

PALAEOMAGNETIC DATA FROM THE PRECAMBRIAN GWALIOR TRAPS, CENTRAL INDIA *

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ABSTRACT

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From alternating-field and thermal demagnetization studies on two dolerite “Traps” in the Gwalior Series (Central India), dated at 1830 ± 200 m.y., three different palaeomagnetic directions could be distinguished. The characteristic magnetization component, which is considered as the primary magnetization, has a mean direction: $D=78^\circ$, $I=+34.5^\circ$, $\alpha_{95}=5^\circ$, $k=369$, $N=4$ (Pole: $155.5^\circ\text{E}19^\circ\text{N}$, $dp=3^\circ$, $dm=5.5^\circ$).

A comparison of the presented data with other Precambrian and Phanerozoic data from the Indian subcontinent might suggest that the Indian subcontinent underwent a continuous anticlockwise rotational movement during the last 1800 m.y.

INTRODUCTION

The Indian subcontinent is composed largely of basement rocks, with ages ranging up to $3 \cdot 10^9$ years. A palaeomagnetic study covering this large span of time is hampered by prevailing metamorphic conditions and by strong weathering. Moreover, radiometric dating of these Precambrian rocks remains a prerequisite for their palaeomagnetic interpretation. Recently a framework of radiometric datings has been established by Crawford (1969, 1970) and Crawford and Compston (1970).

Various Precambrian palaeomagnetic data from the Indian subcontinent have already been reported (Athavale et al., 1970, see caption to Fig.5). The present paper adds new results to a reconnaissance study of the Gwalior Traps (Athavale et al., 1963, 8 samples) in Central India.

GEOLOGICAL SETTING OF THE SAMPLING AREA

Igneous rocks are found at two levels in the Upper or Morar Stage of the

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Precambrian Gwalior Series, exposed near Gwalior City ($26^{\circ}\text{N}78^{\circ}\text{E}$). These igneous rocks are dated by Rb/Sr methods at 1830 ± 200 m.y. (Crawford and Compston, 1970). The lower "Trap", up to 25 m in thickness, is rather poorly exposed. At six sites, eight samples each were taken (sites IGWA—IGWF, 48 samples in total) from fresh exposures throughout the height of the Trap along the Indore road, about 15 km southwest of Gwalior City. The two lowermost sites IGWA and IGWB, were sampled from in-situ lying spheroidal weathered blocks. The upper Trap, exceeding 150 m in thickness, is well exposed in quarries along the scarp below the Gwalior Fort. At two sites in a quarry at the base of this scarp near the Fort road—railroad junction, eight samples each were taken (IGWG, IGWH, 16 samples in total). At another two sites eight samples each (IGWI, IGWK, 16 samples in total) were taken from quarries along the Fort road, rather high in the upper Trap.

The porphyritic quartz-dolerites, which show distinct ophitic structures, are described generally as lava flows (Pascoe, 1950; Wadia, 1953; Krishnan, 1968). However, Bajpai (1953) reported many characteristics which favour an intrusive nature, and he described the rocks as sills.

The very fresh-looking samples show only slight alteration on thin-slide examination, with some decomposition of the minor olivine content into serpentine and secondary ironhydroxides. This decomposition is slightly stronger in the lower Trap. Primary magnetite crystals prevail in large quantities through both Traps.

The sampled cores were obtained by means of a portable drill. Orientation was performed by a normal compass and a clinometer, using a specially designed orientation apparatus. Distance from the rocks to the compass was at least 20 cm, thus avoiding an orientation error due to the rocks' own magnetization. The Gwalior Series are lying subhorizontal at the sampling area.

METHOD OF ANALYSIS

The N.R.M. and induced magnetization of 145 specimens (Table I), 2.5 cm in diameter and 2.2 cm in height, was measured with an astatic magnetometer. From each site one specimen (10 in all) was progressively demagnetized by alternating fields in 21—25 steps up to ultimate peak values varying from 1850 to 3000 Oe. Moreover, from the same samples a second specimen (10 in all) was thermally demagnetized in 22 steps up to 600°C . From the remaining specimens, at least five of each site, were chosen for partial progressive A.F.-demagnetization in 4—11 steps up to ultimate peak values lying between 600 and 3000 Oe.

The directional analysis was made according to Zijdeveld (1967). The computation of directional data and the map plottings were carried out by means of the Philips Electrológica X-8 computer of the Utrecht State University, to which an off-line Calcomp 507 incremental plotter has been attached (Klootwijk, 1971, 1973a).

RESULTS

The two lowermost sites (IGWA, IGWB) of the lower Trap show higher intensities of initial remanence ($870\text{--}5830 \cdot 10^{-5}$ e.m.u./cm³) than the other sites (IGWC—IGWF) from the same Trap ($250\text{--}1070 \cdot 10^{-5}$ e.m.u./cm³). Intensities of initial remanence of sites IGWG—IGWK from the upper Trap were much lower ($100\text{--}160 \cdot 10^{-5}$ e.m.u./cm³), whereas the intensity of induced magnetization in the lower Trap was generally higher ($90\text{--}130 \cdot 10^{-5}$ e.m.u./cm³) than in the lower Trap ($30\text{--}110 \cdot 10^{-5}$ e.m.u./cm³). The *Q*-values ranged between 1—1.5 (upper Trap), 6—19 (lower Trap, IGWC—IGWF) and 9—75.5 (lower Trap, IGWA and IGWB). See Table I.

