changes, and hence the metasediments occur in the basin structures (e.g. iron ores near Thiruvannamalai) as in Attur valley. Another well known E-W fault still to the north is along the southern border of the Cuddapah basin near Tirupathi in Andhra Pradesh. Hence the origin of E-W faults throughout Peninsular India in the post-Cuddapah period is a possible tectonic phenomenon. The E-W and N-S E-W faults appear to be mainly responsible for the Eastern ghats developing into isolated hill masses (unlike the continuous hill mass of Western ghats); and they appear to have dissected the crust into rhombic blocks to whose sides the major trends (NE-SW and E-W) of foliations and fold axes are parallel suggesting contemporaneity. The NW-SE trends observed in the Western ghats are parallel to the oldest faults and dykes (NW-SE) of this area indicating their concomitancy. Therefore these three (NW-SE, NE-SW and E-W in the chronological order) systems of faults have bearings on the respective trends of foliations and fold axes.

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GRAVITY ANOMALIES OVER GONDWANAS OF INDIA

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Introduction: The study of Gondwana formations of India has been of great interest to earth scientists not merely because of their economic importance in being the main coal bearing formations but also because of certain tectonic features associated with them. The study of tectonics of Gondwana formations of India by Fox (1931) brought out the idea that these formations were formed in the block-faulted basins, i.e., rift valley-like basins. This idea of Fox though doubted by some authors like Ahmad (1961) has not yet been written off. The conclusions arrived at by Fox as well as Ahmad are based on almost the same data which are mainly geological.

Girdler (1963) pointed out the importance of geophysical studies such as gravity, magnetic and seismic surveys in studying the problems associated with rift valley-like structures with particular emphasis on the steep negative gravity anomalies associated with well established East African rifts (Bullard, 1936). A good deal of gravity data from the Survey of India, Oil & Natural Gas Commission and National Geophysical Research Institute are available over the Gondwana deposits of India, such as that of Damodar valley, Mahanadi basin, Satpura basin, Godavary valley and the small
deposits dotting along the east coast of India. An attempt is made here to obtain probable configurations of these basins by interpreting the gravity anomalies in terms of the thickness of sediments filled therein. For this purpose, 5 profiles shown in location map (Fig. 1) have been studied.

**Nature of gravity anomalies:** In Figure 2, gravity profiles are shown across the Gondwana deposits of Damodar, Mahanadi, Satpura and Godavari basins and over the small Gondwana deposits dotting along the east coast of India. The anomalies over all the deposits are negative which are evidently due to the fact that the Gondwana sediments are of lower density than the surrounding rocks. It may be seen from the profiles that these negative anomalies are in general very steep at the fringes. This probably indicates that the basins are of block-faulted type, as one expects steep negative anomaly over the basin bounded by normal faults (Girdler, 1963).

The gravity anomalies over the deposits of the east coast are not confined to the extent of Gondwana exposures but also continue beyond them towards east over the area where recent alluvium is exposed. This perhaps would imply that the Gondwana formations may continue below the thin alluvium sheet towards east. Profile 5 in Fig. 2 illustrates this point of view.

**Estimation of thickness of sediments/basin configuration:** The most immediate quantitative interpretation of the gravity anomalies can be done in terms of the thick-
ness of sediments filling the basins. For this purpose smooth regionals are drawn and the residual profiles are made. Assuming that these residual gravity anomalies are caused by two-dimensional sedimentary columns, that is a basin much longer than wider, a quantitative interpretation is carried out with the help of dot charts. It is further assumed that a density contrast of -0.4 gm/cm³ exists between the Gondwana sediments and the surrounding Archaean rocks. This density contrast has been proposed and used by earlier authors (Gulatee, 1949; Qureshy et al. 1968). The results of the present analysis along profiles 1 to 5 are shown in Fig. 2.

The cross sections of the sedimentary columns so obtained are nothing but the cross section of the basins and as such give the approximate configurations of these basins. The maximum thickness of sediments along these profiles are given in the Table below:

<table>
<thead>
<tr>
<th>Profile No.</th>
<th>Area</th>
<th>Max. thickness of the inferred Gondwana sediments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raniganj</td>
<td>3.2 km</td>
</tr>
<tr>
<td>2</td>
<td>Mahanadi</td>
<td>3.2 km</td>
</tr>
<tr>
<td>3</td>
<td>Satpura</td>
<td>2.7 km</td>
</tr>
<tr>
<td>4</td>
<td>Godavari</td>
<td>4.8 km</td>
</tr>
<tr>
<td>5</td>
<td>East Coast</td>
<td>4.6 km</td>
</tr>
</tbody>
</table>

Discussion and conclusions: The most important problem associated with the Gondwana deposits of India is whether or not these were formed in the block-faulted i.e., rift like valleys. Fox (1931) on the basis of geological evidence concluded that
the Gondwana deposits were formed in the block-faulted basins. This view of Fox has its support from most of the later workers, but at the same time it has been contradicted by Ahmad (1961). Ahmad (1961) on the basis of paleogeographic studies, concludes that these basins are not of block-faulted nature; instead the faulting has taken place subsequent to the sedimentation and the sediments are preserved because of this faulting.

