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Defining the Upper Pleistocene Subseries: assessing Antarctic ice cores for a potential global boundary stratotype section and point (GSSP)

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Since 1932, the base of the Upper Pleistocene Subseries has been accepted as corresponding to that of the last interglacial (Eemian Stage in Europe), and in 1987 the base of Marine Isotope Stage 5 was recommended by INQUA to serve as its primary guide. However, later studies showed that the base of MIS 5 is about 6 kyr older than the base of the Eemian pollen stage [1]. The prospect of leads and lags in the climate–ocean system has complicated efforts to define a Global Boundary Stratotype Section and Point (GSSP) for the Upper Pleistocene.

The Amsterdam Terminal borehole in the Netherlands, penetrating a non-marine to marginal marine sequence, was nonetheless proposed as the GSSP for the Upper Pleistocene Subseries in 2008, as it yielded an excellent pollen record and many other paleoenvironmental proxies [2]. The proposed GSSP was at the base of the Eemian pollen stage. For various reasons, however, this proposal failed to achieve ratification. One difficulty was that the level of the proposed GSSP was in non-marine sediment, hindering efforts to tie its terrestrial biostratigraphies with the marine isotopic record. More recently an ongoing study of the Fronte Section in Taranto, Italy, has yielded an excellent last interglacial marine record [3], although Termination II marking the base of MIS 5 appears not to be represented.

Regarding any future proposal for the Upper Pleistocene GSSP, it should be noted that isotope stratigraphy can give Atlantic over Pacific leads of several thousands of years for the past six terminations [4], and that peak temperatures may be globally asynchronous, with North Atlantic high-latitude temperatures lagging southern hemisphere records by several thousand years [5].

Given the above limitations, an Antarctic ice core should be considered for the GSSP, with the abrupt methane rise seen in ice cores at Termination II perhaps serving as the primary guide to the boundary [6]. This methane rise is a distinctive global event [5] and is closely related to rising temperatures in the higher northern latitudes. For the last glacial interval in Greenland, methane lagged temperature rise by less than 30–70 years [7, 8], and its abrupt increase during Termination II in Antarctica is thought to reflect more-or-less synchronous abrupt warming of the air above Greenland [5]. Termination II has a gas orbital age of 132.4 ka at its midpoint, with a subsequent steep methane increase at 128.51±1.72 ka in the EPICA Dome C core [9] that leads the onset of the Eemian in southern Europe by ~2 kyr [10]. Although an ice core is an unconventional choice for a GSSP, the Holocene GSSP has been defined in a Greenland ice core.

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