GEOPHYSICAL STUDIES OF THE RAMNAD BASIN, MADRAS STATE*

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THE results of gravity, magnetic and seismic investigations conducted by the Geological Survey of India in the coastal sedimentary areas of Madras State have been presented in previous papers by the author (1958, 1961, 1963, 1964). These surveys, besides establishing a substantial thickness of 8,000 to 10,000 feet of sediments along the seacoast in the South Arcot and Tanjore Districts, have also brought out some prominent structural features associated with the pre-Cambrian basement in the Porto Novo, Karaikal and Tiruthuraipundi areas, and these appear to be significant and important in respect of their petroleum possibilities. The Karaikal structure is associated with a prominent basement high and partly extends into the sea in the off-shore areas, with a thickness of sediments of the order of 5,500 to 6,000 feet over the crest of the structure as estimated from reflection seismic data (Kailasam, 1961, 1962). Test drilling is now being carried on by the Oil and Natural Gas Commission over this structure and it is reported that the first test well drilled over the crest of the structure struck basement rocks at a depth of roughly 1,750 metres in remarkable agreement with the seismically estimated depth. Some oil shows have also been reported from this test well. Further to the north and south along the seacoast over the flanks of this feature, a thickness of the order of 9,000 feet of sediments has been indicated by the seismic data.

The geophysical data further suggest that the sedimentary areas in the Madras coast may be considered to consist broadly of three major basins (Fig. 1), separated by buried ridges of the pre-Cambrian crystallines branching out towards the sea from the main crystalline mass of the peninsula in a roughly north-east direction. The first of these basins, most parts of which fall within the South Arcot District and which is therefore designated as the South Arcot Basin, is bounded on the south by a buried ridge disposed roughly along the Coleroon river. To the south of this basin lies the Tanjore or Cauvery Basin (basin 2). The southern margin of the Tanjore Basin is characterised by another peninsular mass near Manamadurai, passing south of Sivaganga and extending to the north-east through Kalaiyarkoil and Devakottai to Kattumavadi on the Palk Strait (Fig. 1). To the south of this buried ridge lies a third shallower basin in the Ramanathapuram (Ramnad) District and which is designated as the Ramnad Basin.

Details in respect of sedimentary thickness, basement configuration and structural features of the South Arcot and Tanjore Basins have been presented in the previous papers referred to. The main features of the Ramnad Basin as deduced from the geophysical data are presented in this paper.

The Archæan formations which occur mostly in the western and north-western parts include hornblende gneiss, calc granulites, charnockites and quartzites with a general ENE-WSW strike. The Archæans are overlain unconformably by the Upper Gondwana rocks (middle to late Jurassic in age), fluviatile in origin and consisting of boulder beds, conglomerates and hard micaceous sandstones with alternating shales and grits. These are best exposed in the Sivaganga area (Fig. 1). The tertiary formations (Mio-Pliocene) which consist of coarse sandstones, grits, clays and conglomerates are seen near Karaikudi, Pallattur, Ariyakudi, Sakottai and a few other places. They are the same as the Cuddalore formations encountered further to the north in the Madras coast. The tertiary rocks in the Ramanathapuram District are mostly covered by a cap of hard laterite (Pleistocene) varying in thickness from 6 to 12 feet in the Sivaganga area to a thickness of 10 to 20 feet in the Karaikudi and Pallattur areas.

Outcrops of the Cretaceous rocks are not seen in the Ramnad District in contrast with their occurrence in the South Arcot and Tanjore Basins to the north. A major part of the sedimentary area in the Ramnad District is covered by alluvium (Fig. 1).

