

## Basement configuration of Cuddapah basin, India through Gravity data analysis

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### Keywords

Gravity data, Bouguer anomaly, Cuddapah basin, Gravity models, Depth to basement

### Abstract

Cuddapah basin is a Proterozoic basin in crescent shaped, easterly concave and N-S trending that located in the eastern part of Dharwar craton. It covers an area of 44000 km<sup>2</sup> and extends for a length of about 450 km along the arcuate Eastern Ghat Mobile Belt (EGMB).

In order to encourage exploration activities and appraise the sedimentary basins having no/scanty data, Government of India launched the National Seismic Program (NSP) in 2016. Under this program, regional 2D seismic data has been acquired in the basin has opened up the opportunity to understand subsurface geology of the basin. Therefore, an attempt was made to generate gravity constrained basement configuration of the basin with integrating available exposed surface outcrop, and available G&G data in the basin.

The gravity data analysis inferred that identified three basinal low with thick sediments in the south-western (~9.5 km), central (~5.0 km), and northeastern (~2.0 km) parts of the basin.

### Introduction

Cuddapah basin is crescent shaped that located between latitudes 13°30'N to 17°N and longitudes 78°E to 80°E of Indian sub-continent (Fig.1). It is bounded on its east by two major tectonic features; Nellore Khammam Schist Belt (NKSMB) and Eastern Ghat Mobile Belt (EGMB), while the western front borders the peninsular granites and gneisses (Fig.2). This basin can be divided into several sub-basins like Papaghni, Kurnool, Nallamalai, Srisailem and Palnad

(Fig.2), which are characterized by distinct differences in lithology (Nagaraja Rao et al. 1987).

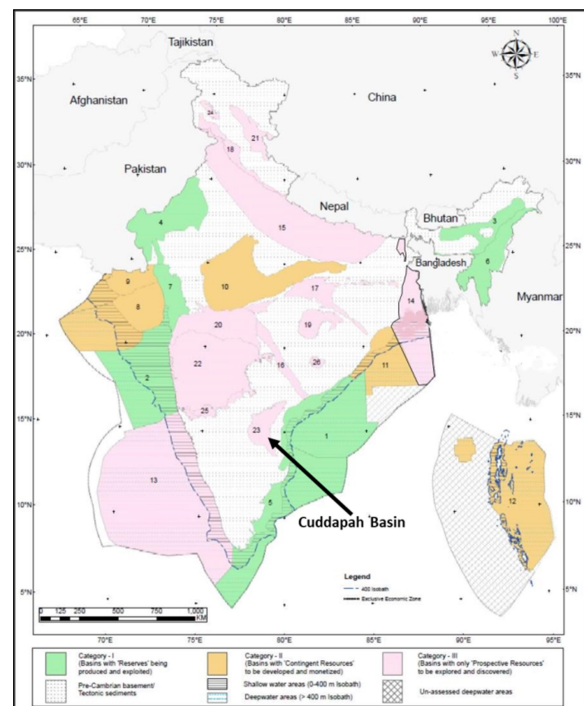


Fig. 1: Location of Cuddapah basin (Source: [www.dghindia.org](http://www.dghindia.org))

Cuddapah basin evolutionary history is a subject of debate; whether it evolved through (i) vertical tectonic movement (Drury and Holt, 1980), (ii) extensional stretching (Anand et al., 2003), (iii) a large meteoritic impact (Krishna Brahmam and Dutt, 1985), (iv) rift setting (Chaudhuri et al., 2002) or (v) even by a deep seated mantle plume (Mall et al., 2008; Chandrakala et al., 2010). This region was associated with sustained magmatic activity since at least mid Proterozoic period. As many as six phases of igneous activities are recorded here (Nagaraja Rao et al., 1987), which include lava flows, sills, dykes

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and 1.1 Ga old kimberlitic magmatism (Hou et al., 2008; Kumar et al., 1993). The basin is also pierced by numerous linear schist belts running roughly north to south (Naqvi and Rogers, 1987).

