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Geological and palaeomagnetic significance of the Kulgera Dyke Swarm, Musgrave Block, NT, Australia

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SUMMARY

The Kulgera Dyke Swarm consists of olivine tholeiites which have intruded late Proterozoic transitional-granulite gneisses and granites of the eastern Musgrave Block, in central Australia. Preliminary Rb/Sr results suggest that the dolerites were emplaced at 1054 ± 14 Ma. In addition, a Rb/Sr age of 1060 ± 10 Ma on a biotite from a pegmatite indicates thermal resetting of the country rock minerals during dyke emplacement. Palaeomagnetic investigations of the dykes yield a primary thermoremanent magnetization direction corresponding to a palaeomagnetic pole at 17°S, 266°E ($A_{95} = 12°$). In addition to this primary magnetization, an overprint component was present in many of the samples, providing a palaeomagnetic pole at 30°S, 138°E ($A_{95} = 24°$), which is similar to previous results from other central Australian rocks affected by the Alice Springs Orogeny. The results extend the area of influence of the Carboniferous Alice Springs Orogeny southward into the Musgrave Block. Further, the results provide no evidence for an earlier, Late Proterozoic, Petermann Orogeny affecting the Musgrave Block in the Kulgera region. However, the possibility that a Petermann Orogeny thermal overprint has been erased by the Alice Springs Orogeny cannot be dismissed.

Key words: Alice Springs Orogeny, Musgrave Block, overprint, palaeomagnetism, Proterozoic Dyke Swarm, Rb–Sr chronology.

1 INTRODUCTION

Palaeomagnetic studies carried out on separate Precambrian terranes can provide important constraints on possible large-scale movements between cratons. Such studies can determine whether the present spatial relationship between the shield areas is the original arrangement, or whether the cratons were initially widely separated and have since fused together. These studies require the determination of palaeomagnetic poles from rocks which have also been dated and shown not to have been reoriented since this time.

A study by Facer (1971b) on the Giles Complex, western Musgrave Block, is the only published palaeomagnetic data on the Musgrave Block. This paper presents the palaeomagnetic results from dolerite dykes of the Kulgera Dyke Swarm along with isotopic results on a biotite from the eastern Musgrave Block.

2 GEOLOGICAL SETTING

2.1 Geology of the eastern Musgrave Block

The east–west trending Musgrave Block is a Middle to Late Proterozoic mobile zone consisting of high-grade metamorphic rocks and intrusives covering an area of 120 000 km^2 in the centre of the Australian continent. Apart from Wilson (1948) and Stewart (1967), little has been written about the geology of the eastern Musgrave Block in the southern part of the Northern Territory. Mapping in the Kulgera region by the Northern Territory Geological Survey during 1987–1989 (Edgoose *et al.* 1990) was aimed at improving the understanding of the geological evolution of the eastern Musgrave Block by combining geological, isotopic and geophysical techniques.

The eastern Musgrave Block consists of the Kulgera and Mulga Park terranes which have distinct structural and metamorphic histories (Camacho 1989). Although both terranes comprise granites and gneisses, the Mulga Park terrane gneisses are amphibolite grade, whereas the gneisses of the Kulgera terrane are granulite to transitional-granulite grade. Deposition of the supracrustal precursors occurred sometime after 1600 Ma (Gray 1978; Camacho 1990), and were subsequently metamorphosed to granulite/transitional-granulite grade at 1200 Ma (Gray 1978). Intrusion of Cavenagh and Kulgera suite granites at approximately 1160 Ma reheated the country rock above 500 °C (Camacho 1990). The latter suite have associated dykes of pegmatite and microgranite that can sometimes be seen radiating from individual plutons. The area did not cool below 500 °C until 1132 ± 8 Ma (Camacho 1990). Sometime after this, and prior to the Petermann Orogeny, the Kulgera terrane was intruded by a dolerite dyke swarm. The Kulgera terrane was thrust onto the Mulga Park terrane and Amadeus Basin to the north, at either 730 Ma (Camacho 1990) or during the Petermann Orogeny at 600 Ma (Forman 1972). The Alice Springs Orogeny, a major Carboniferous tectonic event in central Australia to the north of the Musgrave Block (Armstrong & Stewart 1975), has not previously been recognized in the Musgrave Block itself.

2.2 Geology and petrology of the Kulgera Dyke Swarm

The dolerites of the Kulgera Dyke Swarm form an east–west arcuate belt 90 km long by 10 km wide. Dykes are commonly 500 m long, 2 m thick, sub-parallel or anastamosing and shallowly dipping (5°–30°). Individual dykes may be up to 6 km long by 8 m wide. The dykes tend to dip ESE in the east, and south to SSE in the west, where the greatest concentration occurs.

