Eighty five degree east ridge & its hydrocarbon potential

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Bay of Bengal is characterized by two major ridges, one approximately along the meridian 90 degrees east known as '**Ninety east ridge**' and the other approximately along the meridian 85 degrees east and known as '**Eighty five degree east ridge'**. Both ridges were identified a few decades ago and have a clear signature on the Free Air Anomaly Map of Bay of Bengal (Fig-1).

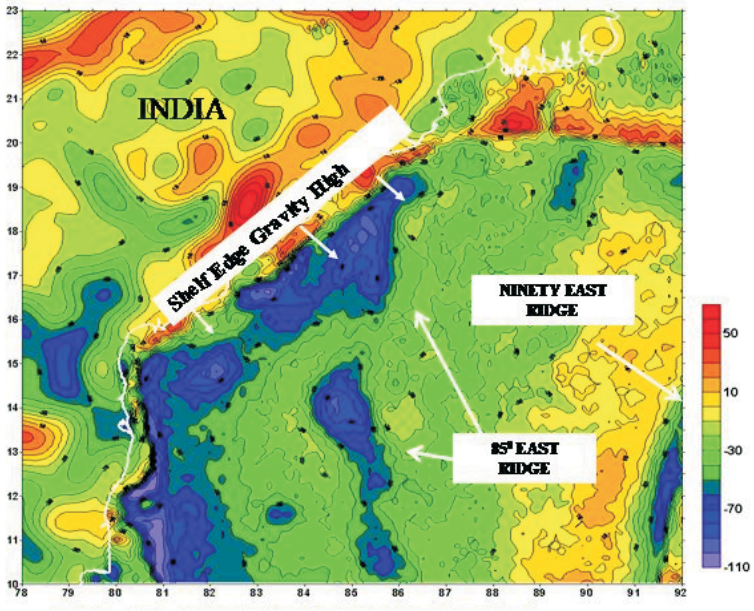

Fig.1 Free air anomaly map of Bay of Bengal (satellite)

It is interesting to see that gravity signatures of the two ridges are opposite. 'Ninety East Ridge' is characterized by strong positive gravity all along (Fig-1) and has been proved to be composed of basalt / intrusive igneous rocks by seven wells drilled over it. The age of these rocks progressively diminishes from 82 MY in the northern most well to 38 MY in the southern most well drilled on the southern end of the ridge near the junction with Broken hill ridge (Southern hemisphere). The Ninety East Ridge is interpreted to have originated during the northward journey of the Indian Plate over the Kerugelen hot spot. Composite plots of seismic, gravity & magnetic data, over 'Ninety East Ridge' available in ONGC, are shown Fig-3 & 4.

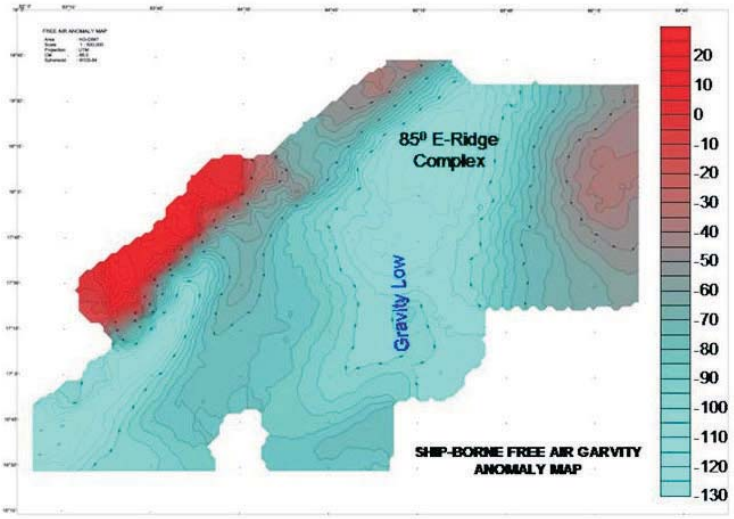

Fig.2 Free air anomaly map of Bay of Bengal (ship borne)

On the other hand, 'Eighty Five Degrees East ridge' is characterized by a strong low gravity (Fig - 1 & 2) and unlike Ninety East Ridge, no well has been drilled on it. The Free Air Anomaly Map of Bay of Bengal shows that the northern most end of the ridge is at the continental slope/rise area of south of Chilka lake (Orissa), continues southwards, then appears to take a turn to South-West of Sri Lankan continent and joins with 'Afanasy Nikitin sea mount'. In the southern part, the ridge does not exhibit a consistently low gravity; instead, it shows both positive & negative gravity anomaly.

