

GRAVITY AND MAGNETIC STUDIES OVER THE CIRCULAR GEOMORPHIC CRATER LOOKING STRUCTURES IN THE NARMADA TRAPS, CENTRAL INDIA

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Gravity and total field magnetic intensity data have been collected over three adjacent circular geomorphic features near Jabalpur, presently reported as volcanic vents in the Deccan volcanic province. Bouguer anomaly variation of the order of 1.2 to 2 mGal in a 1.5 km long profile, and total field magnetic anomaly of the order of -900 to 1400 nT have been observed. The gravity variation does not give any reflection of underlying deep seated high density material; and there are no isolated or elliptical magnetic anomalies that can be attributed to the presence of deep seated anomalous source like a volcanic vent. The basement depth values as determined by Werner deconvolution technique corresponding to the three circular geomorphic features is 51.7, 57.6 and 75 m.

Introduction

Several theories have been proposed to understand the Deccan volcanic eruption. Some of them believe that the major source of eruption that occurred around 65 ± 1 Ma ago was situated in the west coast region and the lava flowed over the entire Deccan Volcanic Province (DVP). The other school of thought believes that especially the compound

lavas cannot flow over long distances of 700 to 900 km. Bilgrami (1999) believed that such eruptions need to be sufficiently voluminous in order to have travelled for a distance of 700 km from the west coast of India. However, West (1985) opined that the lava of flood eruptions reached the surface through fissures in the Earth's crust where the magma solidified as dykes. It has been argued that in the Columbia River Province (CRP) the individual flows, or sequences of flows have travelled as much as 300 to 500 km from their sources, hence the same might have been the case in the DVP also (West, 1985). Srinivasan et al. (1998) have reported the presence of three volcanic vents in the eastern margin of Deccan volcanic province in India, near Jabalpur. The ground gravity and magnetic surveys have been carried out to study the reported circular features from the geophysical point of view.

Geological Setting of the Area

The study area lies between 23.098° - 23.103° N and 80.064° - 80.080° E (about 0.60×1.80 km) at the foothills of Bhonapahar (Hill No. 352, SOI toposheet No. 64A/4). It is about 15 km SE of Jabalpur, between Barela and Junvani villages close to the Mandla road, (Fig.1). The area falls in

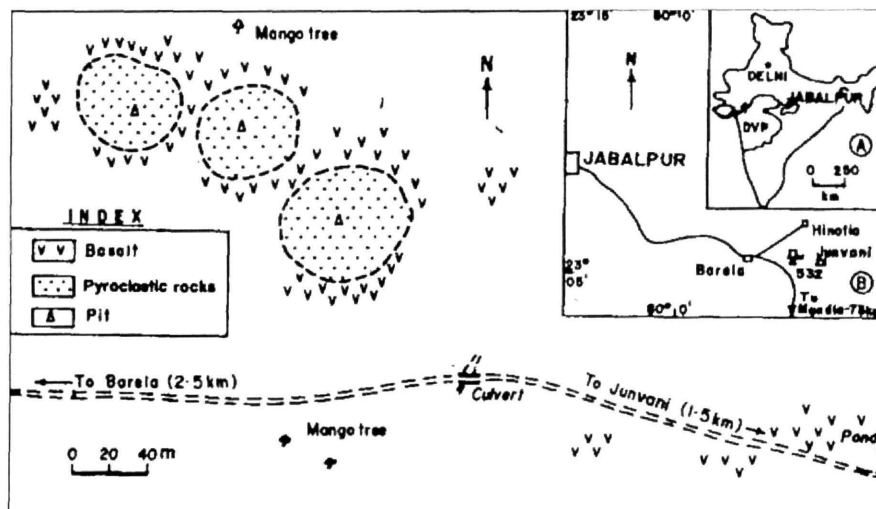


Fig.1. Location map of the study area (after Srinivasan et al. 1998).