The N.R.M.-directions reveal differences corresponding with the groups mentioned above. Initial directions of sites IGWA and IGWB are directed southwards with both slightly negative (IGWA) and slightly positive (IGWB) inclinations. The well-grouped initial directions from sites IGWD—IGWF point steeply upwards and northwards, whereas the directions from site IGWC are directed less steeply upwards in the northwest quadrant. In contrast, the sites from the upper Trap (IGWG—IGWK) show well-grouped and slightly downwards inclined easterly directions (Fig.1A, 2A, 2B).

A.F.-DEMAGNETIZATION

During A.F.-treatment a slight secondary component, present in several samples, was eliminated at about 100 Oe peak value (Fig.3A, 3C). The remaining intensity after elimination of this slight secondary viscous component was generally 70—90% of the initial intensity. In site IGWB specimens (lower Trap), however, a very large secondary component of more than 95% of the initial intensity was eliminated at about 300 Oe peak value.

The normalized intensity decay curves of pilot specimens from the lower Trap sites reveal a very fast and regular intensity decrease of the characteristic component. This component is nearly completely removed at 600—700 Oe peak value (Fig.4A), and continuation of the A.F.-treatment up to peak values of 3000 Oe generally added no further directional information. The coercivity of site IGWF samples was notably higher than coercivities from the other lower-Trap sites (IGWA—IGWE).

Partial progressive A.F.-treatment of site IGWA and IGWB specimens up to 600 Oe peak value resulted in widely scattered characteristic directions (Fig.1B), which are corroborated by thermal demagnetization results. Characteristic directions from sites IGWD—IGWF specimens, treated up to 650 Oe peak value (or 3000 Oe in case of site IGWF), group very well with steep upward and northward directions (Fig.1B, 2C, 3A, 3B). The comparable and well-grouped directions from site IGWC specimens (treated up to 650 Oe peak value) reveal lower inclinations and northwestern declinations (Fig.1B).

In the upper-Trap specimens (sites IGWG—IGWK) two distinct magnetization components can be distinguished upon A.F.-treatment. A less hard

TABLE I

N.M.R.-results of initial measurements

| Site | Samp. | Spec. *1 | Mean direction (degrees) | $\alpha_{9.5}$ (degrees) | K | Intens. *2 | Induc. *3 | Q-value |
|------|-------|----------|-----------------------------|-----------------------------|-----|------------|-----------|-----------|
| IGWA | 8 | 16(7) | 208 | 18 | 12 | 870-1120 | 70-110 | 9 -12.5 |
| IGWB | 7 | 12(7) | 186 | 30.5 | 5 | 2660-5830 | 70-100 | 33.5-75.5 |
| IGWC | 8 | 15(7) | 325.5 | 9 | 44 | 770-1070 | 80-90 | 9 -13.5 |
| IGWD | 7 | 13(7) | 356 | 3.5 | 336 | 410-630 | 40-80 | 7.5-11.5 |
| IGWE | 8 | 12(7) | 11.5 | 8 | 55 | 420-800 | 40-90 | 6.5-12 |
| IGWF | 8 | 14(6) | 348.5 | 6 | 119 | 250-890 | 30-60 | 6 -19 |
| IGWG | 8 | 16(8) | 81.5 | 31.5 | 4 | 110-140 | 90-120 | 1 -1.3 |
| IGWH | 8 | 16(7) | 82.5 | 12 | 27 | 110-160 | 100-130 | 1.2-1.3 |
| IGWI | 8 | 16(7) | 68.5 | 9 | 44 | 100-150 | 100-120 | 1 -1.4 |
| IGWK | 8 | 15(7) | 77.5 | 6 | 95 | 100-160 | 90-130 | 1.2-1.5 |

After A.F.- or thermal demagnetization

| Site | Sample | Spec. *4 | Mean direction (degrees) | $\alpha_{9.5}$ (degrees) | K |
|------|--------|----------|-----------------------------|-----------------------------|------|
| IGWA | 7 | 6(1) | 202.5 | 28.5 | 5 |
| IGWB | 7 | 6(1) | 192 | 25.5 | 7 |
| IGWC | 7 | 6(1) | 320 | 9 | 46 |
| IGWD | 7 | 6(1) | 2.5 | 3.5 | 262 |
| IGWE | 7 | 6(1) | 14 | 3 | 351 |
| IGWF | 6 | 5(1) | 351.5 | 2 | 1446 |
| IGWG | 5 | 5 | 80 | 3.5 | 452 |
| IGWH | 6 | 6 | 77 | 3 | 500 |
| IGWI | 6 | 6 | 76 | 7.5 | 84 |
| IGWK | 6 | 6 | 78.5 | 4.5 | 227 |

TABLE I (continued)

