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# Petro-Physical Properties (Density and Magnetic-Susceptibility) and Lithologic Composition of Some Dolerite Dykes of Andhra Pradesh, India

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**Abstract.** The density and magnetic susceptibility of 40 samples from dolerite dykes have been measured. They occur in the Peninsular granites of South India and belong to tholeiitic and alkali types. It is observed that the dolerites could be classified into two groups based on their density and susceptibility values. While one group with lower values was found to correspond with the tholeiitic type, the other group with higher values possibly signifies the alkali type dolerites.

**Key words:** Rockmagnetism – Dolerites – Correlation of density and magnetic susceptibility.

The basic dykes of Peninsular India possess diversified trends of structural, physical and chemical characters. Analyses of structural, petro-chemical and palaeomagnetic data on dyke rocks from selected places in India, as attempted by earlier workers (Sitaramayya and Appajee, 1972; Murty, 1968; Verma et al., 1968; Divakara Rao et al., 1970 and Iqbal Hasnain and Qureshy, 1970) revealed very interesting results. Briefly, while the emplacement of dykes was controlled by the prevailing tectonic features (Appajee, 1970 and Sitaramayya and Appajee, 1972), the dykes could possibly belong to two lithological groups viz., alkali and tholeiitic and that both these types might have originated during Precambrian as well as Cretaceous and Tertiary periods (Divakara Rao et al., 1970; Verma et al., 1968 and Iqbal Hasnain and Qureshy, 1970).

With a view to substantiate the field geophysical anomalies from certain parts of Andhra Pradesh by the present authors, a set of about 40 dolerite dykes were sampled from the Districts of Hyderabad, Nalgonda and Khammam. The results and analysis of the study of the bulk density and magnetic susceptibility of the samples are discussed in the following.

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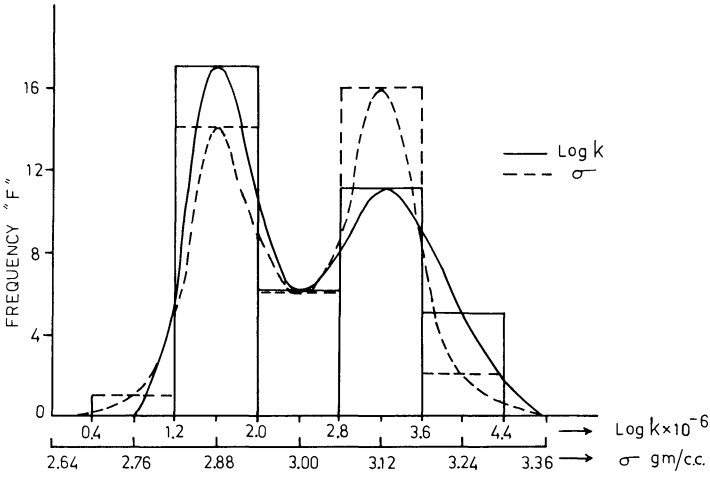


**Fig. 1.** Histograms and frequency curves for density and magnetic susceptibility of dolerites

These dykes of varying sizes trend in E-W, NW-SE, N-S and NE-SW directions and appear in the midst of Peninsular granitic country. A minimum of two samples from each dyke were studied in the laboratory using a densitometer (accuracy 0.02 gm/cc) and a magnetic susceptibility meter (value measured upto $\pm 5 \times 10^{-6}$ cgs unit in earth's field). Both the density ($\sigma$) and susceptibility ($k$) values showed wide ranges of variation (2.81 to 3.22 gm/cc for $\sigma$ and $10 \times 10^{-6}$ to $10{,}000 \times 10^{-6}$ cgs for $k$). Evidently this variation could not alone be due to the effect of weathering. Hence a statistical approach was adapted to study the variation phenomenon of these widely scattered values. It was observed that while the density values obey the law of normal distribution the magnetic susceptibility values follow the log-normal distribution.