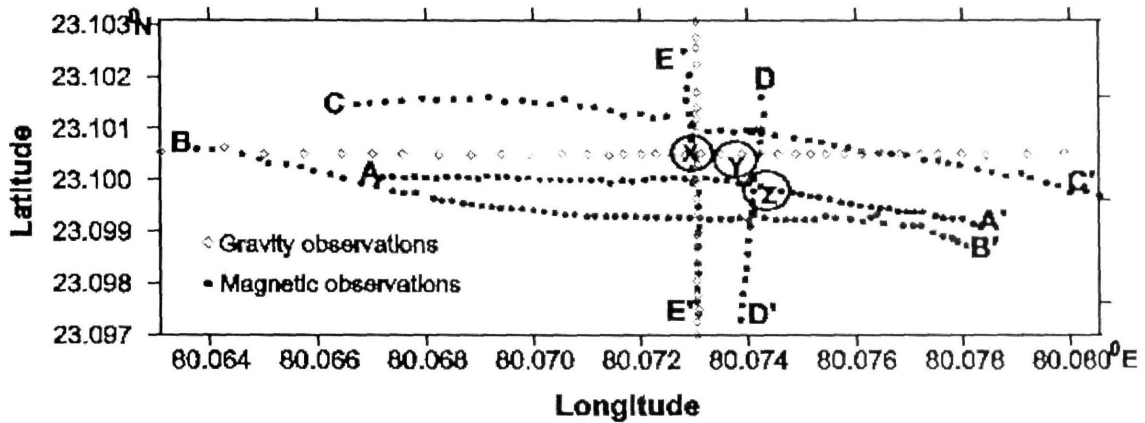


Fig.2. Location of circular morphological features shown as open circles X, Y, and Z. Gravity and magnetic profiles are also shown.

the eastern margin of the DVP and at the verge of the great Vindhyan formation. Basaltic layer of average thickness of about 150-250 m rests over the granitic basement in this area (Rao and Nayak, 1995).

Presently the diameter of the circular rims reported by Srinivasan et al. (1998) range from 50.0 m to 60.0 m. These features have a very low relief of about 1.0 to 1.5 m above the ground level and are filled up to the ground level by black cotton soil. Compact basalt surrounds the circular feature and constitutes 10-12 m thick screens between them. Volcanic tuff is reported underlying ~1.0 m thick black cotton soil within the circular features (Srinivasan et al. 1998).

Data Acquisition

Ground gravity and magnetic surveys have been carried

out over the area in the proximity of the circular features in a rectangular area of 0.60 x 1.80 km. Lacoste Romberg gravimeter of sensitivity 0.01 mGal, and proton precession magnetometer of 1.0 nT sensitivity were used in gravity and magnetic surveys respectively. The Bouguer anomaly along two profiles is shown in Fig. 3. The station interval in gravity observations was about 10 m near the circular features, and it was slowly increased up to about 25 m at the fag end of the profiles. A few profiles of total field magnetic intensity have been recorded at the interval of around 10 m (Fig.2) passing through the circular features and its surrounding. The complex composition of basaltic rocks produces short-wavelength erratic variations in magnetic observations, which were minimized by keeping the instrument sensor at the height of 6.0 m from the ground level. Another magnetometer with the sensor almost at the same height was

