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PALAEOMAGNETIC RESULTS FROM SEDIMENTS OF THE PERTH BASIN, WESTERN AUSTRALIA, AND THEIR BEARING ON THE TIMING OF REGIONAL LATERITISATION

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ABSTRACT

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In an attempt to extend palaeomagnetic investigation of Late Palaeozoic and Mesozoic rock formations in Australia, 222 oriented samples have been collected from sedimentary horizons in the Perth Basin and adjacent areas. The thermal stability of the remanent magnetism has been established, but its direction remained oriented close to the direction of the present local geomagnetic field, irrespective of the age of formation sampled. Further attempts to partially demagnetise some specimens using chemical techniques also failed to isolate the primary component of magnetisation. The results have been interpreted as indicating an episode of "blanket" remagnetisation which occurred during the period of regional lateritisation. The presence of normal and reversed polarities indicates that remagnetisation occurred over an extended period of time. By comparing the palaeomagnetic pole positions with the apparent polar-wander curve recognised for the Cenozoic of Australia, quantitative support for a Late Oligocene to Early Miocene age for the period of lateritisation is given. Other palaeomagnetic evidence suggests this age may be correlated to laterites in Northern Territory.

INTRODUCTION

Late Palaeozoic and Mesozoic palaeomagnetic sampling has previously been restricted to the extreme eastern margin of Australia. The assumption that palaeomagnetic data from this region represent the entire Australian continent has recently been questioned (McElhinny and Embleton, 1974). The southern region has yielded results which show remarkable internal consistency (i.e. between sampling localities) and which are based on measurements from many different rock types. However, taken in the context of Gondwanaland that data appear anomalous — this has been pointed out by several workers, e.g.

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Irving and Robertson (1969) and Creer et al. (1969). The southeastern region constitutes part of a broad tectonic belt marginal to the main Australian platform known as the Tasman Orogenic Zone (Oversby, 1971; and Scheibner, 1972) and was active during much of the Palaeozoic (Brown et al., 1968). In view of those current ideas which view the structural evolution of the southeastern region within the framework of the plate-tectonic concept, it was considered necessary to extend palaeomagnetic sampling to those regions which may be properly described as having maintained their structural unity with the main shield areas. In this context, the results reported here constitute part of a larger programme designed to investigate Upper Palaeozoic—Mesozoic palaeomagnetism of the main Australian platform. This paper describes results obtained from the Permian—Cretaceous sedimentary sequence in the Perth Basin, Western Australia. That the Perth Basin has remained contiguous with the platform has been demonstrated by Embleton and Giddings (1974) who investigated the palaeomagnetism of the Lower Palaeozoic Tumblagooda Sandstone. The palaeomagnetic pole yielded by those beds is consistent with other Lower Palaeozoic data from northern, central and southern regions of the platform (McElhinny and Embleton, 1974; Embleton and Giddings, 1974).

The best developed sequences of Upper Palaeozoic and Mesozoic rock formations outcrop in the north Perth Basin (McWhae et al., 1958); furthermore, sampling was restricted in the southern part of the basin due to low topographic relief. The Darling Fault approximately running north—south is the major structural feature of the area and marks the eastern limit of the basin, having a maximum downthrow to the west of 900 m. Movement associated with the fault has only disturbed strata in close proximity to the fault zone where dips up to 20° occur. Elsewhere the beds are almost horizontal. A total of 222 oriented rock samples was collected during two field seasons.

GEOLOGY OF THE SAMPLING LOCALITIES

The majority of sampling localities were situated in the northern part of the basin. The stratigraphy in this area is shown in Fig. 1 and a geological map is shown in Fig.2.

North Perth Basin

Permian sediments actually outcrop only in the northern part of the Perth Basin. These include 1200 m of glacially derived Sakmarian sediments followed by 900 m of Artinskian coal measures and shallow marine sediments. The strata are deformed along the Darling Fault, but elsewhere have a gently easterly tilt (Playford, 1959). Hence, units successively higher in the sequence outcrop to the east, towards the fault. The beds are apparently conformable with each other (McWhae et al., 1958). A sequence of marine shales and sandstones known as the Kockatea Shale, considered by McTavish and Dickens (1974) to be Early Triassic in age, outcrops at the junction of the Kockatea

