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DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD No. 1964/52

MAGNETISATION OF THE WEIR BASALT, QUEENSLAND

by

P.M. STOTT

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SUMMARY

Measurements of the magnetisation of samples of Weir Basalt and Sugars Basalt, collected by the Geological Survey of Queensland, suggest that the rocks are Triassic rather than Tertiary.

1. INTRODUCTION

The Weir Basalt has been thought to be of Triassic age and to lie at the base of the Ipswich Coal Measures, west of Brisbane (Allen, Staines & Wilson, 1960, 252-3). Recent geological work, however, indicated that the basalt might be Tertiary. This Record describes work undertaken at the request of the Geological Survey of Queensland, in an attempt to distinguish between Triassic and Tertiary ages by measurements of the direction of rock magnetisation. The work was done at the Australian National University, Canberra.

The measurements were made on rock samples collected by the Geological Survey of Queensland. The samples were marked and the field orientation measured by the Geological Survey; these details were shown on the collecting sheets that accompanied the samples.

Of four sites examined, only one yielded fresh material whose attitude could be determined. Two samples (QS 2a and QS 2b*) were collected from a roadside site. The alteration of the material is deuteric, with strong development of serpentine, and with or without calcite (Denmead, A.K., private communication).

Because of the small amount of Weir Basalt available, it was decided to sample also the Sugars Basalt, a similar basalt which crops out about four miles east of Mount Crosby (Allen et al. loc. cit., 253 and Fig. 35). These samples have been called QS 1a and QS 1b. Map references for the outcrops on the national grid system are 933816 for Weir Basalt, and 004808 for Sugars Basalt, on the Ipswich one-mile sheet.

2. RESULTS

The results of measurements on three specimens cut from the four samples sent are given in Table 1 and Figures 1-6. The fourth sample (QS 2a) is an awkward shape for coring and it has not yet been possible to cut a suitable specimen. Specimen QS 2b has a direction of natural remanent magnetisation (NRM) apparently unrelated to that of QS 1a and QS 1b; when magnetically cleaned, however, it shows a stable direction almost parallel to that of the others, but in a reverse sense. In all calculations involving combinations of the results, the reverse of the measured direction of QS 2b has been used. Table 1 shows the mean direction, precision, etc. for the three specimens, for NRM and for remanent magnetisation after cleaning in alternating magnetic fields up to 510 oersteds (peak). In Figures 1-3 the individual specimen directions and the mean direction are shown for NRM, 150 oersteds, and 300 oersteds.

The consistency of observations on the surface of a sphere may be expressed in terms of the precision (k) as defined by Fisher (1953); k increases as the scatter of the results decreases. Figure 4 shows the change in precision, with increasing alternating fields, for the present measurements. Figure 5 shows the variation in intensity plotted as the ratio M/M_n, and with increasing alternating fields. In Figure 6 the changes of direction of magnetisation of QS 2b are shown for various values of the cleaning field.

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* Note: The prefix "Q" has been added to avoid confusion in the palaeomagnetic collection.

Figure 7 shows the mean directions of magnetisation for the Weir Basalt, Brisbane Tuff, and Lower Triassic rocks from New South Wales, compared with the present field and dipole field directions; the circle of confidence drawn about WB, is that within which the true mean direction lies with a probability P = 0.95. Pole positions from Middle Permian to Tertiary (from Australian rocks) are shown in Figure 8, together with the pole corresponding to the Weir Basalt direction; in this figure the (present) South Pole is at the centre, the projected equator is the circumference, longitude is measured 0-360° from 0 at the top, and latitude is measured along the radius with scale dots every 10°.

3. DISCUSSION

The mean direction of magnetisation as measured from these three specimens clearly suggests that a Triassic age is most probable. It is possible, though less likely, that the true mean direction corresponds to some other age; for example, the Lower Tertiary direction (Older Volcanics) could be the true mean direction, but the probability is only 0.2 (i.e. 20%).

In this discussion, the mean direction after cleaning in an alternating field of 300 oersteds (peak) is used - the increase in precision at 510 oersteds is probably spurious for such a small sample; in any case, the mean direction is not much changed.

The direction of magnetisation of sample QS 2b is not significantly different from that of the other two samples, although in the opposite direction. The facts that it is reversed, and that it is less stable, suggest that although the Weir and Sugars Basalts belong to the same geological period they are not parts of the same extrusion. They are not necessarily from different magmas; the variation in stability could be explained by different positions within a flow, giving different rates of cooling, grain sizes, exsolution, and so on. However, the reversal indicates a time interval of at least 10^4 years, more probably 10^5-10^6 years, between the two extrusions.

If the problem is of sufficient importance, more samples (say about 20) would enable a more definite conclusion to be drawn; however, the present results are such that any significant change in the mean direction is not expected.

4. CONCLUSIONS

(a) The Weir Basalt and Sugars Basalt were both magnetised in Triassic time.

