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A Paleomagnetic Study of the Iles de la Madeleine

by

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INTRODUCTION

The experimental stage of the Iles de la Madeleine paleomagnetic study is nearing completion, and first interpretations of the data are becoming possible. The study was undertaken in an effort to expand the understanding of Permian tectonics in eastern North America. As exemplified by the subaereal desert sediments of the Iles de la Madeleine, this part of the continent was elevated and undergoing erosion in the Permian. Because the environment of a continental interior is not conducive to abundant sediment deposition, it is not surprising that the time period is poorly represented in the stratigraphic record.

GEOLOGY

The subaereal redbeds of supposed Permian age (Brisebois, 1981) overlie Carboniferous strata of the Maritime Basin (Pictou to Windsor Groups). A phase of salt-dome tectonics occurred in the Carboniferous prior to the deposition of the Formation du Cap aux Meules, the Permian deposit sampled for paleomagnetic work. Thus the rock unit is disturbed only by minor normal faults, interpreted by Brisebois as a post-tectonic readjustment. A possible relationship of this persistently tensional environment to subsequent Triassic rifting in the Maritimes (ex: North Mountain Basalt, N.S.), warrants further thought.

The formation des Caps aux Meules is divided into an upper and lower member, L'Etang des Caps and L'Etang du Nord, respectively.* Both were sampled paleomagnetically. The distribution of these members and the sampling sites are shown in Fig. 1.

The Caps member is a poorly consolidated, cross-bedded dune deposit. For most sites the only paleomagnetic technique possible was AF treatment. Therefore, the Nord member was studied more extensively.

PETROLOGY

Preliminary thin section analysis has shown that grain size in the Nord member is more variable, and the sediment appears to be more immature than that of the Caps member. Two possible remanence carriers are visible: detrital hematite-rich grains, and a red cement. The detrital grains are more abundant in the Nord member. Dune cross-bedding observed in the Caps member suggests an advanced stage of desert development. Consequently, the source material could have had a different provenance and be better sorted than that of the Nord member. These subtle petrological differences and the presence of two types of hematite can be related to paleomagnetic observations.

*Abbreviations for the convenience of this report are: "Meules formation", "Caps member" and "Nord member".

PALEOMAGNETIC RESULTS

Extensive thermal demagnetization has revealed very high unblocking temperatures (near 700°C). In many cases the unblocking temperature was impossible to reach, because the samples disintegrated. This high stability accompanied by low intensity characterizes hematite. AF cleaning was marginally more successful at isolating remanences, because most samples showed instability by 2000 oe. Results are in full agreement with the thermal demagnetization. Some samples were subjected to leaching with HCl. Lengthy immersion and strong acid were required to affect the remanence vector. A possible explanation is that the intergranular hematite is trapped in a silica cement, which impedes the access of acid.

Two major remanence groupings were recognized in the Meules formation (Fig. 2). Though both directions are very resistant to all forms of treatment, the remanence vector has been noted to migrate from the SW to the SE quadrant during demagnetization. A typical example is shown in Fig. 3. The movement never occurs in the opposite sense. Samples carrying both directions are not common. Usually there is only one well defined direction, either SW or SE.

Occasional aberrant directions, that do not fit into either grouping, were also observed. These are particularly prominent in the Caps members. In the Nord member, scatter notably occurs in site 3, which has abundant detrital hematite and no observable hematite cement. No SE remanences were found in site 3. Site 2, however, is tightly grouped in the SE quadrant, and has abundant interstitial hematite. An association is implied

between the SE remanence and the precipitation of the cement. If the SW remanence is due to detrital hematite, a more diffuse grouping can be expected in view of imperfect alignment of particles in the subaereal environment. This association remains to be verified by detailed thin section analysis.

The remanence vectors plotted in Figs. 1 to 3 have all been corrected to their original bedding attitude. The grouping of the data is improved by this correction. Normal faulting above the underlying salt domes is largely responsible for the disruption of the Meules formation from its original horizontal. Sites 18 and 19 are the best examples of the positive "structural test", which indicates that both remanences (SE and SW), were acquired prior to the faulting. Fig. 4a) shows a sliver of the Nord member tilted by downdrop with respect to the horst that forms the axis of the island. The bedding observed at sites 18 and 19 dips 80° to the northwest. In Fig. 4b) the uncorrected remanence direction from site 18 (DH, IH) was brought into agreement with the SE mean after the bedding correction was applied (DB, IB). The same effect was achieved with site 19 for the SW remanence.