Less hard component in sites IGWG-IGWK

| Site | Sample | Spec. *4 | Mean direction (degrees) | α_{95} (degrees) | K | | | | |
|-------------------------------------|--------|-----------------------------|-----------------------------|----------------------------|----------------------------|-----------------|-----------------|----------------------------------------|------------|
| IGWG | 3 | 2(1) | 85 +13.5 | 3.5 | 119 | | | | |
| IGWH | 2 | 1(1) | 84.5 +16 | — | 109 | | | | |
| IGWI | 5 | 4(1) | 69.5 + 1 | 7.5 | 106 | | | | |
| IGWK | 5 | 4(1) | 79.5 + 1 | 4.5 | 318 | | | | |
| Site-mean directions after cleaning | | | | | | | | | |
| Site | N | Mean direction (degrees) | α_{95} (degrees) | K | Pole position (degrees) | DP (degrees) | DM (degrees) | Corr. direction at Nagpur (degrees) | |
| IGWD-F | 3 | 2.5 | -73.5 | 6.5 | 378 | 77 E — 4S | 10.5 | 11.5 | 5.5 —77 |
| IGWG-K | 4 | 78 | +34.5 | 5 | 369 | 155.5E+19N | 3 | 5.5 | 76.5 +34.5 |
| IGWG-K*5 | 4 | 79.5 | + 8 | 12.5 | 56 | 169 E+11N | 6.5 | 12.5 | 79.5 + 8 |

*1 Number of specimens chosen for A.F.- or thermal treatment is given between brackets.

The qualitative N.R.M.-data are restricted to these specimens in order to obtain a good comparison with the cleaned data.

*2 Intens: Intensity of remanent magnetization in units of 10^{-5} e.m.u./cm³.*3 Induc: Intensity of induced magnetization ($H_z = 0.44$ Oe) in units of 10^{-5} e.m.u./cm³.

*4 Between brackets: Number of thermally treated specimens, used for computation of mean data.

*5 Site-mean direction for the less hard magnetization component in sites IGWG-IGWK (upper Trap).

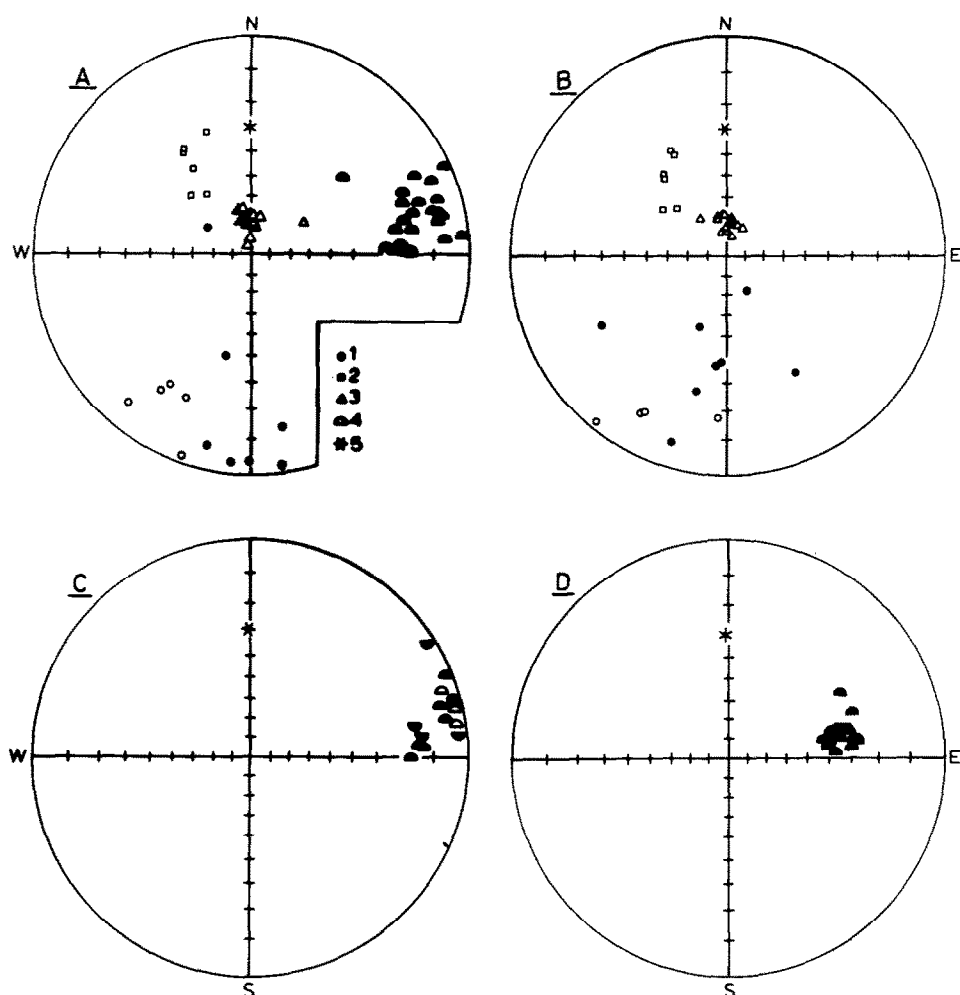


Fig.1. Stereographic projections of specimen magnetization directions of the Gwalior Traps.

