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Determining rates of geomorphic processes over multiple timescales with cosmogenic nuclides Al-26, Be-10, and Ne-21 in Wright Valley, Antarctica

Daniel J. Morgan[1] Jaakko Putkonen[2] Greg Balco[3]

1. Vanderbilt University 2. University of North Dakota 3. Berkeley Geochronology Center

dan.morgan@vanderbilt.edu

Unconsolidated surface deposits in the McMurdo Dry Valleys, Antarctica (MDV) are intriguing to geomorphologists because many of them have been exposed sub-aerially for millions of years, yet they have maintained their meter-scale morphology and retain sharp stratigraphic contacts with other surface deposits. To examine how quickly and by what processes surface deposits in the MDV are degrading, we measured the concentration of cosmogenic nuclides Al-26, Be-10, and Ne-21 in quartz from three unconsolidated deposits (two tills and a colluvium) in Wright Valley, Antarctica. Samples were collected by hand-digging pits and collecting a series of bulk sediment samples in a depth profile. We compared the predicted nuclide concentrations from various exposure models to the observed concentrations in the depth profiles to determine which possible geomorphic scenarios are compatible with the measurements. The Koenig colluvium (stratigraphic age > 15.2 Ma) has been eroding at a rate of ~2m/Ma for the past 2-3 Ma. The Asgard till (13.6 Ma < stratigraphic age < 15.2 Ma) was accumulating sediment at a rate of ~0.5 m/Ma for 2-3 Ma, and has eroded at a rate of ~0.5 m/Ma for the most recent 1 Ma. The Peleus till (3.7 Ma < stratigraphic age < 5.5 Ma) was initially deposited as dirty ice with an initial debris concentration of 2-10%. This ice sublimated rapidly, at 20-200 m/Ma, and the resulting lag eroded ~1 m/Ma for the past 200 ka. Because Al-26 has a half-life of 0.705 Ma, Be-10 has a half-life of 1.39 Ma, and Ne-21 is stable, they record exposure histories of the sediment on different timescales. These results indicate that unconsolidated surface deposits in the MDV have been undergoing steady degradation for millions of years at rates generally on the order of meters per million years.