(b) The Weir Basalt was extruded at a time more than 10^4 years before or after the Sugars Basalt.

5. REFERENCES

ALLEN, R.J., STAINES, H.R.E., and WILSON, E.G.	1960	The Ipswich Basin, in THE GEOLOGY OF QUEENSLAND, p. 252-262. Melbourne, University Press.
FISHER, R.	1953	Dispersion on a sphere. Proc. Roy. Soc. A217, p. 295.

TABLE 1

Mean direction of magnetisation in increasing alternating fields. (N = 3 specimens; mean site position taken as 153°E; 27.5°S; magnetic declination taken as 10°E).

Peak alternating field (oersteds)	D_m	I_m	M_m	k	$\alpha 95$	Pole	
						Long. E.	Lat. S.
0 (NRM)	320	-61	1.051×10^{-3}	4	73	209	36
70	327	-75	1.043	14	35	176	41
150	344	-78	0.811	27	24	162	41
230	347	-78	0.626	32	22	161	41
300	342	-77	0.359	46	18	165	39
420	342	-76	0.260	42	19	165	39
510	347	-75	0.208	167	14	164	35

Notes on Table 1

D_m mean declination relative to true north.

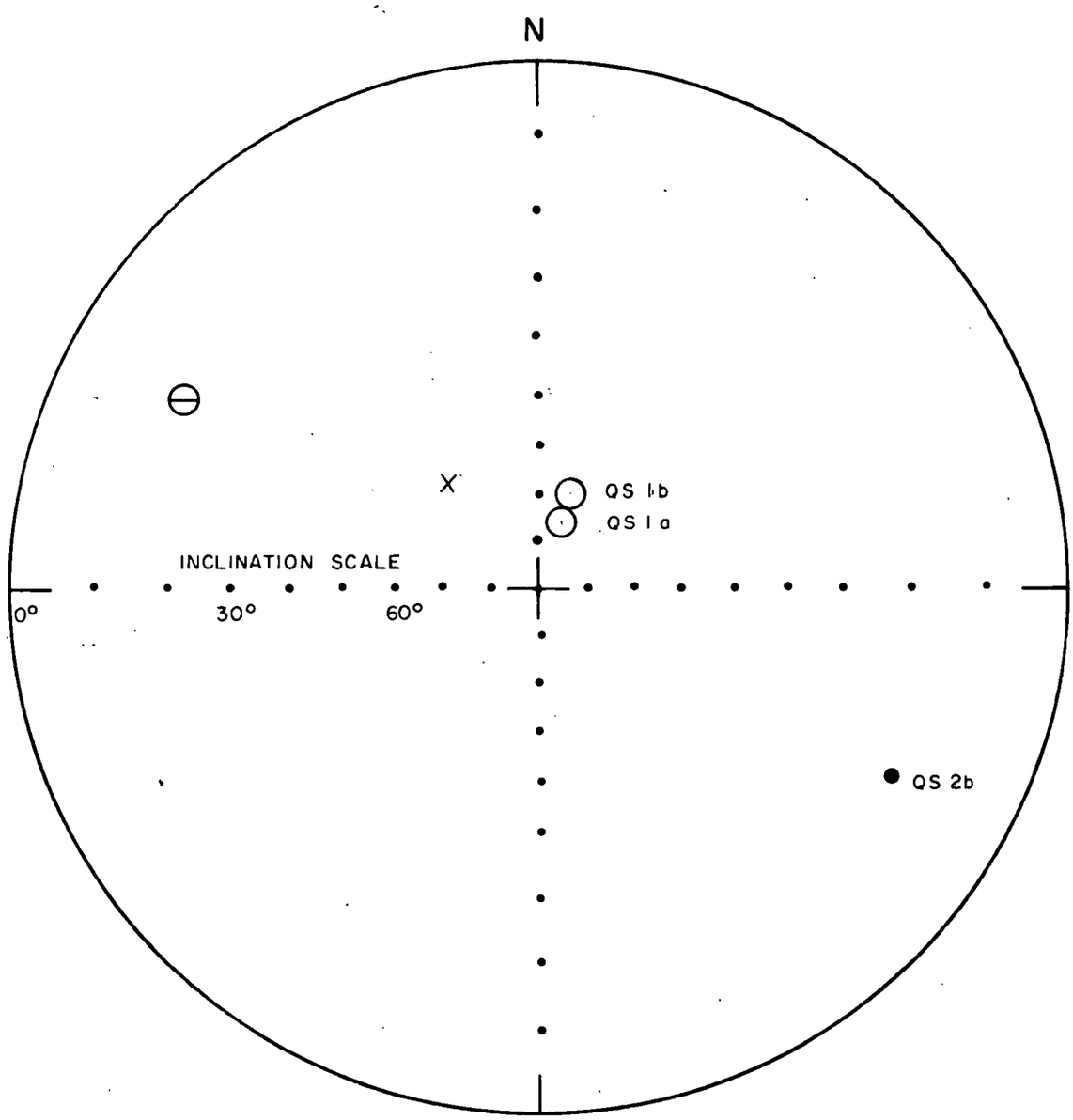
I_m mean inclination relative to horizontal.