Open symbols denote directions pointing upwards; full symbols denote directions pointing downwards. 1 = specimen directions from sites IGWA, IGWB; lower Trap, 2 = specimen directions from site IGWC; lower Trap, 3 = specimen directions from sites IGWD, IGWE, IGWF and IGWD; lower Trap, 4 = specimen directions from sites IGWG, IGWH, IGWI and IGWK; upper Trap, 5 = downward dipping present local field direction at the sampling locality. A. Initial specimen directions from all lower- and upper-Trap sites. B. A.F.-treated specimen directions from lower-Trap sites. C. A.F.-treated specimen directions from upper-Trap sites, computed from the less hard magnetization component. D. A.F.-treated specimen directions from upper-Trap sites, computed from the harder magnetization component. These directions are considered as representing the primary magnetization direction.

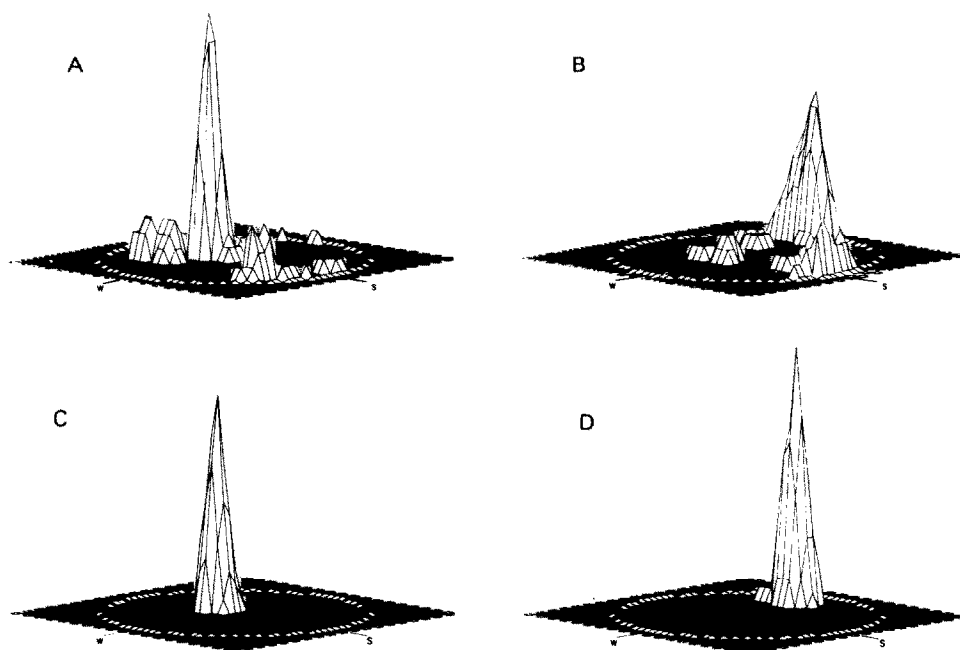
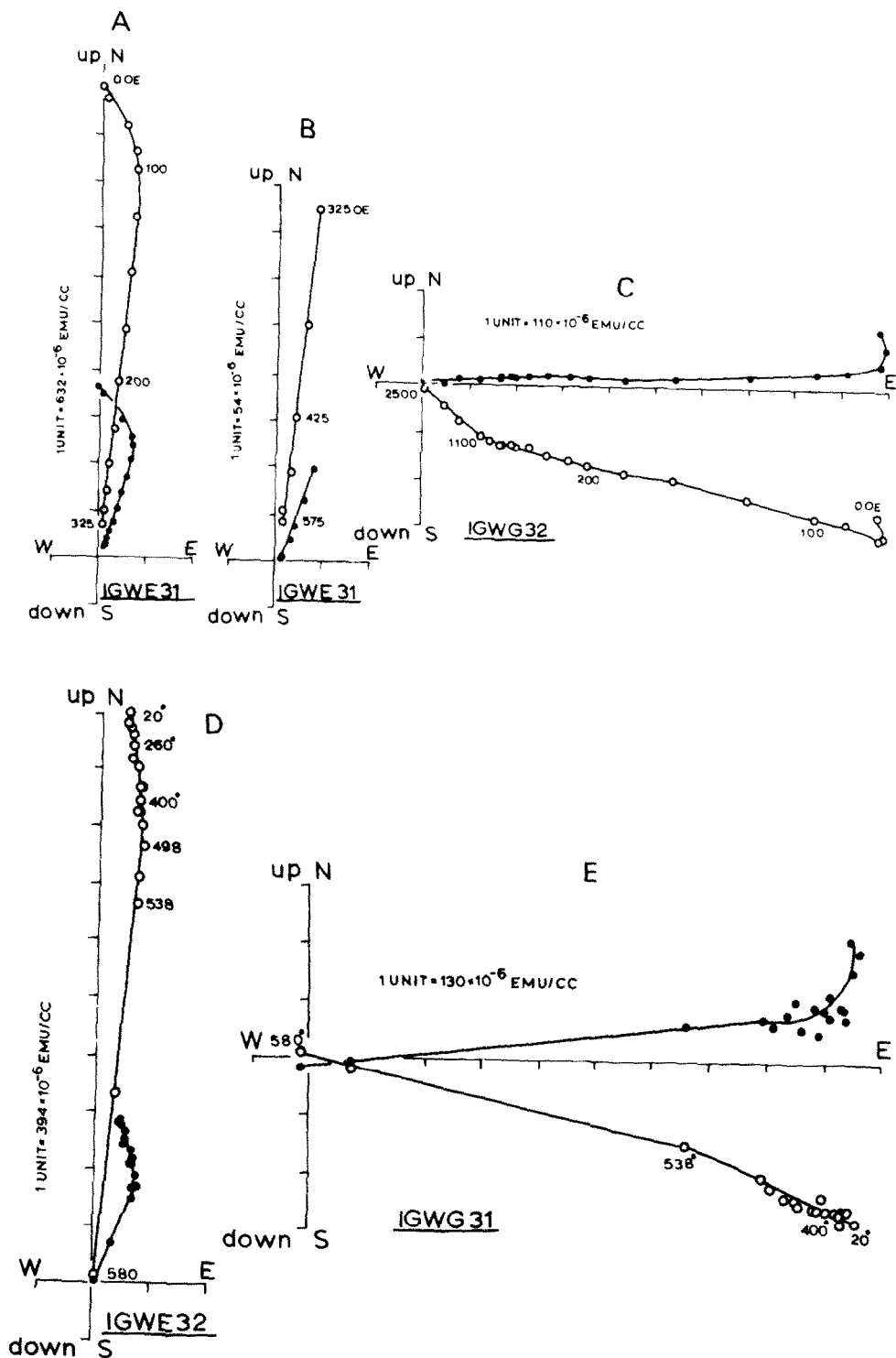


