

# A note on the occurrence of ortho-amphibolites on the inner shelf off Bhatkal, West Coast of India

H. N. SIDDIQUIE, S. M. KARISIDDAIAH AND V. SUBRAHMANYAM  
National Institute of Oceanography, Dona Paula, Goa 403 004

## Abstract

The total magnetic intensity map of the area shows that the inner shelf to a depth of 50 m is marked by a zone of magnetic closures. The occurrence of offshore ortho-amphibolites and the qualitative interpretation of the magnetic map indicate the extension of onshore rocks (or the amphibolites and associated rocks of Precambrian (?) and intrusions of Deccan Trap age) under a thin cover of sediments to the offshore to a depth of about 50 m.

## INTRODUCTION

The geology of the continental shelf is to a large extent the extension of the onshore geology. As a part of an R and D project, N.I.O. has been carrying out systematic surveys of the continental margins of India at a spacing of 20 km with sampling at 10 km interval or at locations of geological interest. These surveys comprise of echosounding, side scan sonar, shallow seismic profiling and magnetics followed by sampling. The total magnetic data was collected with a Barringer Oceanographic Proton Precision Magnetometer by towing the sensing element at a distance of 200 meters behind the vessel in order to avoid the ship's stern effects. The data were recorded at a sampling interval of 12 seconds,

## GEOLOGY OF SHELF AND ADJOINING SHORE

The coast from Honavar to Mangalore is dotted by islands (Netrani and St. Mary) and shoals (Indravati, Nancowry, Gangoli, Mulki and Surathkal) (Fig. 1) *Research Vessels Gaveshani, Sagar Kanya and chartered vessels (MV Farnella and Skandi Surveyor)* carried out geophysical surveys (echosounding, side scan sonar, shallow seismic profiling and magnetics) on the shelf in this region (Fig. 2). The echograms and side scan sonar records collected during Cruise 71 of *R. V. Gaveshani* showed that the seabed in the area is marked by even topography (Fig. 3a) and devoid of significant features except where rocks outcrop. The shallow seismic profiles of the area show that the inner shelf is largely covered by 5 to 10 m thick clays (Fig. 3 b). The clays cover a highly dissected uneven topography marked by numerous channels. An examination of the underway records (echograms and seismics) showed a prominent rock outcrop (Fig. 4) with a relative elevation of 5 meters. A significant magnetic anomaly of 1000 nT was observed over the rock outcrop (Fig. 5). The location was dredged and large quantity of rock samples were collected.

To the east of the study area in the South Kanara District, the Archaean gneissic complex, together with metasediments is intruded by pegmatite and quartz veins, metabasalts, metagabbro, sills of Precambrian age and dolerite dykes of Deccan Trap age. In the southern part of the South Kanara district, pyroxene granulites and charnockites with remanent patches of amphibolites, hornblende

