matters arising

Geomagnetism and climate

FAIRBRIDGE¹ correlates the Gothenburg geomagnetic excursion (about 13,500 yr BP) with climatic changes associated with the North American glacial record, eustatic changes in sea level, and changes in rainfall and river discharge in the Nile Valley. Such a correlation is interesting considering the possible resulting climatic effects as suggested by Harrison and Prospero². But, Fairbridge in presenting his case ignores the cyclical nature of the continental and oceanic climatic histories. The Holocene, viewed as a whole, is characterised by alternating intervals of glacial advance and retreats. When viewed in this way the correlation of the Gothenburg geomagnetic excursion with a small segment of the climatic history of the earth is hardly justified. Two examples illustrate the danger involved in this kind of correlation. Denton and Karlen³, from an examination of ¹⁴C dates on glacial termini, show that the dates of glacial maxima peak at 200–300, 2,800 and 5,300 yr BP which suggests a recurrence of major glaciers every 2,500 yr. Extrapolating backwards in time, this pattern suggests glacial advances peaking at about 7,800, 10,300, 12,800 and 15,300 yr BP. The Gothenburg excursion corresponds to the time of the Port Huron advance (12,700 to 13,000 yr BP), and/or the Cary/Port Huron interstadial (about 13,300 to 14,000 yr BP), and is no way a unique event when the whole record is viewed. The single correlation of geomagnetic and climatic events at 13,500 yr BP fails to explain similar climatic changes occurring with some regular frequency over the whole Holocene.

In the same way, Fairbridge cites the oxygen isotope record of the Greenland Ice Core in support of his hypothesis. He presents, however, only a small time interval of this record. The isotope record shows a long term climatic trend from 14,000 to 10,000 BP superimposed on which are major oscillations (ref. 4). Given the nature of this climatic record, the correlation of geomagnetic changes and climate at 13,500 yr BP seems purely coincidental.

Finally, it may be suggested that the oceans might provide a reasonable source of material from which a correlation of geomagnetic and climatic changes may be recognised. The oxygen isotope record of foraminifera from deep-sea cores in the Gulf of Mexico, for example, record a major influx of freshwater between 15,000 and

12,000 yr BP⁵. This resulted from the deglaciation of the Laurentide Ice Sheet and subsequent drainage through the Mississippi River Valley. Its correlation in time with the Gothenburg geomagnetic excursion seems pure chance when one examines the ¹⁸O record of deep-sea cores throughout the ocean. From such data⁶ one is unable to find any major climatic event over the interval of time in question (11–14,000 yr BP).

Thus while the correlation between geomagnetism and climate is interesting, there is no evidence to support it. The main difficulty with the data given by Fairbridge is that it fails to recognise the cyclical nature of the Holocene Climatic record. While many forcing functions may drive it, the case for geomagnetism as a driving mechanism is yet to be made.

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¹ Fairbridge, R. W. *Nature* **265**, 430 (1977).

² Harrison, C. G. A. & Prospero, J. M. *Nature* **250**, 563 (1974).

³ Denton, G. H. & Karlen, W. *Quat. Res.* **3**, 155 (1973).

⁴ Dansgaard, W., Johnsen, S. J., Møller, J. & Langway, C. C. *Science* **166**, 377 (1969).

⁵ Kennett, J. P. & Shackleton, N. J. *Science* **188**, 147 (1975).

⁶ Hays, J. & Cline, R.-M. (eds) *Geol. Soc. Am. Mem.* **145** (1976).

FAIRBRIDGE REPLIES—Hecht insists that I have ignored cycles in climatic history, but this is not so. Three major systems are identifiable: (1) the 200–250-Myr cycle (possibly galactic); (2) the 20,000–100,000-yr Milankovitch cycles (planetary orbits); and (3) the 11-yr (plus multiples) solar radiation cycle. Each is exogenetic. In contrast, the terrestrial response is greatly dependent on variable palaeogeography—an endogenetic control.

Hecht refers to the excellent glacial chronology of Denton and Karlen. I have made use of it in a paper entitled: 'An 8,000-yr palaeoclimatic record of the 'Double Hale' 45-yr Solar Cycle'¹. The major coolings on the other hand fall closer to 850-yr intervals, but I do not yet have a convincing casual correlation to offer. The variability does not at present justify Hecht's extrapolations.

In my Fig. 1, covering only the 'small interval' of 8,000 yr, I did not suppress evidence of other oscillations, but merely tried to stress the coincidence of the Gothenburg Event with the largest of them.

There still remains a 'chicken-and-egg' problem. The timing of the Gothenburg reversal (closer to 12,500 BP, according to Mörner, personal communications) puts it half-way through the last deglacial phase and thus suggests it was triggered by the massive asymmetric glacial unloading-loading. The latter was catastrophically rapid in geological terms. Thus a general exogenetic global warming trend might trigger an endogenetic geomagnetic phenomenon that in turn introduced a brief cooling. Hecht is right to look at oceanic records, but not for oscillations of only a few centuries. For this information we need carefully analysed cores from lakes where rapid sediment accumulation is taking place.

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¹ Fairbridge, R. W. & Hillaire-Marcel, C. *Nature* **268**, 413–416 (1977).

Palaeomagnetic stratigraphy of the Koobi Fora Formation, east of Lake Turkana (Lake Rudolf), Kenya

IN their recent article on the magnetostratigraphy of the Koobi Fora Formation of northern Kenya, Hillhouse *et al.*¹ noted that amendments to published correlations of the Koobi Fora stratigraphy were desirable but were unable to take this into account in the evaluation of their results. They noted that alternative dates were now available for the KBS Tuff but did not pursue the inference that if one published ⁴⁰Ar/³⁹Ar date was questionable, others might be similarly suspect. Some of their statements concerning the geographic location of tuffaceous outcrops were misleading.

An important offshoot from detailed investigation of the evolution of African Plio-Pleistocene Suidae has been the acquisition of correlative information of value both within the Koobi Fora region and between this and other African sites of similar age (J. M. Harris and T. D. White, in preparation, ref. 7). Suid correlative evidence suggests, for example, that the 'Tulu Bor' Tuff of Koobi Fora Area 102 (102/T.IV) is in disagreement with Cerling *et al.*², clearly younger than the type Tulu Bor Tuff of Area 129