

A Gravity and Bathymetric Study in the South East Continental Margin of India

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Abstract

The Eastern Continental Margin of India (ECMI) has formed as an upshot of separation of India from Antarctica during the early cretaceous period and subsequent seafloor spreading led to the evolution of Bay of Bengal. The study area, which lies between latitude 8° to 14°N and longitude 77.5° to 81°E, has been selected to delineate the width of the continental shelf region of the south east coast of India. GEBCO bathymetry data and Satellite gravity data has been used for the present study. The bathymetry contour map generated by GEBCO bathymetry data shows gradual increase in the depth from the coastal region (~100 m) to the central basin (~3700 m) and nearly follows a N-S trend from Karikal to Chennai. 24 profiles were extracted from the bathymetric as well as satellite gravity grid. The profiles were created perpendicular to the coastal margin. The maximum width of shelf (~45 km) is observed along the coast near Mamallapuram which is the river mouth of Palar River. Shelf width is gradually decreasing from Chennai to Karikal and the continental slope is also very steep. On the southern part of it, the continental shelf of India merges with that of Srilanka. Further south, in the Mannar basin, the shelf width ranges from 25 to 33 km. The continental shelf region is marked by a relatively high (-40 to 40 mGal) compared to the low gravity anomaly (-40 to -180 mGal) observed towards the basinal area. A local gravity high compared to the surroundings centered at 80.6°E and 11.8°N can be associated with the offshore extension of Moyar- Bhavani shear zone, which dissects south Indian terrain.

Keywords: ECMI; Satellite gravity; Bathymetry; Topography; Continental shelf; Seismicity

Introduction

The Eastern Continental Margin of India (ECMI) has formed as a consequence of separation of India from East Antarctica during the early Cretaceous period. Subsequent seafloor spreading led to the evolution of the Bay of Bengal. The most prominent feature of the Bay of Bengal is its sedimentary fill, which classifies it as the largest sub-aerial delta in the world. Bengal fan along with the ECMI It extends over a total length of 3000 km, forming the largest deep sea fan complex in the world. Much of the sediments of the basin were derived from the confluent Ganges and Brahmaputra rives. The ECMI is also characterized by four major sedimentary basins, viz., Cauvery, Krishna-Godavari, Mahanadi and Bengal basins [1,2]. The ECMI, in its northern part, is marked by the Eastern Ghats Mobile Belt (EGMB) of Proterozoic age, which extends for over 1000 km long the east coast. The southern granulite terrain (SGT) of Precambrian age occupies the southern art. The break-up of eastern India from East Antarctica seems to have been accommodated along the Proterozoic EGMB. The rifting and associated magmatism can be related to hotspot activity beneath east Gondwanaland, at least in the northern parts of the ECMI, and these could be a reflection of Kerguelen plume activity. This study aims to discuss the morphological features of the Southeast continental margin of India (SECM) and also to delineate the width of the continental shelf region using bathymetry and satellite altimeter data.

Tectonic setting of study area

The ECMI is a mature margin, having come into existence about 130 Ma ago when India drifted away from East Antarctica. This margin is characterized by thick sedimentary basins, some of which prograde into deltas. The shelf along the ECMI is narrow with the deep ocean floor encountered within 50–60 km distance from the coastline. The southern segment of the ECMI represents a sheared margin while the northern segment appears to be rifted in nature. The study area covers the coastal margin of Tamil nadu, Pondicherry and Gulf of Mannar region (Figure 1).

Methodology

GEBCO bathymetry data and Satellite altimeter data has been used for the present study. Bathymetry and Gravity grids had been prepared. 24 profiles have been selected and gravity and bathymetry data has been extracted from the grid along the profiles. The profiles were created perpendicular to the arbitrary drawn line segments which are nearly parallel to the coastal margin of south India (Figure 2). Using the extracted data, the bathymetry/ gravity graphs has been plotted to study the variation of depth as well as gravity along the coast. A comparison of gravity signature with that of bathymetric variation is attempted.