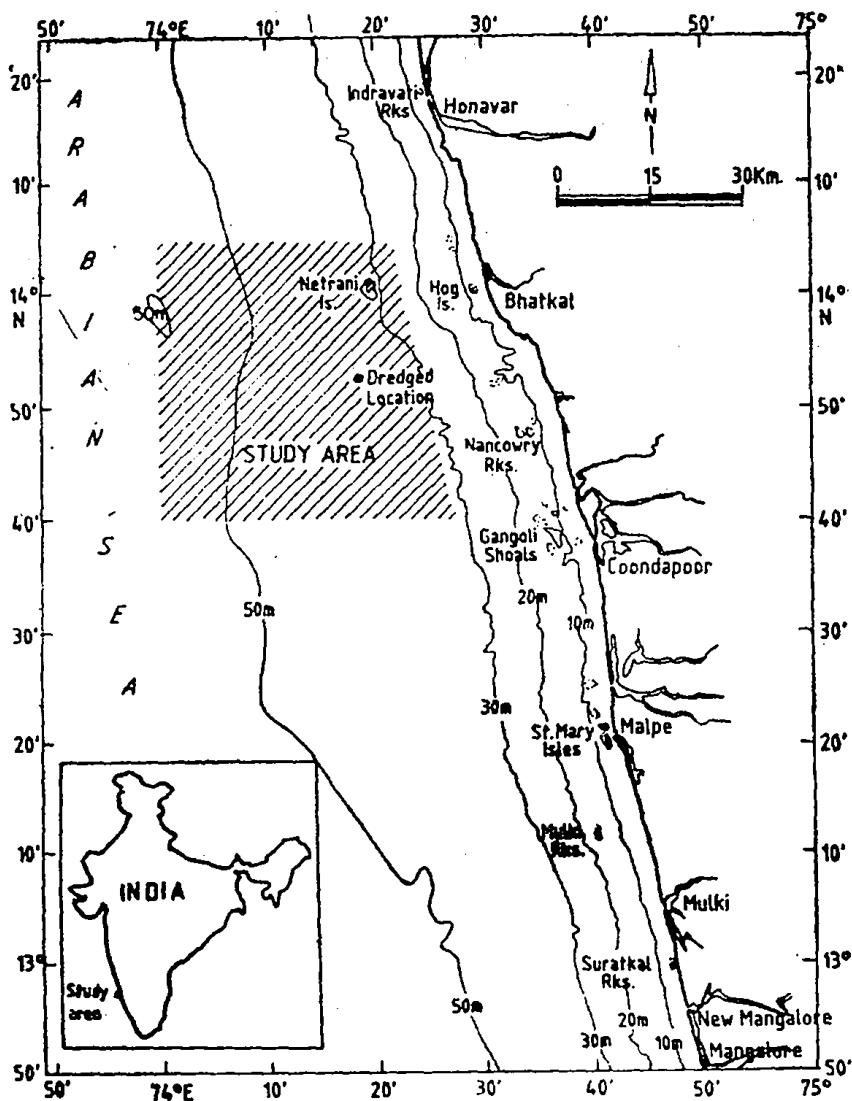


Figure 1. Sketch map showing the location of study area and the dredged locations along with shoals and islands along the coast.

schists, mica schists, talc chlorite schists, ferruginous quartzite and banded magnetite quartzite are reported. These rocks are intruded by pegmatite and basic dykes (Iyengar and Balasubramanian, 1967; Gopal Rao and Balasubramanian, 1970). Naganna (1966) has reported that the rocks of St. Mary Islands (situated to the south of the study area) consist of dacite, rhyodacite and granophyre, showing close similarity in texture, mineralogy and petrochemistry to similar rocks described from Salsette and Bassein near Bombay. The igneous activity on the St. Mary Islands is considered to be related to the Deccan Traps (Cretaceous-Tertiary, 93 m.y.) (Valsangkar *et al.*, 1981).