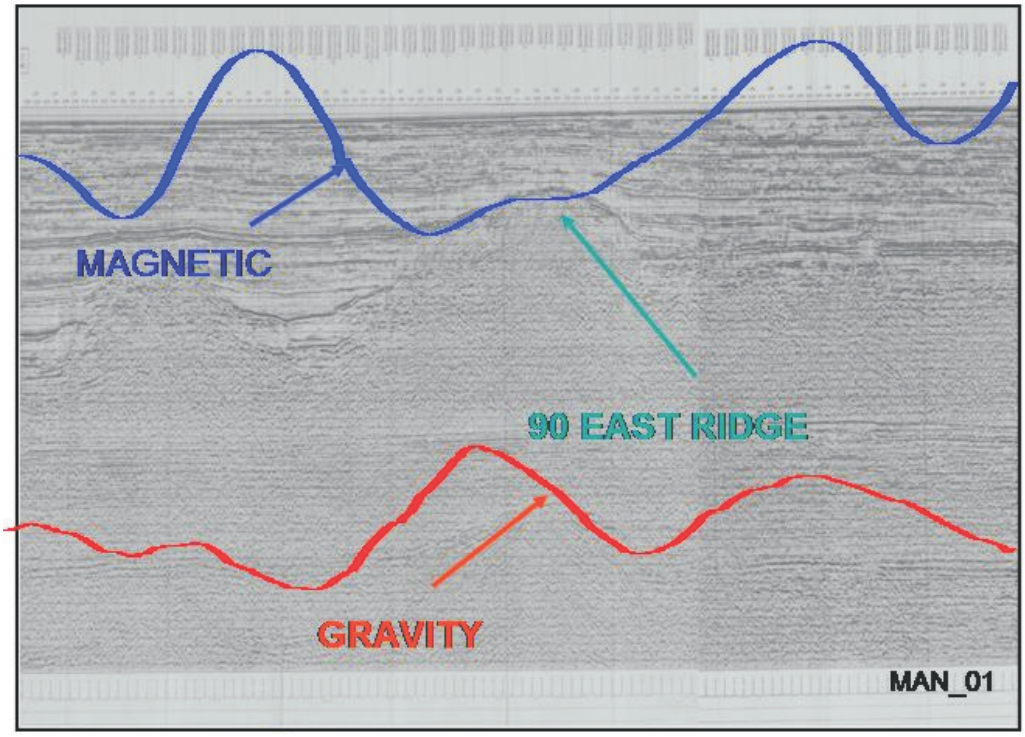

Fig.3 90 E ridge with gravity high underneath

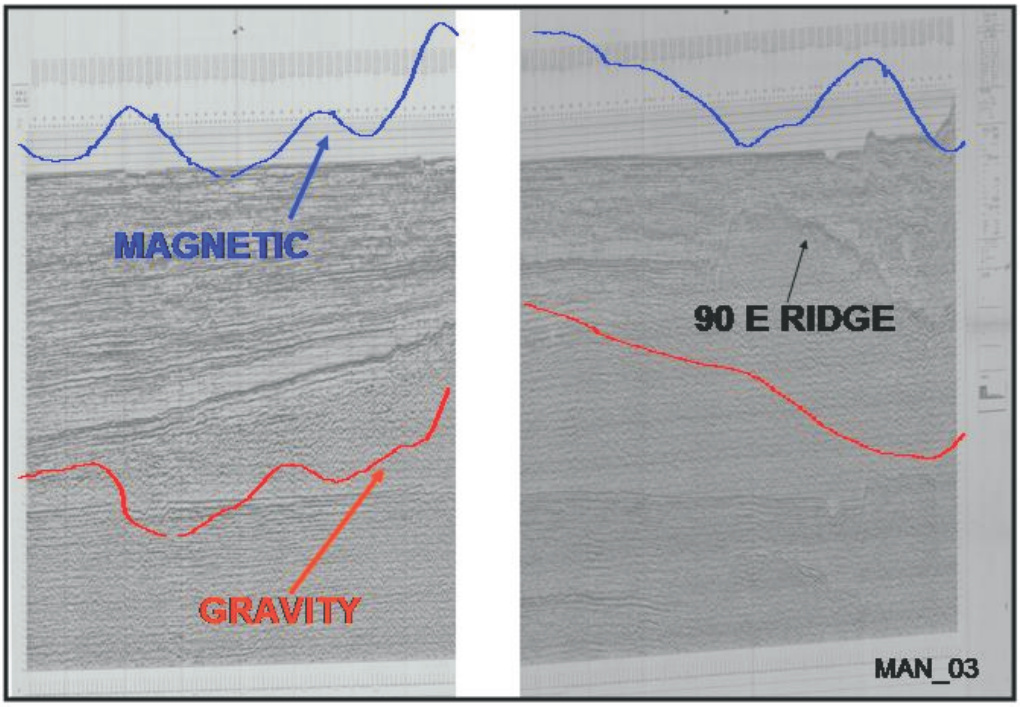

Fig4 Two more seismic lines 90 E ridge with gravity high underneath

Limited seismic data acquired in southern part of the ridge shows that where the ridge is buried under sediments it shows negative gravity and where it is not completely buried by sediments and has a relief above the surrounding sea floor it shows positive gravity (Fig - 5, 6). Samples on Afanasy Nikitin Sea mount have shown ultra basic dunite. However dunite, being an ultra basic rock with a density of the order of 3.0 gms/c.c cannot explain the strong negative gravity observed almost over the entire northern part of the ridge in Bay of Bengal.

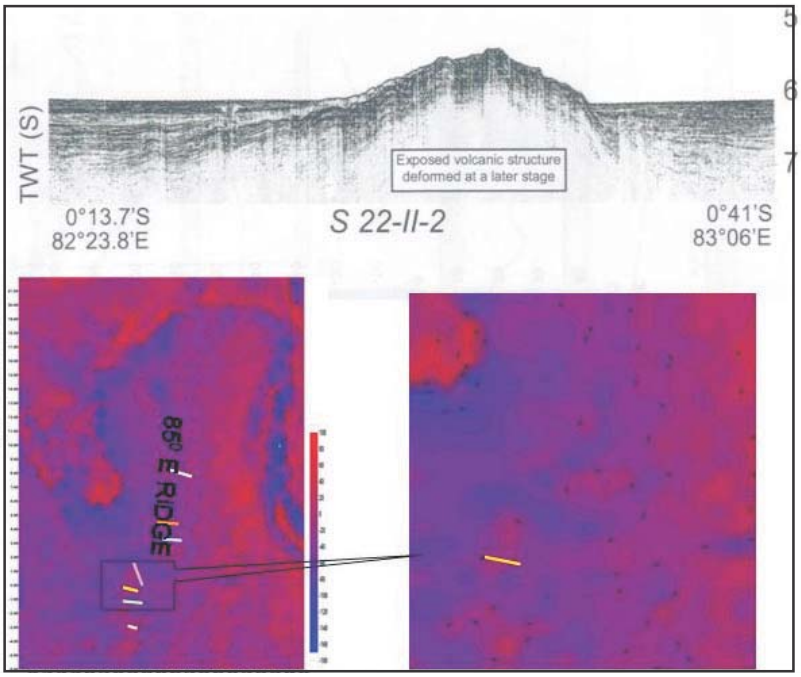

Fig.5 85^0 East ridge relief above the sea-floor showing gravity high

Earlier ONGC acquired Seismic & GM data over both 'Eighty Five & ninety Degrees East Ridge' along the profiles MAN-01 & MAN-03 over 14.70 & 130 North latitude. Subsequently, close grid seismic, gravity & magnetic data were acquired by ONGC over northern most end of the ridge i.e. south of Chilka Lake in NELP Blocks D-5-6-7 in the year 2004-05. On these data as well as on the earlier data, it is seen that the western side of ridge is associated with a steep surface (Fault or a cut surface due to erosion). Composite plots of seismic, gravity & magnetic (Fig - 7,8,9 & 11) show a mild change of the gravity gradient towards positive gravity superimposed over broad gravity low of Eighty five degrees East Ridge.