TENTATIVE INTERPRETATION:

The poles corresponding to the SW and SE remanences, IM_1 and IM_2 respectively, are plotted in Fig. 5 (adapted from Roy, Tanczyk and Lapointe, 1983). Neither pole falls within the main cluster

of other North American poles, but the IM latitude bears more resemblance to the Carboniferous than to the Permian mean. The position of the poles can be explained in one of two ways:

1. The directions represent two episodes of remanence acquisition; one related to Permo-Carboniferous times, and the other to a subsequent overprint. Both directions may be mixtures of unresolved components. Continued experimental work would aim to isolate the pure remanences. The vector subtraction $IM_1 - IM_2$ gives the resultant pole 86°E, 34°N, which falls far away from the Permo-Carboniferous mean, and does not appear in Fig. 5.

Therefore, the following hypothesis is favoured at present, until a better explanation can be found:

2. IM_1 and IM_2 represent the same remanence that was acquired during a rotation or internal deformation of the lithospheric plate. Fig. 2 shows, that the two remanences form a continuous smear, and the distinction between them was based entirely on the shift within individual samples. When all results of the SW and SE remanences are averaged together, the resultant IM pole falls near to the Carboniferous mean. This hypothesis is further supported by several considerations:

a) The two remanences have similar magnetic properties and are difficult to separate.

b) Remanence acquisition in redbeds is known to be a lengthy process in geological time. (Roy and Park, 1974). No large

time lapse is needed between the deposition, represented magnetically by the hematite detritus, and diagenesis, evidenced by interstitial hematite.

c) Because the Meules formation represents a subaereal desert environment, the Iles de la Madeleine area was likely located deep in the interior of a plate. Heat buildup due to thermal blanketing by the plate, and a consequent increase in lithospheric plasticity, could have caused internal deformation, possibly related to incipient rifting. Evidence for Triassic rifting in the area was mentioned above (North Mountain Basalt; Larochelle, 1967).

FUTURE DIRECTION:

More AF treatment is needed on the Caps member, as it is the only method that does not result in disintegration of samples. Analysis such as vector subtraction or remagnetization circles, could be attempted for isolation of pure remenences, or for verification that the ones already defined are not composite. Extensive thin section examination of each site would reveal a possible correlation between the two observed remanences and the two types of hematite. The source of aberrant directions needs to be explored further.

The final results can be examined in the broad tectonic framework and compared to possibly correlative paleomagnetic poles, such as the one from the Prince Edward Island redbeds.

Brisebois, D., 1981. Lithostratigraphie des strates Permo-Carbonifères, de l'archipel des Iles de la Madeleine, Ministère de l'Energie et des Ressources, DPV-796, 48 p.

Larochelle, A., 1967. Preliminary data on the paleomagnetism of the North Mountain basalt, Nova Scotia, Geological Survey of Canada, Paper 67-39, pp. 7-12.

Roy, J.L., and Park, J.K., 1974. The magnetization process of certain red beds: vector analysis of chemical and thermal results, Canadian Journal of Earth Sciences, 11, pp. 437-471.

Roy, J.L., Tanczyk, E.I. and Lapointe, P., 1983. The paleomagnetic record of the Appalachians, in "Regional Trends in the Geology of the Appalachian-Caledonian-Hercynian-Mauritanide Orogen", P.E. Schenk (ed.), pp. 11-26.

FIGURE 1

(AFTER BRISEBOIS, 1981)

DISTRIBUTION OF PALEOMAGNETIC SAMPLING SITES AND MEMBERS OF MEULES FORMATION:

CAPS MEMBER

NORD MEMBER

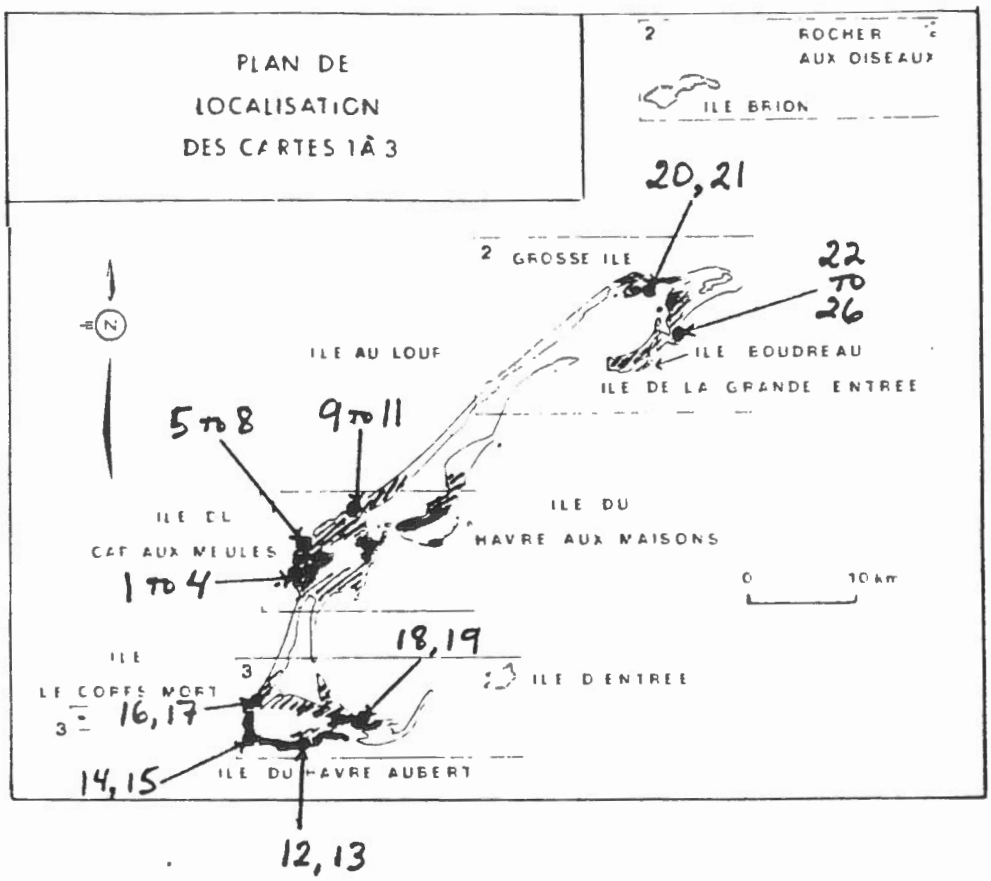


FIGURE 2

TWO MAIN REMANENCE DIRECTIONS
- NUMBERS BY SYMBOLS INDICATE SITES
- $4_1 \rightarrow 4_2$ SHOWS SENSE OF MIGRATION OBSERVED WITHIN SITE