M_m mean intensity of magnetisation, in e.m.u./cm^3.

k precision parameter as defined by Fisher (1953).

$\alpha 95$ semi-angle of the cone about the mean direction, within which the true mean direction lies with a probability P = 0.95.

FIGURE 1



LEGEND

○ North-seeking pole on upper hemisphere

● North-seeking pole on lower hemisphere

X Mean direction for 3 specimens

⊖ Reverse direction of ●

MAGNETISATION OF WEIR BASALT, QUEENSLAND

DIRECTIONS OF NRM

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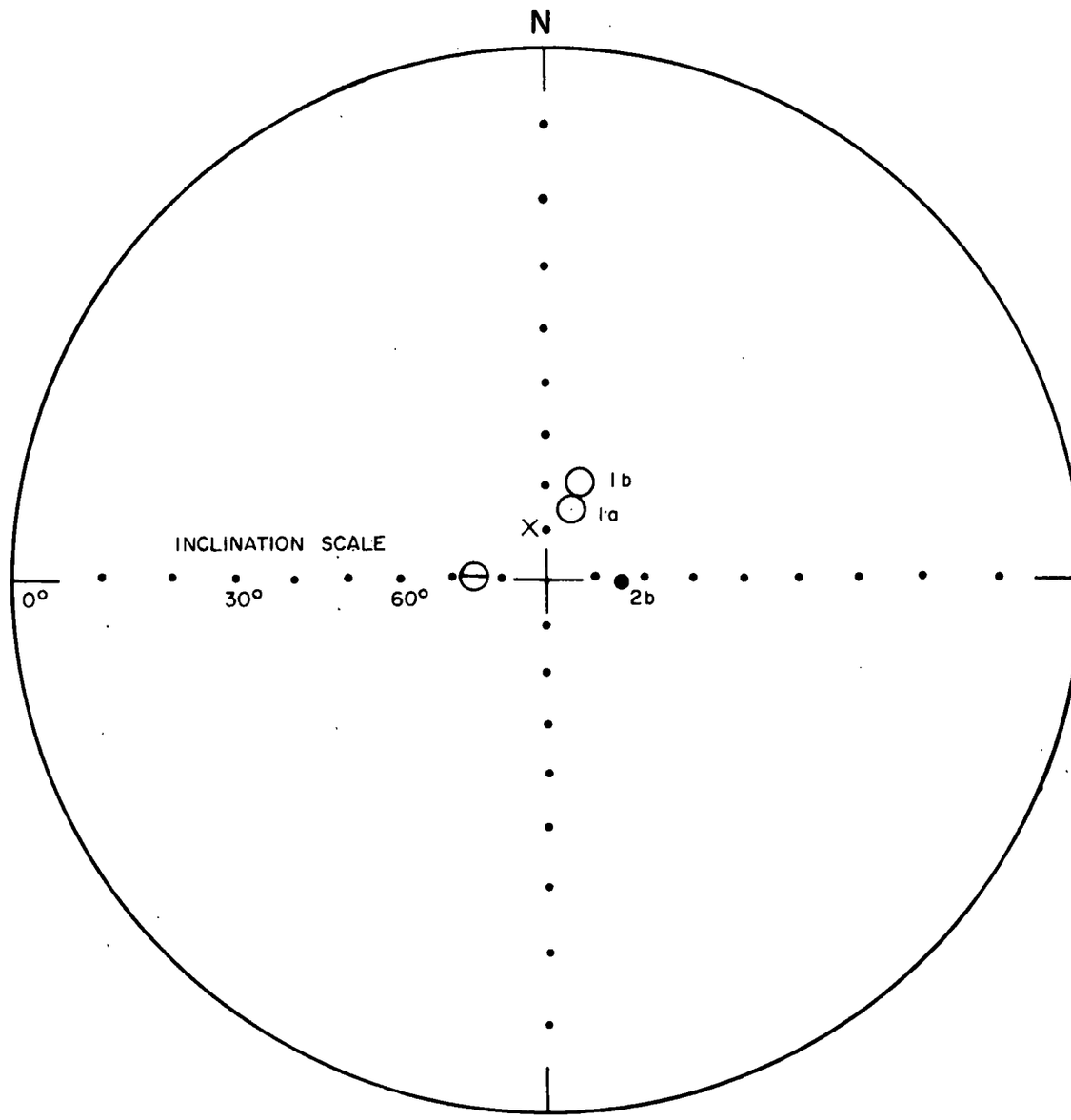
FIGURE 2