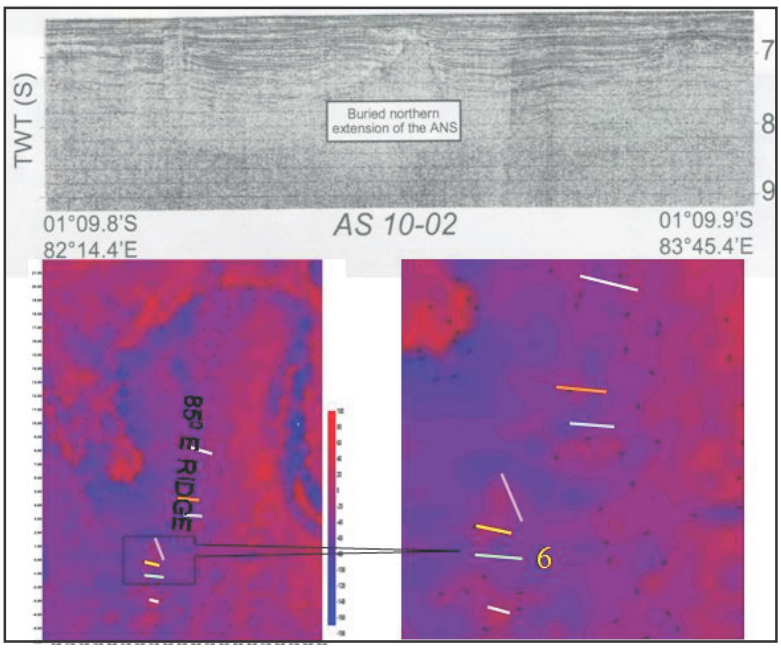

Fig.6 85^0 East ridge buried under sediments showing gravity low

Earlier refraction survey (Fig - 10a & b) has shown the presence of low velocity (hence low density) material encased by materials of higher velocity materials (basalt?). This explains the broad low gravity observed over the ridge. ***However mild change of the gravity gradients across the steep western boundary provides the key signature of the composition of the ridge.***

Since the change of the gravity gradient is over the steep western boundary only, it can be directly correlated with this boundary, which is either a fault or, what is more likely, a cut surface due to erosion.