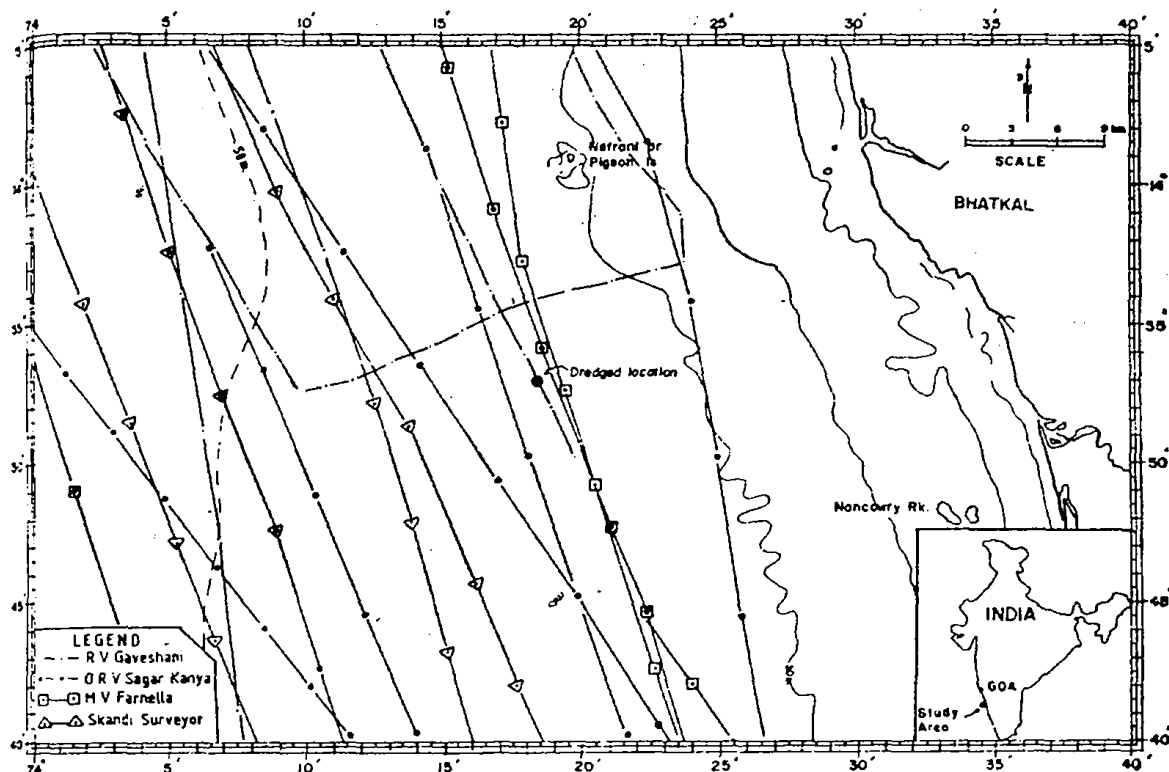


Figure 2. Map showing the tracks surveyed.

### PETROGRAPHY

The rocks collected from the dredge samples are dark greenish-brown to brown, often enwrapped with biogenic material, especially shells. Some samples were friable and showed reddish-brown colour which may be due to intense alteration.

Under the microscope, the rocks are colourless to green, coarse-grained, non-foliated, inequigranular, uralitised and invariably altered or slightly metamorphosed. Most of the sections cut from fresh rock samples consist of actinolite, plagioclase together with epidote, chlorite, garnet, magnetite, hematite, quartz, relic pyroxene, zircon and leucoxene. Hornblende is occasionally seen which is deeply pleochroic from yellow to green, and is seen both as big plates and also as tiny euhedral crystals. Sometimes hornblende is seen restricted to borders with a core of pyroxene (augite). Often hornblende encloses plagioclase simulating a relic subophitic texture (Fig. 6a). Plagioclase feldspar is Ca-poor ( $An \sim 25$  to 35%), and is mostly saussuritised, kaolinised, bent (Fig. 6b) and corroded. Often the plagioclase is traversed by veins of later actinolite. Occasionally droplets of quartz are seen within plagioclase. Garnet (Fig. 6c) is seen both as tiny euhedral crystal aggregates, and also as shattered irregular porphyroblasts. These garnets are of almandine type. Epidote is restricted to veins and within altered plagioclase. Zircon often exhibits pleochroic haloes within amphiboles. In addition to ubiquitous magnetite and hematite, rarely titaniferous magnetite is seen changing over to leucoxene. The occurrence of ortho-amphibolites in the offshore areas indicate a probable extension of onshore rocks.