LEGEND

○ North-seeking pole on upper hemisphere

● North-seeking pole on lower hemisphere

X Mean direction for 3 specimens

⊖ Reverse direction of ●

DIRECTIONS AFTER 150 OERSTEDS

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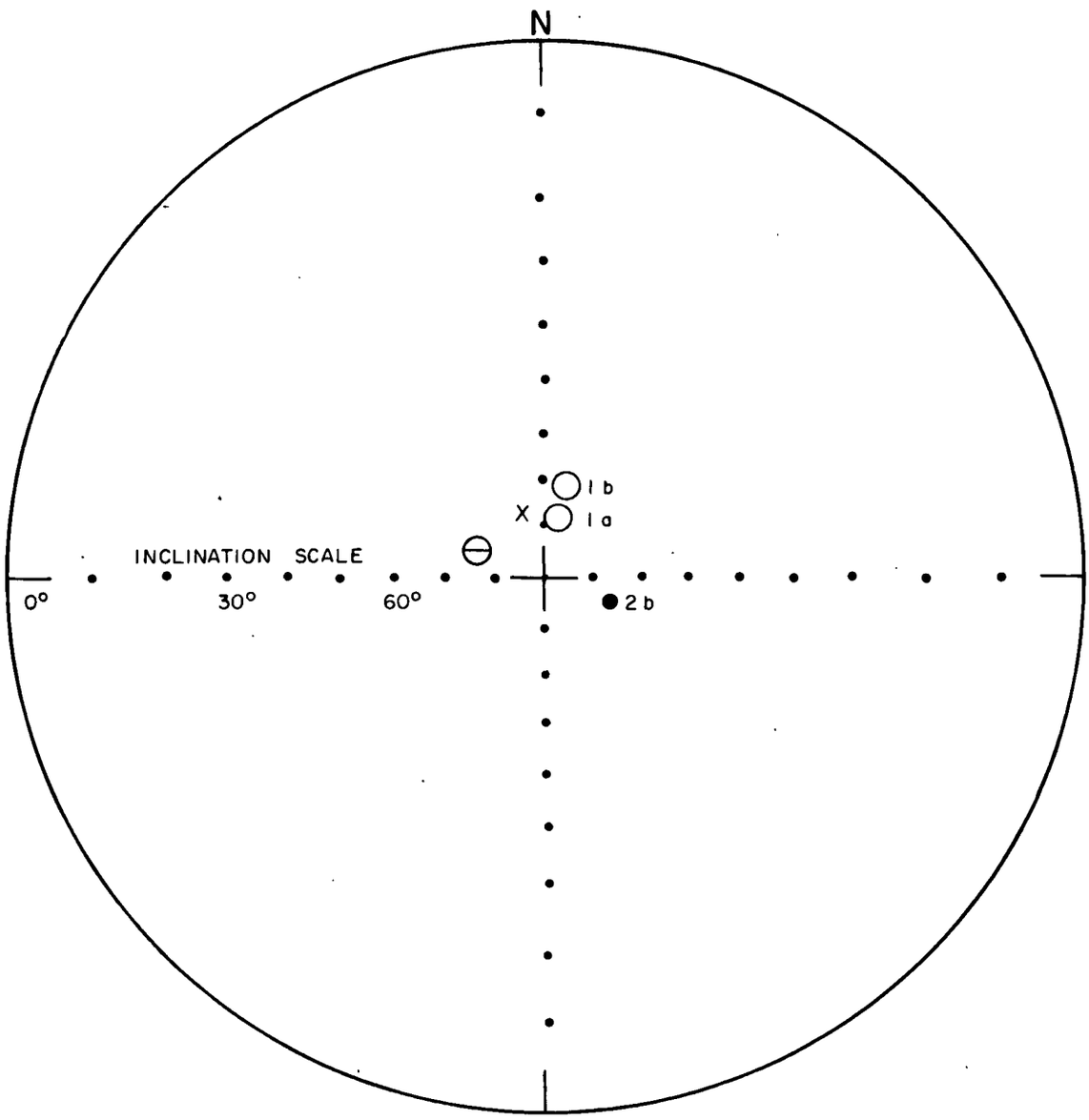
FIGURE 3