Fig.2. Density distribution of specimen directions of the Gwalior Traps, showing clearly the better grouping after A.F.-treatment (C, D), as compared with the initial specimen directions (A, B). The density distribution is represented as a three-dimensional perspective view of an equal-area projection. The rim on the figures represents the outline of the equal-area projection. The view is taken from the southwest. A. Initial specimen directions, upper-hemisphere projection, cf. Fig.1A. B. Initial specimen directions, lower-hemisphere projections, cf. Fig.1A. C. A.F.-treated specimen directions from sites IGWD, IGWE and IGWF (lower Trap), upper-hemisphere projection, cf. Fig.1B. D. A.F.-treated specimen directions from sites IGWG, IGWH, IGWI and IGWK (upper Trap), as computed from the harder magnetization component, lower-hemisphere projection, cf. Fig.1D.

component is eliminated at peak values of 1000–1500 Oe, and from these peak values onwards only another harder single magnetization component is broken down. This is clearly shown on the vectorgraph representations (Fig.3C, 3F, 3G). The harder component represents about 10–20% of the initial intensity (Fig.4A). The less hard magnetization component is directed east-northeast with slight both positive and negative inclinations (Fig.1C). The downdipping and eastward pointing harder magnetization directions group very well (Fig.1D, 2D). The directions of both components were determined by means of a least-square approximation procedure.

THERMAL DEMAGNETIZATION

During thermal demagnetization of one pilot specimen from each site, a secondary component is removed (Fig.3D, 3E) at a wide range of applied peak temperatures (80–540°C). This secondary component is comparable to



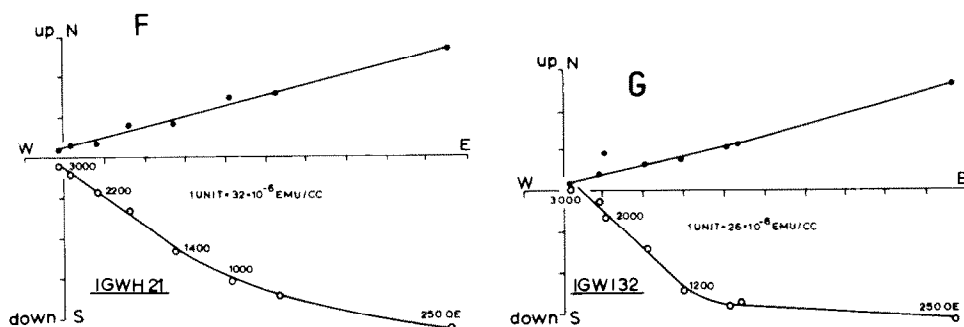


Fig.3. Demagnetization diagrams of Gwalior-Trap specimens treated with alternating fields (A, B, C, F, G) or by thermal methods (D, E). The points represent successive positions — in orthogonal projection — of the end of the resultant magnetization vector during progressive demagnetization. Circles denote projections on the vertical east—west plane. Dots denote projections on the horizontal plane. Numbers denote Oe-peak values of the applied alternating fields (A, B, C, F, G) or successive peak values of the applied temperatures (D, E). Fig.3B is an enlarged continuation of Fig.3A.

the component eliminated by A.F.-methods at 100 Oe peak value. This component could be identified in the upper-Trap specimens as a viscous local field (sampling area) component.

The thermally obtained characteristic directions (ten specimens) are identical with the directions obtained from A.F.-treatment. The four thermally demagnetized pilot specimens from the upper Trap, however, reveal only one characteristic direction. This direction is comparable to the less hard A.F.-component. No convincing evidence was obtained for separation of another component identical with the harder A.F.-component (Fig.3E). In view of the better separation of the diverse components, we preferably applied partial A.F.-cleaning, instead of partial thermal cleaning, to the remaining specimens (48).

The range of blocking temperatures from 540°C onwards, as shown on the normalized intensity decay curves (Fig.4B), clearly confirms that the largely prevailing, rather pure, magnetite is the main magnetization carrier.