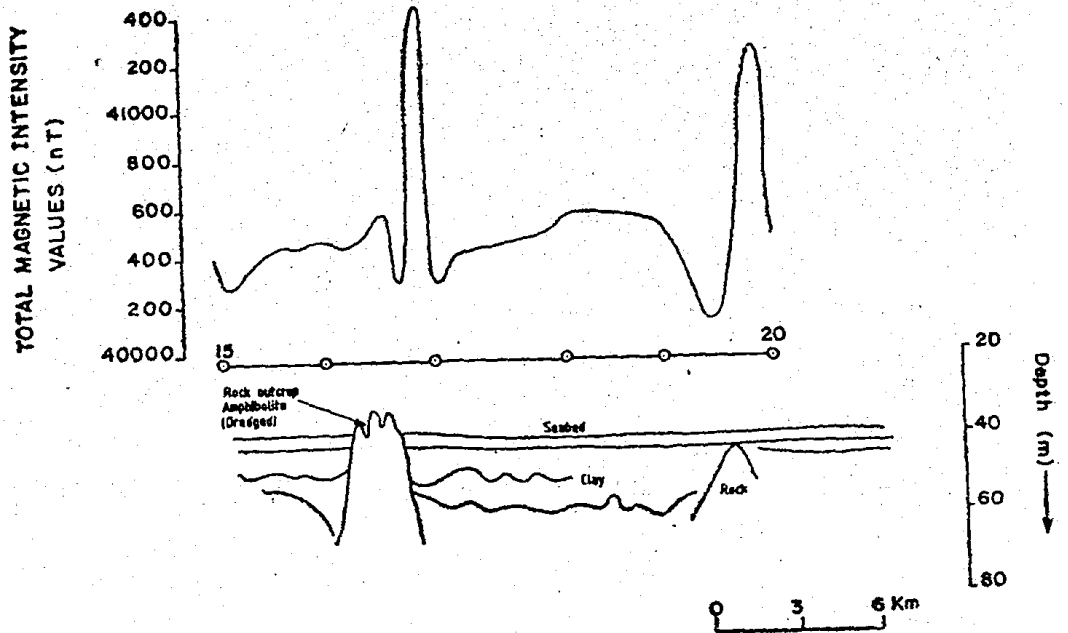


Figure 5. Total magnetic signature over the seismic section of the dredged area.

#### MARINE MAGNETIC STUDIES

A total magnetic anomaly map was prepared with contour intervals of 100 nT in areas of higher magnetisation and 50 nT in areas of lesser magnetisation (Fig. 7). The anomaly map shows ENE-WSW trending magnetic closures. Qualitative study of the anomaly map indicates that the anomaly signature is bipolar in nature with a width of 9 to 10 km. A magnetic anomaly of the order of 1000 nT with a wave length of 1.5 to 2 km was noticed over the dredged location (Fig. 5) which may be due to highly magnetised material. The variable widths (2-10 km) and the bipolar nature of the magnetic anomalies does not correspond to the configuration of a dyke. It could be a mafic intrusion. Petrographic studies indicate a mafic intrusive body.

Further south of the study area (Subrahmanyam; *in press*) a high amplitude magnetic anomaly of the order of 3000 nT was noticed and was interpreted as due to

#### EXPLANATION OF FIGURES

- Fig. 3. (a) Even topography of the area (Echogram), (b) Seismic (ORE) record showing clay thickness.
- Fig. 4. Echogram and Seismic (ORE) record showing the amphibolite rock outcrop (dredged).
- Fig. 6a. Thin section showing relic subophitic texture  $\times 25$ .
- Fig. 6b. Thin section showing bent plagioclase  $\times 25$ .
- Fig. 6c. Thin section showing euhedral garnet crystal, cracked and chloritised  $\times 25$ .

