Indira Mount — An Underwater Mountain in the Antarctic Ocean

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ABSTRACT

A major topographic high on the seabed at 53° 39.79' S and 47° 55.82' E was discovered during the First Indian Expedition to Antarctica.. This has been named. "Indira Mount". The mount rises from a depth of about 4500 m to about 1200 m and has a number of peaks. One of these peaks rises to within 880 m of the sea surface. The apparent width of the mount at the base appears to be about 185 km and at the summit it is about 134 km. The mount is associated with a composite magnetic anomaly of the order of 1000 gammas. The multiple peaks and high magnetic anomalies indicate that the mount is largely composed of volcanic rocks and perhaps the pile of lava did not reach the surface. Magnetic data indicate heterogeny in the magnetic property of the mount perhaps due to more than one episode of volcanic activity.

The limitations in the data collected along a single track do not permit the demarcation of the extent of the feature. However, in all probability the data suggest that it is not recorded before or may belong to an extensive submarine mountain range. The discovery of this hitherto unreported seamount will have an important bearing on the geological history of the Antarctic Ocean;

INTRODUCTION

The knowledge of the depths of the sea is basic for all oceanographic research and development. The topography of the seabed, to a large'extent, reflects the structure, tectonics and geological history of the seabed. With increasing interest in marine, research and surveys, large areas of the seabed have been charted and the bathymetry and morphology of the ocean floor is becoming fairly well known today. However, some areas particularly those which are relatively inaccessible, as these are not on the regular shipping routes, have not been properly charted. Such areas include the seas around Antarctica.

The First Indian Expedition to Antarctica had carried out extensive echosounding from the ship MV *Polar Circle* covering more than 17000 line kilometres. The data are still being analysed. However, continuous monitoring of the echosounding records during the expedition led to the identification of areas of immediate interest and the data for these regions have been analysed on a priority basis. The expedition daring its voyage from Mauritius to Antarctica recorded a topographic high which has not been previously reported (British Admiralty Chart No. 3171 and the Geological Geophysical Atlas of the Indian Ocean, 1975). The expedition team named this as *"Indira Mount"* after Shrimati Indira Gandhi, the Prime Minister of India.

RESULTS

Bathymetry

The echograms of the voyage from Mauritius to Antarctica show a complex topography of the South West Indian Ridge, This is followed by a relatively even topography of the Crozet basin, the Crozet plateau and then a uniformly plain topography of the South Indian Ocean Basin. Within this plain and even topography, from a depth of about 4500 m, rises a hitherto unreported topographic high at latitude 53°39.79'S and longitude 47°55.82'E. The details of the topographic high are shown in Figs. 1 & 2. The northern flank of the high rises to about 1240 m and the southern flank to about 1480 m below the sea level. The'topographic high has multiple peaks with a relative elevation of 40 to 1400 m from the base of the summit and one of these peaks reaches to 880 m below the sea surface. The apparent width of the high at the base is about 185 km and at the top 134 km. The flanks of the mount are fairly steep, the apparent slope ranges from 1:25 to 1:3.7 in the north and 1:6.5 in the south (see Fig.3). The topographic high is marked by a depression at the base of the southern flank which may possibly be caused by deep sea currents (Roberts, Hogg, Bishop and Flewellen, 1974).

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Fig. 1 : Map showing the bathymetry of a part of the Antarctic Ocean with the Indira Mount. The figure is based on sheet 7 of the bottom topography of the Indian Ocean in the Geological-Geophysical Atlas of the Indian Ocean (1975). 0-0, track of the First Indian Expedition to Antarctica; 0, satellite positions; fine dotted lines, tracks of the other vessels. Depths in metres are shown only in a part of the track.

Magnetics

Values of the earth's total magnetic field were obtained along the track from a Geometries marine proton precession magnetometer (model G 801/3) towed behind the ship. The analog data recorded on a strip chart recorder were manually digitized. The values of residual magnetic anomaly were calculated by removing the International Geomagnetic Reference Field (IGRF) for the 1981.9 epoch as a regional field. So far, the data on diurnal observations could not be obtained from the nearby magnetic observatories, and therefore, the diurnal corrections have not been incorporated in the data.