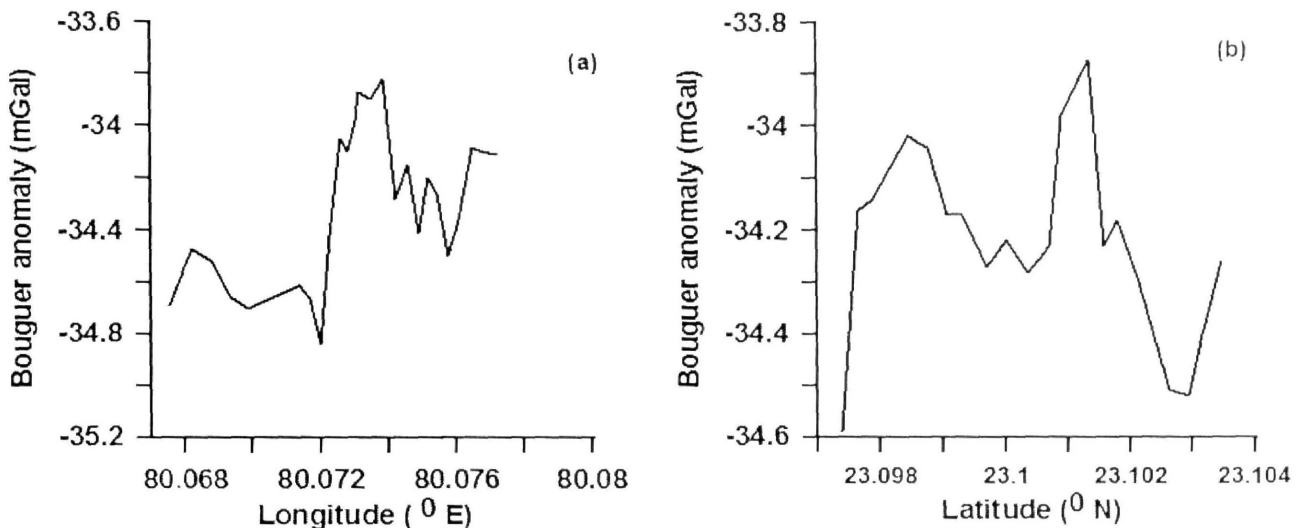


Fig.3. (a) Bouguer anomaly along E-W profile. (b) Bouguer anomaly along N-S profile.

