

21413

Offshore Structural Trends from Magnetic data over Cauvery Basin, East Coast of India

A.S. SUBRAHMANYAM, S. LAKSHMINARAYANA, D.V. CHANDRASEKHAR,
K.S.R. MURTHY AND T.C.S. RAO

National Institute of Oceanography, Regional Centre, Visakhapatnam-530 017

Abstract : Detailed analysis of magnetic and bathymetric data over shelf and slope regions of Cauvery basin, east coast of India, between Mahabalipuram and Vedaranyam demarcated three major offshore lineaments trending N-S, NE-SW and E-W. The N-S lineation has been interpreted as due to dyke intrusions. NE-SW lineament reflects the offshore extension of a major basement depression, viz., the Pondicherry depression. E-W lineation, south of Porto Novo reveals a basement high suggesting the seaward extension of Kumbakonam ridge within the Pondicherry depression. The present analysis gives mosaic of a deep seated graben block flanked by rift related volcanic intrusives over the shelf region of the basin.

Keywords : Structure, Marine geophysics, Cauvery basin

INTRODUCTION

Cauvery basin, formed during late Jurassic period by sagging of a part of the Indian shield mainly along the dominant NE-SW Eastern Ghat trend, is located in the southern part of east coast of India between the northerly plunging Sri Lanka basement massif and the peninsular craton. It occupies an area of 25000 sq km on land and 35000 sq km offshore (Kumar, 1983). This basin is unique among the east coast basins of India by the conspicuous absence of older Gondwana graben that appears over Krishna-Godavari and Mahanadi basins. Geophysical studies over onshore parts of the basin have revealed the basinal trend and the main NE-SW structural features viz., Pondicherry, Tranquebar and Nagapattinam depressions separated by Kumbakonam-Shiyali ridge, Karaikal high and Vedaranyam high (Sastri *et al.* 1974, Kumar, 1983, Venkatarengan, 1987). It is one of the promising petroliferous basins of India with reported occurrences of hydrocarbons at a depth of 1000 to 3600 m (Rao, 1993). The oldest sediments in this basin are Sivaganga beds of late Jurassic age. These beds are overlain by Cretaceous and younger sediments with maximum sediment

thick-ness of about 6000 m (Prabhakar and Zutshi, 1993).

The present study reveals the basement structure of Cauvery basin in relation to the offshore lineaments demarcated from magnetic data over the northern part of this basin between Mahabalipuram and Vedaranyam.

ACQUISITION OF DATA

Magnetic and bathymetric data used in the present study were acquired during the 231st cruise of R.V. Gaveshani in 1992, along 14 traverses normal to the coast, each of about 170 km length (Fig.1) between Mahabalipuram and Vedaranyam (between 40 to 3500 m water depth). Bathymetry data were contoured at 20 m interval (Fig.2). Magnetic contour map compiled at 20 nT interval after applying IGRF correction is shown in Fig.3.

RESULTS AND DISCUSSION

Bathymetry map (Fig.2) is characterised by steep shelf between Pondicherry and Porto Novo which widens towards Vedaranyam. The most striking feature of this contour map is the

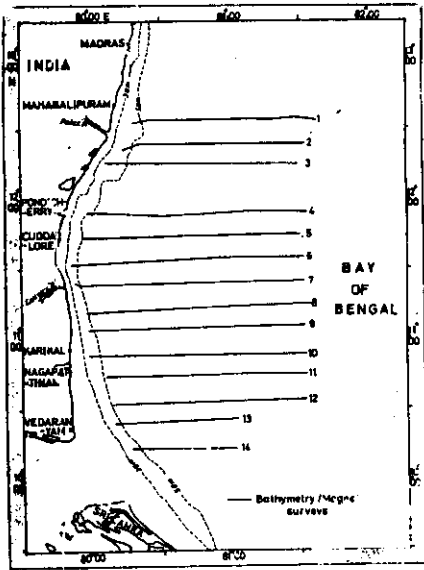


Fig.1. Location map of Cauvery offshore basin.

oval shaped contours which tend to converge at northern (Pondicherry) and southern (Vedaranyam) ends and bulge at the central part of the study region.