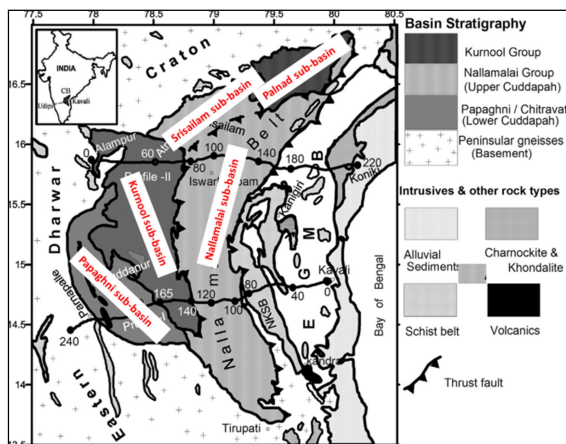


Fig. 2: Geological map of the Cuddapah basin and adjoining regions (after GSI, 1998), showing the DSS profiles. Profile I is the eastern part of the Kavali-Udipi profile (Kaila et al.1979) and profile II is the Alampur-Koniki profile (Kaila and Tewari, 1985). NKSB: Nellore Khammam Schist Belt; EGMB: Eastern Ghat Mobile Belt.

### Gravity data analysis

The Bouguer anomaly map of Cuddapah Basin is generated by vintage data available by Geophysics Group, KDMPIE (Fig. 3). The gravity anomaly value is varies from -49.6 to -111.0 mGal in the basin.

The gravity anomalies of Southwestern side of basin, bounded by the latitudes 14.1° to 15.2°N and longitudes 77.5° to 78.4°E are predominantly negative (i.e. varying from -50 to -105mGal) which decreasing towards east, cannot be explained by the sediments. In order to understand the nature and thickness of the crust, many Geoscientists has been interpreted the gravity anomaly (Glennie 1951; Krishna Brahmam & Dutt 1985), who put forward various explanations for the observed features, including meteoritic impact. This anomaly may be concluded as feature associated with a deep-seated late Proterozoic mantle thermal anomaly, which may be resulting from a plume (Mall et. al., 2007).

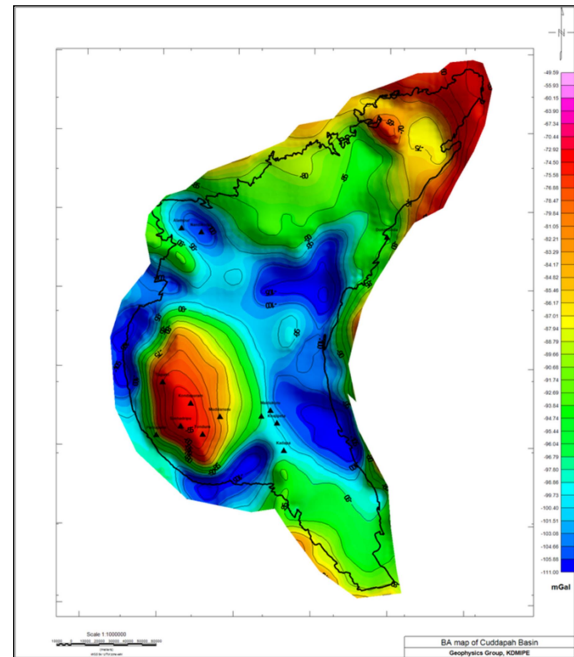


Fig. 3: Gravity anomaly map of Cuddapah basin

### Gravity Modelling and Interpretation

Total 14 numbers of profiles has identified in East - West (7), North-South (4) Northwest-Southeast (1) and Northeast-Southwest (2) directions for gravity modelling considering available NSP Seismic data, Deep Seismic Sounding (DSS) profiles and other G&G information to cover up entire Cuddapah basin (Fig.4). Out of 14 profiles, Gravity modelling were carried out along six NSP Seismic lines CP-L01, CP-L02, CP-L03, CP-L04, CP-L05 & CP-L06) and Eight reconstructed lines RC-L01, RC-L02, RC-L03, RC-L04, RC-L05, RC-L06, RC-L07 & RC-L08.

