A PALAEOMAGNETIC PERSPECTIVE OF PRECAMBRIAN TECTONIC STYLES
P.W. Schmidt and B.J.J. Embleton, CSIRO Division of Mineral Physics and
Mineralogy, P.O. Box 136, North Ryde NSW Australia

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 consensus even
in the grossest terms. There is good evidence that the usual assumptions
employed by palaeomagnetism is 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 arguments 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
igneous 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 Usushvana 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.