The magnetic data show (see Fig. 3) that, for about 150 km from the flanks of the seamount, the magnetic anomalies are relatively smooth. However, over the seamount, several large anomalies are present and the largest among them over the northern edge of the mount, has an amplitude (crest to trough) of more than 1050 gammas. These anomalies, in all probability, appear to be associated with the seamount and the anomalies of high amplitude indicate volcanic rocks occurring at shallow depths. The pattern of anomaly over the mount is complex and shows steep gradients at places and apparently the magnetics do not correlate with the topography over the summit.

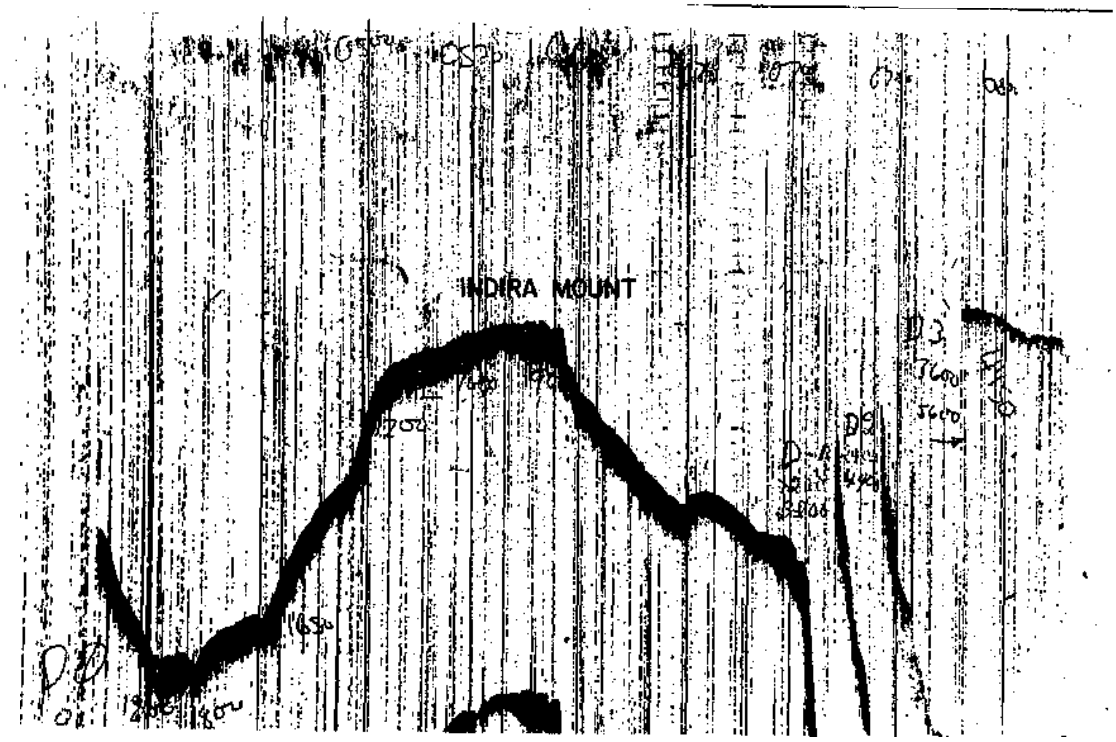

Fig. 2 : Photographic of the original echogram of the Indira Mount. Depths are also marked on the record.

