

Offshore extension of the structural element at Udipi, confirmation from marine magnetics

V. SUBRAHMANYAM

National Institute of Oceanography, Dona Paula, Goa 403 004

Abstract

The isomagnetic anomaly map (1:3,00,000) reflects conspicuous E-W, NW-SE, WNW-ESE, NE-SW and N-S trends which are similar to that of the onshore Dharwar trend. The map also shows short wavelength, high amplitude anomalies off Coondapoor, broad wavelength anomalies off Mangalore and relatively smooth zone further south to Kasaragod. A prominent WNW-ESE structural element (fault) south off Coondapoor is observed in the three eastern profiles (A-A', B-B' and C-C') which was not reflected in the western profiles (D-D', E-E' and F-F') and this can be extrapolated towards the adjacent coast to join an onshore structural element trending in the same direction. This structural element perhaps represents the offshore extension of the fault at Udipi. The broad wavelength anomalies off Mangalore and Malpe may be generated from sources composed at a depth of around 4 km. The observed magnetic smooth zone south off Mangalore is interpreted in terms of insignificant magnetization contrast in the crystalline basement.

INTRODUCTION

The western continental shelf of India is divided into four sedimentary basins i.e., Kutch, Bombay, Konkan and Kerala (Ramaswamy and Rao, 1980). The present study deals with the middle part of the Konkan basin (off Coondapoor up to Kasaragod) and is shown in Figure 1. The shelf in this region is about 90 km wide and the shelf-break occurs at about 200 m depth and the slope of the shelf is about 6°.

Absolute total magnetic data were collected with Barringer Oceanographic and EG & G Geometrics magnetometers during 1982-83 along six tracks (totalling 1100 line km) parallel to the coast between 30 to 100 m depth (Fig. 2) in the cruises of *RV Gaveshani* *MV Skandi Surveyor* and *MV Farnella*. The positions during the surveys were obtained by Magnavox Dual Channel Satellite Navigation system (Mx. 1107-Rs)

GEOLOGICAL BACKGROUND

The geological formations on the adjacent land to the east of the survey area are Dharwar schists (2,500 m.y.), granites, gneiss-migmatite complex (Peninsular Gneisses) and charnockites (Radhakrishna and Vasudev, 1977). The rocks are associated with various types of ortho-gneisses and schists and lavas of dioritic or basaltic composition. A number of tiny rocky islands and submarine banks are reported in the offshore regions of Udipi (St. Mary Islands), Coondapoor and Bhatkal (Pigeon Islands) and further north up to Karwar. Some of these islands have an elevation of about 70 m above MSL and are covered by basalts (Hari Narain, *et al*, 1968; Valsangkar, *et al*, 1981). The tectonic features reported earlier on the adjoining land (Eremenko and Gagelganz 1966; Ray, 1972; Srinivasan and Sreenivas, 1977; Balakrishna and Sharma, 1981 and Venkataramana, 1983) are shown in Figure 3.