FIG. 3a

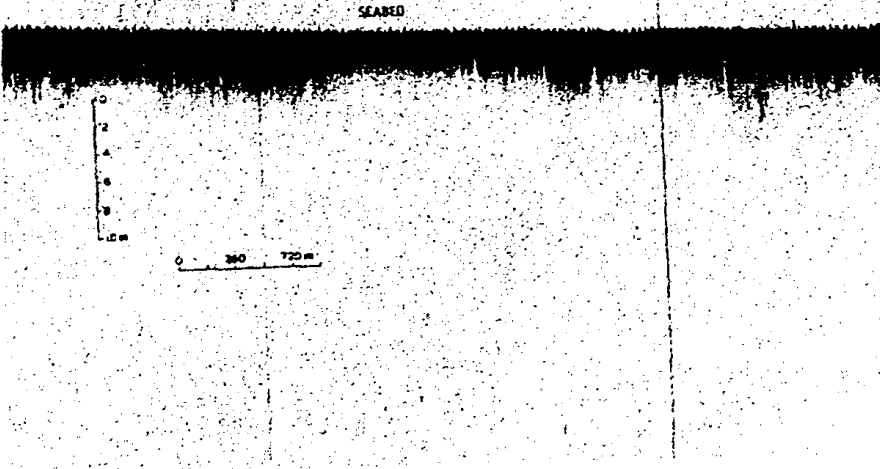
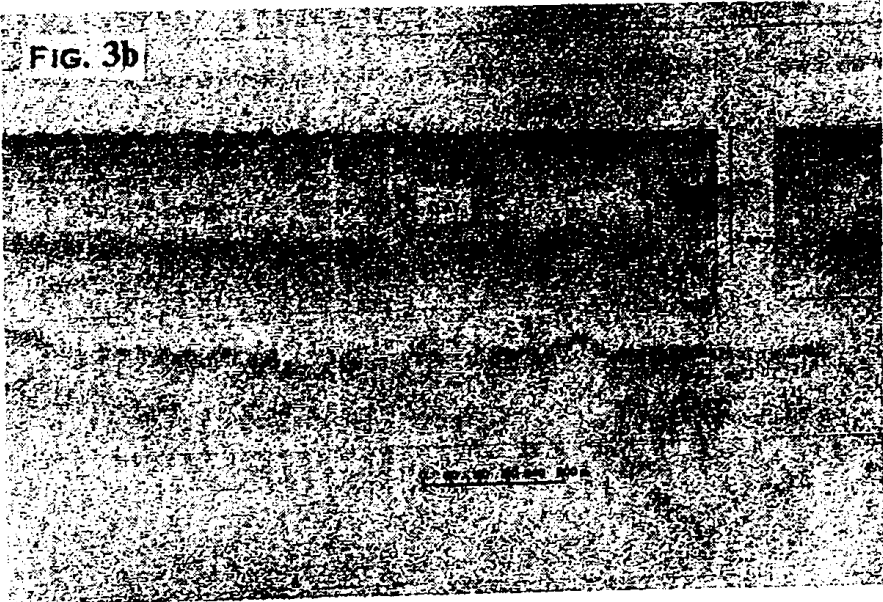