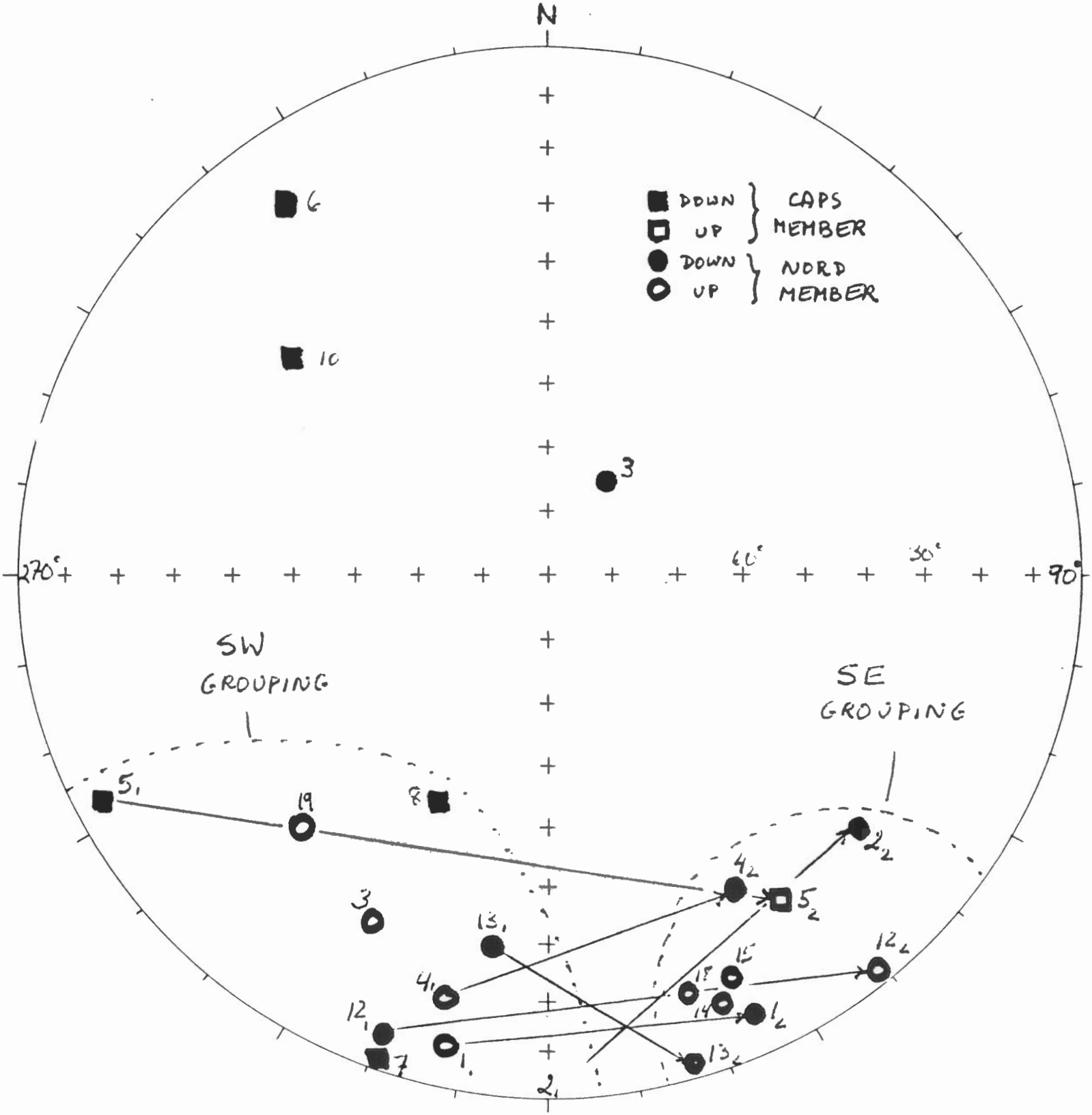


FIGURE 3

MIGRATION OF REMANENCE VECTOR FROM SW TO SE GROUPING