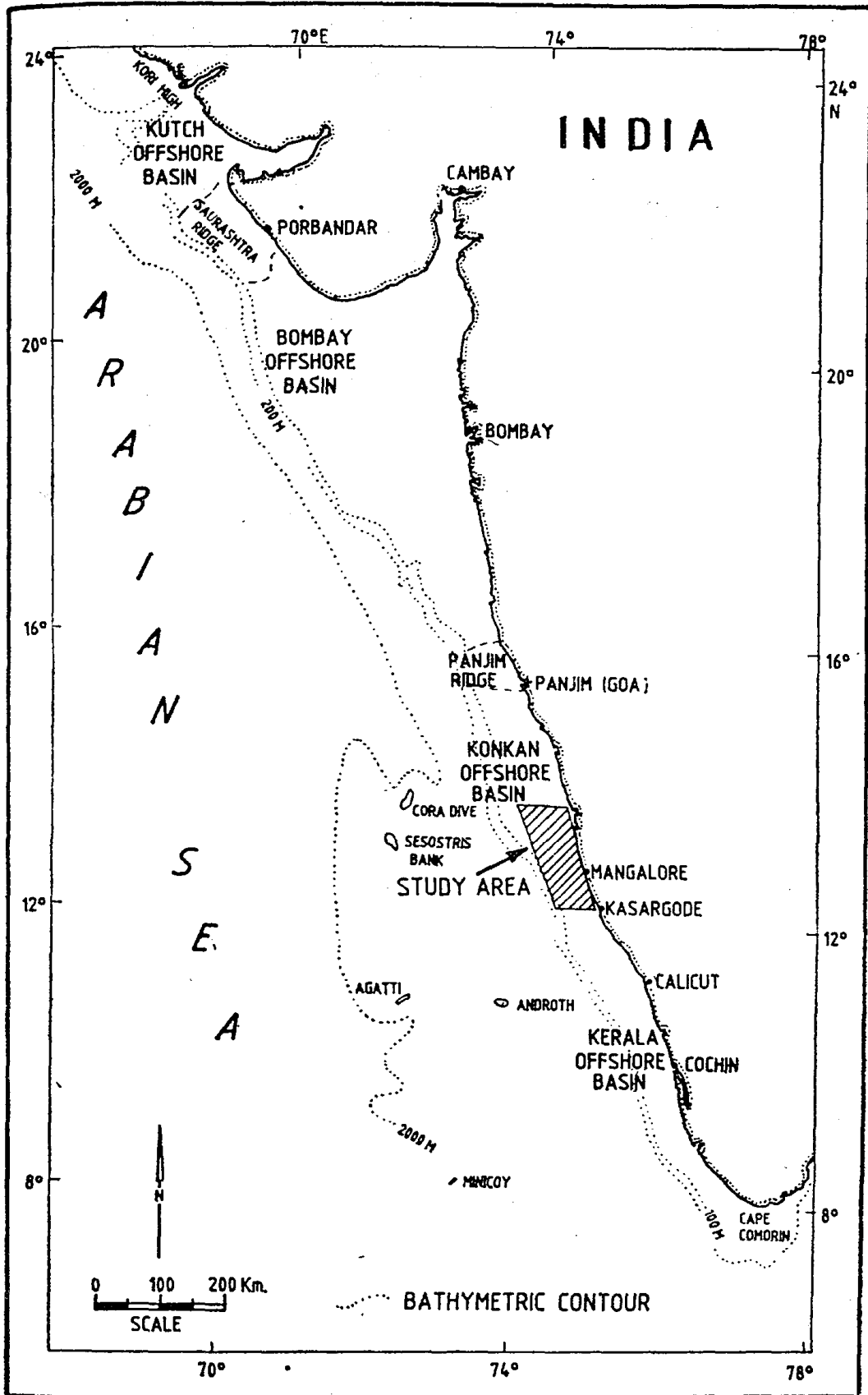


Figure 1. Map showing the different sedimentary basins along the west coast of India (after Ramaswamy and Rao, 1980) and the shaded portion indicates the study area.