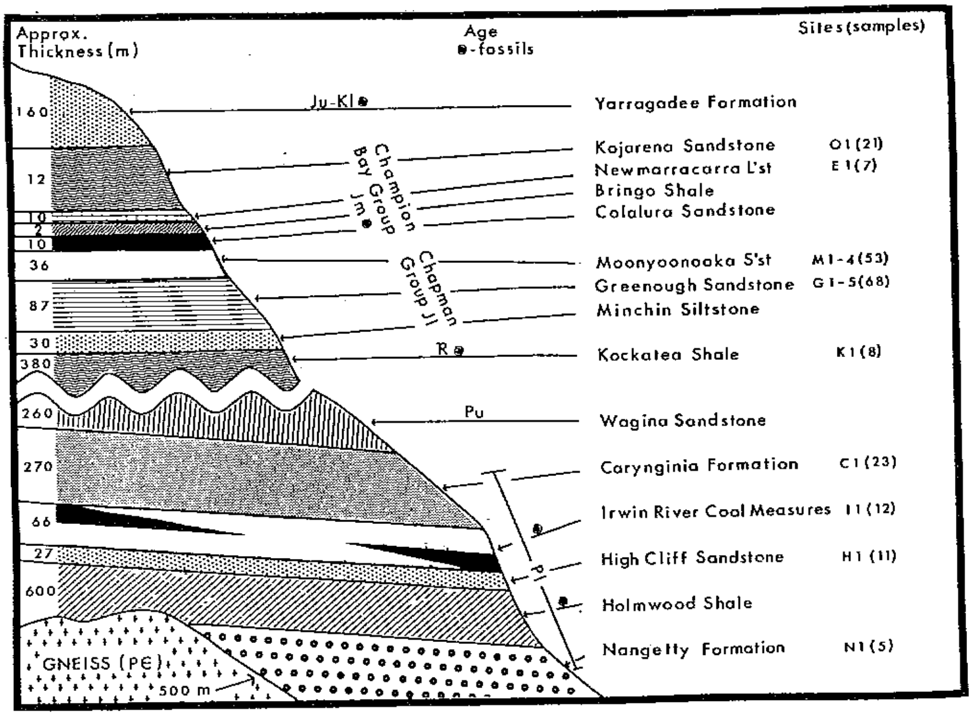


Fig.1. Diagrammatical section of stratigraphy in the north Perth Basin, W.A.

Gully and the Greenough River. Sedimentation was continuous across the Triassic/Jurassic boundary and is represented by 500 m of fluviatile sediments. They are known as the Chapman Group (Playford, 1959) and consist of the Minchin Siltstone, the Greenough Sandstone and the Moonyoonooka Sandstone. The Chapman Group is placed in the Lias Epoch but may extend into the Late Triassic (Playford, 1959). The disconformity between that group and the overlying Champion Bay Group does not appear to represent a very great time interval (McWhae et al., 1958). The Champion Bay Group is a marine succession including the Colalura Sandstone, the Bringo Shale, the Newmarracarra Limestone and the Kojarena Sandstone. The Newmarracarra Limestone is accurately dated palaeontologically as Middle Bajocian (Playford, 1959). The Jurassic sediments have a maximum regional dip of 0.2°, measured by Playford (1959). The dip is attributed to "differential compaction over the sloping Precambrian basement", and is considered negligible for the purpose of this study.

South Perth Basin and Collie Basin

The Permian strata (known from bore cores) in the south Perth Basin are obscured by overlying Mesozoic sediments. The only exposures of Permian