The gravity models have been constrained with help of available seismic, DSS profiles and G&G information in the basin. For Gravity modelling, density is considered 2.65g/c<sup>3</sup> for sediments, 2.70 g/c<sup>3</sup> for Basement, 3.15 g/c<sup>3</sup> for Intrusive and 3.30 g/c<sup>3</sup> for Mantle based on available literatures of the basin as no well is drilled in the basin till date. Depth of the Mantle in the gravity model is

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considered based on two east west DSS profiles in central part of the basin and available literature that carried by earlier geoscientists for the basin.

The Gravity modelling has been carried by using GM-SYS Software of Geosoft. The software calculates gravity response using sediment density and provide an easy to use interface by interactively creating the model to fit the observed and computed anomalies.

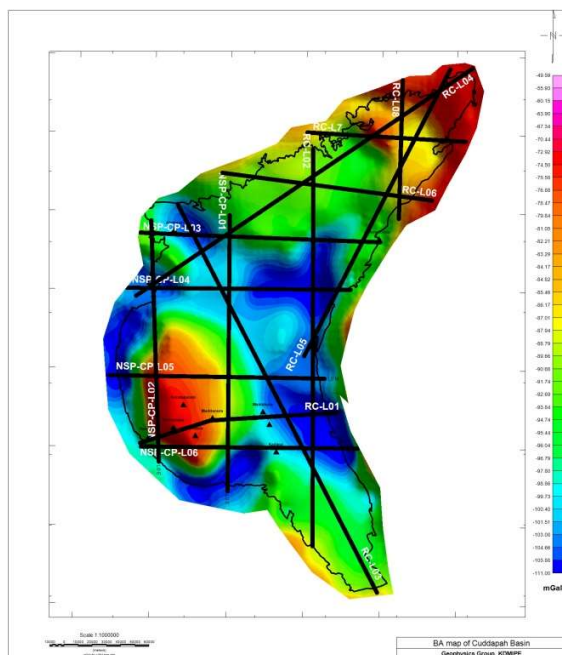


Fig. 4: Gravity anomaly map with selected profiles for Gravity Modelling

For a flat bottom basin, the gravity will be falling towards centre of the basin and rise toward the flanks of the basin (Fig.5.a). If Mantle is raise then the gravity signature will be change. At the flank of the basin, gravity is increasing till the basin margin. After crossing the margin, the gravity value falls down steeply and increases rapidly giving a dome shape inside the basin (Fig.5.b). The steepness of gravity signature at flanks of the basin is characterized by the amount of up-liftment of mantle (Fig.5.c).

If a basin with raise mantle and thicker sediments, rising in gravity signature at the centre of the basin is

compensate by thicker sediments. Hence, rise of gravity signature due to raised mantle is no longer much significant at the centre of the basin, but remains at the flanks of the basin (Fig 5.d). This may be probable explanation for the Cuddapah basin except south-western part of the basin.

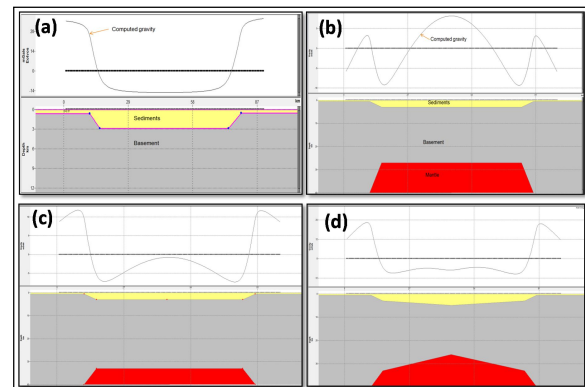


Fig. 5: Signature of Gravity in normal basin (a), Mantle raise in the basin (b & C) and Mantle rise with thick sediments (d)

If a basin with raised Mantle, thicker Sediments and intruded higher density material (Intrusive, Sill, dykes etc.) within the sediments of basin, the gravity signature will be similar to a basin with raised mantle (Fig.6). This may be a probable reason for high gravity signature in south-western part of the Cuddapah basin although thick sediments in the region as per newly acquired NSP Seismic data.