INTERPRETATION

The internal inconsistent results from sites IGWA and IGWB (lower Trap) are discarded. Sites IGWD—IGWF show very consistent results ($D=2.5^\circ$, $I=-73.5^\circ$, Table I), which are entirely different from other palaeomagnetic data from Indian Precambrian rocks. The same holds for the deviating result from site IGWC ($D=320^\circ$, $I=-45^\circ$, Table I), which shows most affinity with the results from sites IGWD—IGWF. A plausible explanation for these very consistent results (lower Trap, sites IGWD—IGWF) is hard to find in view of the absence of evident weathering and oxidation features. From the present

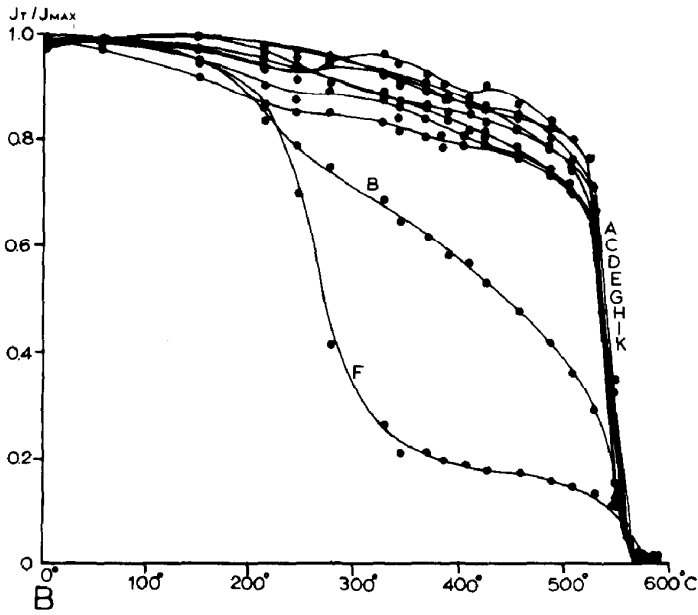
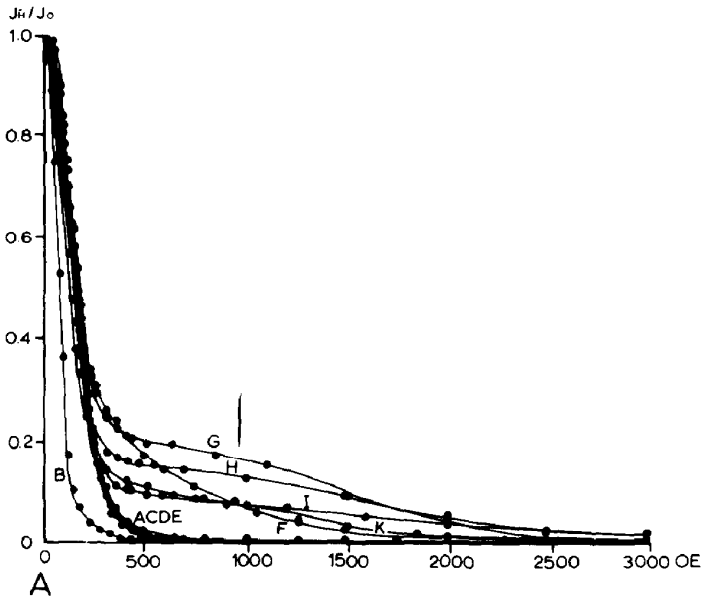


Fig.4. Normalized intensity-decay curves of the remanent magnetization during A.F.-treatment (A) or thermal treatment (B).

knowledge of the drift of the Indian subcontinent, one would expect such high inclinations to have originated during the Palaeozoic Southpolar crossing movement (Klootwijk, 1973b, in press). However, the radiometrically dated samples reveal a definite Precambrian age for the upper Trap (1830 m.y., Crawford and Compston, 1970).

We prefer to interpret the very well grouping harder magnetization directions in the upper Trap (sites IGWG—IGWK, $D=78^\circ$, $I=+34.5^\circ$, Table I) as representing the primary magnetization. This result indicates a palaeoposition of the Indian subcontinent at $10\text{--}30^\circ$ southern or northern latitude, with the palaeolatitude pattern more or less perpendicular to the present pattern (Fig.5A). This position is in accordance with other Precambrian palaeomagnetic data from the Indian subcontinent. The same holds for the position as deduced from the less hard magnetization component (Fig.5A). The latter result shows a declination, corresponding to the harder component but with a lower dip ($D=79.5^\circ$, $I=+8^\circ$, Table I). This direction coincides with results from a reconnaissance study on rocks from the same Trap (Athavale et al., 1963; $D=70^\circ$, $I=+3^\circ$, 8 samples), which were obtained from thermal studies and A.F.-treatment up to 200 Oe peak value only.

Our preference for the former result is based on the higher coercivity of this magnetization component and the better grouped directions.

DISCUSSION

A summary of Indian Precambrian palaeomagnetic data from in part only reconnaissance studies has been given by Athavale et al. (1970). At that time, the chronology and relative stratigraphy of the studied Precambrian formations was not yet based on a firm number of radiometric ages. Crawford (1969, 1970) and Crawford and Compston (1970) have recently dated many Precambrian Formations on the Indian subcontinent with Rb/Sr methods, and have presented radiometric ages for some of the palaeomagnetic results.