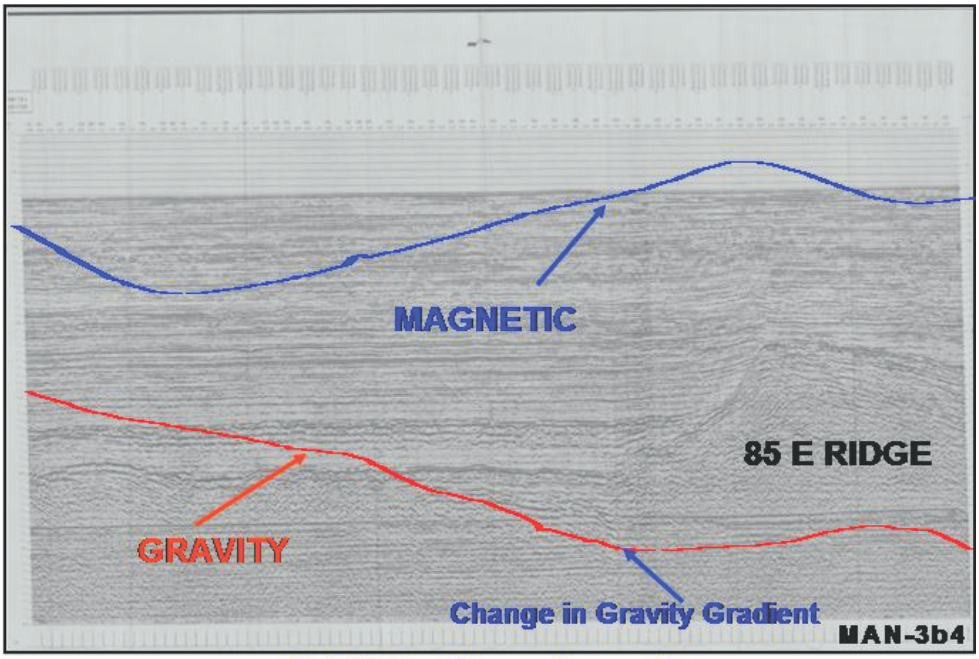

Fig.7 85^0 East ridge with negative gravity

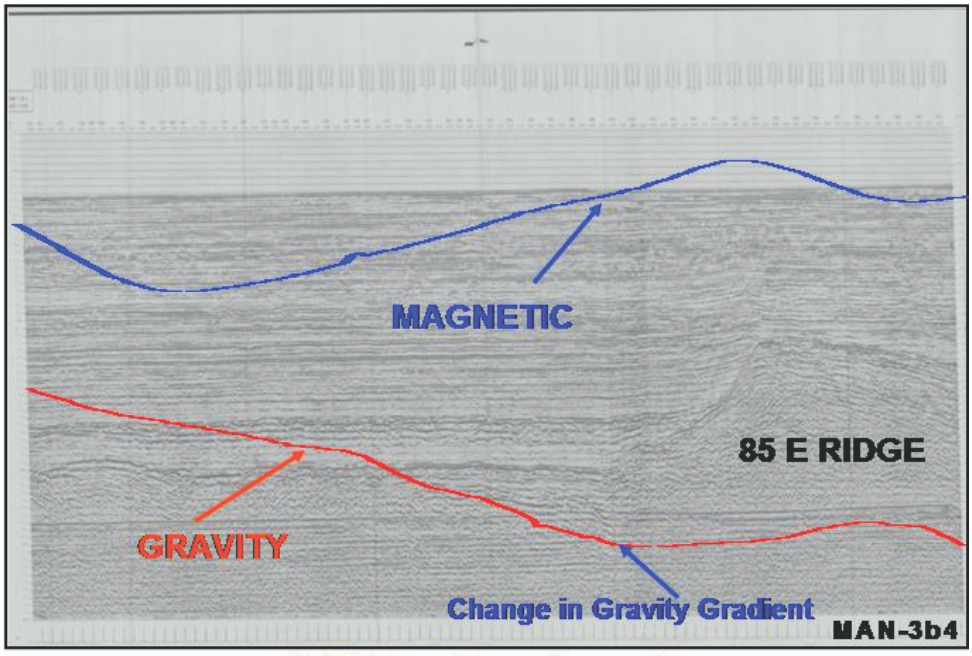

Fig.8 85^0 East ridge with negative gravity

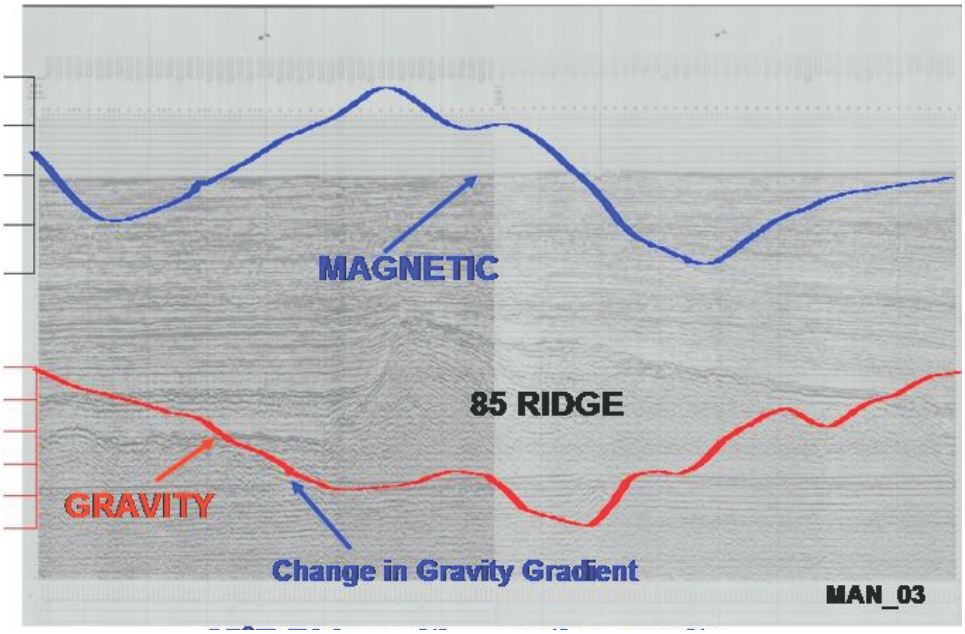

Fig.9 85^0 East ridge with negative gravity

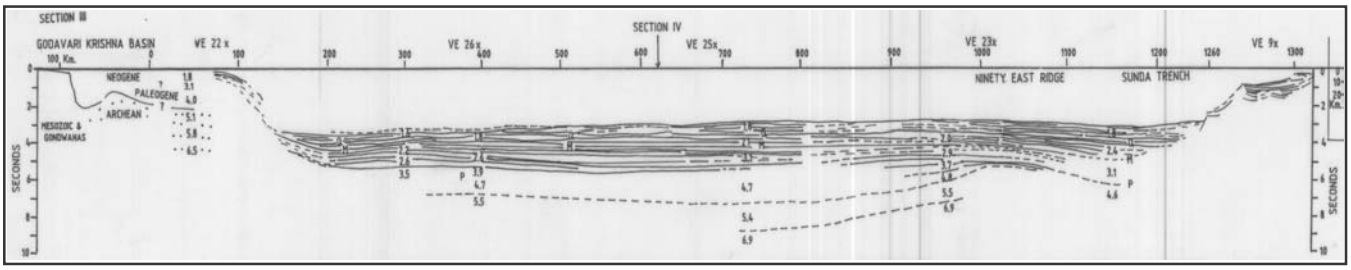