The swarm comprises olivine tholeiites with individual dykes being chemically homogeneous, although they are often texturally zoned with a fine-grained rim coarsening towards the centre. Weathering is confined to a thin orange-brown rind 1 cm thick. Beneath this surface, the rock is dark grey, massive and very fresh. In thin section, the texture is ophitic to subophitic with labradorite, augite and olivine as the major constituents. Olivine is the earliest crystallizing phase occurring as inclusions in labradorite and as individual grains partially surrounded by augite and pigeonite. Labradorite forms laths up to 6 mm, shows polysynthetic twinning and is sometimes oscillatory zoned. Augite is the dominant pyroxene and occurs as equigranular grains. Mesostasis, the last formed interstitial glassy material, in some specimens forms up to 10 per cent of the rock and contains inclusions of plagioclase, magnetite, chalcopyrite and pyroxene. Magnetite comprises up to 7 per cent of the rock, ranges in size from 0.8 mm down to 1 μm and have weakly developed ilmenite lamellae up to 1 μm across.

Alteration to chlorite, epidote and calcite is not widespread in the dolerites and is restricted to joints, microfractures and contacts of the dyke with the country rock.

The Kulgera Dyke Swarm intrudes the Kulgera terrane and is part of the younger group of dolerite dykes defined by Wilson (1948) that occur on the southeast margin of the Amadeus Basin (Fig. 1). They are poorly documented with detailed work restricted to Wilson (1948, 1952). The relationship between the Kulgera Dyke Swarm and Stuart Dyke Swarm, which intruded the Arunta Inlier north of the Amadeus Basin, is unknown, but Rb/Sr isotopic work by Black, Shaw & Offe (1980) on the Stuart dykes provided an age of 897 ± 9 Ma.

3 ISOTOPIC RESULTS

A preliminary Rb/Sr isochron on the total rock and mineral constituents of the dolerite at site KG01 yielded a model 1 isochron of 1054 ± 14 Ma with an initial ^{87}Sr/^{86}Sr ratio of 0.70563 ± 0.00004 (Camacho, A. & Gray, C. M., in preparation).

To determine the latest metamorphic history of the region, a biotite from a pegmatite 6 km north of Kulgera was also analysed using the Rb/Sr technique. The results are shown in Table 1, and provide an age of 1060 ± 10 Ma, for the latest thermal resetting of the surrounding country rock. This result is consistent with that obtained by Wilson *et al.* (1960) using Rb/Sr on a muscovite from a pegmatite adjacent to a large dolerite dyke east of Kulgera, which provided an age of 1042 Ma after correction for the recommended decay constants (Steiger & Jäger 1977).

The two mineral ages are consistent with the preliminary age from the dolerite, and suggests that emplacement of the dykes, and thermal resetting of the country rock by the dykes, occurred at 1060 ± 10 Ma. Further, these isotopic results indicate that the area has not been heated above 300 °C, during either the Petermann or Alice Springs Orogenies.

4 MAGNETIC AND PALAEOMAGNETIC STUDIES

4.1 Sampling

A total of 45 oriented drill cores were collected from seven localities within the Kulgera Dyke Swarm (Fig. 1, Table 2). All cores were oriented with both sun and magnetic compasses and two or three specimens cut from each of the samples, each nominally 2.5 cm in diameter and 2.2 cm in height.

Sites 1 and 2 are a kilometre apart and represent a single dyke dipping to the SSE located in a railway quarry to the east of Kulgera. The dolerite used for the Rb/Sr analysis was also obtained from this quarry. Site 3 is located in a quarry 6 km to the west. Sites 4 and 5 were located 50 km west of site 3, south of Victory Downs. The dykes at sites 3, 4 and 5 dip shallowly to the SSW. The dyke at site 6 dips moderately to the south and the dyke at site 7 is a near vertical north–south dyke, both located 5 km west of site 5. Sites 4 to 7 were natural outcrops and were selected to be topographically low in an attempt to avoid the effects of lightning strikes. However, the large areal extent of the dolerite, low erosion rates and length of time near the surface meant that some lightning-affected samples were inevitable.

The harsh climatic conditions in central Australia have resulted in deep weathering of the country rocks into which the resistant dolerite dykes intruded. Hence, baked contact tests were precluded.