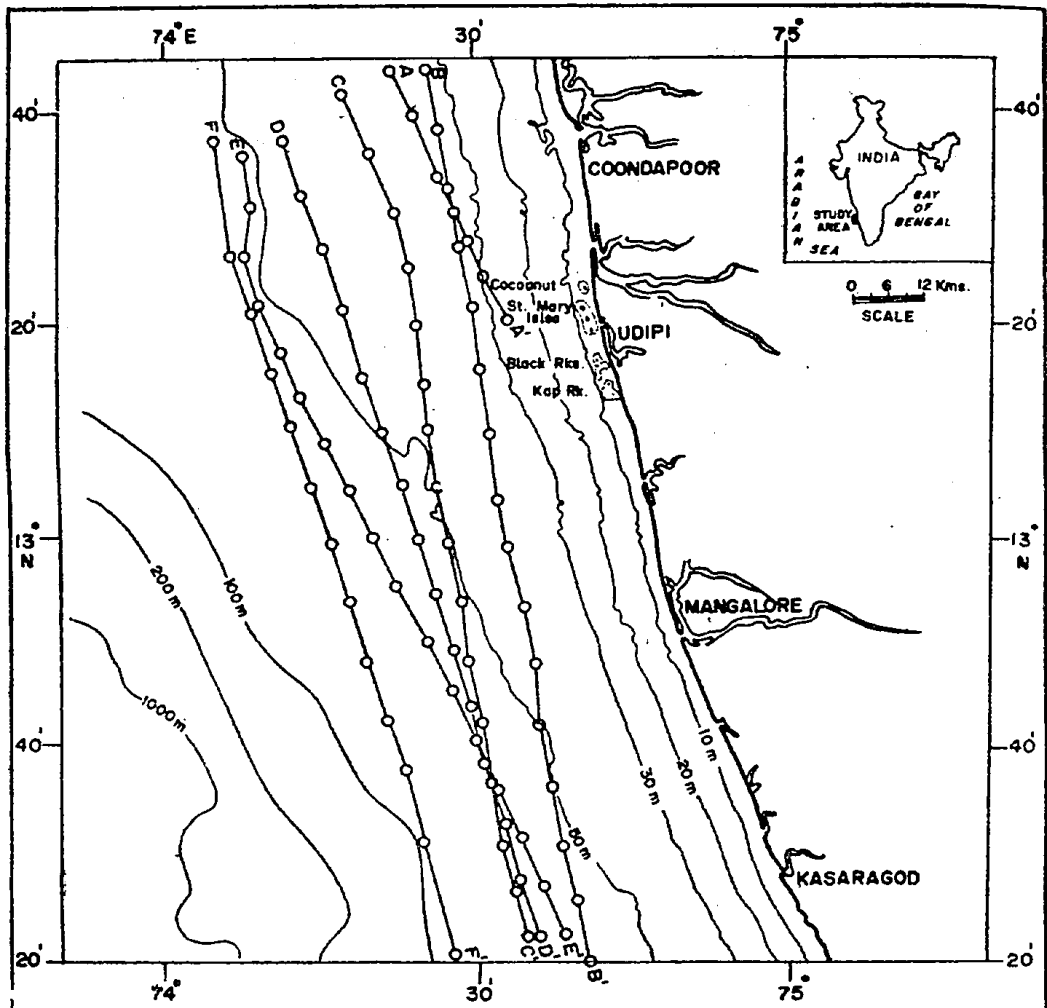
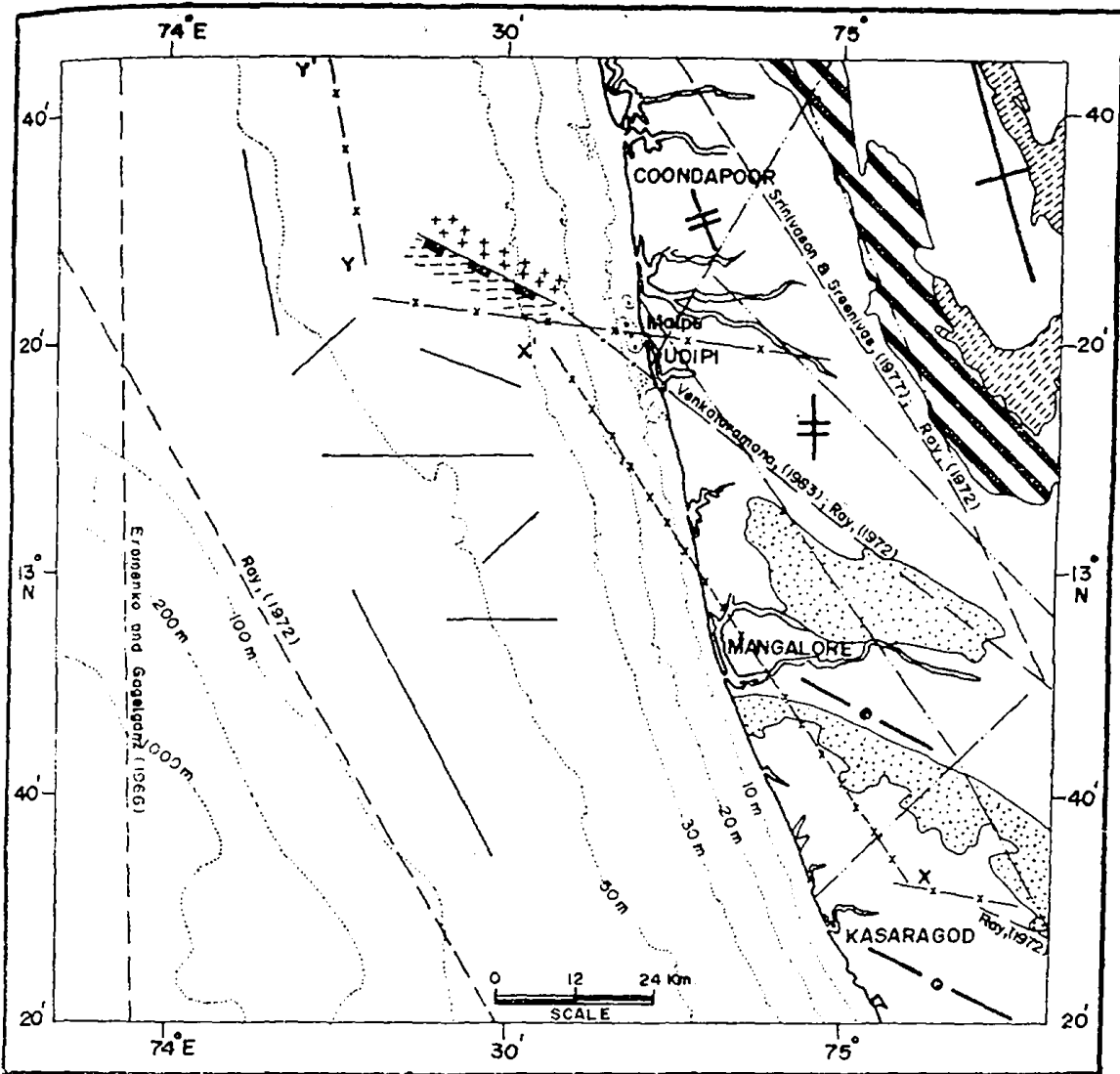


