EGU21-14132, updated on 30 Oct 2021
https://doi.org/10.5194/egusphere-egu21-14132
EGU General Assembly 2021


# A tale of two bogs - new 10Be production rates from UK and NZ calibrated by basal 14C ages

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Cosmogenic production rates (PRs) are the essential conversion factor between AMS cosmogenic concentrations and absolute exposure ages. The accuracy of cosmogenic glacial chronologies and reliability in their comparison to other paleoclimate systems is largely contingent on the precision and accuracy of the adopted production rate. This is particularly critical in determining past glacial geochronologies at the scale of millennial temporal resolution. Most PR calibrations are carried out at deglaciation sites where radiocarbon provides the independent chronometric control usually based on 14C ages in basal sediments or varves from lake or bog cores which is assumed to represent the minimum age for glacial retreat. Under these conditions and hence provide PRs as maximum values. Given that today most AMS facilities can deliver 10-Be, 26-Al and 36-Cl data with total analytical errors less than 2% ( for 10 ka exposure), the precision of a PR remains largely dependent on the error in the independent chronology and accuracy of AMS standards. The history over the past 20 years of the ever-decreasing value of SLHL 10-Be cosmogenic spallation PRs from initial estimates of about 7 atoms/g/a to the current 'accepted' (global average) values of ~4 atoms/g/a, is an interesting story in itself and demonstrates the complexity in such determinations.

Over the past few years new web-based calculators are now available to calculate uniformly new production rates from either new data or combinations of any set of published data (CRONUS-Earth, CRONUS-UW, CosmoCalc, ICE-D, CREp). This delivers a means by which new production rates can be seamlessly integrated and compared using identical constants, methods and statistics that were used to generate (currently accepted) global average or regional production rates.

For the British Isles, there are a number of 10-Be reference sites that give PRs (Lm scheme) between 3.89±3% atoms/g/a (Putnam, QG, v50, 2019) to 4.20±1% atoms/g/a (Small, JQS, v30, 2015) which convert to 3.95 and 4.28, respectively, using datasets in the ICE-D calculator). This difference in 10-Be spallation PRs has recently raised some debate and challenges for the timing of the local-LGM and demise of the British Ice Sheet. This work provides a new British Isles site

specific 10Be PR from the  Arenig Mountains in North Wales where radiocarbon dating of basal sediments from a bog core associated with a series of nearby cirque moraines provides independent age control.  Similarly in the South Island of New Zealand, the current accepted 10Be PR is 3.76±2% (Putnam, QG 2009; converts to 3.94±1% using ICE-D) and is the only available PR that is used for these southern hemispheric glacial sites. This work provides a new Australasian site specific 10Be PR from Arthurs Pass retreat moraines where radiocarbon dating of basal sediments from three cores extracted from a bog impounded by the moraine provides independent age control.