In Figure 1 are presented the histograms and frequency curves with the r.m.s. deviation as the class interval. The two peaks and central low of the frequency curves are corresponding in both the parameters $\sigma$ and $\log k$ in the present case. As these two parameters obey normal distribution law, the two parts of the curves on either side of the central low were treated here as two separate normal curves showing the different groups of dolerites with approximate average values 2.88 gm/cc and 1.6 ($k = 40 \times 10^{-6}$ cgs) and 3.12 gm/cc and 3.2 ($1{,}600 \times 10^{-6}$ cgs) respectively in each group.

The above classification of the dolerites was further verified by statistical probability study by adapting Kalmogorov's test (Kapur and Saxena, 1976). The probabilities that $\sigma$ and '$\log k$' of the whole set of samples follow normal distribution were obtained as 0.02 and 0 respectively. The same test, however, when adapted on the two groups separately for the two parameters $\sigma$ and $\log k$ respectively showed the probability as 0.992 and 0.997 for group I and 0.997 and 0.632 for group II.

The dolerite samples with smaller $\sigma$ and $\log k$ values fall in group I while those with higher values fall in group II. However, it was observed that a few (about 3 or 4) samples with lower density (group I) showed higher susceptibility values (group II) and vice versa. Perhaps this indicates the scatter phenomenon

**Table 1.**

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| Whole set of samples | 39 | $\frac{2.81-3.22}{3.03}$ | 0.12 | 3.89 | 39 | $\frac{1.30-3.72}{2.44}$ | 0.80 | 31.12 |
| Group I | 20 | $\frac{2.81-3.00}{2.932}$ | 0.06 | 1.86 | 18 | $\frac{1.30-2.18}{1.81}$ | 0.25 | 13.81 |
| Group II | 19 | $\frac{3.05-3.22}{3.13}$ | 0.05 | 1.49 | 21 | $\frac{2.65-3.72}{3.23}$ | 0.43 | 13.32 |

Columns 2 to 5: Statistics of Bulk density ($\sigma$)
Columns 6 to 9: Statistics of Magnetic susceptibility ($\log k$)
Columns 2 and 6: No. of samples
Columns 3 and 7: Range and average
Columns 4 and 8: r.m.s. deviation
Columns 5 and 9: Coefficient of variation

in the samples. For such samples and also for samples with border line values additional data from chemical analysis or petrographic studies are necessary for their identification.

In Table 1 are given the number of samples, average value, r.m.s. deviation and the coefficient of variation[1] for the two physical characters studied for the whole set of samples as well as for each group separately. One can find from this table that the r.m.s. deviation and the coefficient of variation for the individual groups are very low when compared to those values for the whole set, thus justifying the two fold classification of the samples.

Correlation coefficient obtained for $\sigma$ and $\log k$ values for the entire set is positive and equal to about 0.84. This is in good agreement as the increase in mafic content increases both density as well as magnetic susceptibility of the dolerites.

Petro-chemical and palaeomagnetic studies by Iqbal Hasnain and Qureshy (1970) suggest that some of the basic dykes of Peninsular India do belong to Precambrian alkali basalts while most of the dykes are of tholeiitic type equivalent to Deccan Traps. Manson (1967) reported that the average chemical composition of tholeiitic dolerites shows slightly higher values of $SiO_2$(51.20%) and CaO (10.10%) and lower values of $Na_2O$ (2.20%), $K_2O$ (0.90%) and $TiO_2$ (1.50%) over those of the alkalic dolerites ($SiO_2-48.30\%$, $CaO-2.80\%$, $Na_2O-3.30\%$, $K_2O-1.30\%$ and $TiO_2-1.80\%$) while the percentages of the minerals are almost identical for both types. The ultimate deduction may be that the tholeiitic dykes could be expected to show smaller values of $\sigma$ and $k$ due to high silica and less mafic content. Thus the two groups of dolerites identified from their $\sigma$ and $k$ values might be representing the tholeiitic and alkali types of dolerites.

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[1] Coefficient of variation is the percentage ratio of the r.m.s. deviation to the arithmetic mean value of the set. It represents the variability of the given property of rock samples (Kreiter, 1968)

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