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Estimation of thickness of Deccan trap in Broach Jambusar block of Cambay basin –an innovative approach

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Summary

An attempt has been made to estimate the thickness of basalt layer overlying the granitic basement of Cambay basin.

Bougurer anomaly of Cambay basin has the contribution from post rift sediments, basalt & sub crustal sources like underplating, uplifted Moho etc. Contribution of sub crustal sources is removed by filtering. Thickness of basalt is estimated from this residual anomaly by modeling using the constraints from seismic for computing the contribution of sediments. The thickness of basalt layer over the middle part of the Broach-Jambusar block of Cambay basin is estimated more than 5.5 Km and thinning to 0.7 Km in the eastern part of the basin.

Keywords*: Residual gravity, gravity modeling, basalt layer*

Introduction

In most of seismic data top of basalt layer can be interpreted with some degree of confidence but botttom of basalt cannot be ascertained because very little energy is transmitted below.

Deep Seismic Sounding data interpretation shows no basalt layer in the Broach – Jambusar block, of cambay basin, though well WC, WL and WN (fig. 3) encounters basalt. Of which WN drilled up to basement passing ~1.6 Km thick of basalt column. The technique of gravity modeling with some innovative ideas and implementation is introduced to delineate the basalt layer in Broach – Jambusar block of Cambay basin.

The Cambay basin, a failed rift Tertiary basin, is divided into six tectonic blocks (Banerjee. et. al, 2000), the Patan, Mehsana, Ahmedabad, Tarapur, Broach-Jambusar, and Narmada, (Figure 1). Many authors has been brought out detail studies on geology, tectonics, and stratigraphy of the basin naming few are Bhandari and Choudhary (1975), Biswas (1982, 1987), Biswas et al. (1994), Kundu et al. (1997), and Raju (1969). As brought out by Biswas(1987) the basin was originated during the Mesozoic and subsided at a greater rate during the Tertiary. Deccan volcanism, which has 29 basaltic flow (Wadia, 1975), in cambay basin has been dated to 68.5 Ma (B. R. Arora.et.al, 2002) contrary to 65 Ma as reported by many authors. Therefore, as rifting is followed by Deccan volcanism a thick layer of basalt may be expected at the synclinal part of the basin, about 2 Km in Ahmadabad block (Biswas, 1987).

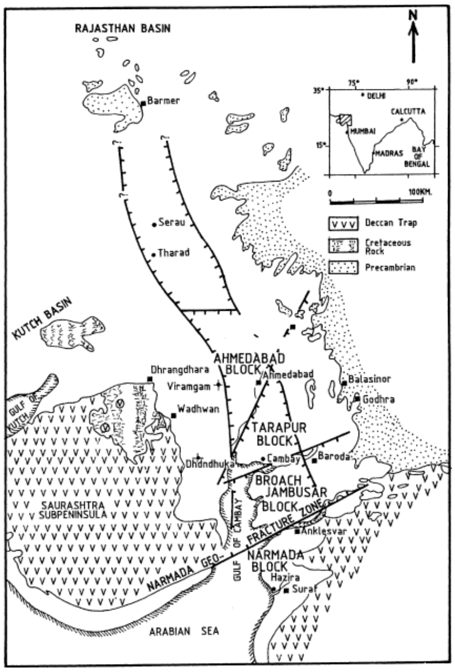

Figure 1. Location map and block boundaries of the Cambay basin (after Banerjee et.al. 2000)

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Figure 2 shows gravity anomaly map of the region which shows clearly the boundary of cambay basin with NNW-SSE trending central gravity high, which is developed up to north of Mahir river. To the south of this river i.e in Broach - Jambusar block, neither the basin margin nor the central gravity high is observed. These boundaries seem to have emerged again in the Narmada Block but with a different orientation. And the central gravity high is not visible in this block. As seen from the gravity anomaly map the northern part of the basin is narrower in comparison to southern part.