IM 054A

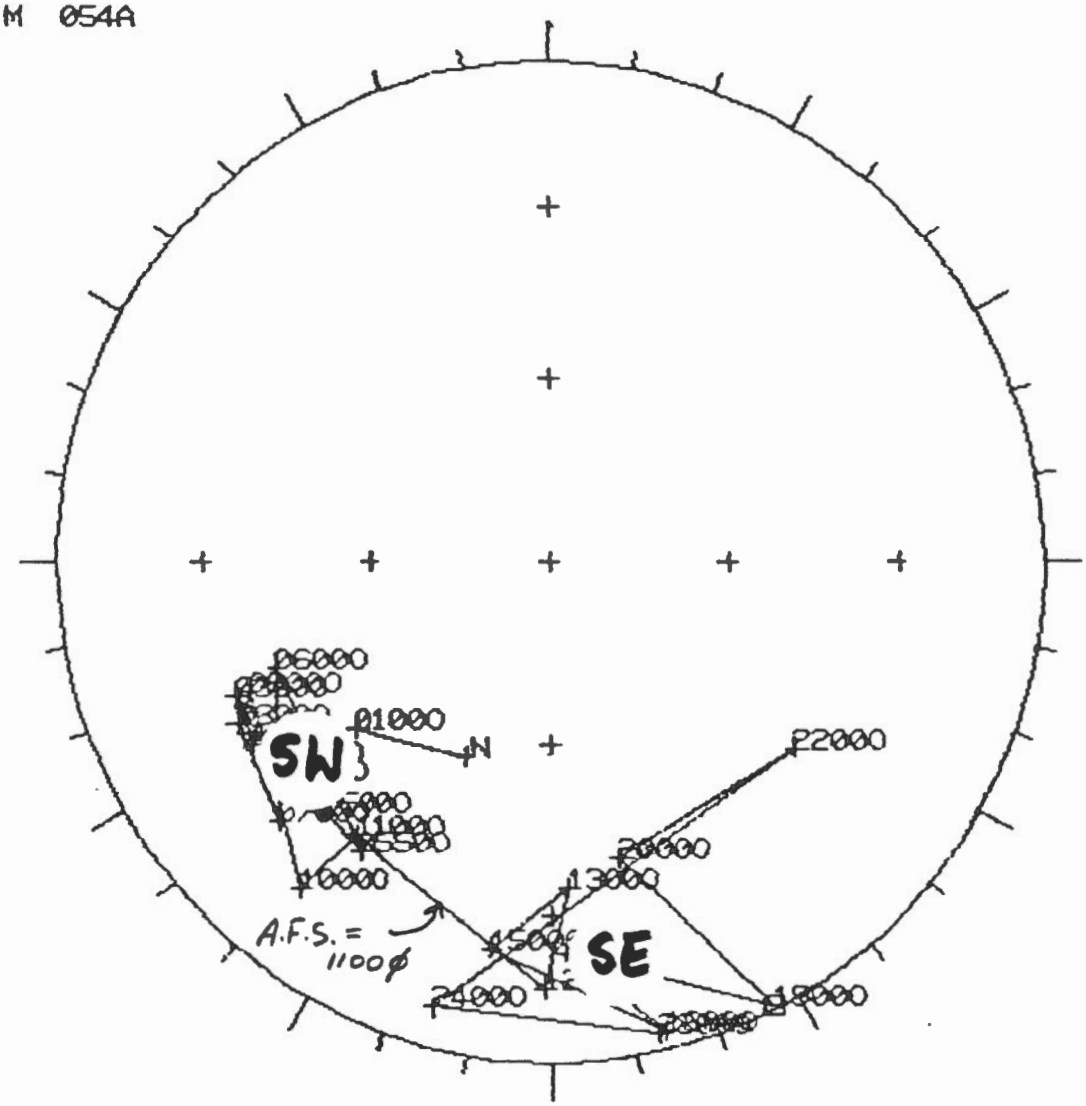
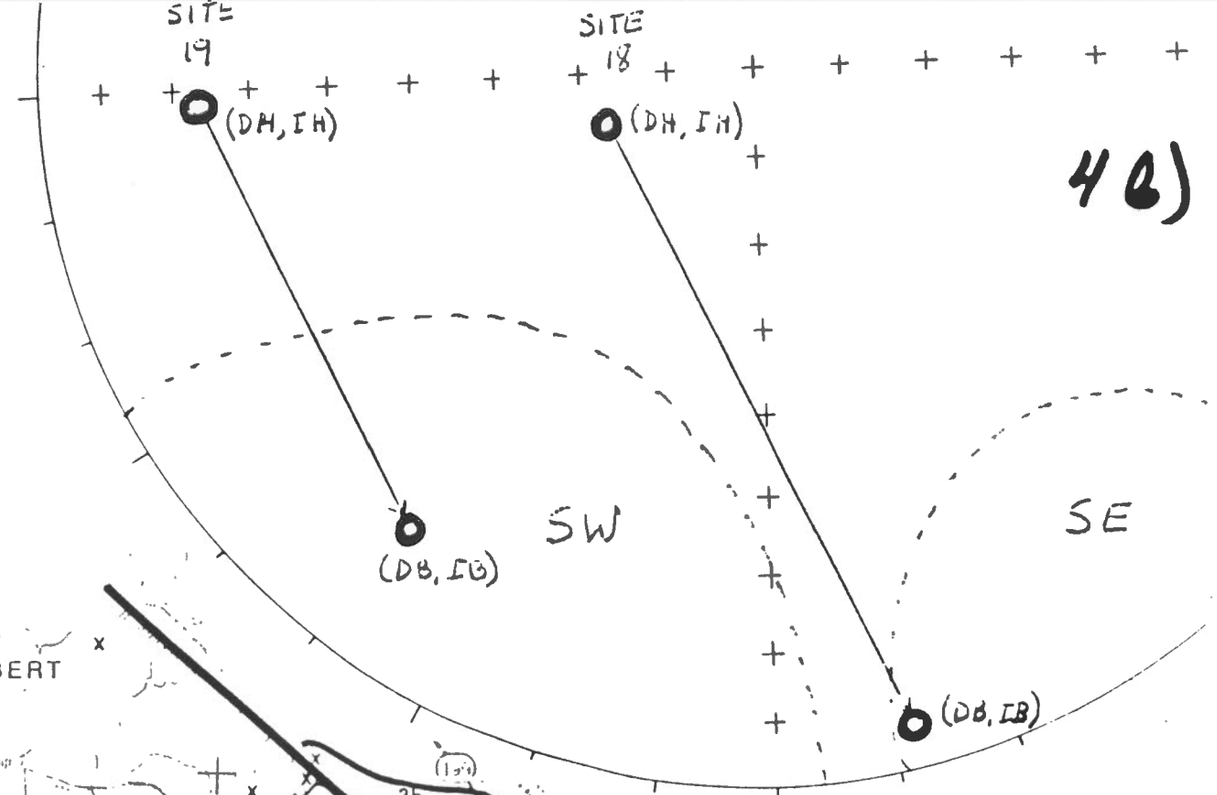