Figure 2. Map showing the tracks surveyed and the bathymetry.

METHOD OF STUDY

The absolute total magnetic intensity values were measured by towing the sensing head behind the vessel at a distance of 180–200 m in order to avoid the vessel's stern effects. The data were recorded at a sampling rate of 2 sec, while the observed magnetic values were digitised for every 600 m. The residual field was obtained by subtracting the International Geomagnetic Reference Field (1982) from the observed magnetic data. Magnetograms during the survey period showed no higher amplitudes in the daily magnetic field (ranges between -40nT and -60nT). Hence, the diurnal variations during the survey period were considered negligible in comparison with the observed data. The stacked total magnetic residual anomalies were plotted along the tracks (Fig. 4). Isomagnetic anomaly map was prepared at a contour interval of 100 nT (Fig. 5) on 1 : 3,00,000.



LEGEND














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|--|--|---|--|
|  | Charnockite |  | Probable extension of the structural element |
|  | Chitradurga Group |  | Trends inferred from the present study |
|  | Bababudan Group |  | Landsat Imagaries (Srinivasan and Sreenivas, 1977) |
|  | Older granite gneiss migmatite complex (Peninsular gneiss) |  | Shallow basement (around 1K.m.) |
|  | Structural Element (Present study) |  | Deeper basement (around 3K.m.) |
|  | Areas of Eastern Ghats folding (Ray, 1972) |  | Major faults (Balakrishna and Sharma, 1981) |
| | |  | Areas of Dharwar - Iron ore - Aravalli folding (Ray, 1972) |

Figure 3. Map showing the land geology (after B. P. Radhakrishna and Vasudev, 1977) and tectonic features.