Reflection and refraction seismic investigations for ground water carried out recently in the Ramanathapuram District by the Geological Survey of India have brought out some interesting subsurface features. To the south-east of Kunnakudi which is on the gneisses and some four miles to the north-west of Karaikudi (Fig. 1),

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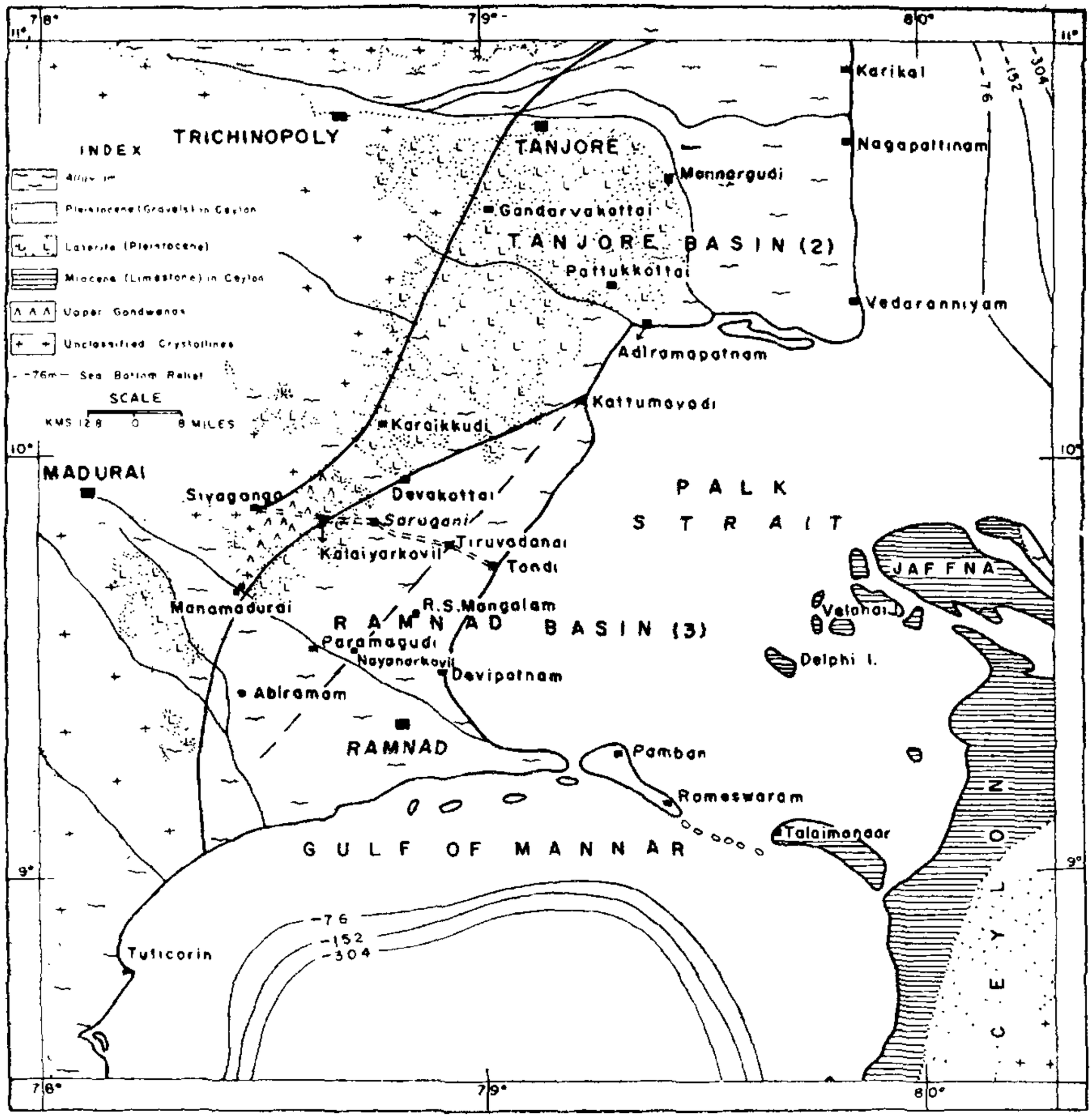
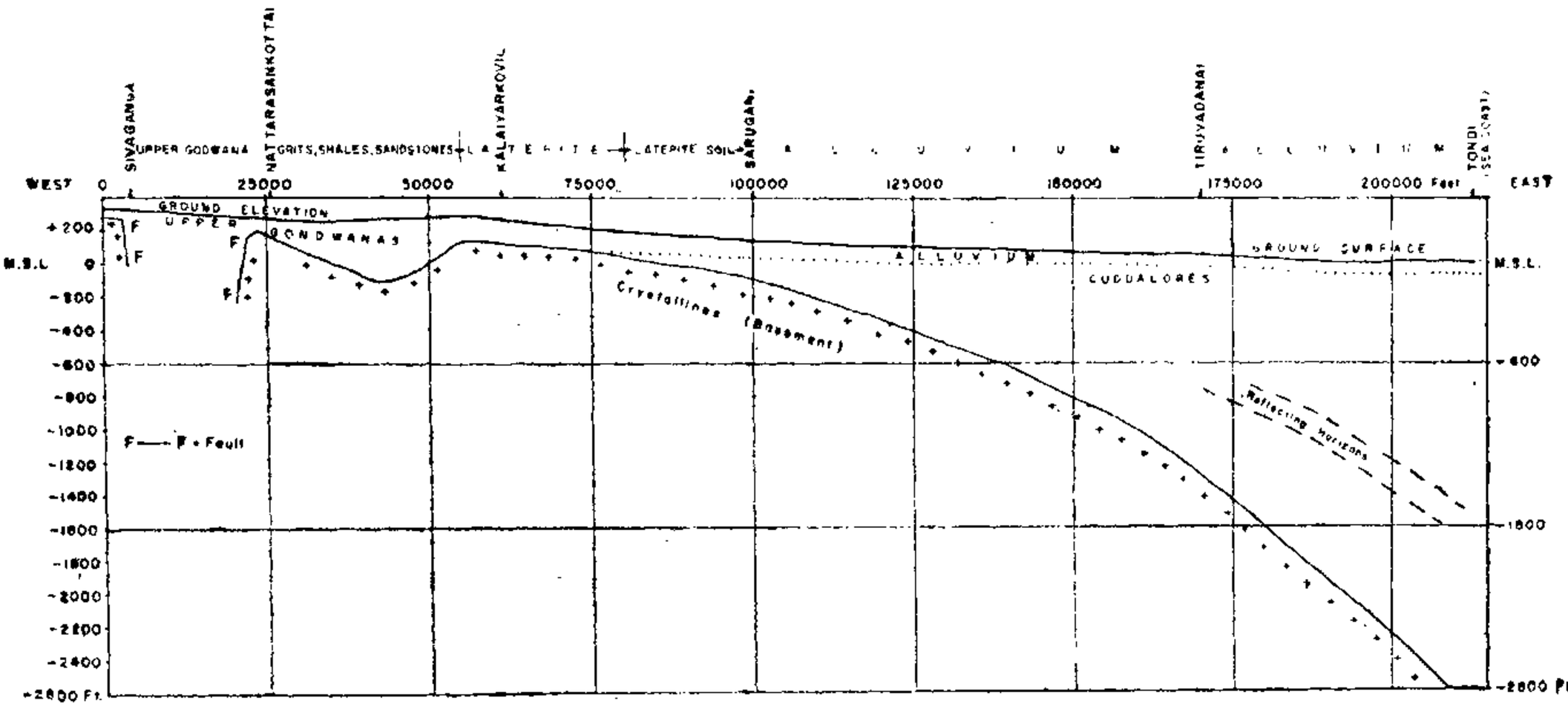