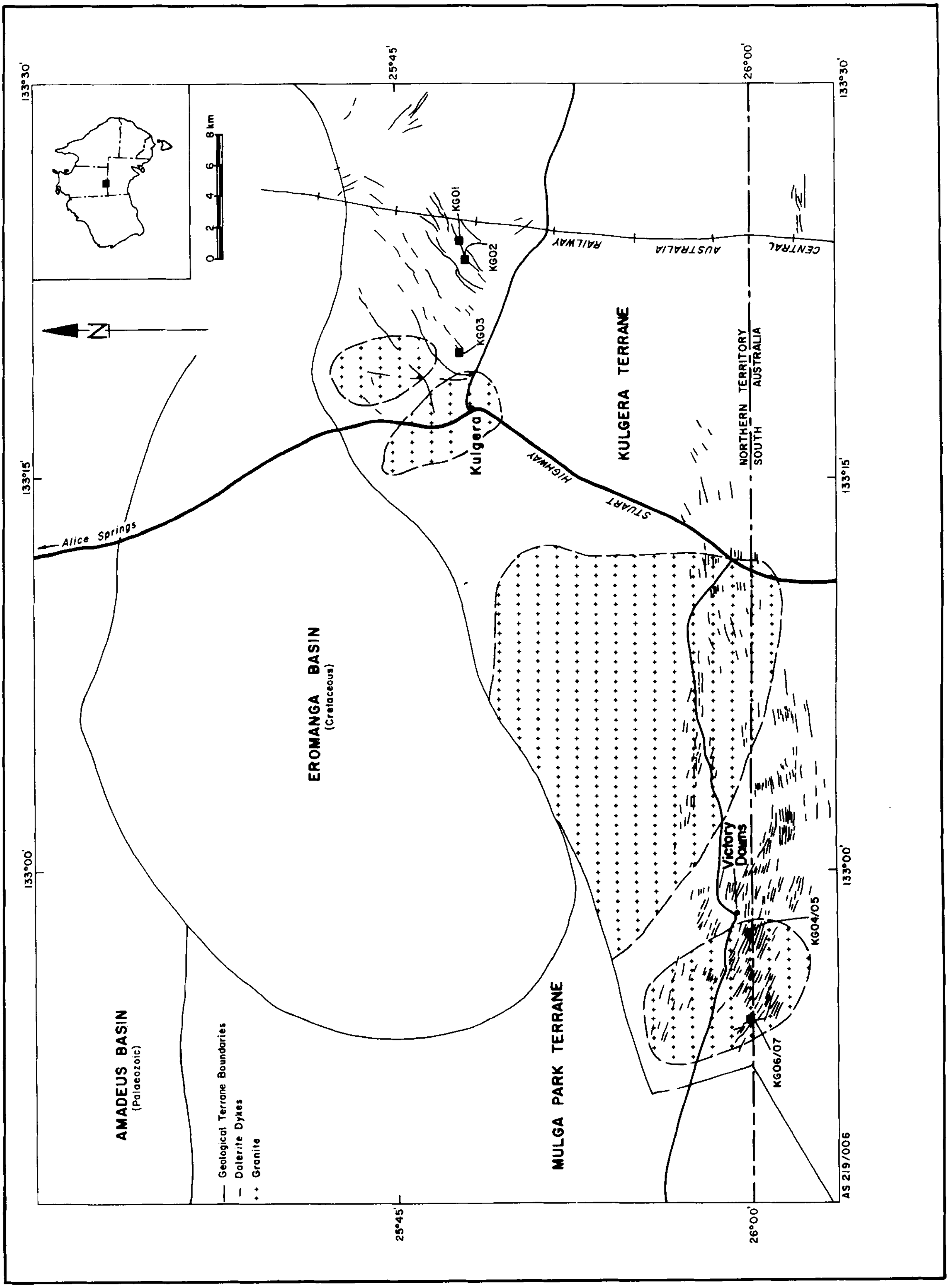

Figure 1. Solid geology and sampling localities—Kulgera region.

Table 1. Analytical data and age for biotite separate from a pegmatite, Kulgera.

Rb(ppm)	Sr(ppm)	$^{87}Rb/^{86}Sr$	$^{87}Sr/^{86}Sr$	Age(Ma)
1138.7	6.7	1842.16	28.661 ± 0.00 7	1060 ± 10

Table 2. Site location and dyke geometry.

Site	Samples	Latitude (°S)	Longitude (°E)	Dip	Strike
1	6	25.8385	133.3942	10 S	056
2	6	25.8402	133.3902	20 S	062
3	8	25.8357	133.3343	16 S	292
4	6	26.0000	132.9600	17 S	304
5	6	26.0000	132.9580	16 S	302
6	6	26.0000	132.9095	32 S	283
7	7	26.0000	132.9090	80 W	330

4.2 *k–T* Curves

Typical susceptibility versus temperature (*k–T*) curves of samples are shown in Fig. 2. These are valuable diagnostic aids for magnetic mineral identification, and grain size range evaluation. Petrographic examinations are limited to grain sizes >1 μm whereas the grains that carry the primary thermoremanent magnetization (TRM) are single or pseudo-single domain (<1 μm). In contrast, *k–T* curves yield information on all grain sizes.

The magnetic behaviour of the dolerites from sites 1 to 5 is uniform and consistent with predominantly pure magnetite slightly diluted by a small proportion (1–2 per cent) of impure magnetite and/or maghaemite. The Curie temperature (T_C) of 580 °C is that of magnetite, while a small bump at 350 °C–400 °C (not discernible on Fig. 2) may be due to maghaemite. The peak immediately preceding the magnetite T_C corresponds to the temperature at which grains of optimum size (<0.1 μm) lose their remanence, or become magnetically unblocked. This grain size fraction is capable of retaining a remanence after heating to almost 580 °C, and is presumed to be carrying a primary TRM, since the dykes show no signs of being heated significantly after their intrusion and initial cooling. The curves are almost reversible, indicating that the main magnetic mineral, magnetite, does not alter after heating, although the impure magnetite apparently exsolves, producing a small increase in magnetite and, presumably, some ulvöspinel. The magnetic mineralogy of the dolerites at sites 1 to 5 is therefore dominated by pure magnetite, displaying a range of grain sizes from single domain (<0.1 μm) to multidomain (tens of μm), the latter being more prone to magnetic resetting.