Magnetic anomaly map (Fig.3) is characterized by three major and one minor lineations. 1) A N-S Lineament 'P' (Fig.3) between $80^{\circ}15'$ and $80^{\circ}45'$ E off Vedaranyam, associated with a short wavelength medium amplitude anomaly of about -300 nT. This is reflected again at south off Mahabalipuram with reduced amplitude (-200 nT). 2) A NE-SW Lineation 'Q' represented by magnetic low of 160 nT which offsets the lineament 'P'. This trend is observed between Porto Novo and Pondicherry. 3) An E-W trend 'R' with -100 nT amplitude between Karaikal and Kumbakonam. 4) A minor NW-SE lineament 'S' extending from Kumbakonam to 50 km off Karaikal high. Correlation of bathymetry and magnetic anomaly maps (Figs.2 and 3) reveal that the broad magnetic low 'B' coincides with the wider shelf contours, while short wavelength anomalies recorded off Vedaranyam and Pondicherry coincide with the converging trends of the bathymetry map, mentioned earlier.

Two dimensional model studies (Talwani and Heirtzler, 1964) are carried out along three

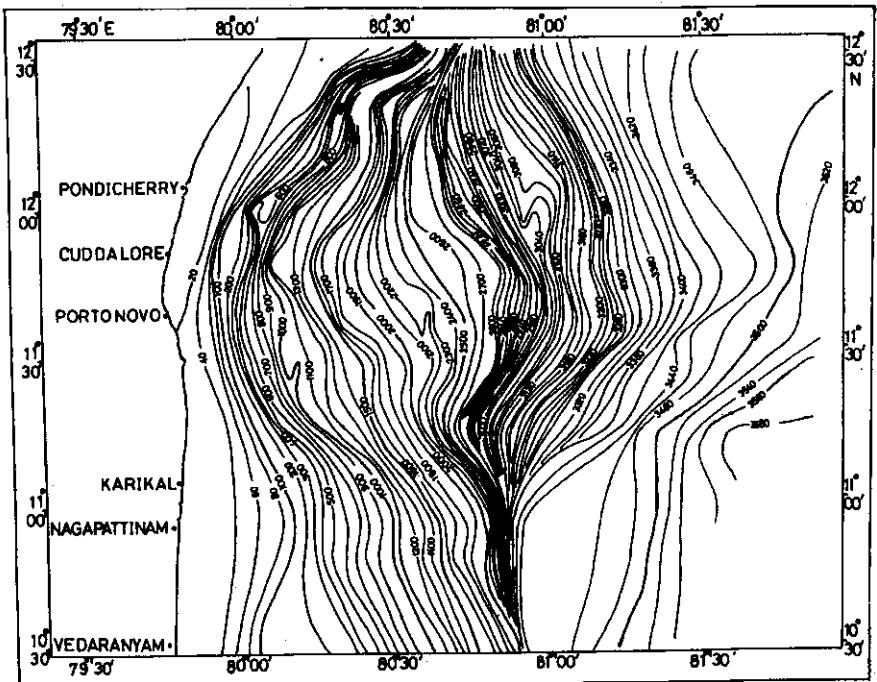


Fig.2. Bathymetry map of study area contour interval 20 and 100 m.

