New Constraints on the Ages of Old Moraines: The Impact of Erosion on Surface Exposure Age Distributions.

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Cosmogenic surface exposure dating techniques permit the development of glacial chronologies for landforms whose ages are beyond the limit of radiocarbon dating. However, old landforms typically yield exposure ages with large uncertainties because of the large variation in the apparent ages of individual boulders. This variation is attributed to erosion of boulders and soil matrix. These processes result in different amounts of accumulated ^{36}Cl and thus different apparent ages for individual boulders. We developed a model which uses Monte Carlo simulation of erosion and gradual exposure to account for its effect on the distribution of apparent boulder ages (Shanahan and Zreda, 2000, *EPSL* **177**, 23-42). The model assumes that soil erosion is constant and uniform across the landform, and that boulder erosion is constant in time but varies among individual boulders. From the observed coefficient of variation of boulder ages, the model produces a range of possible true landform ages and soil erosion rates. Simulations were conducted for five moraines from Bishop Creek, California with apparent landform ages between 60 and 150 kyr. *In-situ* ^{36}Cl and ^{10}Be profiles obtained from these landforms were used to provide independent estimates of landform erosion rates of between 20 and 60 mm kyr^{-1}. Estimates from different isotopic systems yield erosion rates that agree within a factor of two. The results of this study indicate that modeling the effect of erosion on boulder age distributions may reduce the age variance for old landforms.

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