Papers and Proceedings of the Royal Society of Tasmania, Volume 115, 1981

(ms. received 10.8.1980)

PALAEOMAGNETIC RESULTS FROM THE GORDON SUBGROUP OF TASMANIA: FURTHER EVIDENCE FOR A LATE CRETACEOUS MAGNETIC OVERPRINT IN SOUTHEASTERN AUSTRALIA

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(with one table and four text-figures)

ABSTRACT

SHARPLES, Chris and KLOOTWIJK, Chris T., 1981 (30 ix): Palaeomagnetic results from the Gordon Subgroup of Tasmania: further evidence for a Late Cretaceous magnetic over-print in southeastern Australia. *Pap. Proc. R. Soc. Tasm.*, 115, 85-91 (with four figures). https://doi.org/10.26749/rstpp.115.85 ISSN 0080-4703. University of Tasmania and Départment des Sciences de la Terre, Université, Paris 7, Paris, France.

A thermal demagnetization study of 48 limestone samples from the Ordovician Gordon Subgroup of Ida Bay (Tasmania), indicated complete remagnetization ($D = 9.4^{o}$, $I = -81.4^{o}$, $k = 137.5$, $\alpha95 = 1.3^{o}$, $N = 92$ South pole position 59.8^{o}S 141.1^{o}E, $dp = 2.4^{o}$, $dm = 2.5^{o}$) during Late Cretaceous or less likely Early Tertiary time. This finding further supports a recently recognized Late Cretaceous remagnetization event in southeastern Australia, which is attributed to rift forming processes preceding the opening of the Tasman Sea. Conodont colour indicates that the limestones studied have not been subjected to temperatures in excess of 100^{o}C. This suggests a possible widespread occurrence of this magnetic overprint.

INTRODUCTION

Little palaeomagnetic work has been done on Palaeozoic rocks in Tasmania. The only published palaeomagnetic study of the Tasmanian Ordovician is by Briden (1967), who found that the natural remanent magnetization (NRM) of certain Lower Ordovician sandstones represented a secondary magnetization. Briden regarded this as resulting from regional heating during the Tertiary.

The limestones in the Ida Bay region of southern Tasmania are amongst the least folded and the least altered Ordovician rocks in Tasmania. It was hoped, therefore, that they would retain a primary magnetization, thus allowing the determination of the palaeolatitude of Tasmania at the time of limestone deposition.

This study was initially undertaken by one of the authors (C.S.) as part of a broader sedimentological study of Ordovician rocks in the Ida Bay area. The laboratory work in this project was undertaken at the palaeomagnetic laboratory of the Australian National University in Canberra.

GEOLOGICAL SETTING

The limestones studied here belong to the Ordovician Gordon Subgroup (Corbett and Banks 1974) and outcrop on Marble Hill (146^{o} 51'E. 43^{o}28'S) near the township of Ida Bay in southern Tasmania (fig. 1). A stratigraphic thickness of over 350 metres of tidal flat limestone deposits (mainly intertidal and supratidal micrites) is represented and is of probable uppermost Chazyan to Trentonian age (Sharples 1979). The limestones are underlain by sparsely fossiliferous Lower Ordovician quartzites.

The Ordovician sediments are folded into a gentle meridional anticline which probably results from the Devonian Tabberabberan Orogeny. Maximum dips of only 13 degrees have

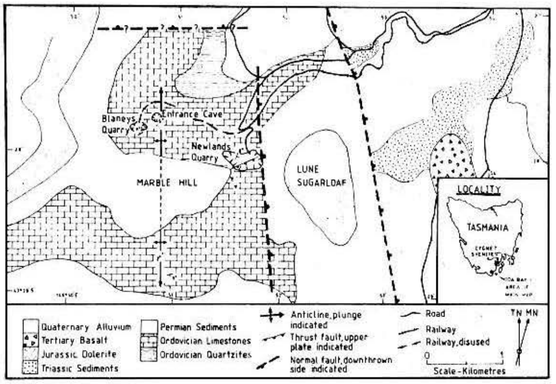

FIG. 1.- Geological sketch map of the sampling area after Sharples (1979).

been measured in the limestones on Marble Hill, and the limestones are warped into a slightly domal structure with northward and southward dip components on the north and south sides of the hill, respectively. Petrographically, the limestones show no signs of metamorphic alteration, although diagenesis has resulted in dolomitisation, dedolomitisation and calcite-pseudomorphing of evaporite crystals.

Dissolution of limestones in acetic acid for retrieval of conodonts revealed the presence of microscopic crystals of pyrite and other metallic minerals (probably including magnetite and haematite). On the grounds of their well-formed unabraded faces, these crystals are regarded as being of authigenic origin.