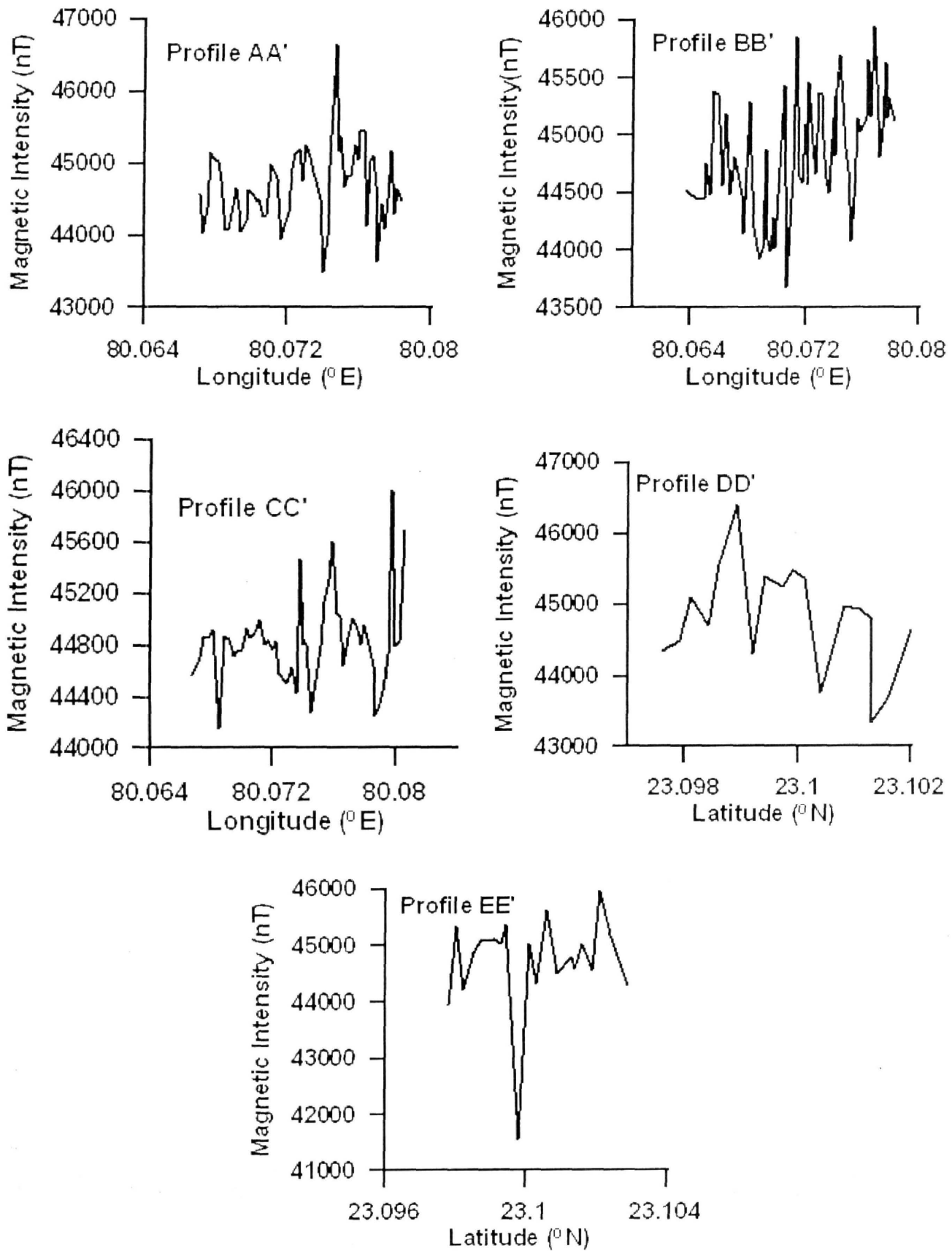


Fig.4. The total field magnetic anomaly over the profiles shown in Fig.2.

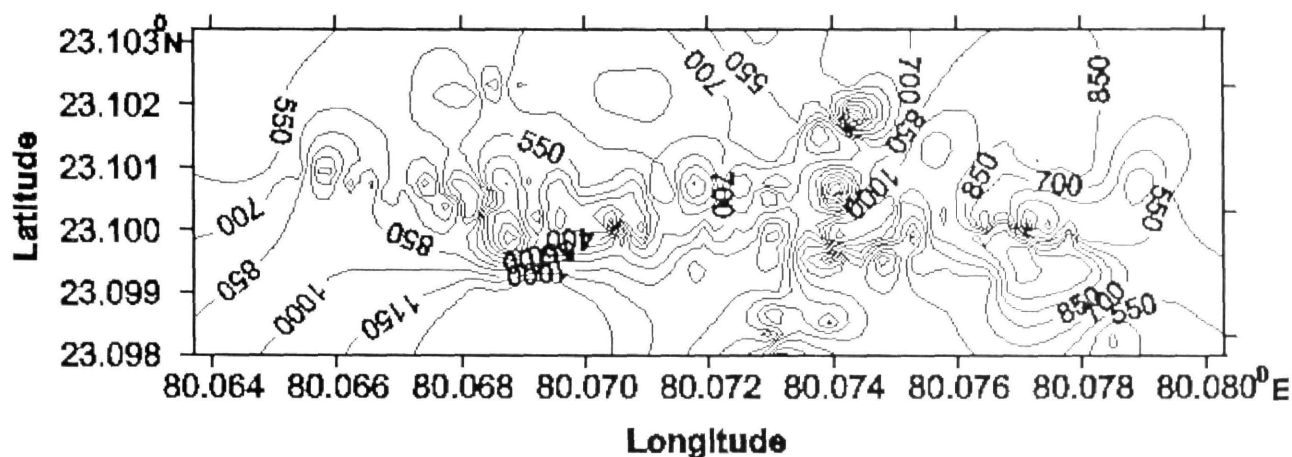


Fig.5. Contour map of the total field magnetic anomaly over the study area, contour interval 150.0 nT.

deployed for diurnal variation, recording at the regular interval of 20 minutes. The area was too small to account for the change in ambient magnetic field hence, the IGRF correction was ignored. The Werner deconvolution technique (Werner, 1953) has been applied to obtain the basement depths in the region.

DATA PROCESSING

Gravity Anomaly

A gravity base station was established in the survey area taking Jabalpur railway station as the primary base station having absolute gravity 978729.01 mGal (Qureshy and Warsi, 1972). The data acquired at close spacing is reduced after applying all the routine corrections. In Bouguer correction the rock density was taken as 2.92 g/cc, which was evaluated using rock samples from the area of

investigation. Since the variation in Bouguer anomaly (Fig.3) was not of the order expected over vents, hence no further interpretation of Bouguer anomaly is given. However, relatively high gravity values are observed over these circular features.