LEGEND

○ North-seeking pole on upper hemisphere

● North-seeking pole on lower hemisphere

X Mean direction for 3 specimens

⊖ Reverse direction of ●

DIRECTIONS AFTER 300 OERSTEDS

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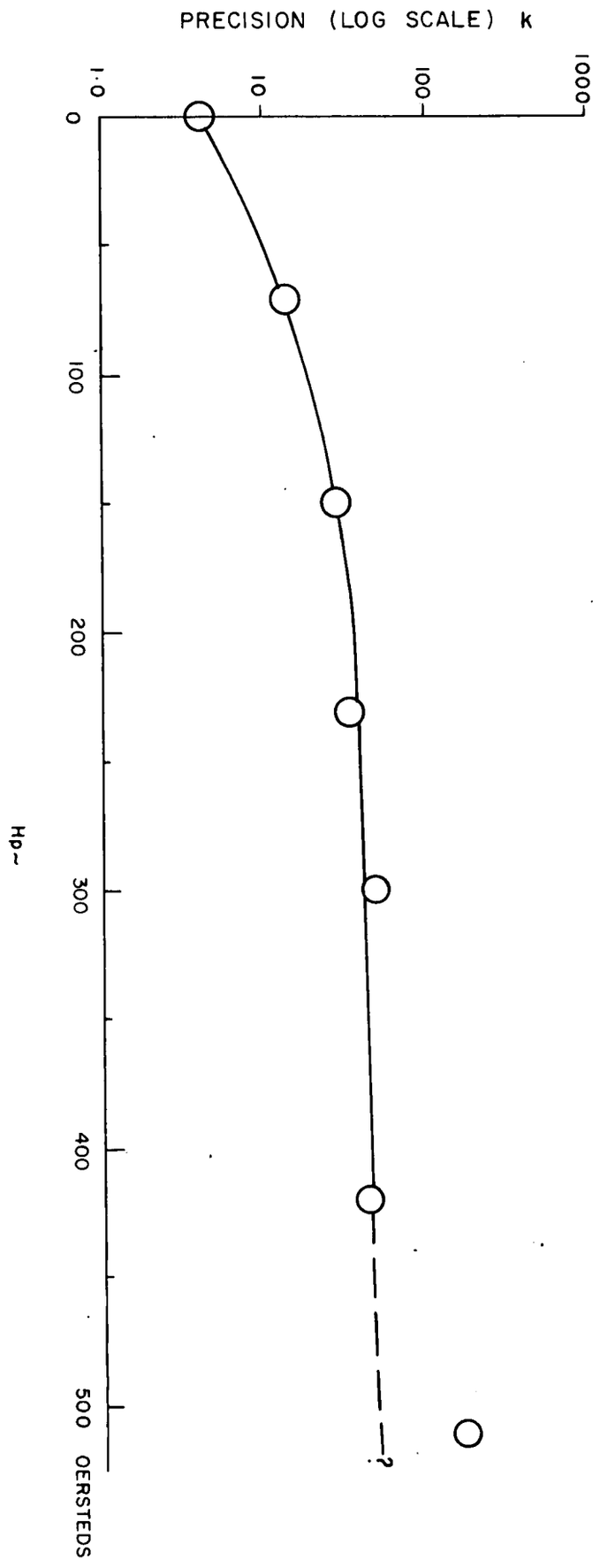
FIGURE 4



CHANGE IN PRECISION

WITH AMPLITUDE OF CLEANING FIELD

(see Table 1)

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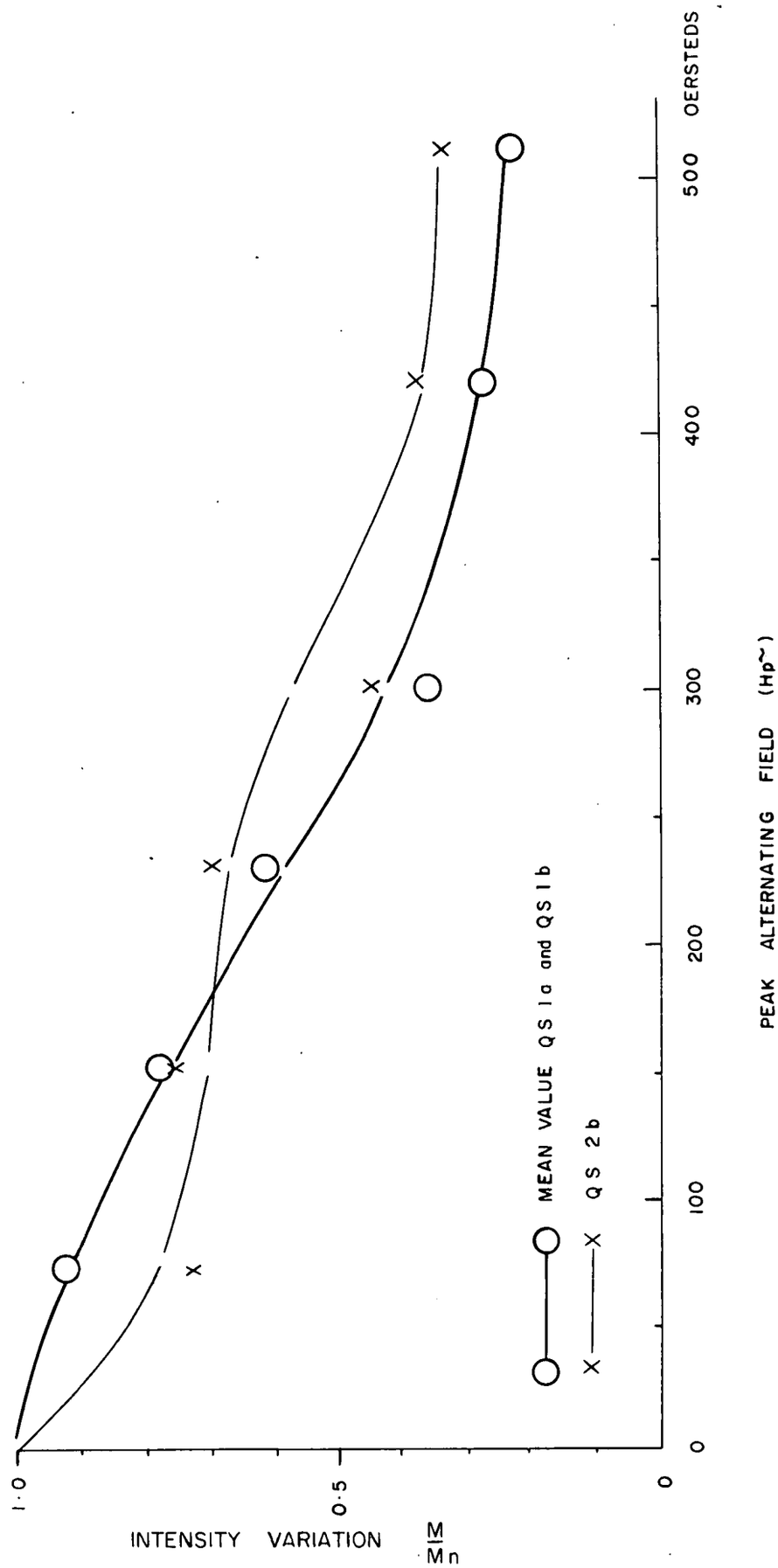
FIGURE 5