At the top of Marble Hill the limestones are unconformably overlain by flat-lying Permo-Carboniferous tillites, arenites and lutites. A sill of Jurassic dolerite over 100 metres thick intrudes Permian sediments in the hills east and west of Marble Hill; it must originally have been present at not less than 120 metres vertically above the uppermost limestone beds. Another large Jurassic doleritic body intrudes Triassic sediments over 1.5 km east of the easternmost limestone outcrop sampled for palaeomagnetic purposes.

A basalt flow of limited extent and probably of Tertiary age, outcrops 3 km east of Marble Hill. The only igneous rocks of Cretaceous age in southern Tasmania are the syenites in the Cygnet area, 30 km northeast of Ida Bay, which have been radiometrically dated at 99 m.y. (McDougall and Leggo 1965).

METHODS EMPLOYED

Block samples were collected from two quarries about 1.5 km apart on the northern side of Marble Hill (fig. 1, Table 1). At Newland's Quarry 36 samples were collected over a stratigraphic interval of 135 metres, and at Blaney's Quarry 12 samples were collected over a stratigraphic interval of 11 metres. Generally three samples were taken over 1 to 2 metres laterally within a bed of up to 1 metre thickness. All samples were oriented in the field with a Brunton compass. The specimens were collected from fresh faces, and show no evidence of alteration by weathering. Between one and four oriented cores (25 mm diameter) were drilled in the laboratory from each sample, and were sliced into specimens 22 mm long.

The specimens were subjected to progressive thermal demagnetization to 520°C, using furnaces as described by McElhinny *et al.* (1971). By this stage intensities were very low and probably in the noise level. All remanent magnetization measurements were made on a two-axis superconducting rock magnetometer (ScT, noise level less than 2.10^{-2} mAm^{-1}), which was interfaced for online data reduction with a Hewlett Packard 2116B minicomputer.

The magnetic content of each specimen was analyzed from Zijderveld plots (1967, 1975) and directions of individual components were determined using a principal component analysis program adapted from Kirschvink (in press).

TABLE 1

SUMMARY OF PALAEOMAGNETIC DIRECTIONS AND POLE POSITIONS
GORDON SUBGROUP LIMESTONES IDA BAY TASMANIA (146°51'E 43°28'S)

	INITIAL NRM DATA		MEAN SPECIMEN DIRECTION[1]					S. POLE POSITION		
	N[2]	Intensity[3]	Decl. (°)	Incl. (°)	k	α95 (°)	N[4]	Lat. (°S)	Long. (°E)	dp (°)
BIB13-24	12(49)	3.5-24.9	16.3	-79.9	256.5	1.9	24	61.7	135.1	3.7
BIB03-12 and BIB65-79	36(123)	1.3-23.3	6.9	-81.9	120.5	1.6	68	59.0	142.8	3.0
Combined	48(172)		9.4	-81.4	137.5	1.3	92	59.8	141.1	2.4

BEDDING CORRECTED DIRECTION

	dm (°)	Decl. (°)	Incl. (°)	k	α95 (°)
BIB13-24	3.6	66.3	-79.5	142.0	2.5
BIB03-12 and BIB65-79	3.1	330.3	-80.8	101.0	1.7
Combined	2.5	353.3	-82.9	64.7	1.9

1 Unit weight given to individual specimen directions.
2 Number of samples, number of specimens studied for NRM directions is given between brackets.
3 Intensity is given in mAm^{-1}.
4 Number of specimens demagnetized and used in the calculation of the mean characteristic direction.

RESULTS

The specimens studied showed the consistent and very dominant presence of a characteristic magnetic component with a blocking temperature range of 150°C to 450°C (fig. 2). Some samples showed additional presence of a recent local field component which was generally removed at 150°C to 200°C. This recent field component, if recognizable at all, was of low magnetic intensity. Consequently the mean grouping of the characteristic directions (fig. 3B) and of the NRM directions (fig. 3A) are rather similar. The mean characteristic direction for the individual sites (table 1) are statistically indistinguishable from each other but this is no longer so after application of a correction for bedding. The characteristic magnetization is therefore considered to postdate the Devonian Tabberabberan folding phase.