In Fig.5A and 5B the position and orientation of the Indian subcontinent is sketched, as deduced from dated Precambrian and Cambrian palaeomagnetic results. There is of course an ambiguity in assigning the results either to the normal or to the reversed palaeomagnetic directions, but a decision was made on the basis of interpolation of successive values of the angle of rotation of the Indian subcontinent.

Interpretation of the few dated palaeomagnetic results (Table II) in terms of drift only, and leaving out of consideration a possible polar wandering, seems to point to a proceeding anticlockwise rotational movement of the Indian subcontinent from at least 1800 m.y. to Cambrian times (Fig.5A, 5B). During the succeeding, rather well-established Phanerozoic Southpolar crossing and subsequent northward movement, the rotation was also anticlockwise (Klootwijk, 1973b, in press).

Reliable radiometric ages are not available at this moment for some other Precambrian palaeomagnetic data from the Indian subcontinent (Table III).

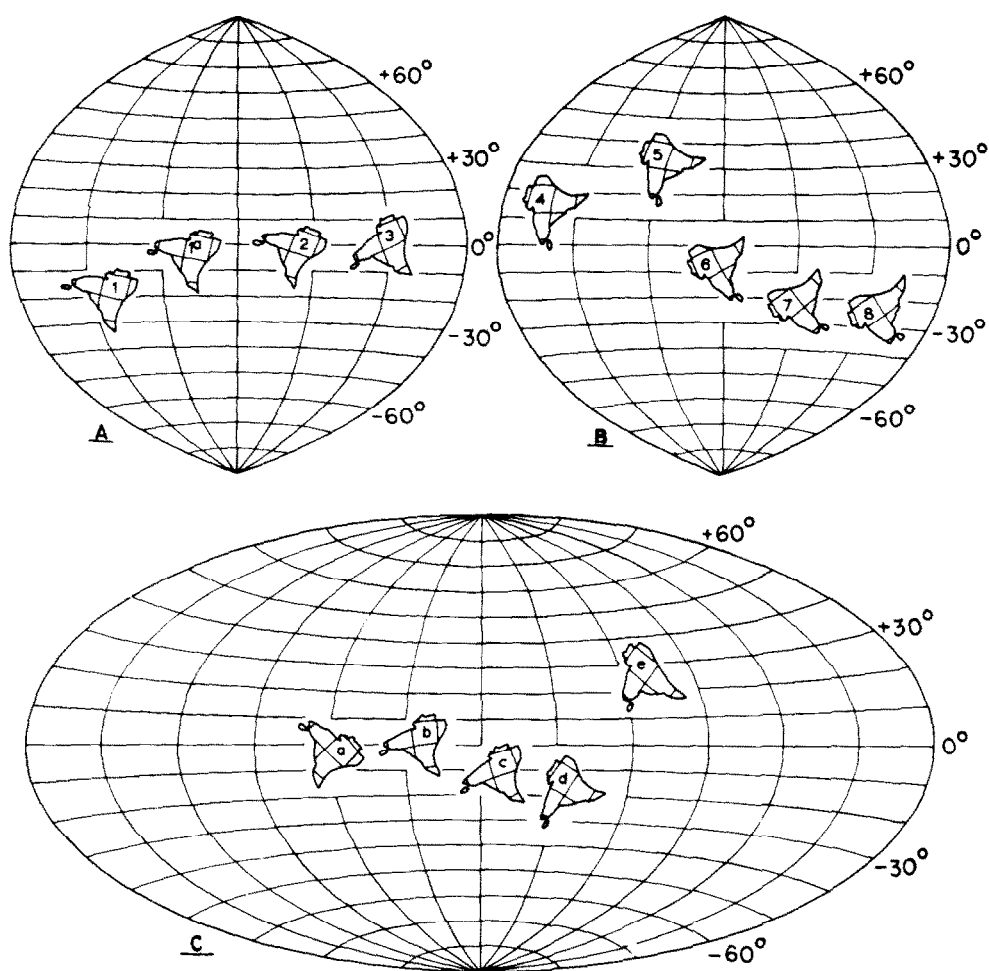


Fig. 5. Comparison of orientations and positions of the Indian subcontinent according to palaeomagnetic data from some radiometrically dated (A, B) and some tentatively dated (C) Precambrian and Cambrian formations. The longitudinal positions of the subcontinent are arbitrary, but throughout Fig. 5A and B, the positions correspond from left to right with data from successively younger formations (cf. Table II). The positions and orientations according to the tentatively dated formations are given for comparison (cf. Table III). Legend: 1 = Gwalior Traps, harder magnetization component, upper Trap (present study); 1a = Gwalior Traps, less hard magnetization component, upper Trap (present study); 2 = Viskhapatnam Charnokites (McElhinny, 1969); 3 = Cuddapah shales and sandstones (Athavale et al., 1970); 4 = Kaimur Sandstones (McElhinny, 1968); 5 = Malani Rhyolites (Athavale et al., 1963); 6 = Upper Bhandar Sandstones (Klootwijk, 1973a); 7 = Purple Sandstones (McElhinny, 1969b); 8 = Salt Pseudomorph Beds (Wensink, 1972). a = Hyderabad dyke (Verma et al., 1968); b = Banded hematite jasper and quartzite (Athavale et al., 1970); c = Chlitoor dyke (Athavale et al., 1970); d = Mundwara complex (Athavale et al., 1963); e = Veldurti Hematite (Verma et al., 1966).