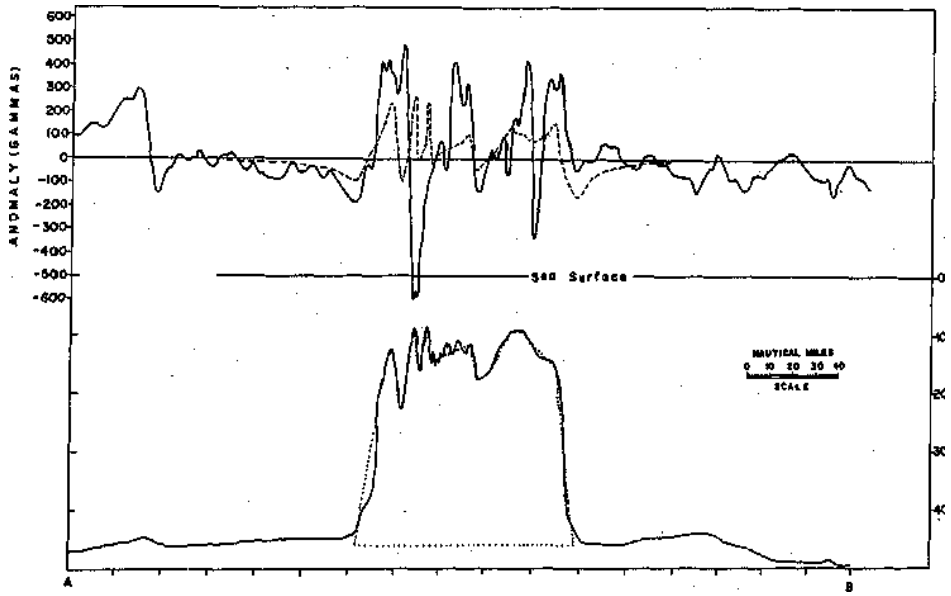

Fig. 3 : A simplified cross section (A to B) of the Indira Mount with its associated magnetic anomalies. Both observed and computed anomalies have been shown in the figure. In the top figure, solid lines show observed magnetic anomalies and broken line, computed-anomalies. In the bottom part of the figure, solid line gives the bathymetric profile of the Indira Mount. Dotted line shows the outline of the assumed body (see text).

An attempt has been made to compute the magnetic anomaly of the seamount with the following assumptions:

(i) The observed bathymetry along the track represents approximately the cross section of the features.
(ii) The seamount is magnetised by induction in the present magnetic field of the earth.
(iii) The axis of the feature is parallel to other similar features in the nearby area.

The available data along a single profile, restricts the scope for further assumptions. The computed anomalies along with the observed magnetic anomalies are shown in Fig. 3 in association with the simplified cross section of the Indira Mount. As can be seen from the figure, although a good fit could not be obtained between the observed and computed anomalies (with the assumptions noted above) the observations indicate that the magnetization over the seamount is rather heterogeneous and the seamount may represent the cumulative effect of more than one volcanic episode during different intervals.

DISCUSSION

Palmer (1966) defined a seamount as an isolated elevation of approximately 1000 m or more on the deep sea floor. Since the topographic high has a near vertical elevation of more than 3000 m from the seabed, it can easily be classified as a seamount. From its height and other features, it can be identified as one of the largest seamounts ever recorded. The largest seamount, presently known, is the Great Meteor Seamount found in the Atlantic. It has a base of 110 km and the area of its flat summit platform is more than 2,000 km^2 (Palmer, 1966).

During the Indian expedition, only one track could be surveyed. The lateral extension, therefore, of the topographic high (seamount) is not known. The tracks of the survey shown in the Geological Geophysical Atlas of the Indian Ocean (1975) indicate that the topographic high may not extend for a considerable distance to the north and south but its further extension to the east can not be ruled out. Unfortunately, upto a long distance towards the east, there are no cruise tracks (see Fig. 1).

The occurrence of major topographic feature such as this on the seabed with multiple peaks and high magnetic anomalies is indicative of an ancient volcano or a volcanic chain. The multiple peaks also indicate that the pile of lava did not reach the sea surface and possibly the volcanic activity was of an explosive type. The volcanic activity did not belong to one phase but probably to multiple phases. Seamounts are not usually randomly distributed. They occur in chains over hot spots, along fracture zones and trenches. The two research vessels *Lena* and *Ob* during the Soviet expeditions to Antarctica had discovered two seamounts which have been named after these vessels (Mal'tsev, 1964). These seamounts rise to about 250 m below the sea surface and are composed of volcanic rocks. The Indira Mount is situated about 100 km west of the *Lena* and *Ob* Seamounts and is almost located along the same alignment.

Its main features appear to suggest:

(i) that it is a new seamount
(ii) it forms a part of an extensive submarine mountain range
(iii) it is probably an extension of a chain to which *Lena* and *Ob* also belong.

Further surveys are necessary to obtain more details of the Indira Mount and its associated range. Undoubtedly it is a major topographic feature hitherto unreported. The discovery of such a large topographic high in this region is of considerable importance. It throws some light on the origin and history of the Southern Ocean. Therefore, it is suggested that intensive work should be carried out in future Indian expeditions to demarcate its extension.

ACKNOWLEDGEMENT

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