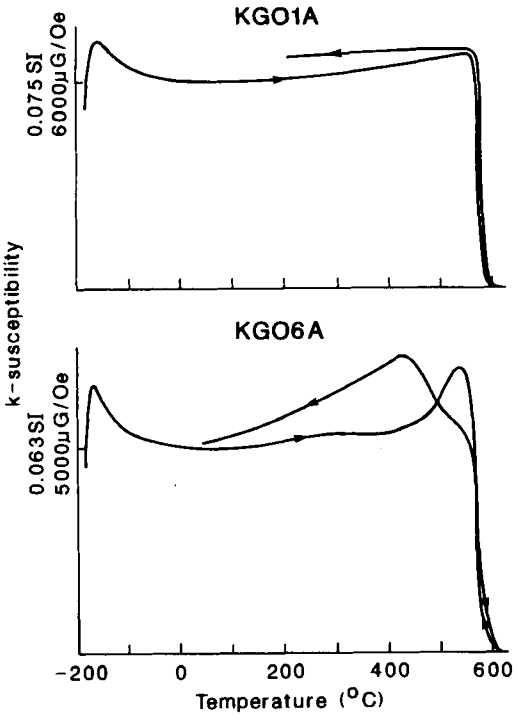

Figure 2. Susceptibility versus temperature (*k–T*) curves from sites 1 and 6.

The susceptibility properties of the dolerites from sites 6 and 7 are quite distinct from those at sites 1 to 5. These two sites are spatially related, with site 6 representing an east–west dyke cross-cutting a north–south dyke at site 7. *k–T* curves from both sites reveal pure end-member magnetite on heating with the production of a pronounced, slightly titaniferous phase evident on cooling. The titaniferous phase probably arises from partial homogenization of intergrowths of magnetite and a non-magnetic titanium-rich phase (ulvöspinel or ilmenite).

Common to all is a peak at −155 °C due to the magnetic unblocking of multidomain magnetite at its isotropic point when the magnetocrystalline anisotropy constant goes through zero (Stacey & Banerjee 1974). This property is exploited to treat lightning-affected samples during palaeomagnetic cleaning.

4.3 Palaeomagnetic methods

With the exception discussed below, the palaeomagnetic methods used are routine and are described in a number of texts (Irving 1964; McElhinny 1973; Collinson 1982). The magnetometer used was a CTF three-axis cryogenic, while the alternating field (AF) demagnetizer was a Schonstedt GSD-1 model and the furnace was a custom-built three-stage carousel type housed inside a 4 m 10 coil helmholtz set with automatic feed-back maintaining 'zero-field' (<5 nT).

Low-temperature cycling was the only non-routine method attempted and involved cooling specimens to liquid nitrogen (LN_2) temperature (−196 °C) and rewarming in quasi-field-free space. Thermal demagnetization is not wholly successful for cleaning lightning-induced magnetizations and so a technique combining low-temperature cycling with AF methods was used. This ensured that the primary thermoremanent magnetization (TRM) was not removed along with any later, presumably isothermal, remanent magnetization (IRM) during cleaning of the NRM. At about −155 °C the magnetocrystalline anisotropy of individual multidomain magnetite grains is low, allowing their magnetization to relax and acquire new directions on warming. This leaves their individual magnetic moments randomly directed, and their net magnetic moment greatly diminished compared to that carried by single domain grains.

The LN_2/AF method proved to be quite successful, as illustrated by the results from sample 04a (Fig. 4), with half the lightning-induced component removed by LN_2 treatment, and the remainder removed by 200 Oe to 300 Oe AF. The direction subsequently remained unchanged to the maximum AF of 1000 Oe, having reached a stable endpoint. By comparison, the lightning-induced component is not successfully removed by thermal demagnetization, and the direction approaches, but never reaches, a stable endpoint.

Specimens from sites not affected by lightning (sites 1–3) were treated using step-wise thermal cleaning to 600 °C, while all other sites were treated with both thermal and LN_2/AF cleaning.

4.4 Natural remanent magnetization, susceptibility and anisotropy

The majority of specimens possess moderately strong natural remanent magnetization (NRM). However, some samples from the naturally occurring outcrops are intensely magnetized, probably resulting from lightning strikes, as the Koenigsberger ratios (Qs) are high (up to 30), and specimens located nearest the outcrop surface have significantly higher remanence than specimens a few centimetres deeper (Schmidt 1990).

The magnetic susceptibilities of the specimens are plotted as a histogram in Fig. 3. The dyke at site 7 is coarser grained than the other dykes samples and has a much lower bulk susceptibility (1000–2000 μG Oe^{-1}). The majority of specimens from the other sites have susceptibilities ranging between 4000 and 5000 μG Oe^{-1}.

The anisotropy of magnetic susceptibility (AMS) and its relationship with the dyke geometry for each site is listed in Table 3. The AMS values vary from 2 to 6 per cent, which is typical of undeformed igneous fabrics (Janak 1973).

The minimum axis of the susceptibility ellipsoid represents a pole to the magnetic foliation. In igneous rocks the magnetic foliation is usually considered to be parallel to the intrusion plane, and the maximum axis parallel to the direction of magmatic injection.