Based on above concepts the gravity-modelling has been carried out along fourteen profiles for basement configuration of the Cuddapah basin. All selected profiles tied to each other at the crossing point from sediments to Mantle.

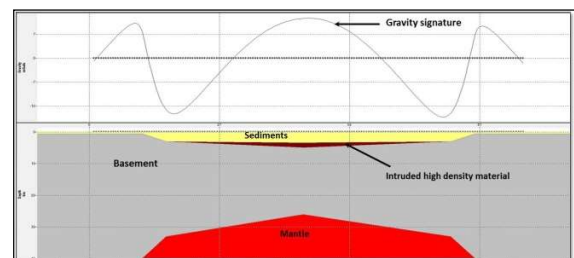


Fig. 6: Probable model for gravity high at SW part of the Cuddapah basin

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The gravity model along a profile CP-L01 of 194.7 km length, oriented in north south direction and passing through NSP line CP-L01 is shown in Fig. 7 a & b. The depth to basement is increasing from south to north direction, upto crossing of Profile CP-L05. After that depth is decreasing toward Northern direction in the profile (Fig.7 a & b). The maximum depth to basement is seen ~8.5km near crossing of NSP seismic line CP-L05.

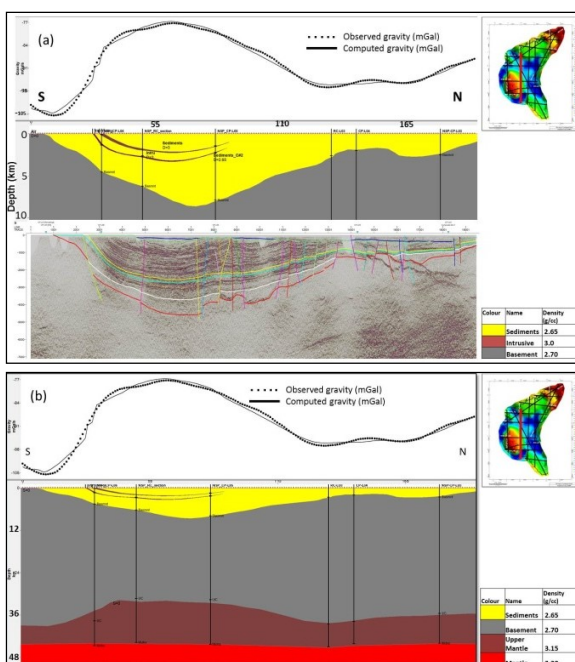


Fig. 7: Gravity modelling along NSP CP-L01

Similarly, the gravity modelling along profile CP-L04 (Fig.8) which is 194.7 km length and oriented in east west direction passing through NSP seismic line CP-L04. The basement is dipping from west to east ward direction and depth to the basement is in the order of 0.0 km (Exposed basement) to ~5.1 km. The maximum depth to basement is ~5.1 km near crossing of reconstructed line RC-L02.

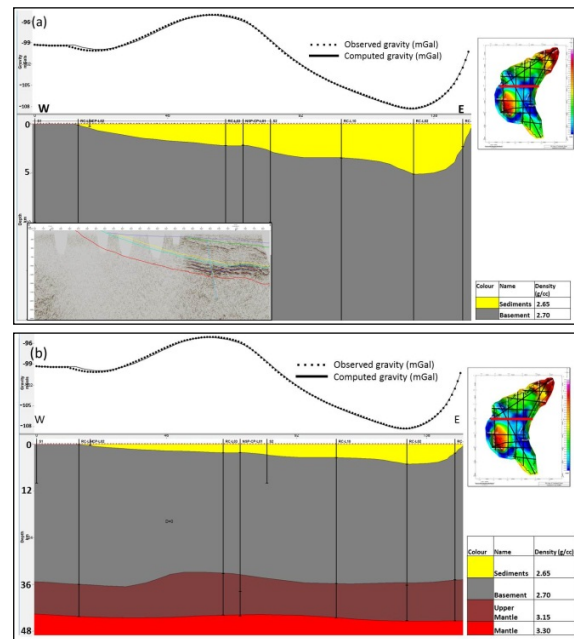


Fig. 8: Gravity modelling along NSP CP-L04

### Result and Discussion

Based on gravity modelling along 14 profiles, depth to basement map of the Cuddapah basin has been generated (Fig.9).

