Analysis of Gravity Data for Estimating Thickness of Pre-Sylhet Sediments (Gondwana) in Dhansiri Valley of Assam & Assam Arakan Basin

Sanjeev Sawai* and D. Sar
ONGC, Dehradun

Summary

Dhansiri valley located between Mikir and Naga hills of Upper Assam in the northeastern part of India is characterized by dominantly north-south trending Bouguer anomaly contours. Well data of the area indicate s the presence of Gondwana sediments below Tertiary. A gravity response of the model upto the Sylhet Limestone marker identified from seismic data and basement was simulated and compared with the observed gravity data. The difference between observed and computed gravity is accounted for by the presence of sediments below the Sylhet Limestone marker. The isopach map of sediments between top of Sylhet Limestone marker and Basement shows 200 m – 1200 m pre-Sylhet sediments. The maximum thickness lies in the central part of study area. Another area of significant thickness of pre-Sylhet sediments appears to be near Naga thrust towards the east. The gravity field due to the thick roots of the Himalayas located in the north and adjoining is the predominant regional field here and it affects the entire area and is unlikely to change significantly in the E-W direction.

Introduction

Dhansiri valley is located between Naga & Mikir hills of Upper Assam, India (figure 1). The area is covered by alluvium (Deshpande, 1993) and has been extensively surveyed for hydrocarbons. A number of wells drilled in this area have shown the presence of Gondwana sediments below Tertiary. Though seismic sections show a strong marker corresponding to top of Sylhet limestone, reflection from basement is patchy and not easily identifiable. Hence, an attempt was made to estimate the thickness of the sediments below Sylhet limestone from available gravity data.

Some important observation on gravity anomaly of the area.

The most striking feature of Bouguer anomaly map of Assam valley (figure 2) is that Bouguer anomaly values in the immediate south of Brahmaputra river is about –190 mgals (near Disangmukh) and increases to –180 mgal towards southeast i.e. towards Naga Hills . However the basin becomes considerably deep near Naga Hills. This reversal of the expected pattern of the gravity field in deeper part of the basin indicates major contribution from some other source in the gravity anomaly of Assam Valley, which is strong enough to overcome the trend of gravity anomaly produced by the sediments of the basin. The basement is found to be about 4.0 km deep in the well "C"

Fig. 1 : Location map of the Area

(Disangmukh area) is expected to produce Bouguer anomaly of about – 40 mgals, but the observed anomaly is about – 190 mgals. This indicates contribution from a large scale feature.

Similarly in the north bank, lowering of the Bouguer anomaly values towards the Himalayas is much larger than expected from the available data of the drilled wells.

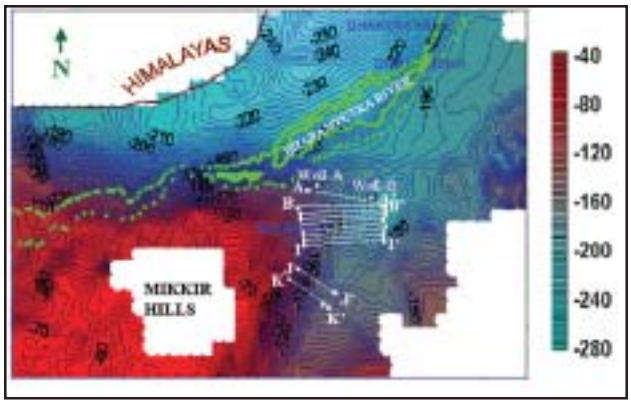


Fig. 2: Bouguer Anomaly Map

(Personal communication,OIL officials) which penetrated basement .

It is well established that due to isostasy. thickness of the crust below the Himalayas is about 70 km. This large thickness of the crust produces strong negative anomaly around the Himalayas (figure 3). The model indicates that crust of 70 km thickness below the Himalayas will produce gravity anomaly around –160 mgals even at a distance of 100 km away from the edge of the root. This explains the strong influence of the roots of the Himalaya in the gravity field of Assam valley & adjoining areas.