CHANGE IN INTENSITY DURING DEMAGNETISATION

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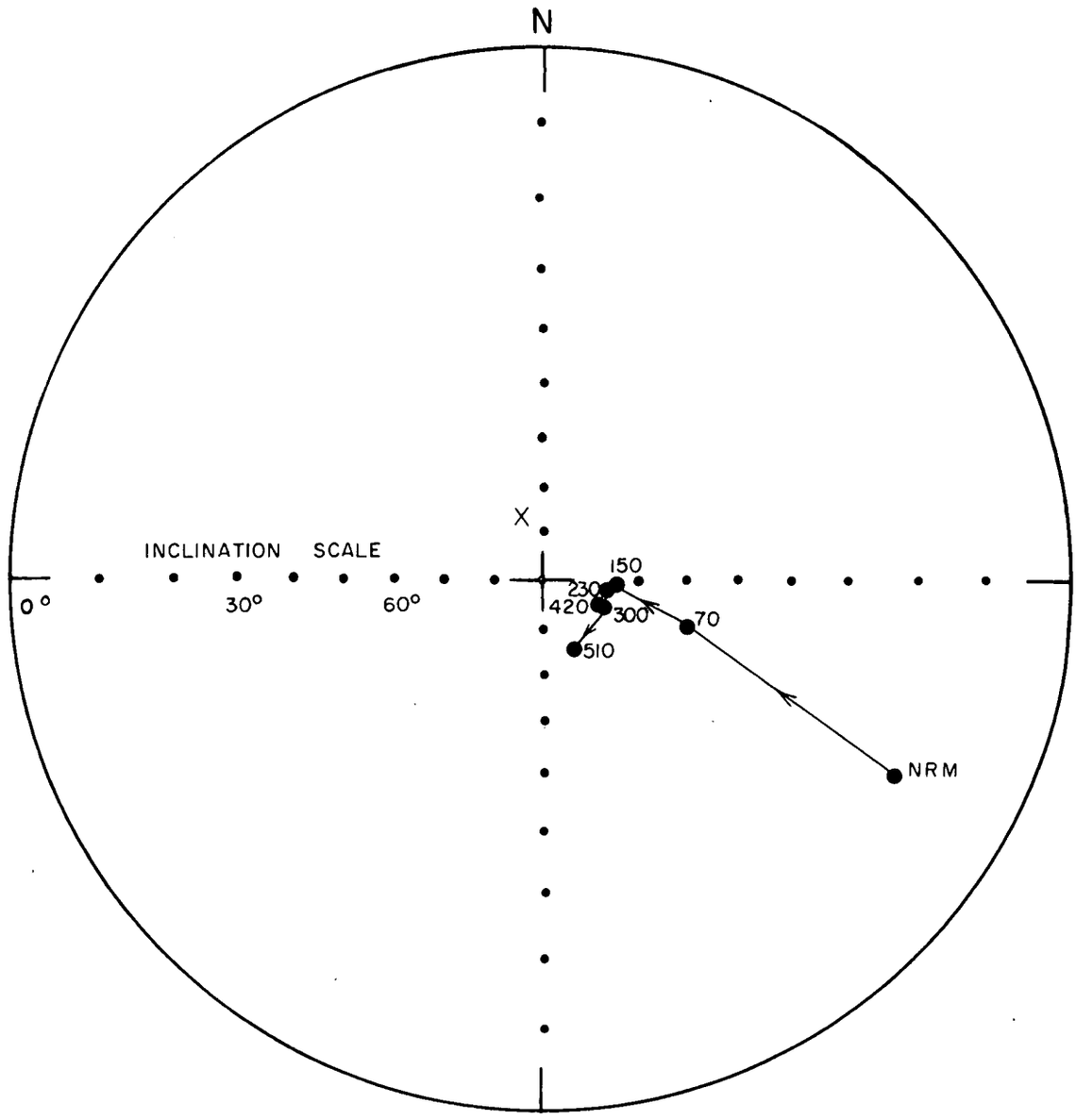