Analysis of bathymetry data

The bathymetry contour map shows that depth gradually increases from the coastal region to the central basin. Depth varies from 100 m in the coast to 3700 m in the Basin. The profile locations are shown in Figure 3 and the bathymetry along theses profiles are as shown in Figure 3. From the figures we can demarcate the shelf extension and its variation along the profiles. For the profiles 1 to 7 (Chennai to Puducherry), the shelf width ranges from 28 to 45 km. The maximum width of shelf is along the profiles 3 and 4 (~44 km width), along the coast near Mamallapuram, which is the river mouth of Palar river. For profiles 8 to 13 (Puducherry to Karikal), the shelf width is ranges from 14 to 23 km. The average width of the shelf is ~17 km. Shelf is very

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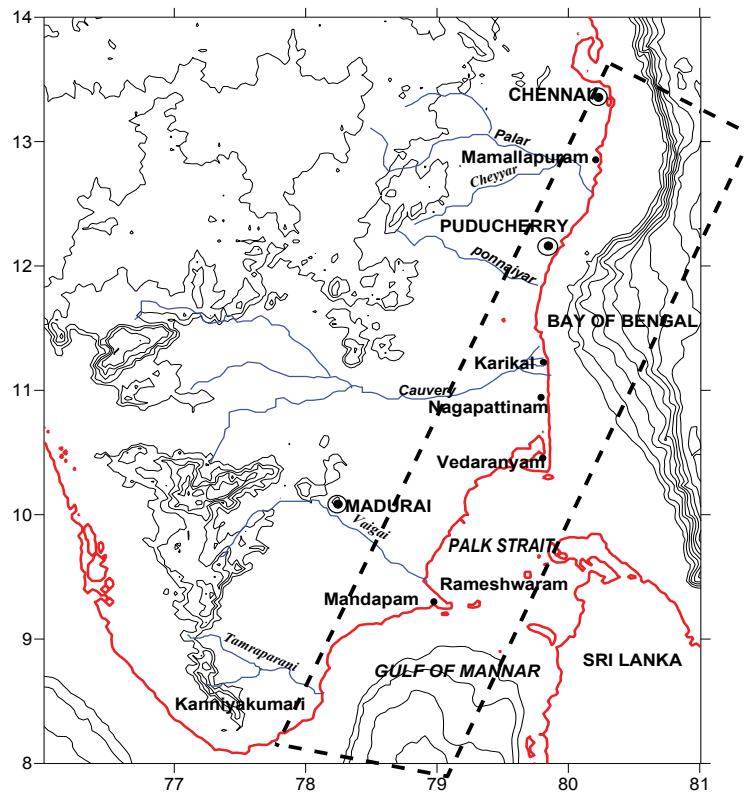


Figure 1: Bathymetric/ elevation contour map of South India and adjoining region. The Area shown with the broken lines represents the study area.

