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The value of geomorphological analysis for investigating mountain glaciations – examples from the Southern Alps/New Zealand

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Research on mountain glaciations has a long history and in the light of current global change, they are increasingly recognised as highly important palaeoclimatic archives for the immediate and more distant geological past. One of the most important leaps forward with the investigation of mountain glaciations during the past 2 decades was substantial improvement achieved within the field of numerical age dating techniques, in particular progress of surface exposure dating using cosmogenic radionuclides (CRN). This development has definitely given the entire research field new momentum. Unfortunately, this methodological progress is in many cases not matched by the recommended necessary level of precautions regarding the interpretative steps with the reconstruction of Holocene glacier chronologies. Improved precision and accuracy with numerical dating techniques comes often with an increasing lack of attention with the geomorphological analysis of the dated landforms.

With recent studies it has subsequently become more popular to outline moraines primarily based on individual CRN boulder age clusters without detailed geomorphological mapping or examination. Such an attempt has also been conducted on Holocene glacier forelands in Aoraki/Mt.Cook National Park where a substantial number of CRN boulders ages have been employed to identify and label numerous “moraines”. Subsequently, arithmetic means of CRN ages for these apparent “moraines” were linked to individual glacier advances and palaeoclimatically interpreted accordingly. A sound geomorphological analysis of the studied glacier foreland does, however, reveal that this procedure is actually erroneous. Among the problems identified are (a) inclusion of hugely overprinted moraine remnants that lack proper characterisation, (b) wrong subdivision of moraine segments belonging to one defined individual moraines, and (c) mismatching of apparent CRN ages for moraine segments that morphologically need to correspond for any meaningful reconstruction of former marginal positions. A revision of this particular glacier chronology provides major implications for any subsequent palaeoclimatic interpretation as the number of reliably documented neoglacial events decrease from 9 to 5.

The value of geomorphological analysis in the context of investigating mountain glaciations is, however, not primarily restricted to chronological approaches. It may also provide assistance with the conceptual context for mechanisms of deglaciation patterns or long-term landscape evolution. In the upper Waimakariri River catchment following a Late Glacial readvance dated to c. 17.5 ka ago, a lake dammed by the related moraine system and debris-covered dead ice should have existed for many centuries before it subsequently drained. That lake would naturally have influenced both the immediate deglaciation mechanism and landform evolution post-LGM. Despite introduced during the 1950s, the concept of this particular palaeo-lake has never been exposed to any detailed geomorphological analysis yet. Whereas the existence of a post-LGM palaeo-lake itself remains out of question, the proposed link to glacier retreat following a Late Glacial re-advance is unrealistic in light of a logical time sequence for individual elements of the local landform assemblage. The lake needs to be younger and postdate Deglaciation in this section of the Waimakariri River.

Summarising, detailed geomorphological analysis is indispensable with any attempt to investigate mountain glaciations.