



Should precise numerical dating overrule glacial geomorphology?

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Numerical age dating techniques, namely different types of terrestrial cosmogenic nuclide dating (TCND), have achieved an impressive progress in both laboratory precision and regional calibration models during the past few decades. It is now possible to apply precise TCND even to young landforms like Late Holocene moraines, a task seemed hardly achievable just about 15 years ago. An increasing number of studies provide very precise TCND ages for boulders from Late Holocene moraines enabling related reconstruction of glacier chronologies and the interpretation of these glacial landforms in a palaeoclimatological context. These studies may also solve previous controversies about different ages assigned to moraines obtained by different dating techniques, for example relative-age dating techniques or techniques combining relative-age dating with few fixed points derived from numerical age dating.

There are a few cases, for example Mueller Glacier and nearby long debris-covered valley glacier in Aoraki/Mt.Cook National Park (Southern Alps, New Zealand), where the apparent “supremacy” of TCND-ages seem to overrule glacial geomorphological principles. Enabled by a comparatively high number of individual boulders precisely dated by TCND, moraine ridges on those glacier forelands have been primarily clustered on basis of these boulder ages rather than on their corresponding morphological position. To the extreme, segments of a particular moraine complex morphologically and sedimentologically proven to be formed during one event have become split and classified as two separate “moraines” on different parts of the glacier foreland. One ledge of another moraine complex contains 2 TCND-sampled boulders apparently representing two separate “moraines”-clusters of an age difference in the order of 1,500 years. Although recently criticism has been raised regarding the non-contested application of the arithmetic mean for calculation of TCND-ages for individual moraines, this problem is still not properly addressed in every case and significant age differences of individual boulders on moraine ridges create uncertainties with their palaeoclimatic interpretation.

Referring to the exemplary case of the glacier forelands mentioned above it is argued that prior to any chronological interpretation the geomorphological correlation of individual moraine ridges and complexes need to be established and potential uncertainties clearly addressed. After the TCND-ages have been obtained from sampled boulders and assigned to the moraines any discrepancy needs to be carefully investigated to ensure that misleading ages don't effect subsequent chronological reconstructions and palaeoclimatic interpretations. Even if dating precision has recently considerably increased, moraines should not be clustered into synchronous moraine-groups based on TCND-ages if their morphological position or sedimentology contradicts such classification. Furthermore, the high precision of TCND-ages do often not consider the concept of 'LIA'-type events and different response times of nearby glaciers to the same mass balance/climate signal, therefore potentially overestimating the true number of glacier advances during a specific period. An alternative interpretation of existing TCND-ages reveals fewer advances during the Late Holocene.

Summarising, modern TCND-ages are possibly “too precise” in some aspects and wrongly judged as superior to geomorphological evidence. A more critical evaluation would be beneficial to any subsequent attempts of intra-hemispheric and global correlation of glacier chronologies.