FIG. 1

the seismic data indicate a sudden deepening of the basement to more than 5,000 feet. Further to the south-east of Karaikudi and some four miles to the north-west of Devakottai, the basement again rises abruptly, its depth in the Devakottai area being of the order of 300 feet. This area which is the south-western tapering end of the Tanjore Basin 2 is thus characterised by marked faulting.

A seismic-*cum*-geologic section from Sivaganga on the west to Tondi on the shores of the Palk Strait in the east along the Sivaganga-Kalaiyarkoil-Tiruvadanai-Tondi Road, compiled from the data obtained by the investigations of Mathew and Jagannadham (1962, 1964) under the direction of the author is shown in Fig. 2. Between Sivaganga and Nattarasankottai the refraction seismic data indicate prominent faulting in the basement, which is apparently the south-western extension of the faults indicated to the north-west and south-east of Karaikudi referred to earlier, giving rise to a graben-like feature in this region. The Upper Gondwana rocks are exposed in this area, as can be seen from the geologic section. The basement is quite shallow in the Nattarasankottai area, being of the order of 100 feet. Between Nattarasankottai and Kalaiyarkoil, a



Geologic section from Sivagonga to Tondi as deduced from Seismic data

FIG. 2

local depression in the shallow basement is indicated, overlain by the Upper Gondwana rocks. In the Kalaiyarkoil area, the basement is indicated at a depth of the order of 100 to 150 feet and is apparently overlain by weatherd gneisses and alluvium as can be seen from well cuttings. Further to the east of Kalaiyarkoil, the basement slopes down gently up to Sarugani where its depth is indicated to be of the order of 200 to 250 feet. To the east of Sarugani, the basement deepens rather steeply, and this trend continues all the way to Tondi on the coast, the basement depth at Tiruvadanai and Tondi being roughly 1,500 and 3,000 feet respectively. Also, to the east of Sarugani, beneath the thin alluvial cover, a seismic layer of velocity of 7,000 to 8,000 feet per second is indicated, which may be representative of Cuddalore formations. Between Tiruvadanai and Tondi the reflection seismograms also bring out a few well-defined reflections from the deeper horizons (Fig. 2). In this connection it will be relevant to refer to the borehole data pertaining to the exploratory tube-wells for ground water sunk in the Ramnad District in the past few years by the Exploratory Tube-Well Organisation of the Government of India in collaboration with the Geological Survey of India. The deepest of these wells in this region drilled at Tiruvadanai and taken to a depth of 1,021 feet without touching basement has indicated beneath the alluvium Cuddalore strata consisting of clays, sands, etc., up to a depth of 295 feet from the ground level, below which calcareous clays and fossiliferous sandstones are reported to have been encountered. It is, therefore, likely that the 295 feet level at Tiruvadanai represents the base of the Cuddalore's below which the formations probably belong to the Eocene sequence as at Alappakkam near the seacoast to the south-west of Cuddalore in South Arcot District where Eocene rocks are known to underlie the Cuddalore formations at a depth of roughly 630 feet, as proved by a borehole drilled for water. In the borehole at Tondi taken to a depth of 600 feet, fossiliferous, calcareous sandstones were encountered at a depth of 333 feet from ground level, which may represent the base of the Cuddalore's.

At Kattumavadi on the shores of the Palk Strait (Fig. 1), reflection shooting has indicated a basement depth of the order of 1,500 feet. The basement progressively deepens southward along the coast and its depth at Tondi, as already stated, is of the order of 3,000 feet.

In the Paramagudi area further to the south-west in this basin, the basement is indicated at the same shallow depths as at Sarugani, being of the order of 250 to 300 feet. Thus, roughly to the west of a line joining Kattumavadi, Tiruvadanai and Nayanarkovil just to the east of Paramagudi (Fig. 1), the basement lies at shallow depths of less than 1,500 feet, with larger depths to the east of this line (dashed line in Fig. 1). Further to the south-east towards the Palk Strait, the seismic data indicate a sudden deepening of the basement. Reflection shooting at a point 6 miles to the north-east of Ramnad town on the Ramnad-Devipatnam Road indicates a basement depth of roughly 6,000 feet. The seismogram for this seismic shot on the Ramnad-Devipatnam Road is reproduced in

FIG. 3

Fig. 3 and brings out the basement indication clearly. Thus, over a small emerged part of the Ramnad Basin including Devipatnam and Ramnad, the sedimentary thickness is more than 6,000 feet. The basement is seen to deepen further in a south-east direction from the Ramnad coast into the Palk Strait which is a *shallow sea. The eastern margin of the Ramnad* Basin is represented by the sedimentary tracts of the north-western coast of Ceylon and the Jaffna Peninsula which are occupied by Miocene formations consisting mainly of fossiliferous limestones (Fig. 1).

