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# The Meghalayan GSSP and the genesis of the ‘4.2 ka event’: the long and short of it

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## Abstract

Perturbed climatic conditions around 4200 years ago have for long intrigued the minds of Quaternary geoscientists. Previously, this climatic event recorded more or less around the globe seems to have been thought of as originating from slow sub-Milankovitch components of the climate system. With these regards, such processes were expressed in terms of the millennial-scale variability in solar activity and North Atlantic deep-water formation, or in relation to the onset of Neoglaciation and discussed in the context of the smoothly decreasing trend in Northern Hemisphere summer insolation over the Holocene (among others). These findings came into a multi-disciplinary spotlight when the ancient Mesopotamian civilization was found to have been abruptly impacted by the changed climate at 2200 BC; moreover, the term ‘4.2 ka event’ was coined first time in illustrating the climatic background to the cultural collapse. More recently, however, the picture has changed once again. Following the ratifications of the Quaternary System/Period and the Pleistocene Series/Epoch, and in particular that of the Holocene Series/Epoch, also the Holocene Series/Epoch has now been subdivided into the Greenlandian, Northgrippian and Meghalayan Stages/Ages, as formally ratified by the Executive Committee of the International Union of Geological Science in 2018. Ratification of these stratigraphic units on the geologic time scale locates the boundary between the Northgrippian and Meghalayan at 4.2 ka and places the Global Boundary Stratotype Section and Point (GSSP) in the Mawmluh Cave (India) speleothem KM-A, which shows a marked shift to less negative  $\delta^{18}\text{O}$  isotopic values around 4250 yr b2k, reflecting an abrupt reduction in monsoonal precipitation. This isotopic excursion represents the most notable feature of the KM-A speleothem and spans  $\sim 415$  years from  $4303 \pm 26$  yr BP (onset) to  $4071 \pm 31$  yr BP (intensification) and to  $3888 \pm 22$  yr BP (termination). Thus, the  $\delta^{18}\text{O}$  excursion overlaps with the timing of the ‘4.2 ka event’, which indeed had been previously ascribed to the weakening of the south Asian monsoon variability, similar to indications inferred from the KM-A speleothem. Since its ratification, the Meghalayan GSSP has received highlight but also criticism, including the questions of the representativeness of the ‘4.2 ka event’ in the KM-A speleothem. Interestingly, it appears that the coverage the Meghalayan GSSP has generated has also changed the ways the researchers from various disciplines now regard the ‘4.2 ka event’. The interpretation of climatic conditions that may have been perturbed for a period longer than several centuries around 4200 years ago due to slow sub-Milankovitch scale forcing have given way to discussion of abrupt and short-term ( $\sim$ centennial) hydroclimatic/monsoonal anomalies inside the longer-term event, ignoring the potential time-transgressiveness of the climatic response to the potential millennial-scale forcing. Moreover, it appears as if the Mawmluh Cave KM-A speleothem would since the

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ratification be regarded as an (unofficial) stratotype for the '4.2 ka event'. Systematic re-naming of the event and anomalies (not the GSSP) could possibly help disentangling the components behind the perturbed climate over an extended period. Unintentionally, the process may already be underway, with the use of coined terms such as "the 4.07 ka BP global climate anomaly", "4000 BP event" and "4.0 ka event" becoming cited in the literature. Finally, the results could be seen to detail the ways in which the ratification of the GSSP(s) may alter the ways we view the history of our planet. The findings of this study are supported by a literature review of more than 100 papers.

**Keywords:** Quaternary, Meghalayan, GSSP, 4.2 ka event, speleothem, dendrochronology