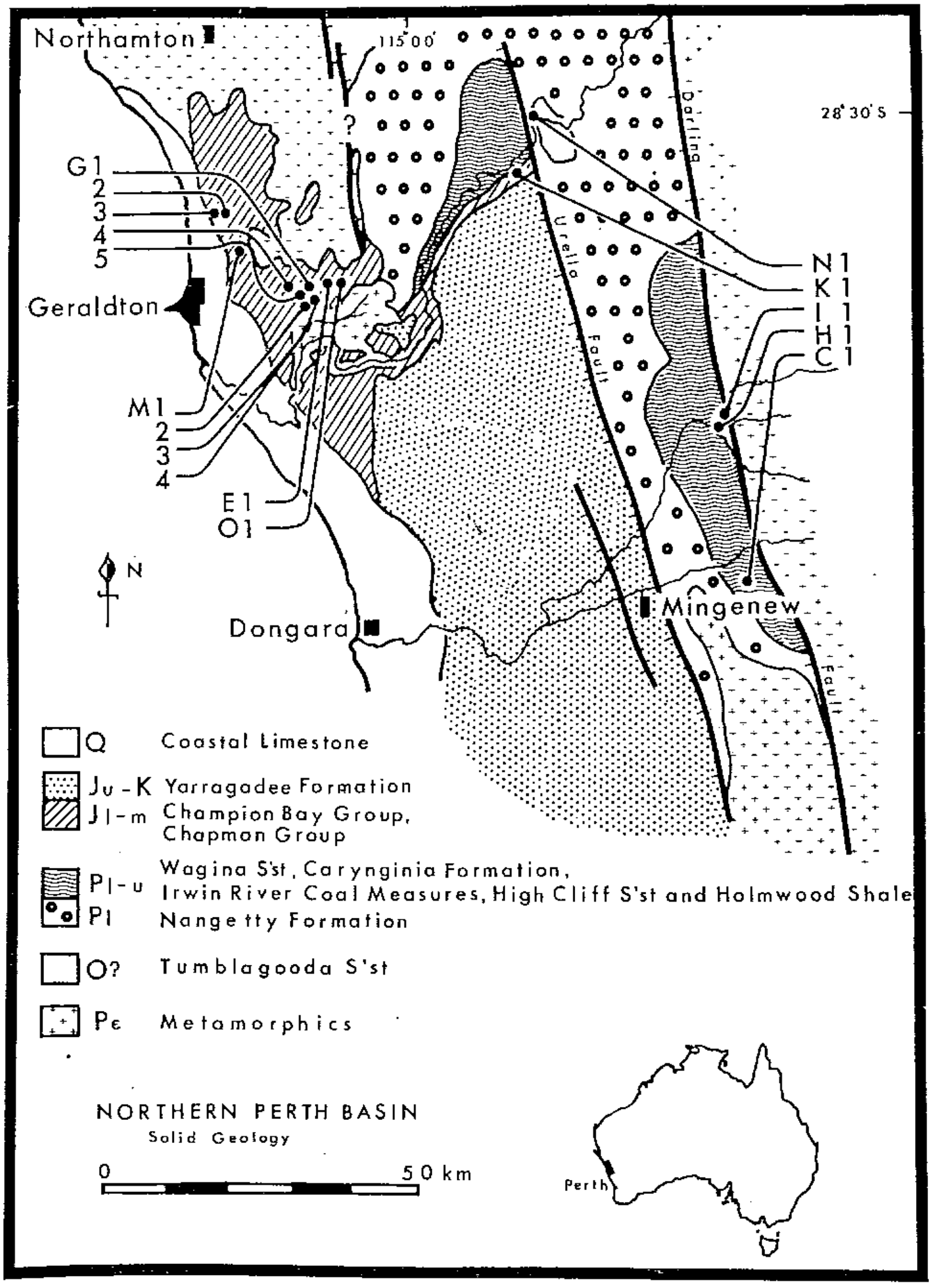


Fig.2. Map of north Perth Basin showing solid geology and sampling sites.

beds in the south occur in the Collie Basin about 170 km south-southeast of Perth (east of the Darling Fault). Balme (in McWhae et al., 1958), considers that these coal-bearing beds are the time-equivalents of the Irwin River Coal Measures in the north Perth Basin.

The Donnybrook Sandstone, a light-buff coloured medium-coarse grained sandstone, was sampled in the southern part of the Perth Basin. It is thought to overlie or interfinger with the Yarragadee Formation in the north Perth Basin (Lowry, 1965). Its age is therefore considered Middle Jurassic to Early Cretaceous.

PALAEOMAGNETIC RESULTS

All samples were oriented using a suncompass-clinometer (Embleton and Edwards, 1973) and magnetic compass. Except when samples were too friable, four specimens were cored and sliced from each sample. Measurements were carried out using a DIGICO "complete results" magnetometer, model MAG101. Stepwise thermal demagnetisation (Irving et al., 1961) was used to isolate components of stable remanent magnetisation. Directions of magnetisation were analysed using the statistics of Fisher (1953) and a test for randomness, devised by Watson (1956). Non-random directions at the 95% probability level for all samples are shown in Figs. 3 and 4.

Permian

The distribution of directions of natural remanent magnetisation (NRM) seemed to be either scattered around the present field direction (Fig.3a) or clustered near the geocentric dipole field axis (normal and reversed polarities were measured), with some directions exhibiting a planar distribution between the two polarities (Fig.3b). Intensities of NRM range from about 0.5 mA m^{-1} for the Collie coal beds to over 100 mA m^{-1} for the Irwin River Coal Measures and the Carynginia Formation. After thermal demagnetisation, only the Nangetty Formation and the Collie coal beds failed to yield meaningful directions.

Nangetty Formation and Collie coal beds. The intensities fell sharply during thermal demagnetisation at low temperatures (<200°C). Above this temperature, directions from only 3 samples (of the tillite) remained non-random (Fig.3a) but these were scattered ($N = 3$, $R = 1.5$).

High Cliff Sandstone. Specimen directions from 2 of the 11 samples were initially random. The remaining NRM directions are shown in Fig.3a. Specimens from all samples were thermally cleaned and 7 samples revealed stable directions of magnetisation between 600 and 660°C.

Irwin River Coal Measures. NRM sample-mean directions displayed a single polarity grouped principally midway between the present field and dipole