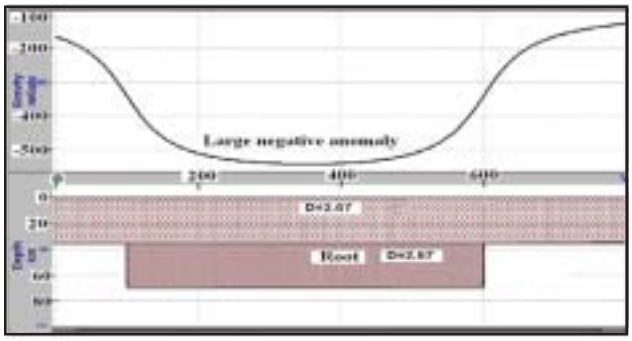


Fig.3 : Schematic model on gravity anomaly due to the root of the Himalayas.

This overshadows the contribution to Bouguer anomaly for the known thickness of the sediments in Assam Valley , which makes it more positive towards south i.e. away from The Himalayas. A schematic model on gravity anomaly due to the roots of the Himalayas is shown in figure 3.

Methodology

Since the Himalayas are located to north of the Assam valley, gravity effect produced by the root of the Himalayas will gradually decrease towards south. To minimize the effect of variation of the gravity field due to the Himalayas, 2D-gravity modeling was done along roughly E-W profiles. The contour trends of Bouguer anomaly are roughly N-S in Dhansiri valley hence gravity modeling along E-W profiles provides an ideal set up. To start with the gravity field along the seismic line 'AA', over which two wells 'well A' & 'well B', drilled up to basement, is computed. The computed gravity (figure. 4a) field is compared with the observed field. A clear mismatch in the central part of the profile indicates presence of additional sediments below Sylhet-limestone .

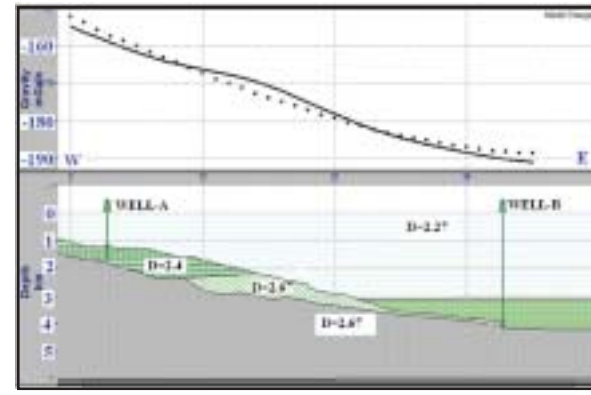


Fig. 4a. : 2D-forward gravity modeling along the profile AA' without adding sediments.

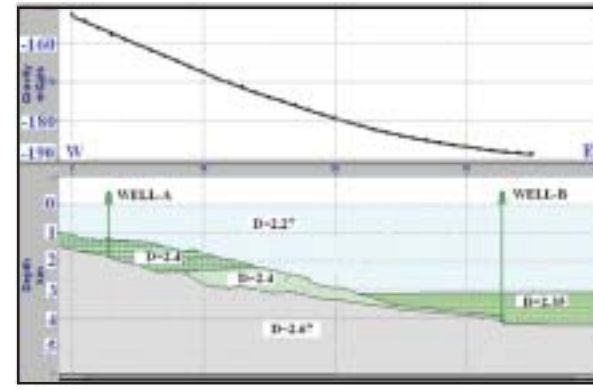
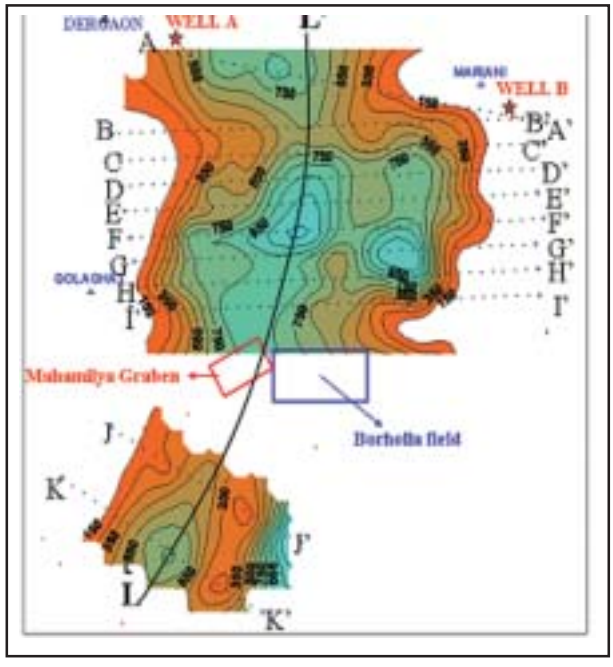