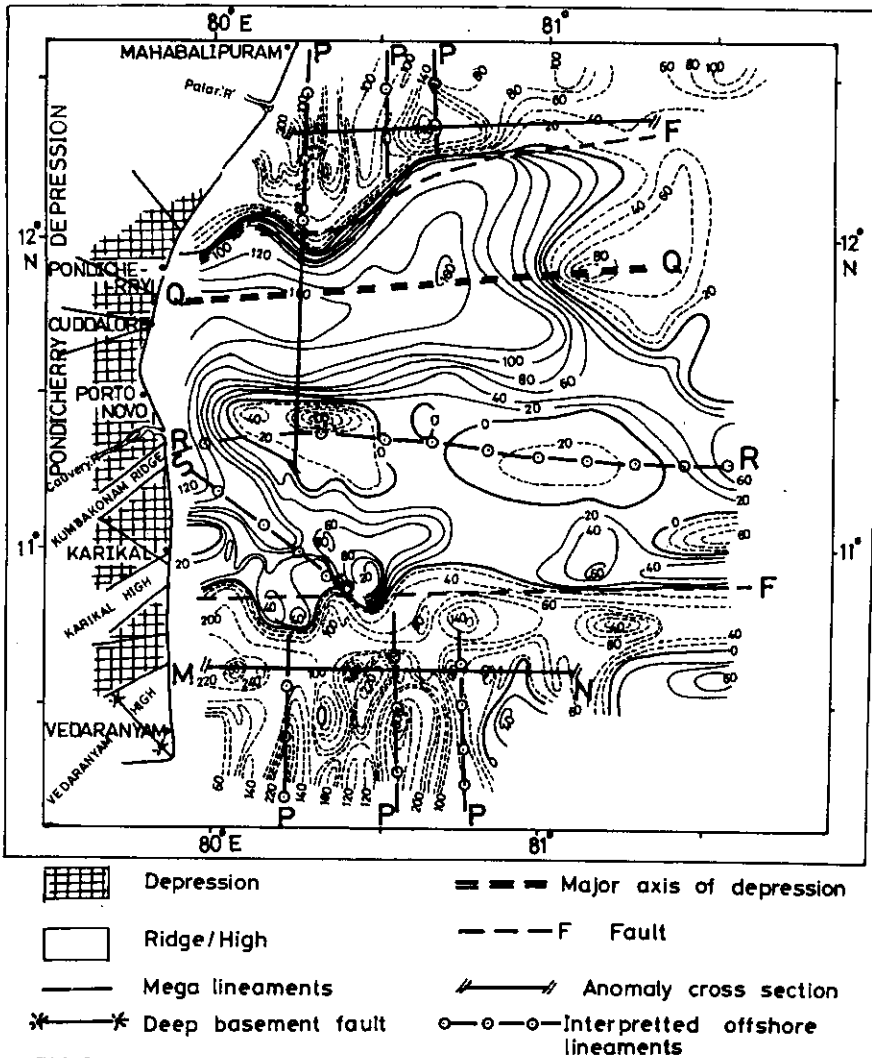


Fig.3. Magnetic anomaly map of the study area contour interval 20 nT.

cross sections of anomalies, IJ (south of Mahabalipuram), KL (between Pondicherry and Kumbakonam) and MN (off Vedaranyam) using remanent magnetisation parameters to deduce the basement structure. Best fit between observed and computed anomalies is obtained (Fig.4).

The nature of the Causative source for the anomalies off south of Mahabalipuram and off Vedaranyam corresponding to trend 'P' appears to be the same, suggesting intrusions of

high magnetisation contrast and high susceptibility located at a depth of about 6-8 km (Figs.4a and c). These might be the result of volcanic activity associated with rift phase during the formation of passive continental margins. Similar inferences were made earlier by Murthy *et al.* (1993) over other parts of eastern continental margin of India. Model studies corresponding to trend 'Q' (Fig.4b) indicate major graben type of basement over offshore parts of Pondicherry to Kumbakonam at a depth of