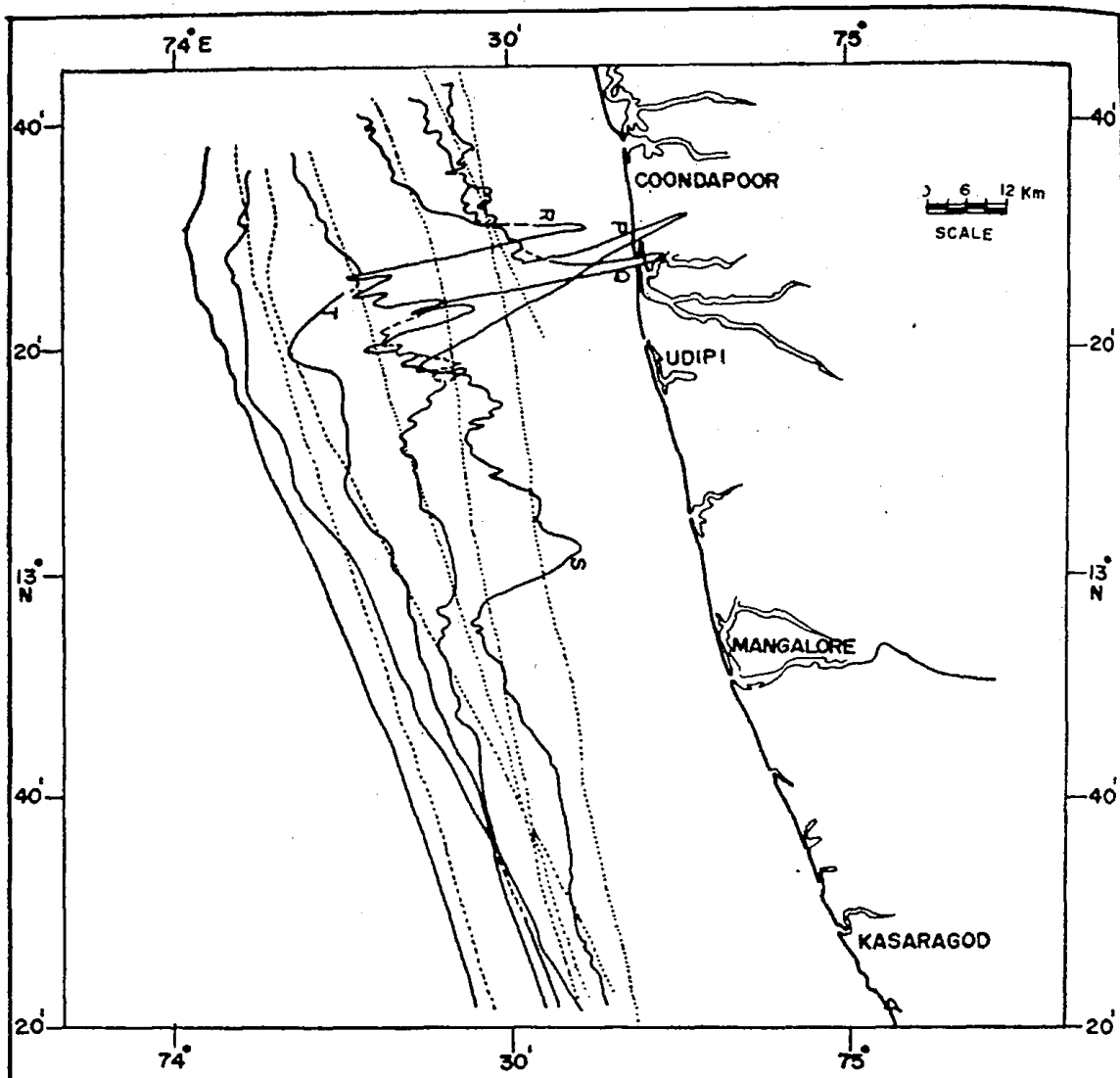


Figure 4. Map showing the residual total field along the the tracks surveyed.

