suggested by Prévot *et al.* can reasonably be used as such a criterion. However, if the continuity can usually be well established in sedimentary records, this appears to us much more difficult in volcanic records. Furthermore, despite the additional information given here by Grommé *et al.*, we are not fully convinced that any of their arguments provide compelling evidence of a continuous mean extrusion rate on a timescale of less than 1,000 yr.

The rather uniform composition of larvas can hardly be used in this sense, as periods of constant chemical composition lasting up to about 150,000 yr have been observed, for example, in Etna[3]. We agree that the K–Ar dating results really indicate the same age for the top and bottom parts of the sequence. However, differences of about 0.3 Myr inside the same directional group (No. 49) are observed and if standard deviation is taken into account, the time span of age could reach 0.7 Myr.

Finally, the argument of the secular variation used by Prévot *et al.*[1] to establish the linearity of timescale is also not convincing. Neither the number attached to the angular displacement of directions nor the stability of the secular variation over long periods of time is confirmed in longer records of secular variation, in lake sediments[4] or by comparison of lake sediments and recent lavas[5].

We are convinced that the data obtained by Prévot *et al.* provide a very impressive description of the geomagnetic field during a transition. What we are saying is that, in the present state of knowledge (or ignorance), part of the interpretation of this record might still be open to discussion.

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Dust production in the Sahel

I WISH to make three points concerning the adequacy and consistency of the Sudanese visibility data used by Middleton in a recent analysis[1] relating the frequency of severe atmospheric dust occurrences to annual rainfall.

First, after 1974, the Sudan Meteorological Service started recording visibility at 00.00 GMT in addition to 06.00, 12.00 and 18.00. Frequencies of poor visibility presented by Middleton for El Fasher in Fig. 1 (and for five Sudanese stations in Table 2) are therefore inflated for the years 1975–78 compared with previous years. Second, each observation of poor visibility does not necessarily refer to a separate dust storm event. Poor visibility at 06.00, 12.00 and 18.00 may be the continuation of a single storm whereas Middleton would categorize these as three separate storms. The resolution of the Sudanese data is insufficient to make this distinction. Again, the caption for El Fasher in Fig. 1 is misleading and the data are almost certainly inflated.

Finally, and most important, no discussion of the reliability of the visibility readings is included. Atmospheric visibility is a notoriously difficult climatic parameter to quantify. The Sudan Meteorological Service used the system of locating key landmarks at known distances from the observing station which are recorded either as seen or unseen by the observer at the designated times. I have observed ephemeral objects such as trees and electric lights being used at Sudanese stations. I would treat with great caution data collected in such a manner, where differences in procedure between successive observers can be crucial.

An inverse relationship between the recorded frequency of dust events and annual rainfall does appear to exist (subject to my first and second points) and the analysis is useful. I suggest, however, that climatic data from Sahelian countries be treated cautiously and their measurement and collection procedures carefully investigated and understood before they are analysed.

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MIDDLETON REPLIES—I thank Dr Hulme for his interest. Dust storms are recorded by meteorological observers using fixed objects as visibility targets in all countries of the world where such phenomena occur, and such observations do present problems of observer error and involve an element of subjective decision making. As with all meteorological data there may also be changes in observational procedures. There are other problems inherent in interpreting data on the frequency of dust storms and dust storm days; I have highlighted some of the problems in a recent paper[1]. Briefly, the statistics may conceal considerable variation in the areal and volumetric extent of dust storms and their duration. However, some of these problems are less serious when a group of stations is used[2] to illustrate a particular trend in dust storm activity.

There may well be some inflation in the data for the Sudanese stations since 1974 as a result of a change in the frequency of visibility recording to which Hulme correctly refers, but the increasing trend that started before 1974 has continued to rise since that date and seems to be confirmed by studies in other countries of the Sudano-Sahelian belt. Note also that mean summer concentrations of dust at Barbados were again very high during 1982 and 1983 (ref. 3), although any comparison of dust storm frequency with dust mobilization or transport should be cautious because the scale of dust-raising events and the altitude to which material is lifted are of fundamental importance to the long-range transport of dust, and such information is not provided by dust storm frequency data for a particular station, as mentioned above.

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