The southern limits of the Ramnad Basin are defined by the northern margins of the Gulf of Mannar. The broad, generalised Bouguer gravity map of these parts as presented by Gulatee (1956) is shown in Fig. 4. This map

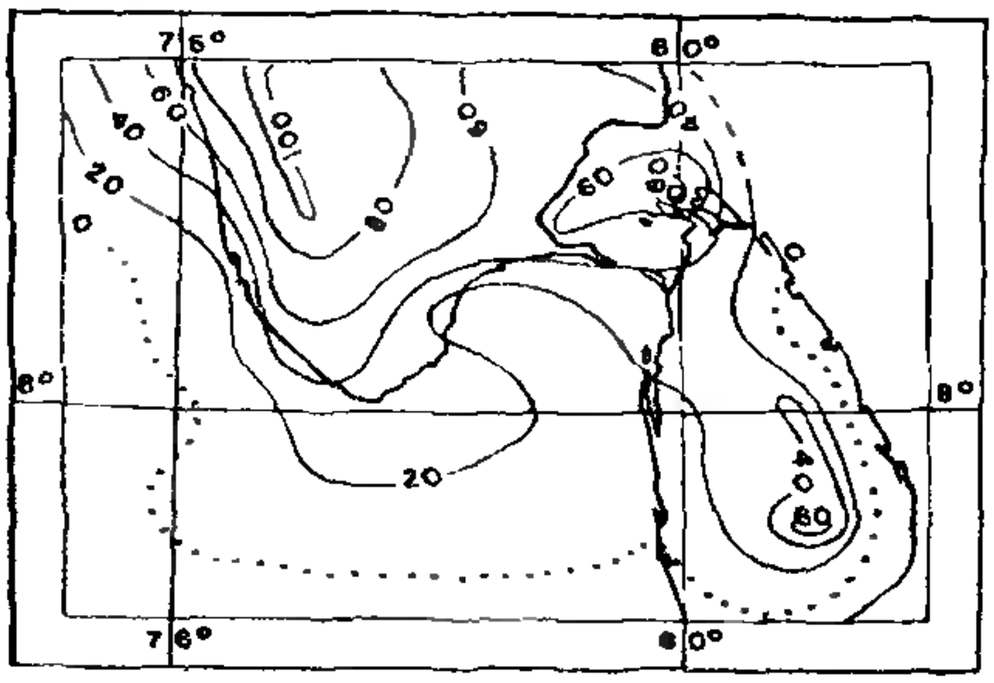


FIG. 4

shows a prominent gravity low in the form of a nose extending from the south-eastern coast of the peninsula into Ceylon through its north-western parts trending in a north-west-south-east direction. The same map also shows a local gravity low near the Jaffna coast of Ceylon. As has been *stated, the* seismic data clearly indicate a fairly large thickness of more than 6,000 feet of sediments in the off-shore areas of the Ramnad coast in the south-eastern parts of the Palk Strait. It is quite likely that similar large thickness of sediments also occurs in the fringes of the north-western coast of Ceylon, *especially the Jaffna coast*, as also in the off-shore areas in its western neighbourhood including the Velahai and Delphi islands where reflection seismic shooting should yield valuable and interesting results.

The results described herein and the foregoing discussions clearly indicate the scope for further detailed geophysical surveys in the Ramnad Basin of which the Palk Strait constitutes the major part, and the off-shore areas of the Ramnad coast and the north-western coast of Ceylon should be considered important in respect of their petroleum possibilities.

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