FIGURE 9

STRUCTURAL CORRECTION FOR SITES 18 AND 19



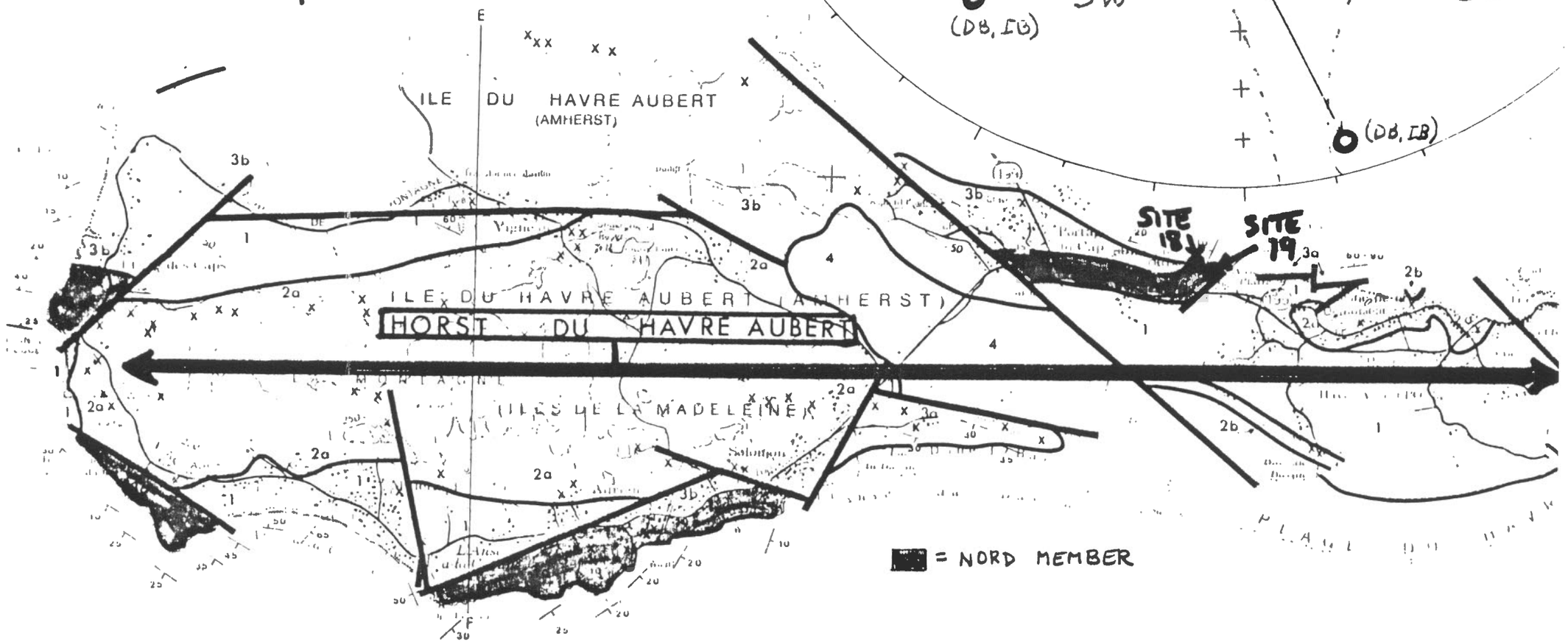


FIGURE 5

CARBONIFEROUS POLES FROM NORTH AMERICA
(AFTER ROY, TANCZYK AND LAPOINTE, 1983),
SHOWING IM POLES