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Deconvolving the process-origin of sediments on volcanic mountains and implications for paleoclimatic reconstruction: Mt Ruapehu area, New Zealand

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Glaciation on the central North Island of New Zealand is limited to the volcanoes of Tongariro National Park, including Mt Ruapehu, the largest and most active andesitic stratovolcano on the North Island. At 2797 m asl, Mt Ruapehu represents the only peak in the North Island to currently intercept the permanent snowline, with small cirque glaciers descending to an altitude of ∼2300 m. During the last glacial maximum (LGM), small ice-caps existed on Mt Ruapehu and the Tongariro Massif (15 km to the NNE of Ruapehu), with a series of small (<10 km-long) valley glaciers radiating out from domes centered on the summit areas to altitudes of ∼1200 m. Holocene glacier advances have left smaller deposits inboard of some of the LGM moraines. However, understanding of moraine deposition and reconstructing former glacier extent is limited by: (1) the fragmentary nature of glacier moraines in this high precipitation environment; and (2) the broad range of possible process-origins for unconsolidated debris ridges on active volcanoes. Here, we describe the clast roundness, clast shape and textural characteristics associated with active and former glaciers on Mt Ruaephu and the Tongariro Massif, in order to assist in classifying the process-origin of sediments on glaciated volcanic mountains. Supraglacial inputs include rockfall, tephra, and avalanche material delivered to the surface of glaciers. Basal debris, where observed at the terminus of active cirque glaciers, consists mainly of incorporated fluvial material. Following deposition, reworking is mainly by proglacial streams, debris flows and lahars. Within the vicinity of glaciers, the dominant facies appear to be: (i) bouldery gravel with angular clasts on steep slopes surrounding glaciers, (ii) silty-sandy boulder gravel, with mainly subangular clasts, forming lateral moraines, (iii) boulder/cobble gravel with mainly subrounded clasts and associated laminated sediments representing fluvially-reworked material; and (iv) debris-avalanche deposits including fragmental rock clasts with an unsorted inter-clast matrix. As some of these deposits appear to include unambiguous indicators of glacial transport, interpretation of unconsolidated debris ridges on volcanic mountains should not necessarily exclude the contribution of glacial processes.