LEGEND

● 230 Peak alternating field (oersteds)

× Mean of 3 specs after demagnetisation in 300 oersteds

CHANGES IN DIRECTION OF QS 2b

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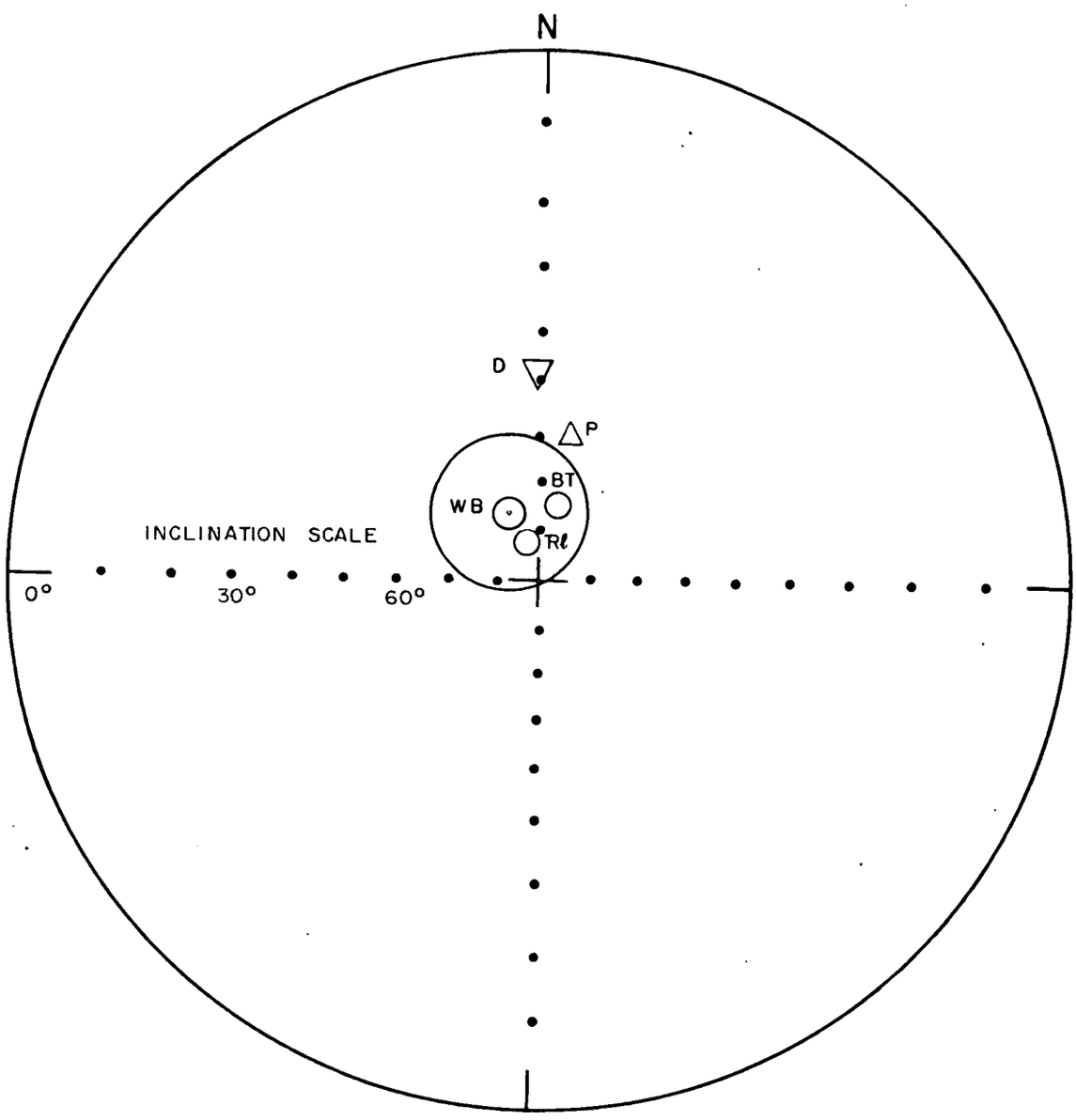
FIGURE 7