Magnetic Anomaly: Werner Deconvolution

We have taken three E-W profiles (viz. AA', BB' and CC') and two N-S profiles (viz. DD' and EE') in the survey area shown in Fig.2. We apply the Werner deconvolution technique (Werner, 1953), which is very useful and simple for preliminary interpretation of the potential field data, for isolated bodies. The technique is based on the assumption that the source is vertical thin dyke; however, it can be applied for other types of bodies as well, assuming that the body is made up of several thin dykes. Usefulness of the method is expanded by the fact that the horizontal gradient

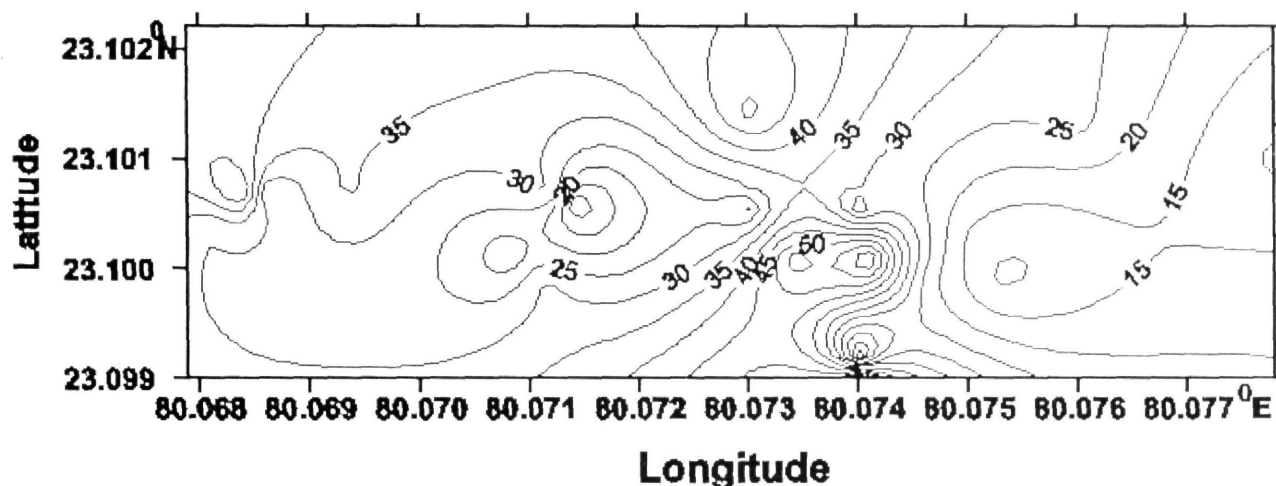


Fig.6. Basement depth contour map of the study area, contour interval 5.0 m.

of the total field caused by the edge of a thick interface body is equivalent to the total field from a thin dyke. Also, this technique does not require any initial model for the interpretation (Ku and Sharp, 1983, Jain, 1976, Hartman et al 1971). Seven point Werner deconvolution operator has been used for the analysis of the profiles shown in Fig 4. The seven point operator reduces the noise and other interference effects.

RESULTS AND DISCUSSION

The order of variation in gravity anomaly does not support any significant anomalous feature present in the area. It is noticed that the variation in gravity anomaly in close vicinity of the reported vents ranges from 0.2 to 0.6 mGal. There is no signature of any isolated high gravity anomaly source, which is normally expected over the volcanic vents.

A steep gradient has been observed in the total field magnetic anomaly of short wavelength. The order of the anomaly is about -900 to 1400 nT, which is possible in some highly magnetized terrain viz., basalts, kimberlites etc. Profiles passing through the circular features and their proximity exhibit a sinusoidal pattern of the magnetic anomalies (Fig 4). Contour map of the total field magnetic anomaly has been shown in Fig 5, which shows that there are no isolated or elliptical magnetic anomalies that can be attributed to the presence of deep seated magma or the so called volcanic vents. The basement contour map has been

prepared from the depth values obtained by the Werner deconvolution technique. The basement depth contour map (Fig 6) depicts the depth of the interface between granitic basement and the overlying basaltic column, which varies from 50 to 750 meters. The basement depth values obtained beneath the three circular features marked as X, Y and Z (Fig 2) is 51.7, 57.6 and 75 m respectively. These features are considered here as shallow because none of these indicate great depth, as expected in case of volcanic vents. Also, the absence of an isolated or elliptical magnetic anomaly over these morphological features defy the presence of deep seated magnetic sources. Hence gravity and magnetic study does not support the occurrence of volcanic vents in the study area. Geologically these bodies could be fissures in the tholeiitic flows, dyke swarms or feeder dykes (Mahadevan and Subbarao, 1999, Subbarao and Hooper 1988) along the deep-seated fault passing through Jabalpur (Kaila et al 1989) and possibly would have, acted as a pathway for fissure eruption.

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