The AMS results show that the magnetic foliation consistently dips at a steeper angle than the plane of the dyke (Table 3). The reason for this is unknown, but probably relates to variations in flow, rather than a tectonic overprint. For most sites the direction of the maximum axes lie towards the planes of the dykes and may represent the flow direction. At sites 3 and 4, however, the direction of the maximum AMS axis tends to be at 90° to the dyke plane, also suggesting variable flow directions. The field examination of individual dolerite dykes confirms this, with the geometry of the dykes locally displaying deviation from the regional trends.

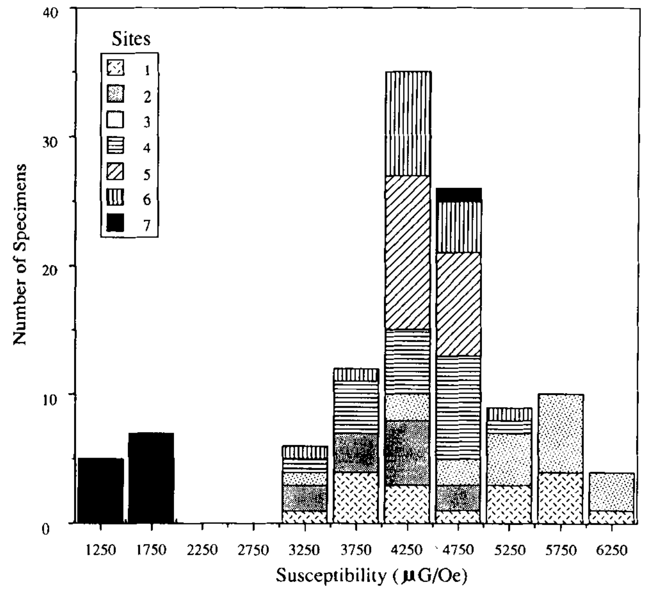

Figure 3. Histogram of bulk susceptibility values.

Table 3. Tensor mean anisotropy of magnetic susceptibility and relationship to dyke geometry.

Site	N	Bulk Suscept.	Anisotropy (Max/Min)	Maximum AMS Axis	Minimum AMS Axis	Max. AMS^ Dyke Plane	Min. AMS^ Dyke Plane
1	17	4741.44	1.03	13/067	48/322	32	79
2	12	3985.84	1.03	28/082	50/312	22	70
3	18	5351.65	1.03	66/289	11/173	86	29
4	19	4381.73	1.02	53/300	1/208	74	42
5	20	4414.59	1.06	9/288	49/028	25	82
6	15	4357.22	1.02	35/269	51/058	26	68
7	13	1778.86	1.04	84/192	6/011	49	84

N = total number samples measured; Max. and Min AMS ^ Dyke Plane = angle between the AMS axes and the plane of the dyke.

4.5 Palaeomagnetic results

Dykes can provide reliable palaeomagnetic records (Evans 1987). The observed k–T curves are in agreement with microscopic analysis of the magnetic minerals (in this case magnetite). It is unlikely that the Kulgera dolerites have undergone post emplacement (i.e. cooling) thermochemical remanence magnetization as the magnetic properties and palaeomagnetic data are consistent over a wide area, and the magnetic anisotropy is very low and consistent with a magmatic origin. Although a contact test could not be performed, secular variations detected among different dykes may indicate that the magnetization is primary (e.g. Halls 1986).

All sites exhibit a palaeomagnetic component which is only removed after high-temperature or high-AF cleaning. However, some sites also revealed a steep, normally polarized overprint. The high-temperature/AF component of the NRM is interpreted to be a primary TRM. Lightning affects a broad band of unblocking temperatures and therefore only magnetization directions isolated by the LN_2/AF method have been used to calculate the mean TRM directions for sites 4 to 6. The results from all sites are plotted in Fig. 5, and the mean directions for each site listed in Table 4. The primary TRM is directed downwards, toward the west–northwest, and the overall mean pole position calculated from this palaeomagnetic component is 17°S, 266°E ($A_{95} = 12°$).

In addition to the primary TRM, a less stable, palaeomagnetic component is also present at all sites except 4 and 5. Temperatures of 520 °C to 540 °C remove this secondary component, which is directed steeply upwards (Fig. 6) and interpreted to represent a thermal overprint of the primary TRM. The overprint at sites 4 and 5 has presumably been destroyed by the effects of lightning strikes. Some samples from site 7 show overprinting directions that are steep-up, while others have an overprint which is directed to the southeast shallow-up. The reason for this variation is unclear, and as a result no mean overprint direction was calculated for site 7. The results from the other sites are plotted in Fig. 7 and listed in Table 5.