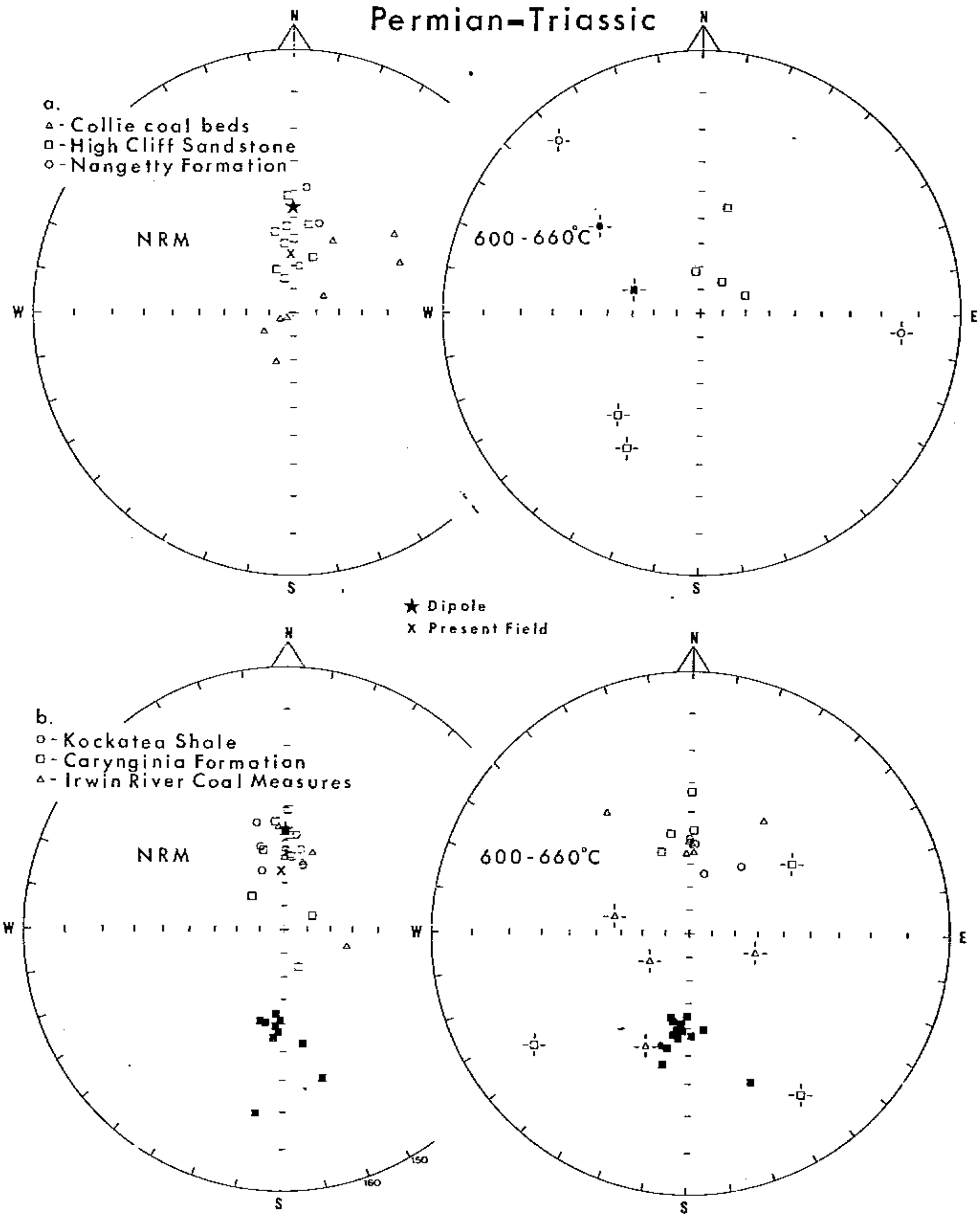


Fig.3. Non-random NRM and thermally stable directions of Permian and Triassic sediments. Solid (open) symbols plot on lower (upper) hemisphere. Sample directions marked with a cross have been omitted from site mean direction calculations.

field directions (see Fig.3b). After thermal treatment at 600—630°C, 6 samples remained magnetised in the NRM direction, but directions in 4 other samples were oblique though apparently stable. Further cleaning of the "oblique" samples revealed unstable components of magnetisation, the intensities of which fluctuated even on the time scale required for measurement. They were omitted from calculations of the site mean direction.

Carynginia Formation. The NRM directions plot as two almost anti-parallel groups close to the dipole axis. At high temperatures (600—660°C) the directions remained unchanged, indicating the presence of a stable magnetic remanence. The site mean direction of magnetisation, computed with respect to the present horizontal, is given in Table I. In view of the interpretation placed on these directions (see Discussion) none of the Permian directions have been corrected for bedding tilt.

Triassic

The Kockatea Shale. The NRM intensities lay between 20 mA m^{-1} and 50 mA m^{-1} and the directions group close to the present field. At high temperatures (600—650° C) the intensities reduced to a few percent of their initial values (0.2—0.5 mA m^{-1}) as the upper limit of the blocking temperature spectrum was reached. Three sample mean directions were rejected on the test for randomness. Of the remaining 5 samples, 1 was reversed. The site mean direction is given in Table I.

Jurassic

The directions obtained from Jurassic sediments show a high degree of internal consistency. They are also remarkably similar to directions in the Permian and Triassic sediments (compare Fig.3 with Fig.4) in that they appear to cluster around the present/dipole field axes.

Greenough Sandstone. A total of 68 samples was collected from the 5 sites described earlier. NRM sample mean directions which are non-random plot with normal and reversed polarities (Fig.4a — sample mean directions constituting individual sites are given the same symbols). Intensities generally lay in the range 10—50 mA m^{-1}. After thermal cleaning, 2 polarities were maintained with all samples from 2 sites (G1 and G3) being entirely reversed. The other 3 sites contain mixed polarities without any apparent stratigraphical relationship, e.g., both polarities occur in a narrow band of red mudstone sampled at two points only a few metres apart. The implications of this are discussed on p. 267.