FIG. 3b



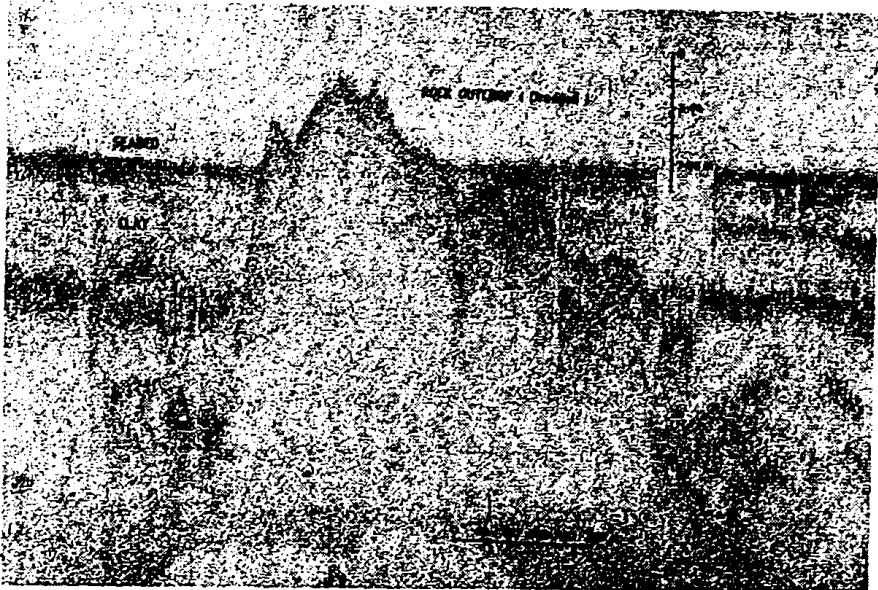
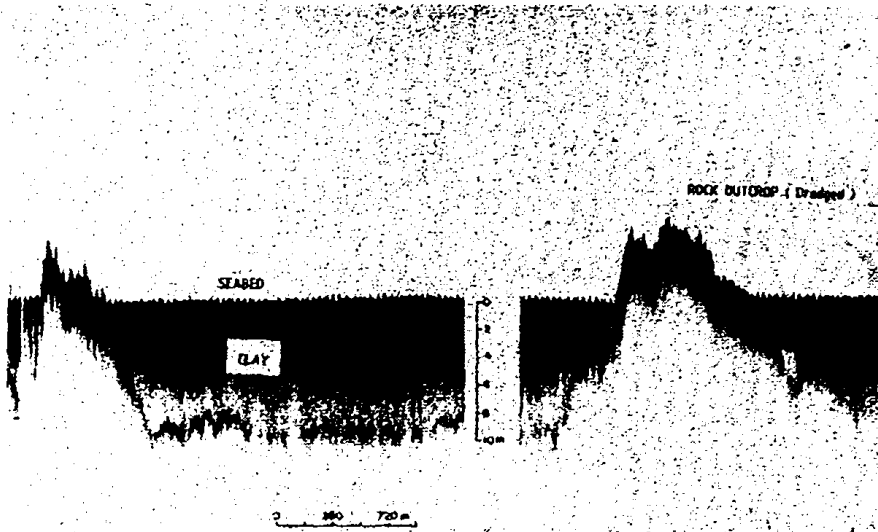