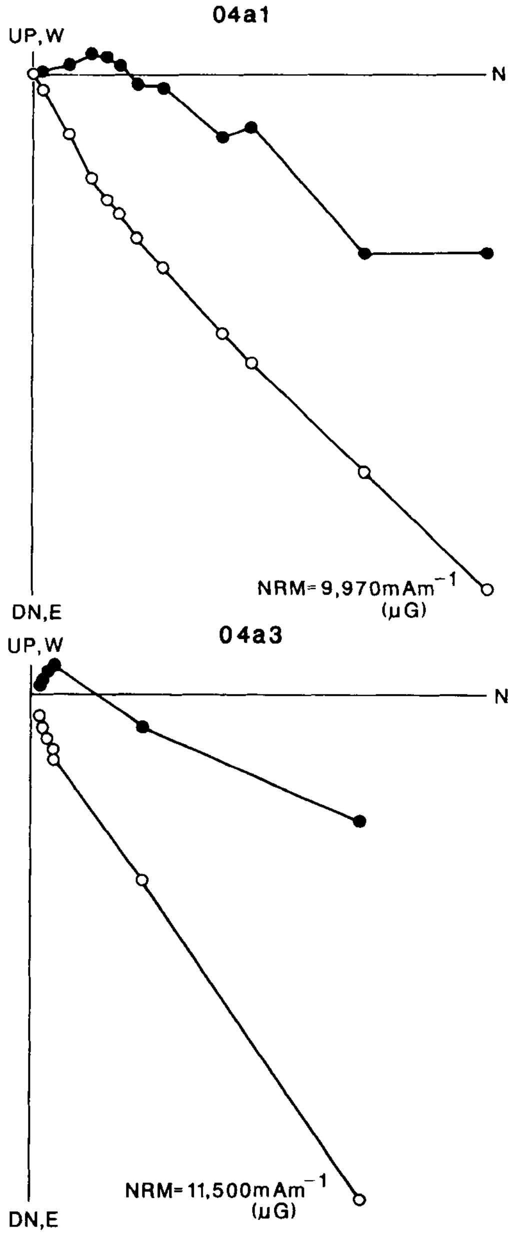

Figure 4. Orthogonal projections of demagnetization vector during cleaning by thermal demagnetization for sample 04a1 and LN_2/AF for sample 04a3. Full symbols plot on the horizontal plane while open symbols plot on the vertical plane. Thermal demagnetization intervals for sample 04a1 = NRM, 200 °C, 300 °C, 400 °C, 450 °C, 500 °C, 520 °C, 540 °C, 560 °C, 580 °C, 590 °C, 600 °C. Cleaning intervals for sample 04a3 = NRM 1LN, 200 Oe, 300 Oe, 400 Oe, 500 Oe, 700 Oe, 1000 Oe.

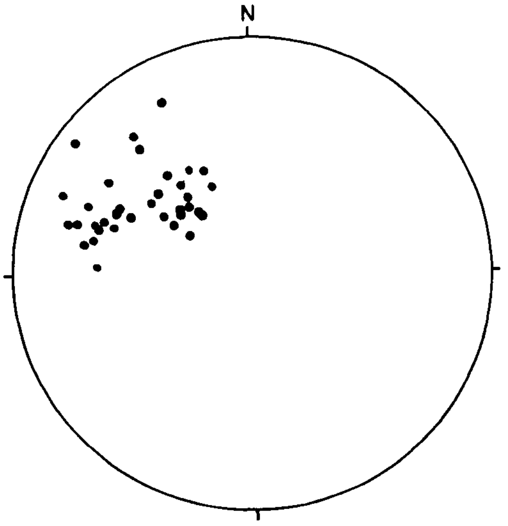

Figure 5. Stereographic projection of primary TRM directions for all sites. All directions plot on the lower hemisphere (reversed polarity). (Wulff equal area projection.)

The overall mean pole position determined from this secondary palaeomagnetic component is 30°S, 138°E ($A_{95} = 24°$).

The sites were selected to obtain the maximum variation in dyke geometry in order to test whether the dykes had been folded after emplacement. The grouping of the primary palaeomagnetic directions deteriorates after rotating the dykes to the vertical, or realigning the dykes to a common trend. This suggests that the Kulgera terrane has not been folded since emplacement of the dykes, but does not preclude the possibility that the block has rotated. Comparison with poles from other cratons of similar age is required to determine whether the Kulgera terrane has been reoriented by later thrusting. However, this test is not conclusive as these blocks could also have undergone rotation.

5 DISCUSSION AND CONCLUSIONS

The palaeomagnetic pole positions listed in Tables 4 and 5 are plotted in Fig. 8, where they are compared with the Middle–Late Proterozoic part of the Australian apparent polar wander path (Idnurm & Giddings 1988). The primary TRM pole position for the Kulgera dykes falls most closely to the 900 Ma Stuart Dyke Swarm pole position. Although

Table 4. High-temperature and high-AF cleaned remanent magnetization and corresponding palaeomagnetic pole positions.