TABLE I

Site mean directions of magnetisation

Formation	Site No./ thickness (m)[1]	Cleaned directions		Polarity[2]	N^3	R	Pole		A_{95}
		Decl.	Incl.				Lat.	Long.	
Kojarena Sandstone									
28.7S 114.8E	1/10	182.0	60.1	m	8	7.727	76.35	111.3E	16.0
Newmarracarra Limestone									
28.7S 119.8E	1/10	179.1	52.8	m	7	6.975	85.15	122.2E	4.6
Moonyoonooka Sandstone									
28.8S 114.8E	1/10	2.1	−54.0	n	15	14.742	83.25	103.2E	6.5
28.78S 114.7E	2/3	178.4	56.2	m	9	8.914	81.48	124.0E	6.9
28.85 114.8E	3*/25	174.8	55.9	m	9	8.840	80.65	140.2E	9.3
Greenough Sandstone									
28.7S 114.7E	1/5	164.5	63.0	r	5	4.804	68.0S	148.6E	3.6
28.5S 114.5E	2/15	184.6	54.7	m	18	17.864	81.8S	87.8E	3.6
28.5S 114.5E	3/10	179.7	55.3	r	8	7.914	82.1S	115.7E	7.4
28.7S 114.7E	4/15	180.0	52.3	m	5	4.970	85.6S	114.6E	8.8
28.7S 114.7E	5/10	179.0	54.5	m	11	10.556	80.6S	125.0E	12.7
Kockatea Shale									
28.5S 115.1E	1/10	192.6	52.8	m	5	4.912	77.6S	54.7E	14.0
Carynginia Formation									
29.1S 115.6E	1/20	180.9	46.8	m	17	16.690	88.8S	2.9E	5.1
Irwin River Coal									
29.0S 115.5E	1/60	359.6	−48.7	n	7	6.714	88.8S	120.1E	14.8
High Cliff Sandstone									
29.0S 115.5E	1/20	23.6	−67.0	n	4	3.854	60.5S	83.7E	29.3
Mean (sites)					14	13.907	81.2S	108.8E	4.5
Mean (samples)					128	123.143	82.7S	109.9E	2.4

[1] Approximate thickness of sediment sampled at each site.

[2] m indicates mixed, n normal and r reversed polarities.

[3] N is number of samples, R the resultant unit vectors and A_{95} the half angle of the 95% cone of confidence.

*Site 3 includes results from site 4 (see text).

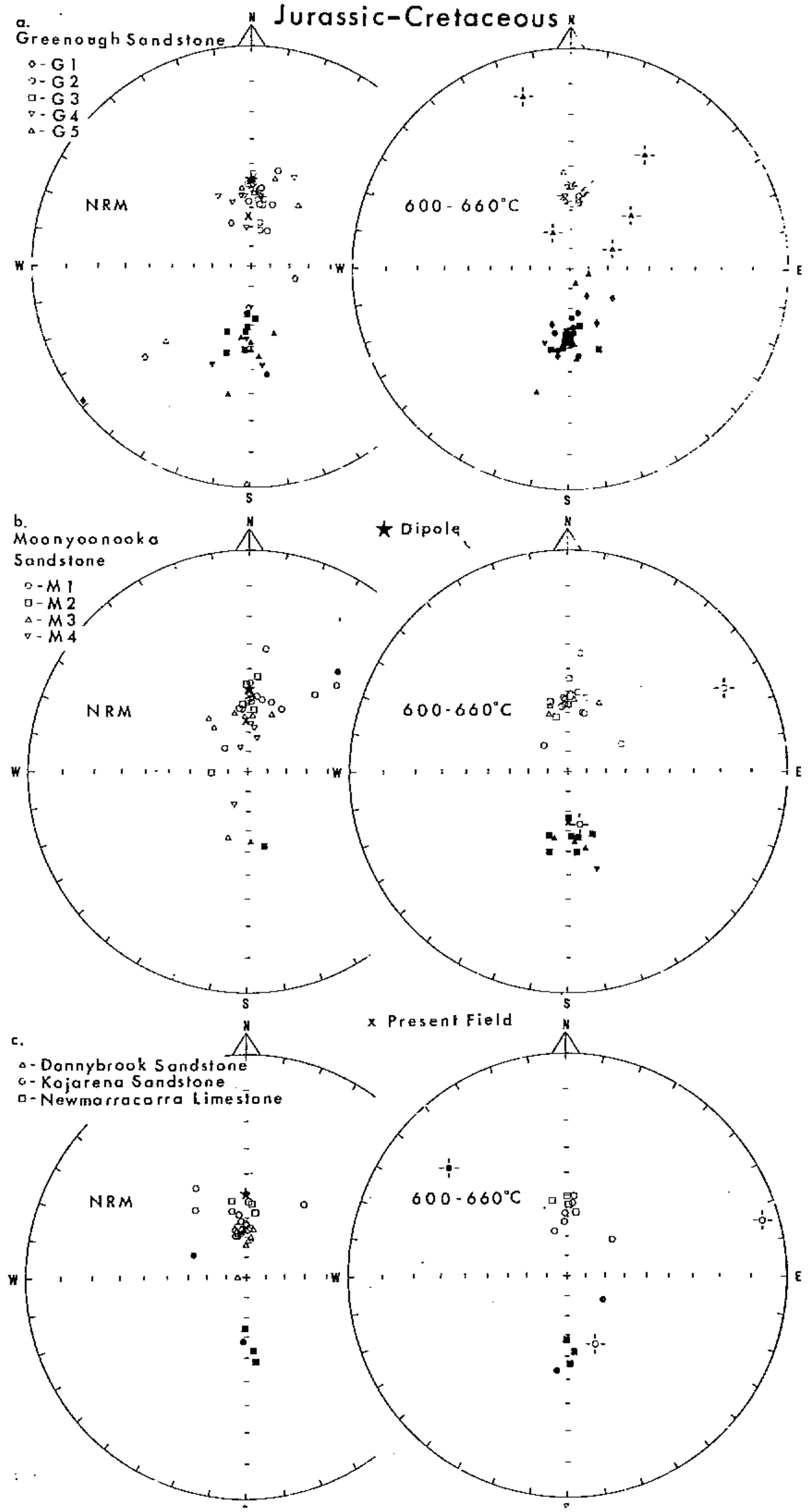
Moonyoonooka Sandstone. Of the 53 samples collected, results from 35 satisfied the selection criteria. The results from one sample from site M4 has been combined with the results from site M3 since all but one sample from site M4 were rejected. Sample mean directions from different sites are given individual symbols in Fig.4b. The NRM directions indicate a scatter about the present field direction although several directions appeared to be reversed or oblique. After thermal treatment, scattering was reduced and almost half of the collection yielded stable directions with reversed polarities. A systematic deviation towards the dipole axis is also apparent. This is evidence of the preferential removal of a component of magnetisation in the direction of the present field. Samples from the type section (M1) display only normal polarity whilst the polarities of magnetic directions of samples from other sites are mixed. Both polarities would be expected to have been detected at the type section if polarity transitions occurred regularly throughout the sequence (the type section is 30 m thick while the thickest section measured (Playford, 1959) is only 35 m). It therefore appears that no correlation exists between polarity and stratigraphical horizon, as noted earlier in the Greenough Sandstone. The site mean directions are given in Table I.