In the basin, the basement is exposed in the periphery of the basin. The depth to basement in the basin is varies from 0.0 km (Exposed basement) to ~9.5 km. The maximum depth of basement is ~9.5 km has been observed in the south-western part of the basin. Although having thick sedimentary thickness, this region having high gravity anomaly, which may be due to feature associated with a deep-seated late Proterozoic mantle thermal anomaly, which may be resulting from a plume (Mall et. al., 2008) and intrusive in the area. This thick sediments in this region also visible in recently acquired NSP Seismic lines CP-L01, CP-L05, and CP-L06 (Fig. 10).

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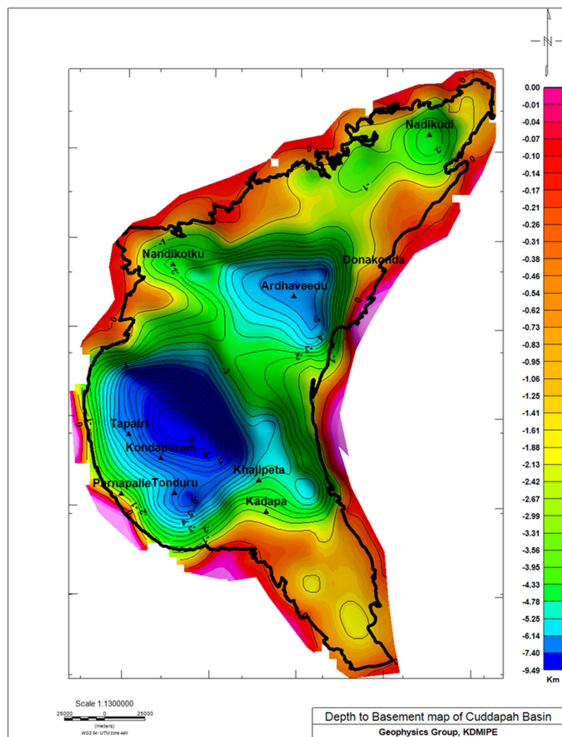


Fig. 9: Depth to basement of Cuddapah basin on basis of gravity modelling

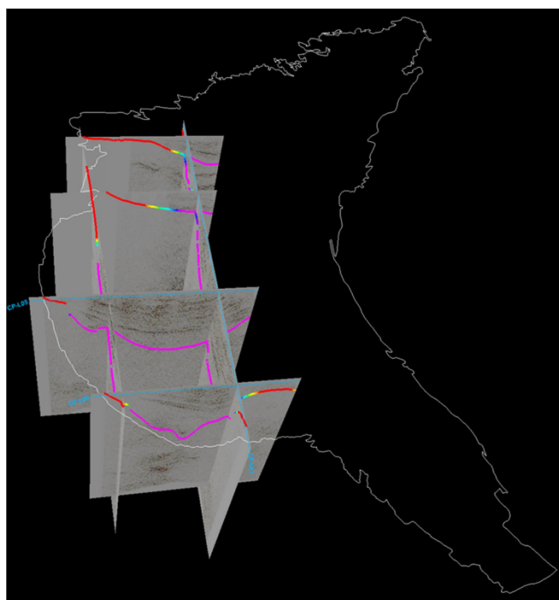


Fig. 10: NSP Seismic Lines with interpreted basement of the Cuddapah basin

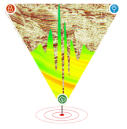
### Conclusions:

The gravity inversion (modelling) has brought out basement configuration of the Cuddapah basin. The study indicates that sedimentary thickness is continuously increasing from flank to centre of the basin. The maximum depth to basement is estimated about 9.5 km in south-western part of the basin.

Based on gravity modelling, three basement lows regions has been identified at Southwestern part (near Kondapuram), Central part (near Ardhaveedu) and northeastern part (near Nadikudi) of the basin with maximum depth about 9.5 km, 5.0 km and 2.0 km respectively in the Cuddapah basin.

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