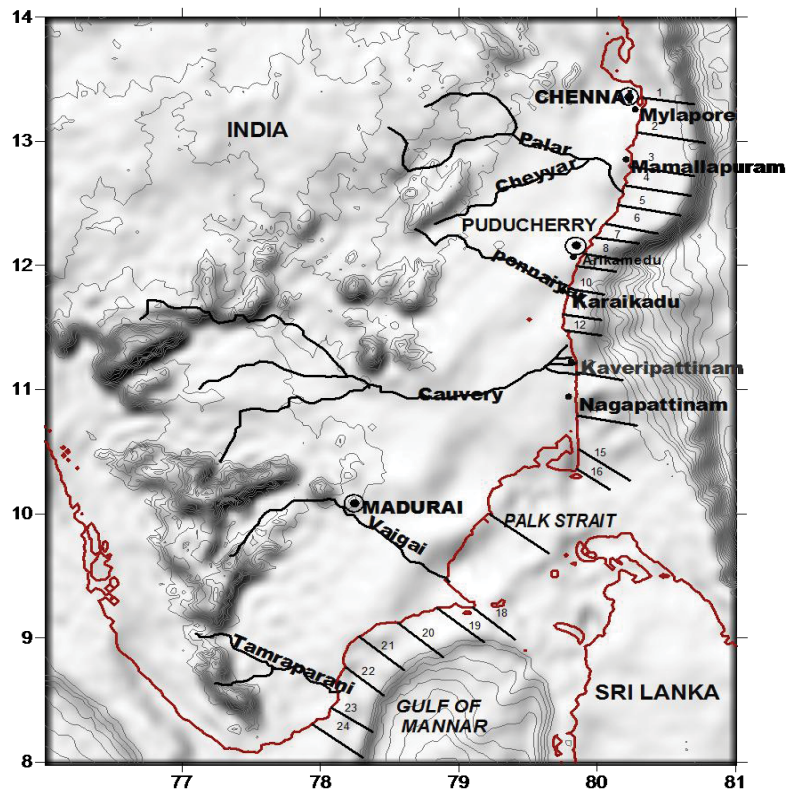


Figure 2: Shaded relief map of the area showing bathymetric contours. The 24 profiles selected for the present study is also shown.