Newmarracarra Limestone. There is little difference between the NRM directions of magnetisation and the sample mean directions after thermal demagnetisation. The intensities of NRM are very high ($>10^3$ mA m^{-1}) only showing substantial decrease at temperatures higher than 660°C. This indicates a very stable magnetisation with a narrow blocking temperature spectrum. Four samples were normally magnetised whilst three were reversed. The site mean direction and calculated pole position are given in Table I.

Kojarena Sandstone. Results from the majority of these samples have been rejected because (a) they are random at the 95% probability level, or (b) the directions are oblique being greater than 40° of arc from the site mean direction. Again with the remaining samples there appears to be a trend towards the dipole axis similar to the trend observed in the Moonyoonooka Sandstone results. This indicates the removal of a secondary component in the direction of the present field. Intensities of magnetisation drop from >20 mA m^{-1} to about 1 mA m^{-1} at high temperatures (600°C). The blocking temperature spectrum is thermally discrete (Irving and Opdyke, 1965). Results from eight samples have been combined to yield the site mean direction and pole position given in Table I.

Cretaceous

The Donnybrook Sandstone. This unit represents the youngest horizon sampled in the Perth Basin. Low NRM intensities (<5 mA m^{-1}) decreased sharply at low temperatures (200°C); and were close to the level of sensitivity of the instrument. None of the directions satisfied the test for significance at


Jurassic-Cretaceous
a.
Greenough Sandstone
◇ - G 1
○ - G 2
□ - G 3
▽ - G 4
△ - G 5
NRM
600 - 660°C
N
S
W
E
b.
Moonyoonooka Sandstone
○ - M 1
□ - M 2
△ - M 3
▽ - M 4
★ Dipole
NRM
600 - 660°C
c.
△ - Dannybrook Sandstone
○ - Kojarena Sandstone
□ - Newmarracarra Limestone
x Present Field
NRM
600 - 660°C

the 95% probability level. The results indicate the unsuitability of these sediments for further palaeomagnetic work.

DISCUSSION

It is apparent from comparing Figs.3 and 4 that the rocks sampled, although ranging in age from Early Permian to Middle Jurassic, have recorded very similar palaeomagnetic directions. There are several reasons leading to the conclusion that these directions are not true records of the primary magnetic field prevalent at the time of rock formation:

(a) Whereas the Permian results consist of both normal and reversed directions, original directions would most likely have been entirely reversed conforming to the Late Palaeozoic Reversed Interval (Irving, 1971) as originally defined by Irving and Parry (1963).

(b) Steeper magnetic inclinations would be expected from original Permian field directions to reflect the high palaeo-latitudes thought to have prevailed during the Late Palaeozoic (Irving, 1966; Brown et al., 1968; and Embleton, 1973).

(c) The majority of directions measured in Jurassic rocks should be normal according to the model of McElhinny and Burek (1971). Their analysis of world-wide Mesozoic palaeomagnetic data demonstrates the Jurassic to be a period of predominantly normal polarity. However, normal and reversed polarities are almost equally distributed.

(d) The disparity that exists between the polarity and stratigraphic level, particularly in the Jurassic strata, is most easily explained as a secondary feature. Magnetisation acquired at the time of deposition or diagenesis usually results in one-to-one correspondence between stratigraphic level and magnetic polarity zone. Chemical remagnetisation during lateritisation will be partly controlled by permeability, moisture content and the movement of ground water from above or below. Points at which remagnetisation commences would probably be unevenly distributed throughout the rock unit. Particularly in the case of the Greenough Sandstone and the Moonyoonooka Sandstone, where zones of polarity showed no apparent relationship to bedding, some samples, may comprise a mixture of normal and reversed directions of magnetisation. This would contribute to increased scatter of directions.