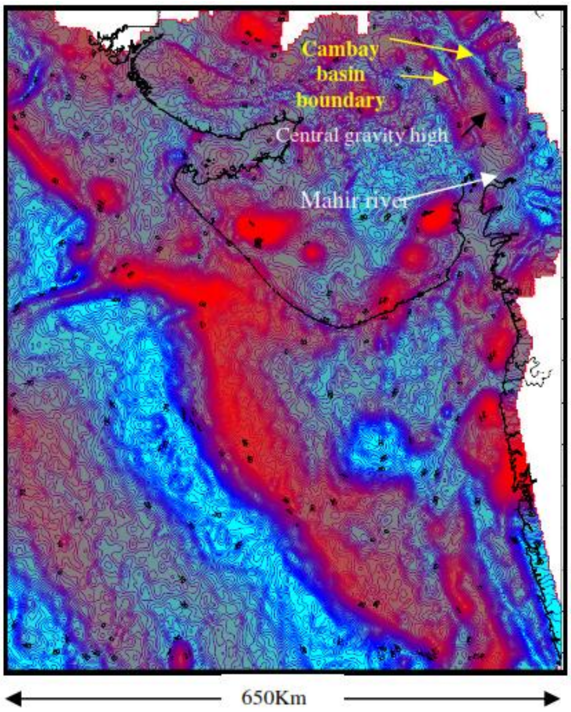

Figure 2. Gravity anomaly map of the region

Figure.3 shows the Bouguer anomaly map of the study area along with the location of seismic data, which shows a clear gravity low in the eastern side and an intrusive like gravity high on which well WM is drilled and terminated at Olpad; the gravity feature around the well WE is the Gandhar nose which seem to be protruding towards north west.

The residual gravity after removing wavelengths longer than 136 Km (two times the width of the basin) is shown in the figure 4a and its regional is in figure 4b. It shows two gravity lows clearly one at the eastern low and another at the Gandhar nose and the gravity high due to intrusive is becomes wider.

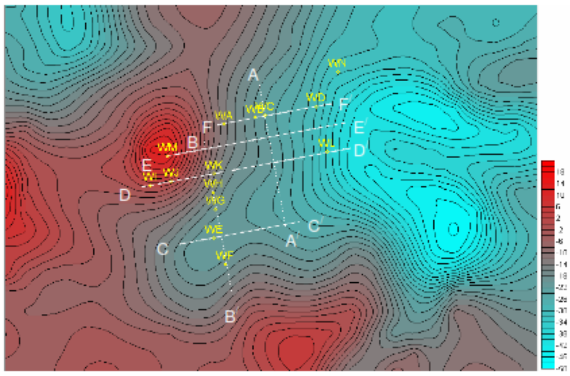

Figure 3. Bouguer anomaly map of the study area , 60x60 Km.

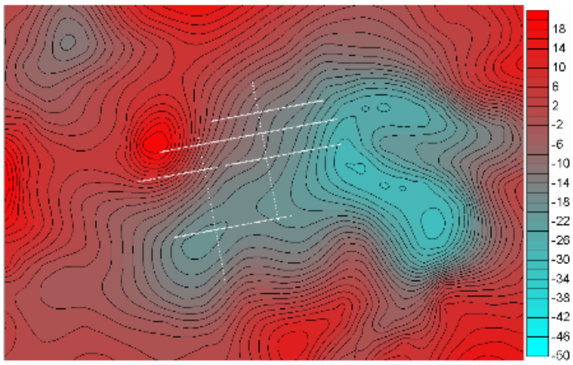

Figure. 4a. Residual gravity map of the study area (60x60 Km) after high pass Gaussian filter of wavelength shorter than 136 Km.

Methodology

Six profiles, four of which are trending EW and two along NS direction, is considered for attempting to compute basalt thickness. Seismic horizons correlated to Cambay shale, Olpad and basalt top has been pick up and converted into depth sections along the profiles $AA^{/}$, $BB^{/}$, $CC^{/}$, $DD^{/}$, $EE^{/}$ and $FF^{/}$. Seismic data along the profile DD/ shows clear reflections from the basalt top (fig. 5). Converted depths are tied with well depth and adjusted to the network for any mismatch specially for those profiles which does not have well drilled up to basalt top viz. $BB^{/}$, $CC^{/}$, and $EE^{/.}$ Respective densities of layers obtained from the well logs

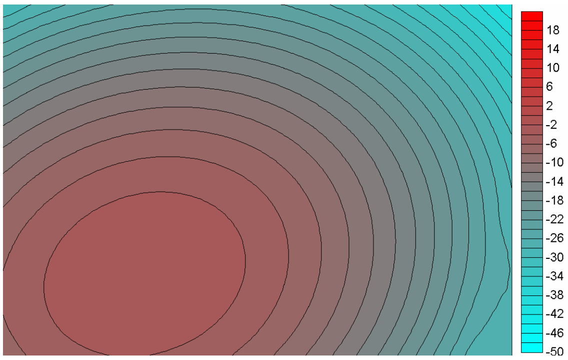

Figure. 4b. Regional gravity features of the study area (60x60 Km) of wavelength greater than 136 km.

are used to compute the gravity response of the sediment overlaying the basalt layer.