INTERPRETATION

The palaeomagnetic pole position corresponding with the characteristic magnetization component determined in this study (table 1) falls close to the Late Cretaceous and also to the Early Tertiary parts of the Australian apparent polar wander path (APWP, fig. 4), as revised by Klootwijk and Peirce (1979), but is nowhere near to the Ordovician segment of the Australian APWP (Goleby in press). Consequently, we interpret this characteristic component as representing a magnetic overprint of most probably Late Cretaceous age. This remagnetization cannot be accounted for by heating effects of the Jurassic doleritic sill as is clear from comparison of the present results with the revised APWP for Australia, neither can it be attributed because of its distance to direct heating effects of the Tertiary (?) basalt flow.

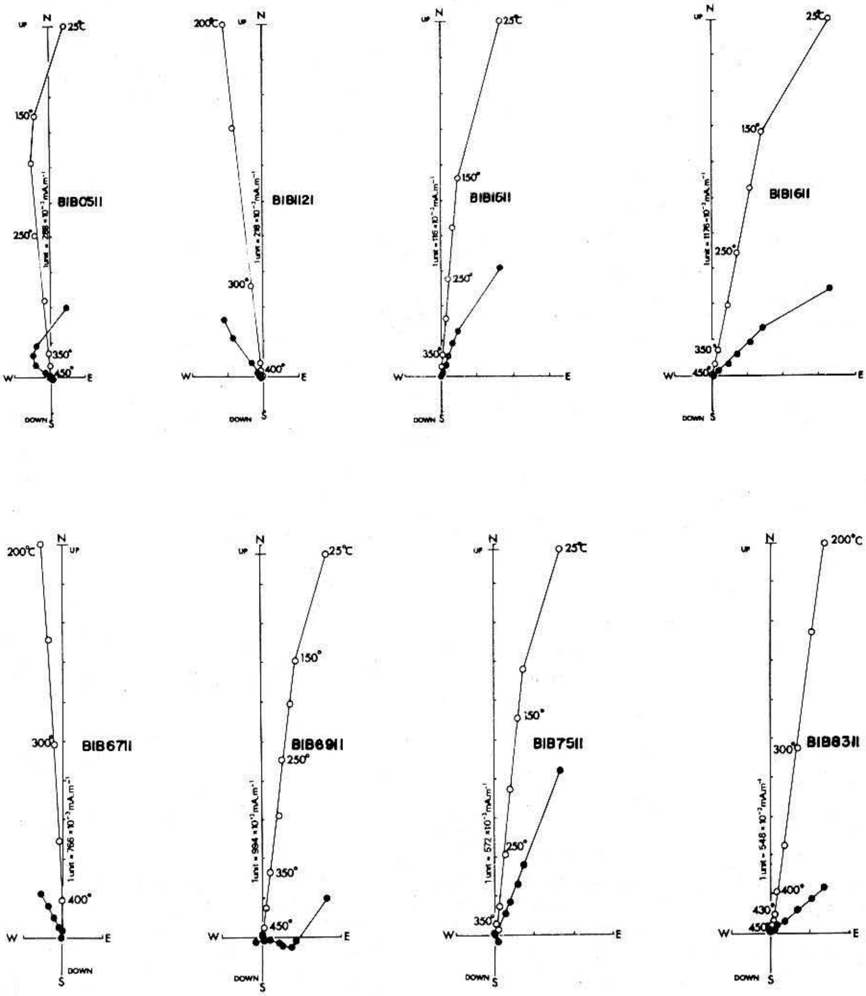

FIG. 2.- Demagnetization diagrams of representative specimens. The points denote successive positions - in orthogonal projection - of the end points of the resultant magnetization vector during progressive thermal demagnetization. Open circles denote projections on the vertical east-west plane, dots denote projections on the horizontal plane. Numbers denote successive peak temperature values. All plots are shown without correction for bedding.

It is possible but unlikely that this overprinting may have resulted solely from regional heating associated with the Late Cretaceous intrusion of the Cygnet Syenite complex, which outcrops in the Port Cygnet region 30 km northeast of Ida Bay. Country rocks adjacent to the syenites show little metamorphic alteration (R. Ford, *pers.comm.*1979), and the primary magnetization direction of this complex ($D = 314^{o}$, $I = -85^{o}$) is near to but statistically different from that determined in the present study (table 1).

