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A PALAEOMAGNETIC PERSPECTIVE OF PRECAMBRIAN TECTONIC STYLES

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The considerable success derived from palaeomagnetic studies of Phanerozoic rocks with respect to the tectonic styles of continental drift (1) and plate tectonics (2), etc. have not been repeated by the many palaeomagnetic studies of Precambrian rocks. This is undoubtedly related to the vast amount of Precambrian time compared with Phanerozoic time, and the concomitant uncertainties of magnetisation ages and rock ages, yet it is still surprising that there is little evidence of consolidation or even convergence of opinions regarding tectonic styles prevalent during the Precambrian. After all, there are 30 years of research with results covering the major continents for Precambrian times that overlap considerably yet there is no concensus even in the grossest terms. There is good evidence that the usual assumptions employed by palaeomagnetism are valid for the Precambrian which only serves to exacerbate the problem. The existence of magnetic reversals during the Precambrian, for instance, is difficult to explain except in terms of a geomagnetic field that was predominantly dipolar in nature. It is a small concession to extend this notion of the Precambrian geomagnetic field to include its alignment with the Earth's spin axis and the other virtues of an axial geocentric dipole that characterise the recent geomagnetic field. In addition it is not a forceful argument to claim that early studies of Precambrian rocks need to be re-done, since re-studies have often only served to confirm the early works. Therefore we submit that the palaeomagnetic results derived from Precambrian rock units are not easily dismissed. It is simply untenable that the majority of the data are spurious and claims that synopses of Precambrian data are invalid, cannot be sustained in such terms. Such arguements posed against the evidence for continental drift have long been debunked. There are, nevertheless, differing interpretations of Precambrian palaeomagnetic data and it is the purpose of this brief article to address this problem.

Methods that have been used to interpret Precambrian palaeomagnetic data fall into two classes. The first class assumes the existence of a "Pangaea" or some supercontinent and proceeds to use the palaeomagnetic data, a posteriori, to support the model. The second class, which we prefer, accepts the palaeomagnetic data at face value (as synthesised by workers closely in touch with the results) and proceeds to view the overall relationships of the data, isolated from preconceived notions. This latter approach has led us to suggest that the present day geographical relationships of continents (from which a reasonable amount of data for the Precambrian are available) yields the more satisfactory comparison. Of course small adjustments of the continents refine this comparison, but overall an excellent agreement in Precambrian pole paths can be realised by leaving the continents in their present locations.

Limitations of the available data in our earlier comparisons (3) restricted the time span of comparisons between different continents to 2300 Ma - 1900 Ma for North America and Africa and 1800 Ma - 1600 Ma for North America, Greenland and Australia. Recently two results have been derived from igeneous rock about 2900 Ma in age, in Australia and Africa. The palaeomagnetic pole positions from these rock units are in close proximity, suggesting that the present geographic relationship of Australia and Africa is valid for 2900 Ma ago. The pole position from the Millindinna Complex, Australia, dated at 2860±20 Ma is at 11.9°S, 161.3°E, dp=6.8°, dm=8.4°(4), while the pole position from the Usushwana Complex, Africa, dated at 2880 Ma is at 11.6°S, 165.8°, dp=5.1°, dm=7.5°(5). Thus there is evidence that during the Precambrian North America and Australia were in their present relative geographic locations for 1800 Ma-1600 Ma, as were North America and Africa for 2300 Ma-1900 Ma, and now Africa and Australia, at least for 2900 Ma ago.

These observations are not easily reconciled with Phanerozoic palaeomagnetic results as we have already discussed(3), but they are a matter of record and must be explicable. In terms of greenstone terranes it is obvious that tectonic models postulated to explain these observations are paramount in understanding Precambrian geology. What relevance the current geographical relationships of continents have with their Precambrian relationships remains a paradox, but it would seem that the ensialic model for the development of greenstone terranes is favoured by the Precambrian palaeomagnetic data.

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