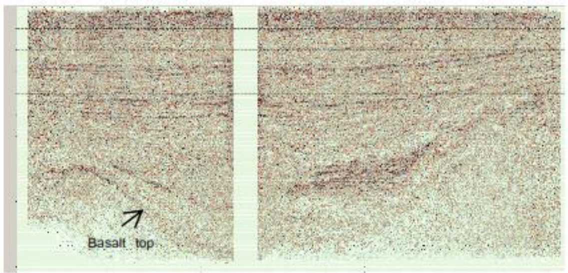

Fig 5 . Seismic section along profile DD/ showing the top of the basalt.

As regional is removed already, the residual value is expected to be the contribution of sediments, basement and basalt layer only. Though well WN shows Mesozoic sediment of ~100 m, gravity contribution from this layer is not significant and this contribution from this layer is ignored. 2D modeling along the profiles CC/, DD/, EE/ and FF/ is carried out. Modeling along profile AA/ and BB/ is carried out assuming a 2.75D model.

Gravity modeling along the profile DD/ shows (fig. 6) a thick basalt layer, below the Olpad formation overlaying the basement, of up to approximately 5 Km in the middle of the profile thinning towards eastern boundary of the basin.

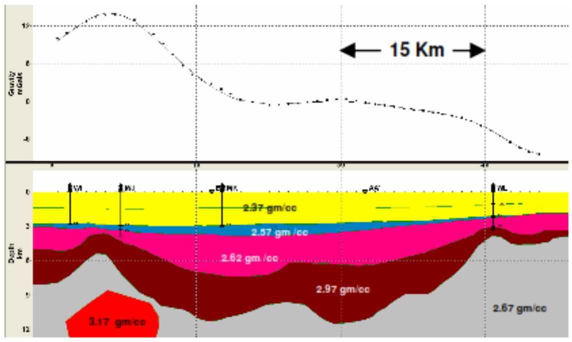

Fig. 6. Residual gravity modeling along profile DD

About 700 m of basalt is estimated towards east. Short wave length gravity high towards western end which also associated with strong magnetic anomaly (not included in this paper) is interpreted as intrusive. Similarly modeling along other EW profiles gives thicker basalt at the middle and thinning towards east. As the western part of the basin margin is out of study area hence no modeling for this part is done.

Figure 7 shows the map of basalt thickness derived from the modeling described above. Residual gravity modeling gives a thinner basalt layer in the eastern part where the gravity low is prominent and a thick layer of ~ 6 Km at the middle part of the basin. In other part of the area the basalt thickness is range from 2.5 Km to more than 5 Km.

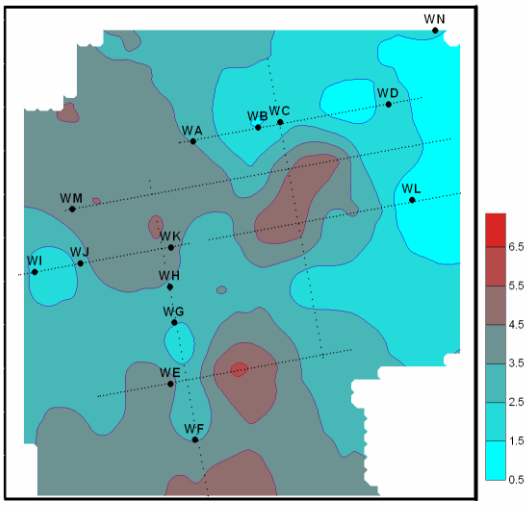

Fig 7. Basalt layer thickness contour map

Conclusions

Thickness of basalt layer varies from around 0.7 Km in the eastern flank to about 5.5 Km at the centre of the area.

The method introduced can be used effectively to estimate the thickness of individual layers separately for any two layer case with known density and total thickness.

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