FIGURE 4

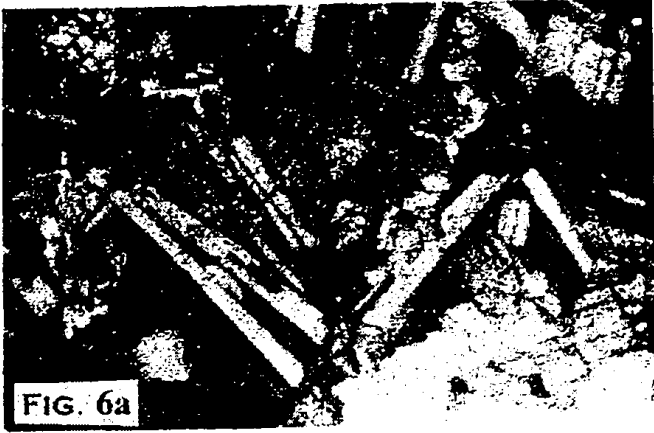


FIG. 6a



FIG. 6b



FIG. 6c

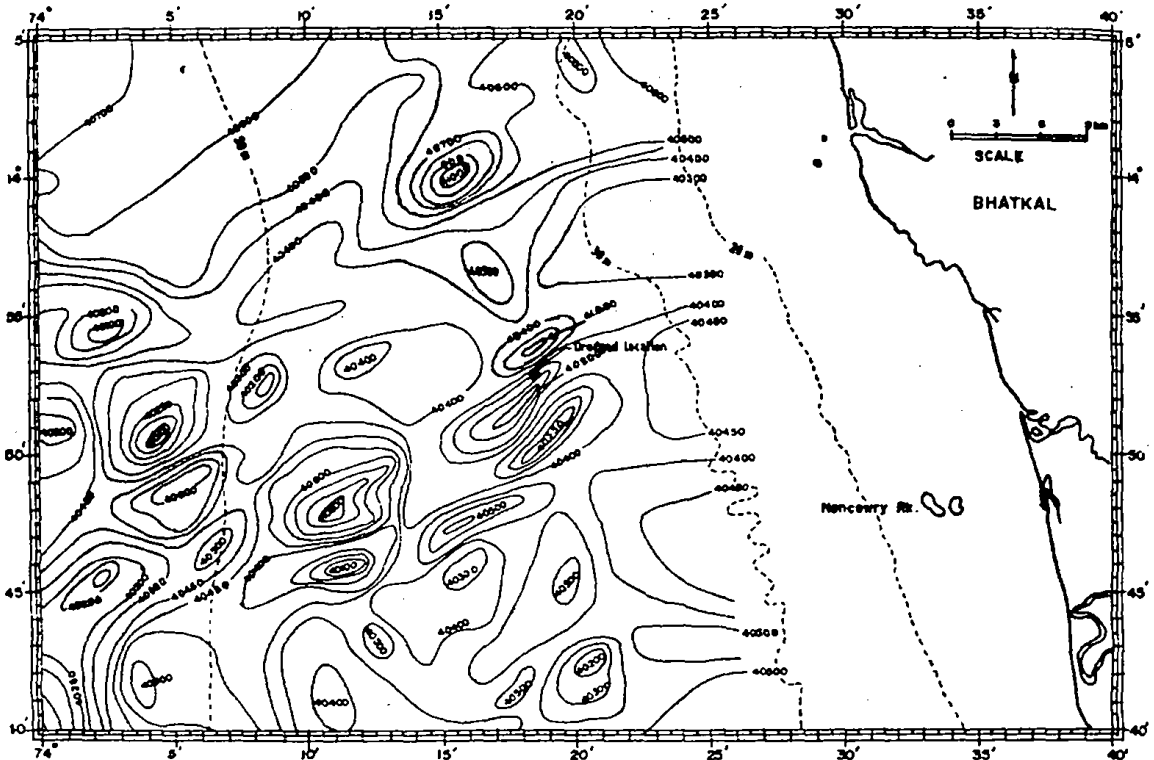


Figure 7. Map showing the total magnetic intensity values in the area surveyed (contour interval 50 nT to 100 nT).

mafic volcanic material. St. Mary Islands which are genetically related to the Deccan Trap igneous activity are situated 12 km southeast of this high amplitude anomalous zone. The magnetic anomaly map of the area shows number of magnetic closures similar to ones observed over the dredged location. It is inferred that the magnetic closures in the area may be due to the extension of onshore rocks with a thin cover of sediments.

#### References

- GOPAL RAO, B. and BALASUBRAMANYAN, M. N., (1970) Director General's Report. Rec. Geol. Surv. India, v. 101(1), pp. 261-262.
- IYENGAR, B. R. C. and BALASUBRAMANYAN, M. N., (1967) Director General's Report. Rec. Geol. Surv. India, v. 99(1), pp. 64-65.
- NAGANNA, C., (1966) Petrology of the rocks of St. Mary Island, near Malpe, South Kanara District, Mysore State. Jour. Geol. Soc. India, v. 7, pp. 110-117.
- SUBRAHMANYAM, V., (1987) Offshore extension of the structural element at Udipi, confirmation from marine magnetics. Jour. Geol. Soc. India, v. 29, pp. 256-263.
- VALSANGKAR, A. B., RADHAKRISHNAMURTHY, C., SUBBARAO, K. V. and BECKINSALE, R. D., (1981) Palaeomagnetism and potassium-argon age studies of acid igneous rocks from the St. Mary Island. Mem. Geol. Soc. India, No. 3, pp. 265-276.

(Received: August 11, 1986; Revised form accepted: Jan. 8, 1987)