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Research note

A short note on early Cambrian palaeomagnetism from Normandy, France

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Morris (1980) has published palaeomagnetic directions for Lower Cambrian (and perhaps latest Precambrian) red sediments from Carteret and Pointe-de-Rozel in Normandy, France. His recalculated directions and poles (errors occurred in the original publication) are reproduced here in Table 1. Poles essentially identical to these have also been reported from the same unit by Duff (1979). In this brief note we want to draw attention to the fact that these poles convincingly fit the apparent polar wander path for the Eocambrian and Cambrian constructed for the Armorican Massif of France by Hagstrum *et al.* (1980). This path is shown in Fig. 1 with the Lower Cambrian red bed poles of Table 1 added as squares.

The order of acquisition of these two magnetizations is still somewhat uncertain. Whenever red beds carry multivectorial magnetizations, the order of acquisition of the components and the primary nature of any of the components can be a matter of dispute. Morris (1980) suggested on the basis of the magnetic properties during thermal, alternating field and most importantly chemical demagnetization as well as reflected-light microscopy, that pole B was older than pole A. The magnetizations resulting in pole A are thought to be chemical remanent magnetizations (CRM), acquired during hematite diagenesis in the early Palaeozoic. Using similar arguments, however, Duff (1979) suggested the opposite acquisition sequence for his equivalent poles C (= our A) and B3 (= our B).

The formations studied are moderately tilted and provide a possible fold test: for the B magnetizations it was found upon recalculation that although the tilt correction produces an improvement in kappa, it does not constitute a positive fold test, whereas for the A magnetizations the test is inconclusive with the precision parameter k (Fisher 1953) decreasing slightly upon unfolding. Duff in his study concluded that both magnetizations predate folding. It can be assumed therefore that both these magnetizations must have been acquired at some time during the period between Lower Cambrian and Carboniferous, because most workers (e.g. Robardet 1973) argue that the folding was of late Palaeozoic age (Devonian to Carboniferous). Moreover, the A directions are steeply inclined and since no steeply inclined directions are known for late Palaeozoic or younger periods for the Armorican Massif (Jones, Van der Voo & Bonhommet 1979; Duff 1979), a post-folding age for the A magnetizations appears unlikely. Nevertheless, the exact time of these acquisitions remains uncertain; despite the dangers of possible circular reasoning, there is no other recourse than to interpret the poles by comparing them to other results. Both Morris (1980) and Duff (1979) com-

Table 1. Mean directions and (recalculated) pole positions for Early Cambrian red sediments from Normandy, France (Morris 1980).

Component	*N* (sites)	*D*	*I*	*k*	α_{95}	Pole position
A magnetization, *in situ*	9	253	+75	40	8	35.5N, 324.5E
A magnetization, tilt corrected	9	281	+80	35	9	49.3N, 326.9E
B magnetization, *in situ*	7	210	+16	18	15	26.6S, 323.4E
B magnetization, tilt corrected	7	208	+29	27	12	20.5S, 328.1E

pared their poles with results from Great Britain. Morris, noting a faint similarity between his A pole and Ordovician poles from Great Britain, suggested an Ordovician age for this magnetization, while maintaining a Lower Cambrian (primary) age for the B magnetization. In contrast, Duff examined the thermal demagnetization characteristics of his specimens in the light of theoretical blocking temperature curves and speculated that both the A and B magnetizations might have been reset in the Middle Palaeozoic. (It might be noted that there was no direct evidence of remagnetization for the Normandy sites of Morris or Duff.) By then comparing the poles with the known Palaeozoic pole path for Britain, Duff proposed ages of Siluro-devonian, and late Devonian, respectively, for the A and B magnetizations.

We examine in this note a third possibility. Although it is quite possible that the Armorican Massif and southern Great Britain were part of the same plate during the early Palaeozoic, this is by no means proved and it would be best to compare the Armorican A and B poles of Table 1 with other Armorican results. Unfortunately, there are no reliable Ordovician and Silurian results for the Armorican Massif, but we note that there is a good agreement (Fig. 1) between both the A and B pole and the latest Precambrian to Middle

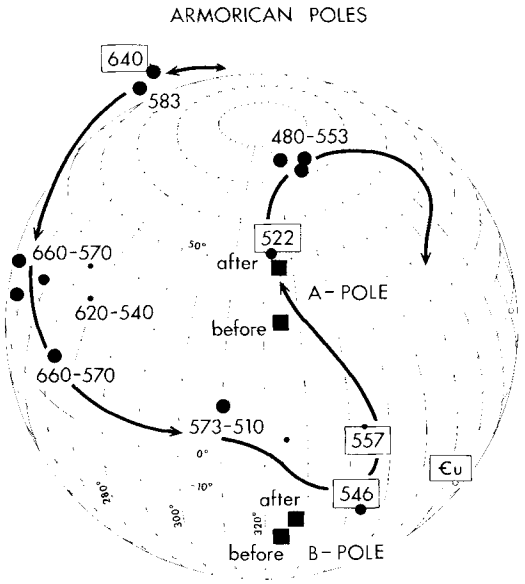

Figure 1. Palaeomagnetic pole positions and apparent polar wander path for the Armorican Massif for Eocambrian to Cambrian (650–500 Ma) time from Hagstrum *et al.* (1980), with the poles from the Normandy red sediments of Morris (1980) added as squares: the B pole as well as the A pole are shown both before and after correction for the tilt of the strata.

Cambrian segment of the Armorican apparent polar wander path of Hagstrum *et al.* (1980). The B pole falls near latest Precambrian–earliest Cambrian poles for the Armorican Massif, derived from 546 to 557 Ma intrusive and extrusive rocks (poles MR and PS). Recent evidence for the age of the Precambrian–Cambrian boundary gives ages as young as 540–530 Ma (Charlot 1976), whereas more conventional time-tables (e.g. Van Eysinga 1975) give 570 Ma. Thus, the pole B of the Normandy rocks agrees very well in age as well as position with the available palaeomagnetic data from elsewhere in the Armorican Massif. The same reasoning can be used for the A pole. It falls (Fig. 1) between the earliest Cambrian poles mentioned above and a pole obtained by Duff (1980) for the 522 Ma Jersey Volcanics (Channel Islands).

In summary: although we cannot disprove a younger age of the magnetizations, we argue that it is equally possible that the magnetizations are latest Precambrian–early Cambrian and thus near-primary. The two pole positions obtained from the red sediments of Cartaret and Pointe-de-Rozel in Normandy (France) agree well with a recently published apparent polar wander path for the Armorican Massif and the ages of the rocks match the radiometrical and stratigraphical/relative age calibrations used for the path. The poles from the Armorican Massif come from the north coast of Brittany (Trégor region), from the Channel Islands and from Normandy, which apparently acted as a coherent unit since latest Precambrian times.

Acknowledgments

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