USAGE OF TREND SURFACE METHOD IN THE STUDY OF CRYSTALLIZATION TREND OF PORPHYRIES AT NAUSAHI, ORISSA

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Introduction: Trend surface analysis is a method to study the trend or spatial variability of an observed parameter in a region. The raw data usually contain a broad pattern of variation of trend and local fluctuations or noise. It is customary to filter the noise component so that the trend is amplified and in some cases can be related to some known geological processes. Trend surface method facilitates such separation of the trend and the noise. The two dimensional trend surface[2] involves fitting of a polynomial or fourier surface to the observed data collected at regular intervals on the ground. When the depth factor is also taken into consideration as in the case of bore hole data, a three-dimensional trend surface[3] is used to study both the lateral and vertical variations of the parameter and the trends it exhibits.

In the present case, the polynomial trend surface method is used to study the crystallization pattern in porphyries occurring north of Nausahi in Keonjhar district, Orissa.

Geological Setting: The rock types exposed around Nausahi belong to the Archaean formations. These include older metamorphics (quartzites, quartz schists and quartz-mica schists) into which the igneous rocks intruded. Gabbro group of rocks, constitute the older intrusives while the porphyries possibly represent the later fractions of the same magmatic intrusion.

These porphyries are exposed south of Bhaunra on Chhattra Huli and the hill west of it. They are medium to fine grained and contain phenocrysts of sodic plagioclase (usually oligoclase) in the groundmass of myrmekite, magnetite, biotite and small amounts of quartz. Sometimes, the groundmass contains potash feldspar as an additional component of the mineral assemblage when the diorite porphyries grade into granodiorite porphyries with quartz forming the major component of the groundmass.

Discussion: Crystallization in general, is a function of various process operators and the crystallization trends presented by a magmatic body reveal the process operators. In choosing the parameters to represent the crystallization trends, the decision is empirical. Some workers use mineralogy whereas some others use specific gravity, because these are some of the parameters which are related to the process of differentiation. Saha (1964), Chatterjee and Saha (1967) used modal compositions to study their areal variability in the Bahalda Road and Dalima granodiorites. Whitten and Boyer (1964) studied the process response models based on heavy mineral content whereas Piekert (1962) studied the specific gravity variation in the Glen Alpine stock. In the present case, specific gravity, which is an index of crystallization, being lower for acidic rocks than for intermediate rocks, has been used to study the differentiation trends of the porphyries on the hill west of Chhattra Huli (Fig. 1).

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[2, 3] Some workers use the terms three-dimensional and four-dimensional trend surfaces, but in the present context, the terms refer to the number of independent variables (geographical directions) which are used to compute the surfaces.

The samples were collected on an 8 × 10 orthogonal grid pattern, the spacing between two samples being 250 ft. Specific gravity of samples was determined using pycnometric technique. When the raw data were used for trend computations, negative coefficients of determination were obtained, which might be due to the

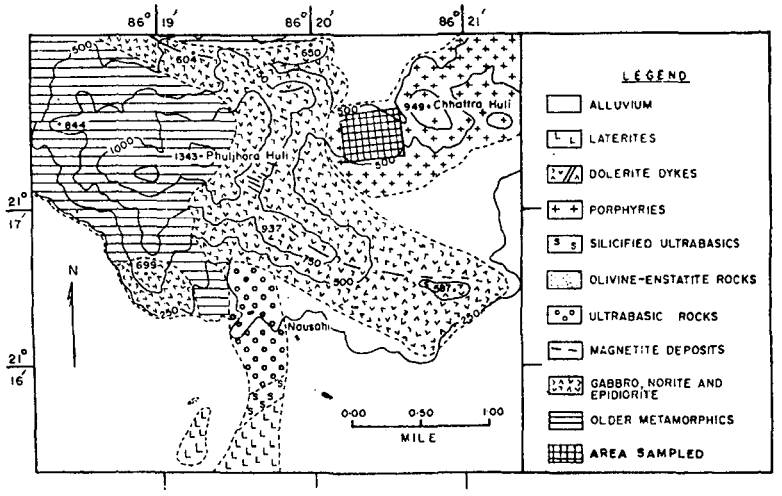

Figure 1. Geological map of Nausahi area.

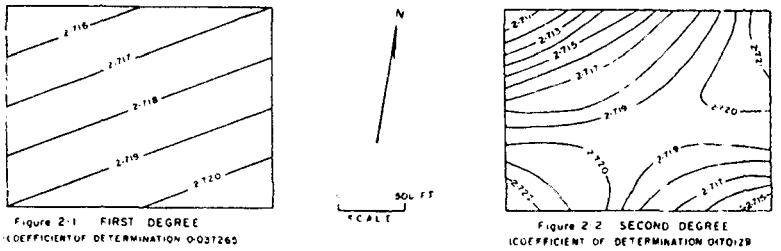

Figure 2·1 FIRST DEGREE
(COEFFICIENT OF DETERMINATION 0·037265)

Figure 2·2 SECOND DEGREE
(COEFFICIENT OF DETERMINATION 0·170128)

TREND SURFACE MAPS FOR SPECIFIC GRAVITY
DATA (AFTER SMOOTHING) OF PORPHYRIES

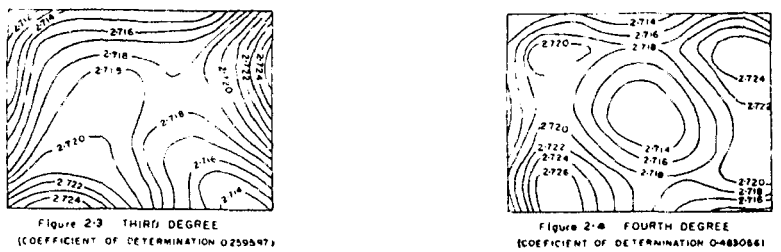

Figure 2·3 THIRD DEGREE
(COEFFICIENT OF DETERMINATION 0·259547)

Figure 2·4 FOURTH DEGREE
(COEFFICIENT OF DETERMINATION 0·483066)

dominant presence of stochastic noise component (either inherent or introduced during determination). This necessitated smoothing of the data by filtering noise to some extent. The smoothing was done by taking the average of the values of the four points that form a square and putting the value at the centre of the square.

Thus smoothing of the data matrix yielded a smoothed data matrix of the order of 7×9 and trend computations were carried out on these data up to fourth degree.

The linear trend map (Fig. 2.1) with a goodness of fit of nearly 0.04 shows an increase in values of specific gravity towards south east. Since the goodness of fit is very low, the surface does not truely represent the characteristics on the data structure; however, it is interesting to note that the strike of the linear map (NE-SW) coincides with the foliation direction of the country rocks, possibly indicating conformability in intrusion.

The quadratic trend map (Fig. 2.2) with a goodness of fit of 0.17 is in the form of a hyperbolic surface, with an increase of specific gravity values from the centre towards NW and SW, and with a decrease in values towards SE and NW.

The cubic trend map (Fig. 2.3) with a goodness of fit of 0.26 presents more or less similar pattern.

In the quartic trend map (Fig. 2.4) which has a goodness of fit of 0.48, the central portion presents a more or less basin shape with peaks in NE, SW, and NW directions. The trend presented in the central portion is similar to that of a uniformly cooling rock mass with lighter and increasingly acidic rocks forming the core, and probably represents granodiorite porphyries at the central part and diorite porphyries at the margins.

A lithological map can perhaps be prepared by choosing the proper parameter and using the trend surface method. However, this requires defining of the threshold values of the parameter, where one rock grades into another. But once a proper parameter with correct threshold values has been chosen, it may not be difficult to prepare the lithological map.

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