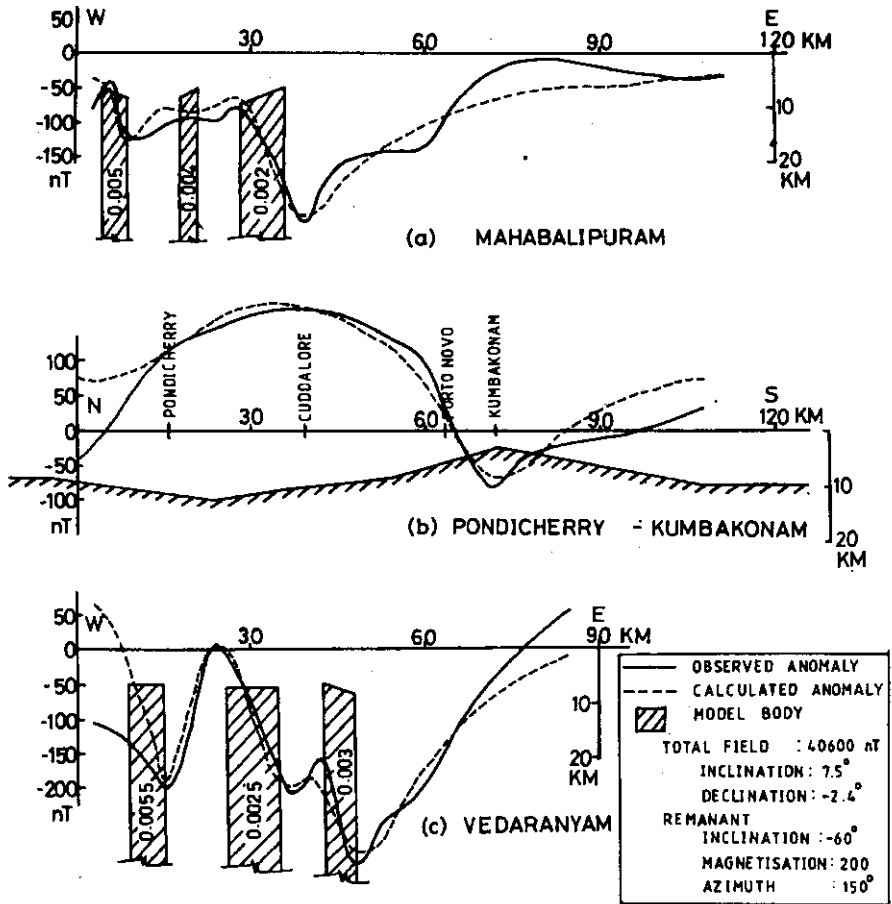


Fig.4. Model derived from anomaly cross sections
 (a) IJ (south of Mahabalipuram) (b) KL (Pondicherry to Kumbakonam) (c) MN (off Vedaranyam)

about 10 km having a gentle throw (Fig.4b). From the nature of the causative source it can be considered as the offshore extension of major Ariyalur-Pondicherry depression, delineated onshore from gravity and seismic studies (Sastri *et al.* 1974), and extending to about 140 km offshore. The minor basement high inferred within the overall graben model might correspond to the trend 'R' and suggests the offshore extension of Kumbakonam high. The graben might have formed during the pull apart phase of the Indian plate from Antarctica. Onshore basement depths over this depression are in the order of about 7 km (Sastri *et al.* 1974). A

minor lineament 'S' trending NW-SE of medium amplitude shows the offshore continuation of pre-Gondwana breakup lineament considered to be the oldest. The younger onshore NE-SW structural lineaments might have masked this trend. However in offshore regions this lineament appears undisturbed.

The significant change in the magnetic anomaly pattern at the junction between the trend 'P' and Pondicherry depression, both in the northern (12°20' N) and southern (10°45' N) parts gives a clear indication of the basin boundary. In the southern part, this junction coincides with the offshore extension of the

major Tiruchirapalli - Vedaranyam cross trend inferred from land geophysical data (Prabhakar and Zutshi, 1993).

In summary the basement tectonics inferred from the present analysis thus presents a mosaic of major offshore depression/ graben over shelf/ slope region between Pondicherry and north of Vedaranyam flanked by volcanic intrusives originated during rift phase of the eastern margin. The presence of intrusives sug-

gests that Cauvery Basin might have experienced rift related volcanic activity.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, National Institute of Oceanography, Goa, India for his permission to publish this paper. Thanks are also due to their colleagues for their help in data collection and processing and to Mr. Ch. Jawahar Kumar for neat tracing of illustrations.

References

- KUMAR, S.P. (1983). Geology and hydrocarbon prospects of Krishna-Godavari and Cauvery basins. *Petroleum Asia Journal*, v.1, pp.57-65.
- MURTHY, K.S.R., RAO, T.C.S., SUBRAHMANYAM, A.S., MALLESWARARAO, M.M. and LAKSHMINARAYANA, S. (1993). Structural lineaments from magnetic anomalies of eastern continental margin of India (ECMI) and NW Bengal Fan, *Marine Geology*, v.114, pp.171-183.
- PRABHAKAR, K.N. and ZUTSHI, P.L. (1993). Evolution of Southern part of Indian east coast basins, *Journal Geological Society of India*, v.41, pp.215-230.
- RAO, G.N. (1993). Geology and hydrocarbon prospects of east coast sedimentary basins of India with special reference to Krishna-Godavari basin. *Journal Geological Society of India*, v.41, pp.444-454.
- SASTRI, V.V., RAJU, A.T.R., SINHA, R.N. and VENKATACHALA, B.S. (1974). Evolution of Mesozoic sedimentary basins on the east coast of India, *Australian Petroleum Exploration Journal*, v.14, pp.29-41.
- TALWANI, M. and HEIRTZLER, J.R. (1964). Computation of magnetic anomalies caused by two dimensional structures of arbitrary shape; *In: Computer in Mineral Industries*, G.A. Parks (Ed.), Stanford University Press, pp.464-480.
- VENKATARENGAN, R. (1987). Depositional systems and thrust areas of exploration in Cauvery basin, *Bull. ONGC*, v.24(1), pp.53-68.

(Received: 8 November, 1993; Revised form accepted: 1 September, 1994)