(e) The Permian directions are concordant with the Triassic and Jurassic directions although they have not been corrected for tectonic tilt. This is considered unlikely to be coincidental, and strongly suggests the magnetisations were acquired simultaneously.

(f) Assuming the directions are primary, a necessary consequence of the data based on the axially symmetric geocentric dipole field mode, would require the Perth Basin to have occupied its present latitude at least from the Early Permian to the Middle Jurassic. In the light of palaeomagnetic data from other regions of Australia and continents constituting Gondwanaland (McElhinny, 1973) this is considered a highly unlikely interpretation.

The palaeomagnetic data obtained from the Late Palaeozoic and Mesozoic rock formations in the Perth Basin are consistent with an interpretation based on a remagnetisation event in post-Jurassic times. Presumably, the later magnetisation is chemical in origin and was acquired during alteration (recrystallisation) of magnetic minerals formed during the original magnetisation process in the sediment and through the addition of iron oxy-hydroxide-rich solutions. For this to take place, conditions conducive to the formation of red beds/ lateritisation and oxidised magnetic products should prevail (e.g., Creer, 1970). As the minerals grow, by a nucleation process, the grains reach a critical volume and the direction of magnetisation of the ambient field at that time is blocked (Haigh, 1958). A further small increase in grain size will increase the relaxation time of magnetisation to the order of 10^9 years (Nagata, 1961; Stacey, 1963; and McElhinny, 1973). The magnetisation will thus remain stable over geological time unless the rock is heated for extended periods, in which case the relaxation time rapidly decreases according to the theory of Néel (1949, 1955), or a subsequent remagnetisation event prevails.

The magnetic mineral most common in the sediments investigated in the present study has a high blocking temperature (evident from the results of thermal demagnetisation) indicating that it is possibly haematite or an associated mineral. Pilot specimens from 44 samples of the Greenough Sandstone have been chemically leached following the method described by Roy and Park (1972). Although a *chemically* stable magnetisation was subsequently isolated from most specimens (whose direction was different to that before chemical treatment though not systematically acquiring a new direction after treatment), *magnetic* cleaning indicated that the chemically isolated magnetisation was unstable to alternating fields and to have a low coercive force spectrum, atypical of haematite. Examination of thin sections prepared from original unleached samples showed the majority of the opaque oxides to be clustered around quartz grains. On the other hand, thin sections cut from samples that have been treated with hydrochloric acid ($10N$) reveal that fewer opaque grains remain after treatment and are distributed randomly. This indicates that the dominant magnetic remanence exists in the haematitic phase (as shown by thermal demagnetisation) which clusters around the quartz grains and the finely disseminated specularite corresponds to the phase with a low coercivity. The origin of the chemically isolated grains is obscure though they may be primary, whereas the origin of the haematite is most likely to be secondary.

It is proposed that the lateritisation prevalent in the area studied is responsible for the remagnetisation. Playford (1954) notes that the Newmarracarra Limestone is commonly altered to a haematite-rich rock and maintains "this alteration is connected with lateritisation". The palaeomagnetic results presented here are interpreted as indicating that the outcropping sediments of the Perth Basin have been chemically remagnetised.

Woolnough (1930) argues that the laterite in Western Australia belonged to a "period of highly perfect peneplanation, about Miocene in age, on a land almost devoid of topographic relief and in a climate marked by the dominantly seasonal character of its rainfall". This allows iron oxides, which are leached during the "wet" periods, to be precipitated in a preferred horizon during the "dry" periods. Whether the iron oxides migrate up or down through the weathering profile is not known. A marked leached zone underlies the laterite in the Geraldton area which would seem to indicate that at least some of the haematite in the laterite is derived from the underlying sediments. Playford (1954) shows that the form of the Geraldton laterite reflects an older land surface characterised by a well-developed (sloping) drainage system and that the laterite marks the ancient water-table level as it fluctuated from season to season. The impermeable nature of the laterite finally stopped percolation of ground waters, preventing leaching of the underlying sediments and the further development of laterite. Playford's evidence strongly suggests that peneplanation is not required for the formation of laterite and, in fact, the Geraldton laterite formed *after* the uplift of the Darling Peneplain. Prider (1965) is in full agreement.

Although the laterite zone in Western Australia has received much attention from a number of authors, its age has not been uniquely defined using purely geological constraints. The results described herein do, however, supply a quantitative estimate of the age of lateritisation. Epeirogenic uplift of the Great Plateau follows the deposition of the Eocene Plantagenet Beds of the Norseman area. The laterite is therefore younger than Eocene. Other geological constraints put the laterite age as post-Late Eocene but older than Late Miocene, since the youngest laterised strata, recorded in the Carnarvon Basin, are the Merlinleigh Sandstone which is Late Miocene (McWhae et al., 1958) and overlying limestones are unlaterised. Prider (1965) notes that Condon et al. (1956) also imply this age diagrammatically. However, Prider (1965) believes the Miocene limestones may not be susceptible to lateritisation and prefers a younger Pliocene age. Teichert (1946) also considers the laterite to be Pliocene, although this age was based on a Miocene age for the Plantagenet Beds. These rocks are now more reliably dated as Eocene.

