaus of Boulder or Thousand Lakes Mountains. Using ^{3}He exposure age dating we determined the exposure ages of multiple boulders from several of these terraces. We interpret these deposits to be proximal debris-flows and therefore assume deposition was rapid and do not include a correction for cosmogenic inheritance due to transport. We do include a correction for non-cosmogenic (nucleogenic) ^{3}He produced in the basaltic-andesites since crystallization (~25 Ma). This component is typically less than 8% of the total ^{3}He inventory. Maximum boulder exposure ages of these land-surfaces range from 1.2 Ma to 196 ka and represent average local incision rates ranging from ~0.15 m/kyr to 0.40 m/kyr. The incision rates we calculate are some of the highest on the Colorado Plateau and add to a growing body of evidence suggesting that there was significant fluvial incision of the Plateau during the Pleistocene.