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Paraglacial geomorphology

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Abstract

Paraglacial geomorphology is the study of earth-surface processes, sediments, landforms, landsystems and landscapes that are directly conditioned by former glaciation and deglaciation. The withdrawal of glacier ice exposes landscapes that are in an unstable or metastable state, and consequently liable to modification, erosion and sediment release at rates greatly exceeding background denudation rates. This paper (1) reviews research on paraglacial processes, landforms and landscape change in a range of geomorphological settings; (2) explores the importance of paraglacial landscape modification and sediment recycling as a component of alternating glacial/nonglacial landscape evolution; (3) assesses the nature and significance of paraglacial facies in Quaternary stratigraphic sequences; and (4) develops a general model of the sequence of paraglacial landscape modification and the changing nature of paraglacial landsystems.

Six paraglacial landsystems are identified: rock slopes, drift-mantled slopes, glacier forelands, and alluvial, lacustrine and coastal systems. Each contains a wide range of paraglacial landforms and sediment facies. Collectively these landforms and sediments (e.g. talus accumulations, debris cones, alluvial fans, valley fills, deltas and coastal barrier structures) can be conceptualised as storage components of an interrupted sediment cascade with four primary sources (rockwalls, drift-mantled slopes, valley-floor glacigenic deposits and coastal glacigenic deposits) and four terminal sediment sinks (alluvial valley-fill deposits, lacustrine deposits, coastal/nearshore deposits and shelf/offshore deposits). Paraglacial sediment stores and sinks may form major sources of readily erodible sediment during the early stages of glacial cycles, leading to high rates of sediment transport during periods of glacier or ice-sheet expansion. Probably because of the limited preservation potential of paraglacial sediments that were subsequently over-run by glacier ice, identification of paraglacial facies in both terrestrial and marine settings has been almost exclusively limited to sequences that post-date the Last Glacial Maximum.

The unifying concept of paraglacial geomorphology is that of *glacially conditioned sediment availability*. Relaxation of landscape elements to nonglacial conditions operates over timescales of $10^1 - > 10^4$ years, and is conditioned by both process and spatial scale. Rate of sediment reworking can be described by an exhaustion model. In the case of primary reworking of glacigenic sediment, the rate of reworking declines approximately exponentially through time, though extrinsic perturbation may rejuvenate paraglacial sediment flux long after termination of the initial period of paraglacial adjustment. Landscape-scale (particularly alluvial and coastal) systems may exhibit intrinsically complex responses due to reworking of secondary paraglacial sediment stores. The long relaxation time of such systems implies that many areas deglaciated in the Late Pleistocene or Early Holocene have still not fully adjusted (in terms of sediment supply) to nonglacial conditions.

Contents

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