

Quaternary Times – Measuring, Precision, Understanding

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It is essential to know not only the amplitude but also the frequency of climate change in order to understand Quaternary earth history, or to do meaningful paleoclimate modeling. This dimension is called “chronology of events” in earth history; it is called a “dating problem” in global change discussions.

Classical Quaternary stratigraphy relies on lithostratigraphy and on morphostratigraphic considerations. The first “absolutely dated” input to ice age frequencies came from calculations on the astronomical cycles by Milankovic. Radiocarbon has brought a breakthrough for the chronology of the last glaciation and the Holocene. Supplements by U/Th-series still depend on suitable material.

A new dimension in the determination of the timing of ice age events is the application of surface exposure dating by using cosmogenically produced isotopes (^3He , ^{10}Be , ^{14}C , ^{21}Ne , ^{26}Al , ^{36}Cl and ^{53}Mn) from earth surface material, mainly quartz. This method allows direct dating of physical evidence of climate change at the earth surface (e.g. moraines). In addition, advanced luminescence methodology is able to directly date clastic sediments and will be, in combination with burial dating ($^{10}\text{Be}/^{26}\text{Al}$) a powerful tool for the next decade of research.

Is there an increase in knowledge precision over the past 20 years to be observed? Yes:

- the existence of multiple (15+) alpine glaciations over the past ≈ 2.5 my is lithostratigraphically ascertained
- three basal units of Obere Deckenschotter are older than 1.67 my
- the Wanderblock Formation is not of glacial origin
- the last glaciation is a two (to three) phase event with the LGM in OIS 2
- there are several pre-Emion interglacials archived in the records of the Swiss Midlands
- over the last 10 ka glaciers were <now for >50 % of the time