LEGEND

D ▽ Dipole field

P △ Present field

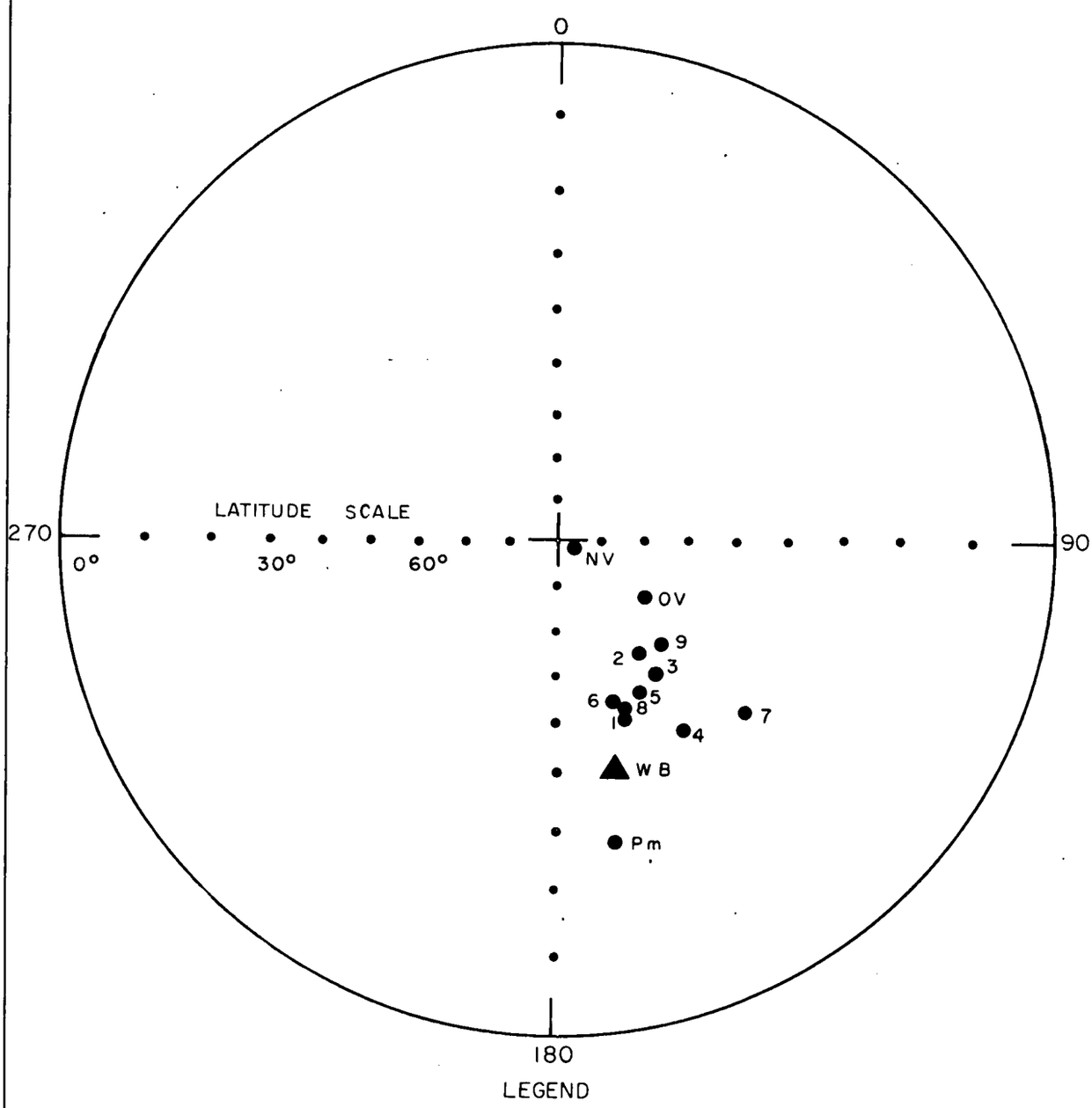
BT ○ Brisbane Tuff (Middle Triassic)

WB ◯ Weir Basalt (with circle of confidence P=0·95)

Rℓ ○ Lower Triassic (NSW)

COMPARISON OF DIRECTIONS

FIGURE 8



LEGEND

- ● NV Newer volcanics (Tertiary - Recent)
- ● OV Older volcanics Victoria (Lower Tertiary)
- ▲ WB Weir Basalt, mean of 3 specimens
- ● 1 - 9 Mesozoic poles, Eastern Australia 1 oldest to 9 youngest
- ● Pm Middle Permian

COMPARISON OF POLES

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