		Palaeomagnetic Components					Palaeomagnetic Pole			
Site	N	R	D	I	k	α_{95}	lat.(°S)	long.(°E)	dp(°)	dm(°)
1	5	4.939	302	+44	65.5	9.5	14	261	7.4	11.9
2	6	5.627	298	+29	13.4	19.0	17	250	11.5	20.9
3	8	7.918	286	+30	85.0	6.0	7	245	3.7	6.7
4	5	4.970	312	+57	135	6.6	12	276	7.0	9.6
5	6	5.915	321	+56	59.0	8.8	17	281	9.1	12.6
6	3	2.976	315	+29	82.3	13.7	30	261	8.3	15.1
7	3	2.985	322	+59	132	10.8	16	284	12.0	16.1
Mean	36						17	266	$A_{95} = 12.3$	

N = total number samples measured; R = resultant of N unit vectors; D = declination, degrees E of N; I = inclination, positive downward; k = precision parameter (Fisher 1953); α_{95} = half-angle of cone of 95% confidence for directions (Fisher 1953), A_{95} = half angle of cone of 95% confidence for poles.

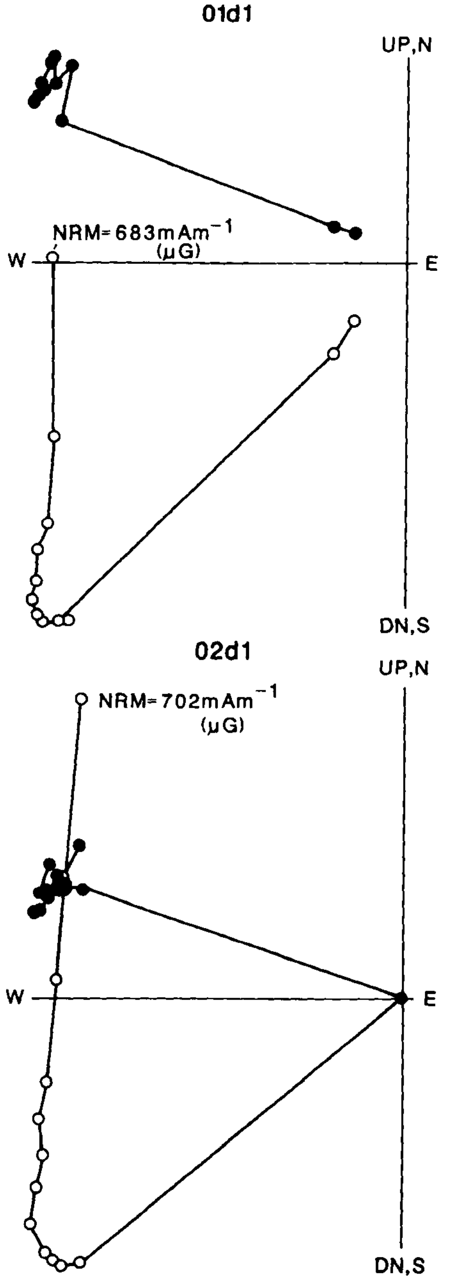

Figure 6. Orthogonal projection of demagnetization vector for samples 1d and 2d. Symbols as for Fig.4. Thermal demagnetization intervals for sample 1d and 2d = NRM, 200 °C, 300 °C, 350 °C, 400 °C, 450 °C, 500 °C, 520 °C, 540 °C, 560 °C, 580 °C, 590 °C,.

the Stuart Dyke pole is preliminary (Idnurm & Giddings 1988) the close proximity of the poles from the Stuart and Kulgera Dyke Swarms suggests that they may be more closely related than the isotopic ages suggest.

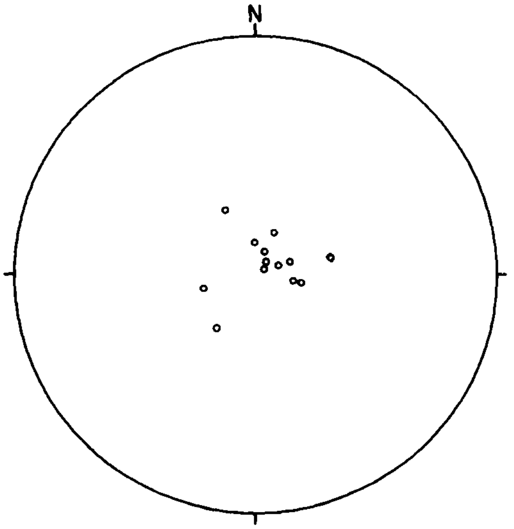

Figure 7. Stereographic projection of overprint directions for sites 1, 2, 3 and 6. All directions plot on the upper hemisphere (normal polarity). (Wulff equal area projection.)

The age for the Stuart Dyke Swarm may require revising as the more precise age (897 ± 9 Ma) is largely constrained by biotite, whereas the mineral and total rock fractions, excluding biotite, provide a less precise age of 924 ± 96 Ma (Black *et al.* 1980). Biotite from the Arunta Inlier is generally partially or completely reset during the Alice Springs Orogeny (Marjoribanks & Black 1974). Subject to confirmation of Idnurm & Giddings (1988) Stuart Dyke Swarm pole and further isotopic work on the Stuart Dyke Swarm, the results presented here indicate the possibility of an earlier (1050 Ma) onset of sedimentation in the Amadeus Basin to the north.

Other Australian pole positions from rocks of comparable age are poles IB (<1450) and IA (1120 ± 10 Ma, Page 1983) from dykes of the Mount Isa Block (Duff & Embleton 1976), the Wooltana Volcanics (WV >1200) and the 'B' dykes of the Yilgarn Block (YB, ~700 Ma) (Idnurm & Giddings 1988).