TABLE II

Radiometric dated palaeomagnetic results

| Formation | Sites | Samples | Mean direction (degrees) | α_{95} (degrees) | Pole position * ⁵ (degrees) | Age (m.y.) | Reference |
|--------------------------------------------------|-------|------------------|-----------------------------|----------------------------|-------------------------------------------|----------------|-----------------------------------------------------------|
| Salt Pseudomorph Beds (Salt range 32.7°N73°E) | 6 | 43 | 217.5 + 35.5 | 6 | 26.5 S 33.5 E | E.-M. Cambrian | Wensink (1972) |
| Purple Sandstone (Salt range 32.7°N73°E) | 1 | 10 | 218 + 31.5 | 11* ¹ | 28 S 32 E | E.-M. Cambrian | McElhinny (1969) |
| U. Bhandar sandstone (26.5°N77.5°E) | 6 | 43 | 207.5 + 9.5 | 5.5 | 48.5 S 33.5 E | * ² | Klootwijk (1973a) |
| Malani Rhyolites (26°N73°E) | 9 | 60 | 353 + 56 | 10 | 78 N 45 E | 745 | Crawford and Compston (1970) |
| Kaimur Sandstones (24.5°N83.1°E) | ~20 | ~50 | 357 + 31 | 6* ¹ | 82 N 76.5 W | about 1150 | Athavale et al. (1963) Crawford and Compston (1970) |
| Cuddapah Shales, sandstones (15°N78°E) | 2 | >5* ³ | 294.5 — 8 | — | 22.5 S 157 E | 1300—1400 | McElhinny (1968) Crawford (1969) |
| Visakhapatnam Charnokites (17.5°N83°E) | 2 | 10 | (334.5 + 61) | —* ⁴ | 57 N 47 E | 1650—1800 | Athavale et al. (1970) McElhinny (1969) |
| Gwalior Traps (26°N78°E) | 4 | 23 | 77.9 + 34.7 | 5 | 19 N 155.5 E | 1830 ± 200 | Crawford and Compston (1970) |
| idem | 4 | 11 | 79.6 + 7.9 | 12.5 | 11 N 169 E | idem | present paper |
| idem | 1 | 8 | 70 + 3 | 18* ¹ | 18.5 N 175.5 E | idem | present paper Athavale et al. (1969) |

*¹ Unit weight given to samples.*² Probably correlative with the Cambrian sequence from the Salt range area.*³ 5 samples and another 24 specimens.*⁴ Mean of two widely dispersed mean site directions: $D = 280^\circ$, $I = +35^\circ$ and $D = 45^\circ$, $I = +45^\circ$.*⁵ The pole position given is that which is nearest to the sampling locality.

TABLE III
Palaeomagnetic data with unknown radiometric ages

| Formation | Sites | Samples | Mean Direction (degrees) | α_{95} (degrees) | Pole position* ⁶ (degrees) | Reference |
|-----------------------------------------------------------------------|-------|---------|-----------------------------|----------------------------|------------------------------------------|--------------------------------------|
| Hyderabad dyke (17.4°N78.5°E) | 1 | 13 | 44 | 5* ¹ | 42.5 S 7.5 E | Verma et al. (1968) |
| Banded hematite jasper and Banded hematite quartzite (24°N81°E) | 2 | 10 | 279.5 | — | 6.5 S 162 E | Athavale et al. (1970)* ² |
| Chittoor dyke (14.6°N79°E) | 3 | 9 | 296.5 | 5 | 21 S 147.5 E | Athavale et al. (1970)* ³ |
| Mundwara complex (25°N73°E) | 1 | 8 | 329 | 21* ¹ | 42 S 115.5 E | Athavale et al. (1963)* ⁴ |
| Veldurti hematite (15.6°N78°E) | 4 | 30 | 133 | 14 | 45 N 2 E | Verma et al. (1966)* ⁵ |

*¹ Unit weight given to samples.

*² Tentatively classified as predating the Vindhyan System (thus probably older than 1400 my.), Tewari (1968)

*³ Age suggested by Athavale et al. (1970): 1100–1200 m.y.

*⁴ The Mundwara complex is situated in the Erinpura Granite. Radiometric ages for granitic bodies attributed to this suite show a wide range from 935 m.y. to more than 1650 m.y.

(Crawford and Compston, 1970). Athavale et al. (1970) suggested 650–850 m.y.

*⁵ The hematite deposits are younger than the base of the Cuddapah System ~ 1400 m.y.

Dolerites in the Cuddapah System are radiometrically dated at 980 ± 110 m.y. (Crawford, 1969).

Athavale et al. (1970) suggested 900–1200 m.y. for this Veldurti Hematite.

*⁶ The pole position given is that which is nearest to the sampling locality.

These data indicate orientations of the Indian subcontinent (Fig.5C) comparable to those sketched in Fig.5A (nr. 1, 2 and 3), one might therefore conclude that these "undated" formations are older than the Kaimur Sandstones (about 1150 m.y., Fig.5B, no. 4).

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