Most probably the overprint has to be interpreted in wider perspective as further evidence for a widespread Late Cretaceous overprinting (viscous partial thermoremanent

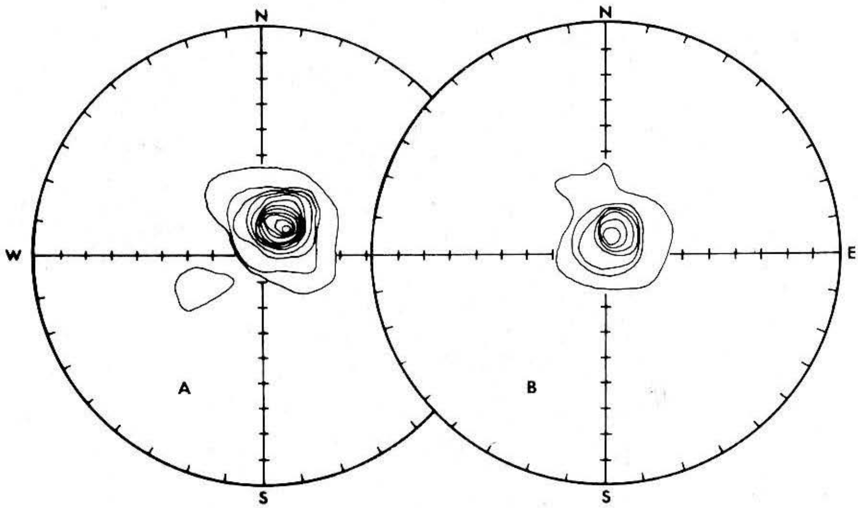

FIG. 3.- Frequency distribution of all observed NRM directions (fig. 3A, 172 specimens) and all observed characteristic directions (fig. 3B, 92 specimens). Upper hemisphere projection only. Frequency interval = 10. Present local field direction Decl. = 14°, Incl = 73°. Axial geocentric dipole field direction Decl = 0°, Incl = -62°.

magnetization [VPTRM], Briden 1965, Pullaiah *et al.* 1975) in southeastern Australia. This overprinting can be attributed to an increased geothermal heatflow during initial rift forming processes preceding opening of the Tasman Sea. Subsequent uplift and cooling resulting from the rifting, with erosion of overburden, may have preserved the VPTRM. A similar mechanism has been proposed for magnetic overprinting of rocks in the Sydney Basin, on basis of new data and a reappraisal of earlier palaeomagnetic results (Schmidt and Embleton 1980), and on basis of newly obtained apatite fission track datings (Morley *et al.* in press) from southeastern Australia. A relation with the Early Tertiary initiation of the Australia - Antarctica rifting cannot be excluded, however, for the obtained palaeopole position is not far off the Early Tertiary trajectory of this revised APWP.

On the evidence of conodont colour (Epstein *et al.*, 1977) the limestones at Ida Bay have not been subjected to temperatures exceeding 100°C (C.F. Burrett *pers. comm.*). Since the VPTRM is not removed until the rocks are demagnetized at temperatures of 400°C to 450°C for a period of about 5 minutes, it can be estimated (Pullaiah *et al.*, 1975; Dunlop and Buchan 1977) that this low-temperature heating event must have persisted for a period in the order of 10 m.y. Widespread magnetic overprinting is therefore to be expected in the region under study.

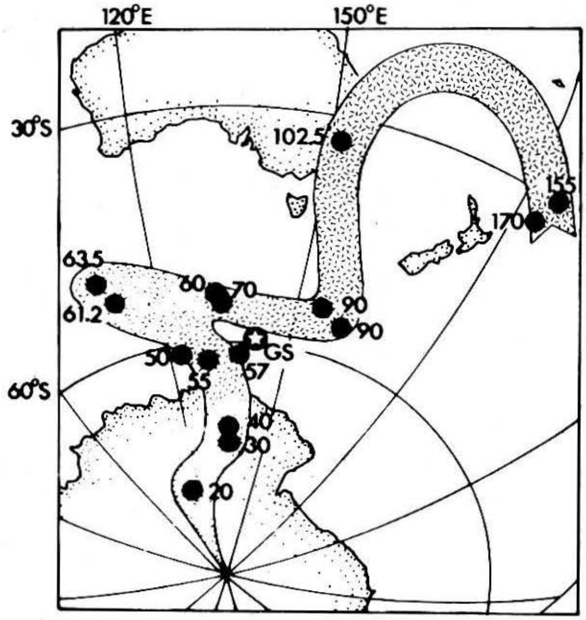

FIG. 4.- A comparison of the pole position obtained here for the Gordon Sub-group limestones (GS) with the revised APWP for Australia, based on pole positions from the Indian plate transferred to Australia according to seafloor spreading data (Klootwijk and Peirce 1979). Radiometric or mean stratigraphic ages are indicated for the latter pole positions.

ACKNOWLEDGEMENTS

Thanks are due to Dr. M.R. Banks for instigation of the project, and to Drs. M.W. McElhinny, B.J.J. Embleton, P.W. Schmidt, C.F. Burrett and W.D. Parkinson for valuable discussions.

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