RESULTS AND DISCUSSIONS

The isomagnetic anomaly map (Fig. 5) reveals E-W, NW-SE, WNW-ESE, NE-SW and N-S trends similar to the Dharwar trend on the adjacent land mass suggesting a probable extension of the trends offshore. The anomaly map has been divided into two zones for qualitative and quantitative interpretation. Figure 4 shows that the near-shore profiles are characterised by high frequency and short wavelength (1.5-2 km) anomalies followed by a very prominent high amplitude magnetic anomaly (3,500 nT), a broad wavelength anomaly in the middle of the profiles B-B and D-D and towards south off Mangalore, a magnetic smooth zone which is characterised, in general, by anomaly amplitudes of ± 20 to 60 nT in contrast to typical value of ± 500 to 1800 nT in the disturbed zone. The offshore

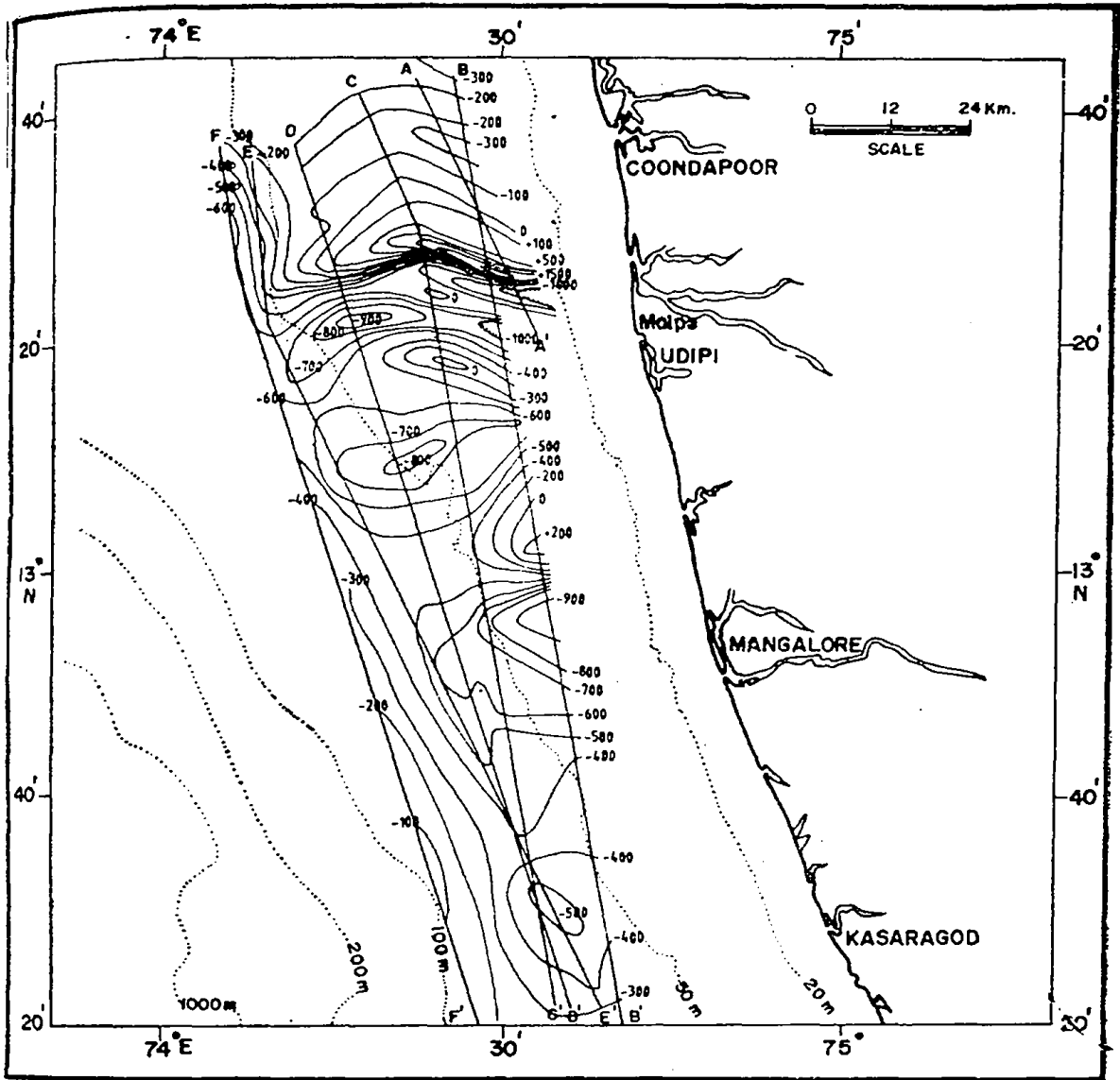


Figure 5. Map showing the isomagnetic anomaly contours (contour interval 100 nT).

magnetic profiles show a relatively smooth zone suggesting that either the basement is deeply buried or the magnetization contrast is minimum to give rise to any magnetic anomaly. No significant correlation exists between the magnetic anomalies and bathymetry.

Five anomalies marked as P.Q.R.S. and T (Fig. 4) were chosen for quantitative interpretation (Peter, 1949; Qureshi and Nalaye, 1978; Atchuta Rao and Ram Babu, 1983) and the results are shown in Table I. The anomalies P, Q and R are trending WNW-ESE and terminating approximately at 50 m water depth. The high amplitude anomaly (3,500 nT) is interpreted as the effect of intrusion of mafic material occupying a weak zone at a shallow depth. Valsangkar, (1980) reported

TABLE I. Results of Quantitative Interpretation of the Magnetic Anomalies P, Q, R, S and T.

Anomaly No.	Depth to the top of the block (km)	Vertical thickness of the block (km) (Qureshi and Nalaye, 1978)	Depth to the source (km) (Peter, 1949)	Depth to the source (km) (Atchuta Rao and Ram Babu, 1983)
P	0.980	2.9	—	—
Q	0.990	3.0	—	—
R	1.2	3.0	—	—
S	—	—	4.0	4.1
T	—	—	4.1	4.2

