matters arising

The Late Weichselian geomagnetic event

THOMPSON and Berglund[1] describe palaeomagnetic results from Björkeröds Mosse which, they claim, invalidate all previous evidence for a Late Weichselian geomagnetic event. In this note I discuss these results and answer their criticisms in regard to evidence which I have presented[2].

Thompson and Berglund stress the difficulty of interpreting palaeomagnetic records from sedimentologically complex cores and yet the 'carefully selected site' at Björkeröds Mosse contains eight sedimentary units from three climatic zones. The high noise content of the magnetisation, evident in Fig. 1 of ref. 1, thus supports their contention that variable sediments are poor recorders of the ambient field and this is confirmed by the absence of any secular variation periodicity comparable with cycles in archaeomagnetic data[3]. Their scattered directions have probably arisen from the spasmodic growth of post-depositional magnetisation, while the general decrease in inclination with depth through layers 8 to 2 is consistent with increasing compaction in these organic sediments[4,5]. These factors question the reliability of the Björkeröds Mosse data and thus the confidence with which the authors reject all previous results.

In contrast, I have described evidence for a Late Weichselian excursion from a single lithology of exceptionally uniform clay varves from Stärnö, Sweden[2]. Studies of similar varves[5,6] show that such clays were magnetised depositionally and if sedimentation occurred on a horizontal surface in the absence of strong water currents then the remanence is an accurate record of the ambient field. This is shown, for example at Stärnö, by the virtual absence of noise in varves which satisfy these criteria. The Revised Swedish Time Scale also provides a precise chronology within which to assemble the history of an excursion. At Stärnö the varve data were characterised by a reversal of declination and a shallowing, but not a reversal, of inclination while elsewhere in Sweden southerly declinations with positive inclinations are a feature of younger varved clays (~8,000–7,600 BC) (ref. 5). As the Björkeröds Mosse core was unoriented, declination values are arbitrary and cannot be used to contradict these observations. Furthermore, according to Berglund[7] it is impossible to correlate the varved clays in layer 1 with the Swedish Time Scale thus raising doubts concerning any direct age comparison between the Björkeröds Mosse data and results from dated varves.

Thompson and Berglund are correct in emphasising the need for caution when interpreting palaeomagnetic information from sediments, but their suggestion of using the repeatability of between-core directions as a major criterion for confirming the direction of the palaeofield could be misleading. Water movements in a basin are capable of producing large deflections[6] which can be coherent at separate localities and a similar effect could arise through changing bedding errors[6] as a basin infills. Thus observation of between-core coherence arising from these factors may mistakenly lead to a 'within-site reinforcement syndrome'. Thompson and Berglund's three-item criteria must be qualified according to individual circumstances and only a detailed consideration of all factors at each locality can decide the reliability of palaeofield directions. The Stärnö data survive as important evidence for a Late Weichselian excursion in Sweden which will achieve creditability as a world-wide phenomenon if palaeomagnetic results from sediments reveal global similarities, yet this is the objective which the authors seek to denounce.

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1 Thompson, R. & Berglund, B. *Nature* 263, 490–491 (1976).
2 Noël, M. *Geol. För Stockh. Förh.* 97, 357–367 (1975).
3 Aitkin, M. J. *Phil. Trans. R. Soc.* 269A, 77–88 (1970).
4 Keen, M. J. *Deep-Sea Res.* 10, 607–622 (1963).
5 Noël, M. thesis, Univ. Newcastle-upon-Tyne (1976).
6 Noël, M. *Trans. Am. geophys. Un.* (*EOS*) 57, 657 (1976).
7 Berglund, B. *Geol. För. Stockh. Förh.* 93, 11–45 (1971).

THOMPSON AND BERGLUND REPLY—Noël[1] assumes that precise palaeomagnetic data are an accurate record of the ancient geomagnetic field. We distinguish between precision and accuracy, and stress the importance of within-site repeatability as one requirement for the recognition of accurate palaeomagnetic recording of geomagnetic excursions.

Noël questions the reliability of our Björkeröds Mosse data[2] because of his qualitative assessment of the high variability of the sediments and scatter of palaeomagnetic directions. Inspection of the palaeochemical diagrams (Fig. 1 of ref. 3), rather than simply the column of layer numbers, shows that between ~13,000 and 11,000 BP the rate of sedimentation varied from only 50 to 100 mm per 100 yr, the sediment was never coarser than clay grade and that certain of the 'sedimentary units' alluded to by Noël are in fact transition zones. The mean direction of the oriented, cleaned, normally magnetised subsamples spanning the period ~13,000–11,000 BP is dec. = 2°, inc. = 66°, giving unit weight to each core, with an average 95% cone of confidence of radius of only 3.5° for each core section. We cannot agree with Noël's summary that these data are from sedimentologically complex cores with high noise content.

Noël stresses that "The Revised Swedish Time Scale also provides a precise chronology" for varved clays. Most Swedish Quaternary geologists are now convinced that there is no revised absolute time scale—based on varves—available for South Sweden. There seems to be a discrepancy of 600–800 yr between the varve years and the radiocarbon years south of the Central Swedish Moraines (B.B., in preparation). This is partly due to complications in the varve chronology, partly due to ^{14}C variations in the atmosphere. Noël consequently uses a floating chronology which is less accurate than the biostratigraphic zones and transferred chronozones of the Björkeröds Mosse sections.

Noël misrepresents our conclusions. Correctly stated they are, "The Swedish late Weichselian reversal has become an example of Watkins's reinforcement syndrome" and "Furthermore, reversals or excursions of the geomagnetic field from other parts of the