The geophysical study of the East African rifts by gravity, magnetic and seismic methods by Girdler (1963) has shown that such studies can throw light on the nature of basins. The steep gravity anomalies which have been observed over the Gondwana deposits of India are almost similar in nature to the anomalies observed over the well established East African rifts. The configuration of the basins obtained by the quantitative analysis of the gravity anomaly also show block-faulted nature of the basins. This can be said with more confidence about the Godavari basin in particular, and with lesser degree of confidence for the Gondwana deposits in general because the Mahanadi basin case is not very simple.

The Mahanadi basin presents a complex problem from the point of view of its being a rift type or not. This is due to the fact that some inliers of Archean rocks are observed within the Gondwanas. In order to make some observations in regard to Mahanadi region, we have however selected a profile in the Lower Mahanadi basin near Korba (Profile 2. in Fig. 2). The interpreted sedimentary column along this profile shows steep gradient on s-w fringe indicating a faulted boundary of the type one expects with block faulted basins; the other fringe, however shows a relatively gentle gradient which could perhaps mean that the n-e boundary of the basin does not coincide with the n-e boundary of the Gondwana exposure, and the actual boundary of the basin existed somewhere near F'. As such, the interpretation of this profile gives some evidence for this part of the Mahanadi basin (around the discussed profile) to be of block-faulted type, but one cannot take it to be representative of the whole Mahanadi basin. The Gondwana deposits of Mahanadi basin need a very thorough geological and geophysical study with a very close net work of gravity stations.

Till such studies are complete for the Mahanadi basin and the results regarding the other Gondwana basins are substantiated by further detailed gravity work and other geophysical surveys such as deep electrical soundings, seismic etc., a generalised statement that all the Gondwana deposits of India are formed in block-faulted basins, cannot be made. It can however be stated that the Godavari and Satpura basins appear to be of rift-type valleys.

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References


OCCURRENCE OF HIGH URANIUM-BEARING GRANITIC GNEISSES
NEAR NARSIPATNAM, VISHAKHAPATNAM DISTRICT, A.P.

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During the course of investigation of the mineralogy and geochemistry of the granitic gneisses and associated rocks of Narsipatnam area (N lat. 17°33' and E long. 82°27') the authors have come across two samples of granitic gneisses with high uranium in relation to thorium content. (Table I).

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>Uranium (in ppm)</th>
<th>Thorium (in ppm)</th>
<th>Th/U</th>
</tr>
</thead>
<tbody>
<tr>
<td>S 10</td>
<td>17</td>
<td>9.7</td>
<td>0.57</td>
</tr>
<tr>
<td>B 11</td>
<td>4.7</td>
<td>3.4</td>
<td>0.72</td>
</tr>
</tbody>
</table>

$S$ 10: Pink granitic gneiss from 1 km NW of Sanyasi Raja Agaharam.
B 11: Grey granitic gneiss from Buchammapeta.

The uranium and thorium contents in the rocks were determined by Neutron activation analysis applying radiochemical separation techniques. Usually, the distribution of U and Th in various rocks types shows an abundance of Th compared to U; but the granitic gneisses under report, however, show reverse relation in that the uranium is more than thorium.

The granitic gneisses essentially consist of quartz, potassium feldspar, plagioclase, biotite, garnet, and accessory magnetite, zircon, apatite, and sometimes epidote. The modal composition of the two granitic gneisses is given in Table II.

The granitic gneisses are medium to coarse grained and occasionally pegmatitic and aplitic. Porphyroblasts of feldspar and rarely quartz are common. The gneisses are crushed, and show alteration of feldspar to kaolinitic and sericitic material. Biotite is in the form of bands and contains of inclusions of zircon. Magnetite is secondary, and formed due to the alteration of biotite.

The high content of Uranium in the two granitic gneisses under report may be either due to the presence of zircon and biotite (Adams et al, 1959) or the U content may simply be entrapped between major mineral crystal grains as absorbed ions.