Because two polarities of magnetisation exist in the beds sampled, the lateritisation has apparently occurred over a period of at least two polarity intervals (say 10^3–10^4 years). The magnetisation must also post-date the uplift of the shield because the Permian strata, although tilted, give results consistent with the horizontally lying Jurassic beds. It is stressed that the direction of magnetisation of the Permian beds is thought not to be original because the polarities are mixed and were therefore unlikely to relate to the Late Palaeozoic Reversed Interval.

When plotted on the Tertiary apparent polar-wander path for Australia, the mean pole (Table I and Fig.5) falls near the path segment representing the 20–25 m.y. pole position (McElhinny et al., 1974). Although the cone of confidence (at the 95% level) also intersects the cones of confidence for the

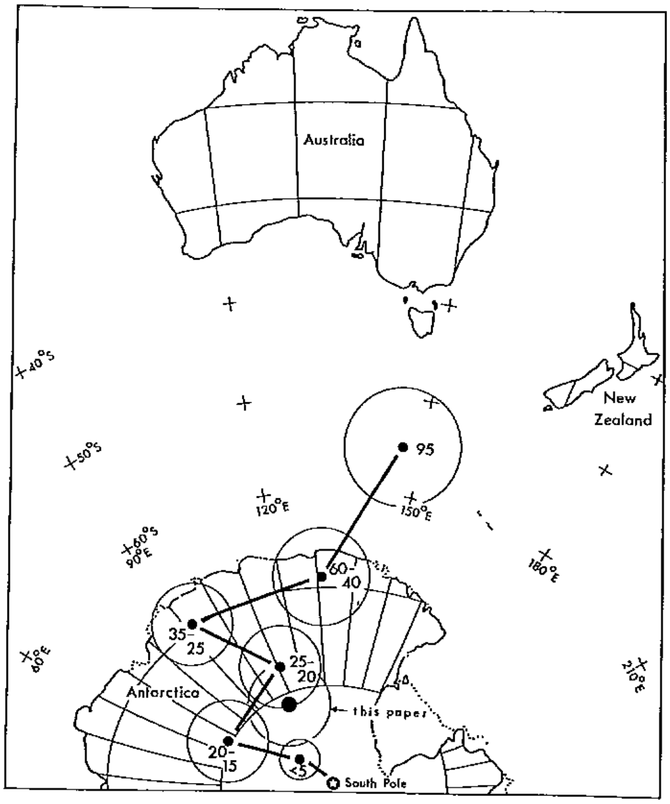


Fig. 5. Polar wander path for Australia from the mid-Cretaceous to present (after McElhinny et al., 1974) comparing the pole derived from Permian to Cretaceous sediments (from Western Australia) with the Cenozoic pole groups from eastern Australia.

TABLE II

Summary of an F ratio test to compare the Perth Basin palaeomagnetic data (remagnetised) with other Cenozoic results.

Pole position	Total N	Perth Basin R_1	Other R_2	Total R	F ratio for 2, 2 (N—2) degrees of freedom
1. 0—5 m.y.	60	13.90702	44.85075	58.45015	14.36
2. 15—20 m.y.	65	13.90702	48.50755	62.27674	3.36
3. 20—25 m.y.	89	13.90702	70.74973	84.55776	1.98*

Data taken from: 1. Aziz-ur-Rahman (1971); 2. McElhinny et al. (1974), Wellman et al. (1969) and Irving et al. (1961); 3. McElhinny et al. (1974), Wellman (1975) and Robertson (1966).

*1.98 is less than 3.05 and there is no significant difference (at the 95% level) between the pole positions.

15—20 m.y. and the 5 m.y. pole positions, it is shown by an F ratio test (see Table II; Watson and Irving, 1957), that the true mean pole position is significantly different from those pole positions. This then provides a quantitative estimate of the age of lateritisation of the north Perth Basin. Based on the Tertiary time scale proposed by Berggren (1969), the age of the magnetisation, and hence the lateritisation is Late Oligocene to Early Miocene.

It is possible to infer this age for laterite horizons in the Northern Territory and possibly for all laterite horizons in northern Australia. Luck (1970) has reported results from the Middle Cambrian Montejinni Limestone which (although having mixed polarity magnetic directions) are irreconcilable with the other Lower Palaeomagnetic data from Australia. He showed that the stable magnetic remanence indicated after treatment at 600° C was directed approximately along the axis of the present geomagnetic field with normal and reversed polarities and concluded that certain levels in the Limestone had been remagnetised by chemical action, associated with a weathering process during a period covering at least one field reversal. The pole position, calculated from Luck's data (1971), lies at 76°S, 107°E ($N = 12$, $R = 11.039$ and $A_{95} = 14°$) and is indistinguishable from the pole position given here for the north Perth Basin sediments. This suggests a synchronous remagnetisation event for a large area of northwestern Australia (and possibly most of northern Australia). The evidence for Mesozoic lateritisation in South Australia (Daily et al., 1974) restricts correlations with southern regions.

In conclusion, the chronological order of events in the Perth Basin appears to have been (1) a pre-Late Oligocene uplift of the Western Australian shield area, followed by (2) a prolonged period of laterite formation in the Late Oligocene to Early Miocene. This concurs with the geological information of Playford (1954), Condon et al. (1956) and McWhae et al. (1958). The younger ages of Pliocene or Pleistocene are considered unlikely in view of palaeomagnetic data now available.

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