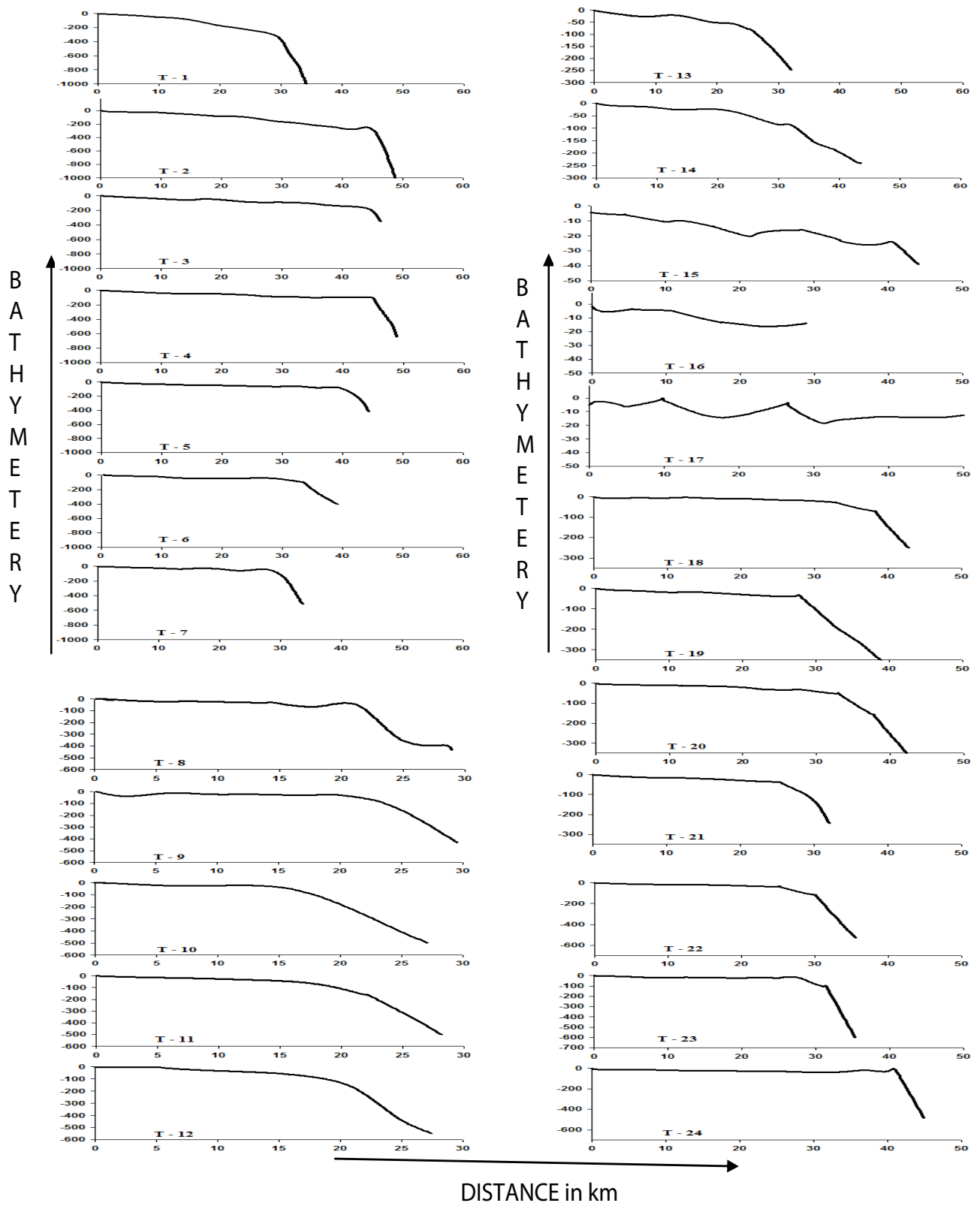
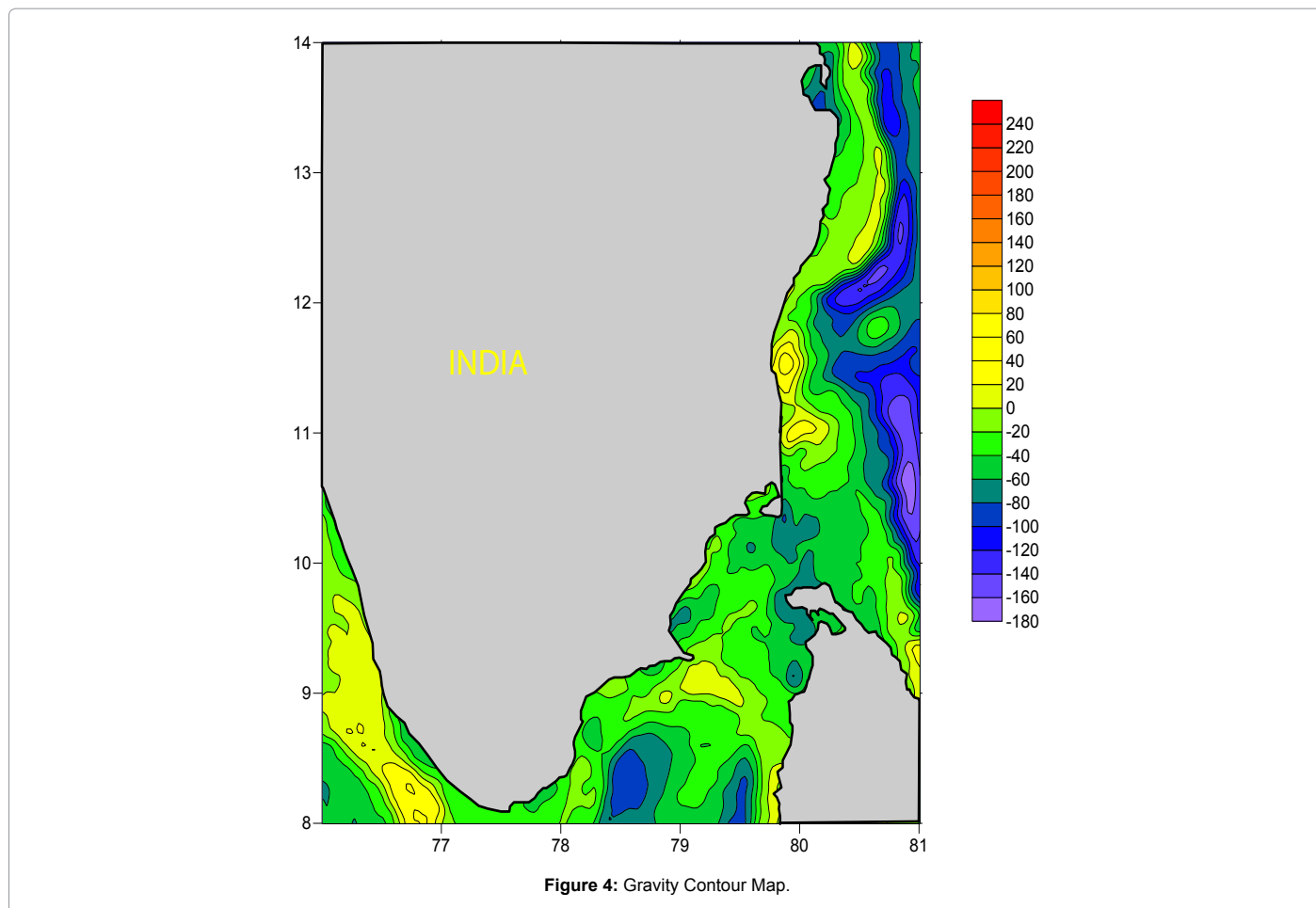


