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Advances in Cryoplanation Terrace Research: Recent Contributions

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Cryoplanation terraces (CTs) are large, staircase-like erosional features found in upland periglacial environments throughout the circum-Arctic region. They are ubiquitous in unglaciated Beringia. This presentation summarizes recent research on these features conducted in interior and western Alaska and northwestern British Columbia. The work falls into several categories:

(1) Relative dating: Relative weathering indices (fracture counts, Cailleux roundness and flatness, Krumbein sphericity, rebound, and weathering rind thickness) were measured at a series of sites extending across eastern Beringia. Patterns of these indices indicate that inner treads were more recently exposed than distal locations. A model of time-transgressive CT development through nivation-driven scarp retreat addresses the removal of weathered material from terrace treads down side slopes through piping and gravity-driven mass-wasting processes.

(2) Absolute dating: Several ^{10}Be and ^{36}Cl Terrestrial Cosmogonic Nuclide ages reveal that terrace scarps in the Alaskan Yukon-Tanana Upland were last actively eroding during the last glacial maximum (LGM). CT treads exhibit time-transgressive development. Boulder exposure ages and distances between sampled boulder locations were used to estimate rates of scarp retreat. The numerical exposure ages demonstrate that CTs are diachronous surfaces actively eroding during multiple cold intervals.

(3) Landscape evolution: The unusual deglaciation history of “Frost Ridge” in northwestern British Columbia facilitates estimation of long-term denudation attributable to nivation processes since the LGM. Snowbanks accumulated and persisted in marginal drainage features on the ridge’s north-facing ridge flank, creating a series of CTs through nivation. Data obtained from an unmanned aerial vehicle were used to estimate the volumes of eroded material. Estimated erosion rates are comparable to short-term nivation rates reported from Antarctica and mid-latitude alpine periglacial areas.

(4) Process monitoring: Soil thermal and moisture records, particle-size analysis, apparent thermal diffusivity calculations, and sediment-deposition patterns were used to examine periglacial processes operating on two active CTs. The coarse portions of sorted stripes function as underground channels (pipes) for sediment transportation across CT treads by flowing water. Late-

lying snowbank environments are highly dynamic during warm weather, with large amounts of sediment transported over short periods.

(5) Geomorphometry: Semi- and fully automated recognition algorithms (CTAR) were applied to high-resolution DEMs to identify the locations of CTs. CTAR achieved an overall accuracy of 90 percent. A strong linear relation exists between the size of CTAR-delimited terraces and those identified in a previous study. Hypsometric analysis was applied over extensive areas of eastern Beringia. Glaciated areas have hypsometric signatures distinctly different than those of cryoplanated terrain, across a spectrum of geographical scale. Results from fluvial morphometric analysis of a sorted-stripe field verifies the origins of such networks and their effectiveness for transporting water and suspended sediment across CT surfaces.

(6) Climatic dependencies: Geospatial analysis involving nearly 700 CTs in eastern Beringia demonstrates that their elevation rises from Bering Sea islands to the Alaska-Canada border at rates nearly identical to those of Wisconsinan cirques, indicating close genetic links between the two classes of feature. Cryoplanation terraces can be considered the periglacial equivalent of glacial cirques.