Fig. 4b.: 2D-forward gravity modeling along the profile AA' with sediments.

The final model, after incorporating additional Sediments below Sylhet Limestone in the central part is shown in figure 4b. This observation gives a clue for estimating the thickness of sediments below Sylhet lime stone marker by 2D-gravity modeling. For quantitative gravity modeling, depth to the top of Sylhet limestone is obtained by converting the two way time read on isochron map of top of Sylhet limestone , using the velocity function of the 'well A'. The gravity field for the sediments up to the top of Sylhet limestone is computed along a series of E-W profiles

and are compared with the measured field along the same profiles. It is found that gravity field computed for the sediments (up to the top of Sylhet lime stone) can not explain the measured variation of the field along the profile . Additional sediments are required below Sylhet lime stone marker to obtain a match between the computed and measured gravity field. Since Gondwana sediments of Dhansiri valley has shown presence of hydrocarbon in them, the area of large thickness of these sediments are important for hydrocarbon exploration (Bharali et al:, 1999). Thickness of the sediments below Sylhet lime stone marker is thus computed along eleven East- West profiles and an isopach map of the sediments between top of Sylhet limestone & basement is prepared (figure 5). Results of the modeling are dependent on the accuracy of the depth to the top of the



Fig, 5. Isopach map of the sediments between Sylhet and Basement.

Sylhet lime stone marker and with the presumption that regional field is roughly E-W i.e. LL' does not vary significantly along the profile. While modeling a constant value of regional field is assumed along the line. It is interesting to note that the regional field monotonously decreases to south as can be seen in the Table 1 . This is in conformity with the presumption that it is dominantly caused by the Himalayas. While carrying out gravity modeling in the southern part of the study area it was noticed that a major graben, identified from seismic data, does not show expected low gravity over the area. The reason for lack of gravity signature over this graben, having a depression of more than 500 m could not be ascertained. Hence gravity modeling was not done in this area.

Table 1. Regional component of the gravity field. along the profile..

Profile Name	Regional Component (mgal)	Direction
AA'	-129.5	North
BB'	-126.5	
CC'	-125.0	
DD'	-121.0	
EE'	-120.0	
FF'	-118.0	
GG'	-117.0	
HH'	-116.0	
II'	-115.0	
JJ'	-107.0	
KK'	-98.5	South

Conclusions

In the central part of Dhansiri valley, presence of 200m - 1200m of pre-Sylhet/Gondwana sediments are mapped in the patches by gravity modeling. Area of maximum thickness appears to be roughly along a line of NNE - SSW orientation and marked "LL' "on the map. Further east towards Naga thrust another area appears to have good thickness of these sediments. Since Gondwana sediments of Dhansiri valley has shown presence of hydrocarbon in them, the area of large thickness of these sediments are important for hydrocarbon exploration.

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Views expressed in this paper are that of the author only and may not necessarily be of ONGC.

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