A pole from the Giles Complex (GC) in the western Musgrave Block also has a similar age (1000–1100 Ma, Facer 1971a). However, there seems to be some confusion over the GC pole, probably stemming from the several versions published by Facer (1967, 1971a, b). Curiously, Idnurm & Giddings do not use the pole reported in the GJRAS Pole List (McElhinny 1972), which would at least appear to be correctly calculated after inverting the reversed directions (Facer 1971b). Interestingly, although the data are scattered, the mean pole position from the Giles Complex (34°S, 131°E) is very similar to the overprint direction found in the Kulgera dolerites (30°S, 138°E).

Table 5. Low-temperature palaeomagnetic component and corresponding palaeomagnetic pole positions.

		Palaeomagnetic Components					Palaeomagnetic Pole			
Site	N	R	D	I	k	α_{95}	lat.(°S)	long.(°E)	dp(°)	dm(°)
1,2	5	4.907	008	-87	43.1	11.8	32	132	23.4	23.5
3	5	4.785	097	-80	18.6	18.2	22	155	33.3	34.8
6	3	2.942	003	-80	34.6	21.3	34	124	24.3	24.7
Mean	13						30	138	$A_{95} = 23.8$	

Legend as for Table 4.

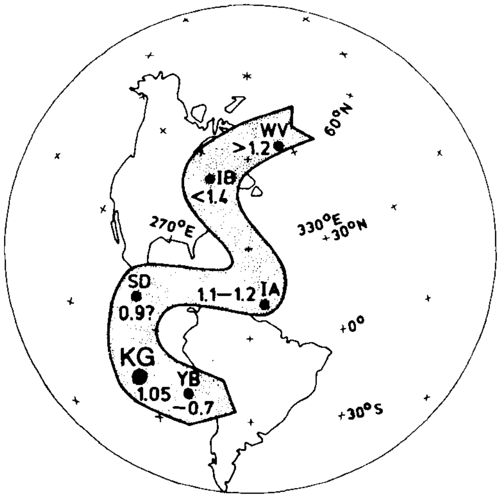

Figure 8. A summary of the Precambrian pole positions for Australia adapted from Idnurm & Giddings (1988). IB = Mount Isa 'IB', WV = Wooltana Volcanics, IA = Mount Isa 'IA', SD = Stuart Dykes, KG = Kulgera Dykes, YB = Yilgarn Block 'YB'.

The pole position derived from the Kulgera overprint is quite close to Australia, and similar to others derived from rock units affected by the Alice Springs Orogeny (Fig. 9). Li, Powell & Schmidt (1989) summarize the studies that have shown a remanence related to this period and conclude that they all indicate high inclinations, consistent with Australia being in high latitudes during the Carboniferous. Although Whiting (1986) does not consider it, the pole for the Attutra Metagabbro in the Arunta Inlier (33°S, 152°E) also appears to be an overprint by the Alice Springs Orogeny.

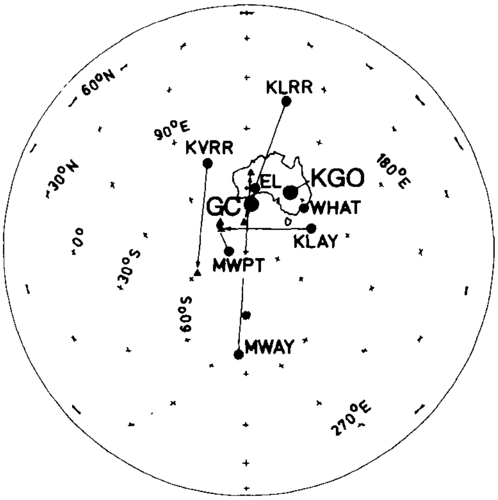

Figure 9. Pole positions from central Australian rocks are tightly grouped after correction for tectonic tilt, indicating that although the magnetizations of many of the units are overprints, they were acquired prior to tilting. KGO = Kulgera Overprint, GC = Giles Complex, RR = Ross River, PT = Pertatataka Fm, AY = Areyonga Fm, EL = Mt Eclipse Sst, AT = Attutra Metagabbro. Kl = Klootwijk (1980), KV = Kirschvink (1978), MW = McWilliams (1977), WH = Whiting (1986) (after Li *et al.* 1989).

Rock units showing either partial or complete overprinting by Carboniferous tectonism cover a wide area, from the Ngalia Basin north of the Arunta Inlier, within the Arunta Inlier itself and throughout the northern part of the Amadeus Basin. The results presented here extend the known area south into the eastern Musgrave Block, and southwest into the Giles Complex in the western Musgrave Block.

The common overprint poles suggest that the Musgrave Block has been tectonically stable since at least the Carboniferous. Whilst it is likely that the Kulgera terrane has been tectonically active since the emplacement of the Kulgera Dyke Swarm, the apparent agreement between the TRM pole from the Kulgera dykes and the Australian polar wander path, suggests that the angular rotation involved in this movement has been small.

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