Figure 3: Graphs showing the bathymetry variation along the 24 profiles selected.



narrow along this part. In general, shelf width is showing a decreasing trend from Chennai to Karikal coast.

The profiles also show that the continental slope is very steep. Profiles 14 to 18 shows that continental shelf of India merges with that of Srilanka and hence does not show a break in the shelf. Profiles 18-14 starts from the south coast of India and ends up in the Mannar Basin and the shelf width ranges from 25 to 33 km.

Analysis of gravity data

Geosat altimeter suggests first global view of the ocean basins at a resolution of 10 km. Satellite altimeter data have been used to decompose the sea surface topography into the marine geoid and the dynamic topography. One micro radian of sea surface slope corresponds to 0.98 m Gals of along track gravity disturbance. These variations are caused by several factors, including oceanographic and climatological factors. However, the major causative factor by far is gravitational, i.e. local variations in the Earth's gravity field over the ocean.

Very sharp gravity gradient is evident from the gravity anomaly contour map (Figure 4) and the continental shelf region is marked by a relatively positive gravity anomaly and it is gradually becomes more negative towards the basinal area. This low gravity value can be due to the increased sediment thickness near the foot of the slope. The continental shelf region is marked by a gravity high which ranges from -40 to 40 mGal, where the adjacent slope and basinal area shows a low

gravity which ranges from -40 to -180 mGal (Figure 5). There is a SW-NE trend of local gravity high of -60 to -20 mGal in the basin, where the low centered at 80.6°E longitude and 11.8°N latitudes which doesn't have a coinciding bathymetric high. The gravity high can be associated with the offshore extension of Moyar- Bhavani-shear zone [3].

Results and Discussion

The bathymetry contour map shows gradual increase in the depth from the coastal region to the central basin and nearly follows a N-S trend from Karikal to Chennai (Eastern coastal margin). The average width of the shelf is ~17 km. The shelf width from Chennai to Puducherry ranges from 28-45 km. The shelf width from Puducherry to Karikal ranges from 14 to 23 km. The maximum width of the shelf is along the coast near Mamallapuram, which is the river mouth of Palar River. The gravity contour map generated by the satellite gravity data shows gravity high ranging from -40 to 40 mGal, where the adjacent slope and basinal area shows low gravity which ranges from -40 to -180 mGal. This can be attributed to the increased sediment thickness near the foot of the slope. There is a SW-NE trend of local gravity high of -60 to -20 mGal in the basin, where the low centered at 80.6°E longitude and 11.8°N latitudes which doesn't have a coinciding bathymetric high. The gravity high can be associated with the offshore extension of Moyar-Bhavani-shear zone [4]. An analysis of earthquakes in the south east coast of India proves that the earthquakes are associated with structural lineaments. Detailed geophysical study has been proposed in the area in order to establish the Neotectonic activity.