similar material exposed on Daryabahadurgarh Island and the St. Mary Islands. Anomalies S and T are characterised by broad wavelengths with high amplitudes of the order of 1,200 nT. Since these two anomalies generated at deeper source are separated by a considerable distance, no prominent trend has been observed. The dominant trends noted from the isomagnetic anomaly map (Fig. 5) are E-W, NW-SE, WNW-ESE, NE-SW and N-S. E-W, NW-SE, WNW-ESE, NE-SW and N-S structural trends have been notified both onshore and offshore. The major structural element trending WNW-ESE may be the offshore extension of the onshore feature. This major structural feature has been interpreted as a fault zone with its down throw towards south west. Balakrishna and Sharma, (1981) from their geophysical studies inferred that the west coast fault is sheared with offsets. The structural feature (fault) Y-Y' trending approximately N-S in the offshore perhaps form the western boundary for the presently inferred structural element. The present inferred structural feature may be the offset of the major structural features (faults) X-X' and Y-Y'.

The results indicate a shallow basement north off Udipi and deeper basement south off Udipi (Fig. 3). Inferred shallow basement north off Udipi is well supported by the deep seismic sounding observations along Kavali to Udipi (Kaila *et al.*, 1979) with the basement exposed at Udipi, due east of the present study area. To the north of the study area (off Ratnagiri), the magnetic source (basalts) noticed at a depth of 1-1.4 km has also given rise to the same kind of short wavelength magnetic anomalies (Gopala Rao, 1984). The magnetic anomalies off Mangalore and Malpe are generated by a magnetization contrast at an approximate depth of 4.2 km., matches well with the basement computed (Hari Narain *et al.*, 1968). Valsangkar *et al.* (1981) reported that the Hog and Pigeon islands and St. Mary's islands comprise of basalts. The high amplitude and broad wavelength positive anomalies may indicate basalt at greater depths.

The absence of high amplitude anomalies in the offshore profiles (E-E' and F-F') may indicate that the magnetic source lies deeper or the magnetization contrast is insignificant with the surrounding formations.

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