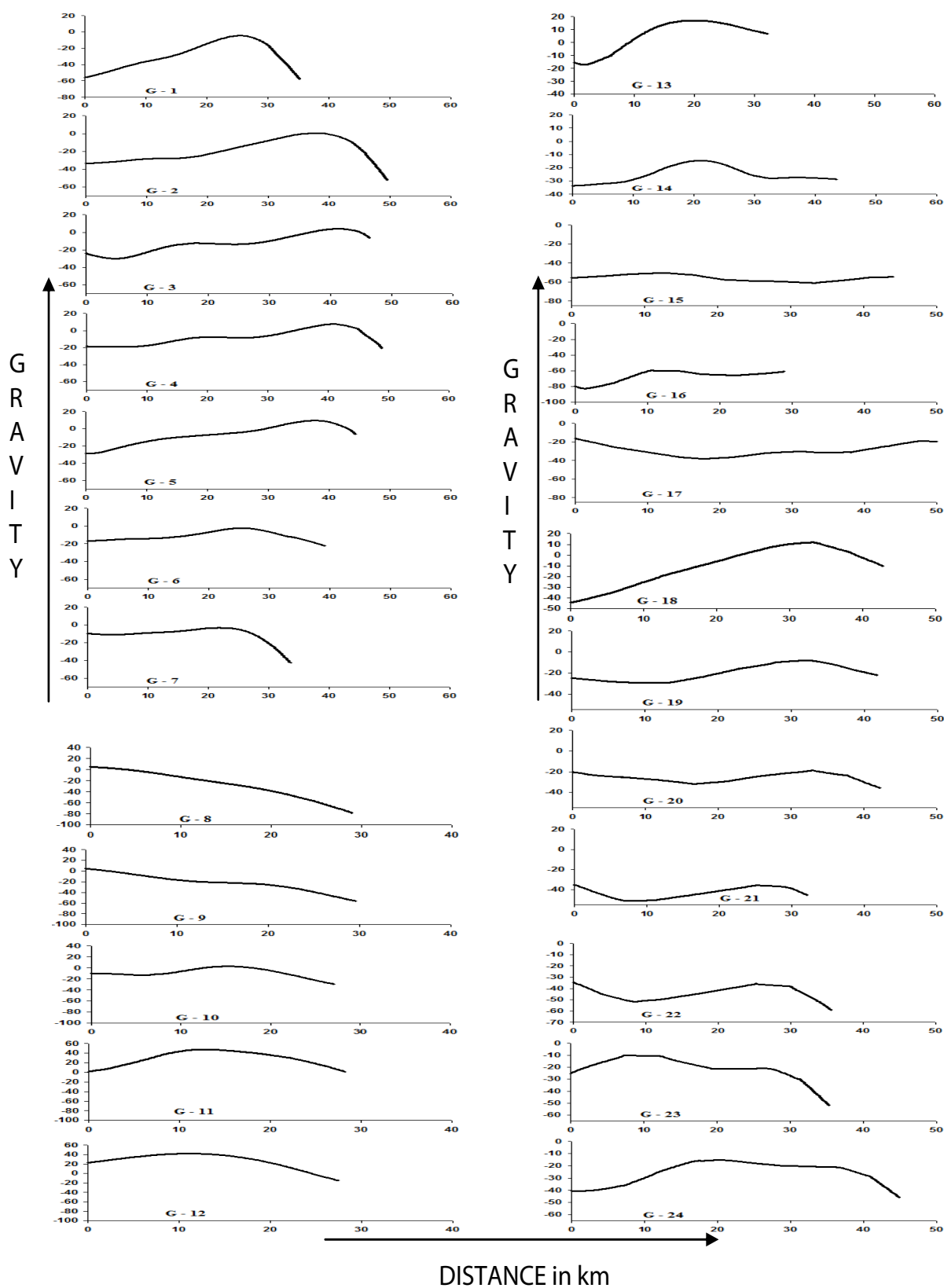


Figure 5: Graphs showing the Gravity variation along the 24 profiles selected.

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