Fig.10a

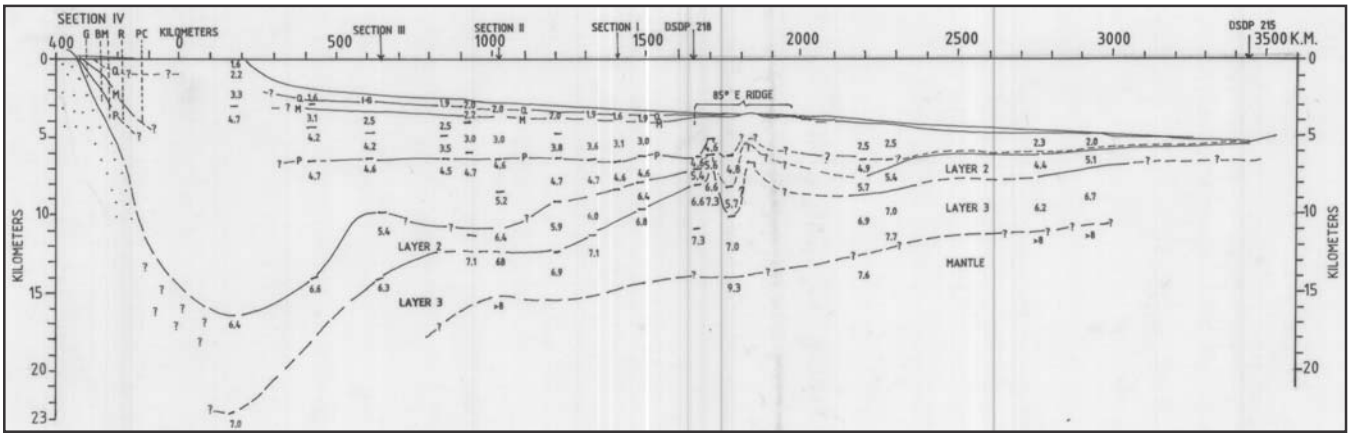

Fig.10b

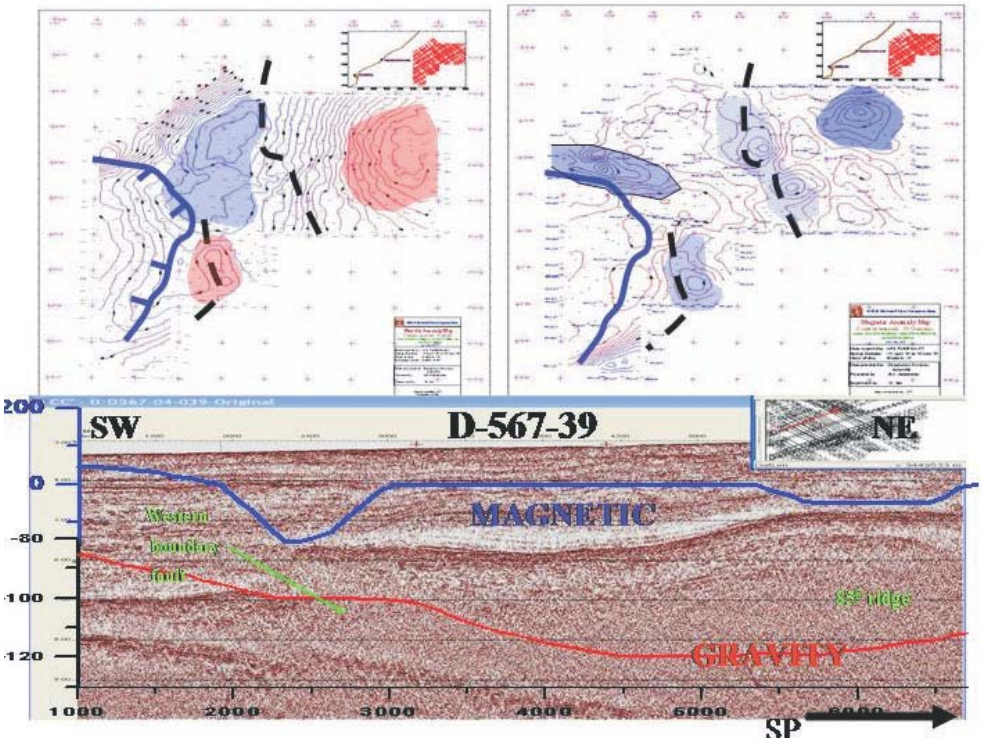

Fig.11 Observed gravity & Magnetic field along a SW-NE seismic line

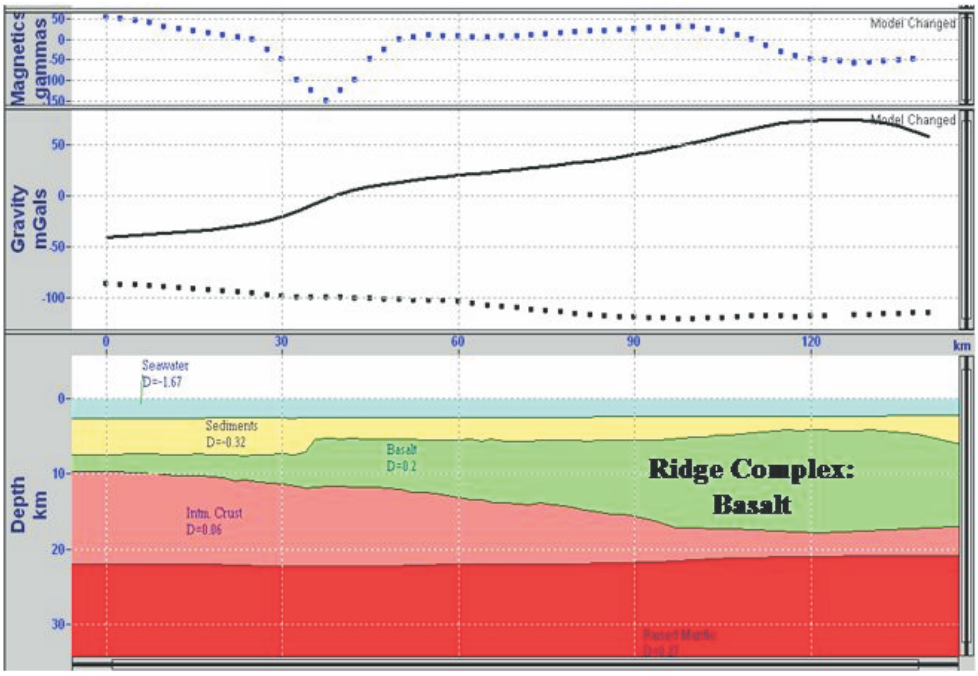

Fig.12 Deeper layers considered as basalt

Gravity modeling has been carried out to simulate this gravity signature. It is seen that if the ridge is composed of basalt or granite, then the gravity signature will be diametrically opposite to the observed field (Fig - 11,12 & 13) i.e. in both cases, eighty five degrees ridge would have been associated with a strong positive gravity anomaly.

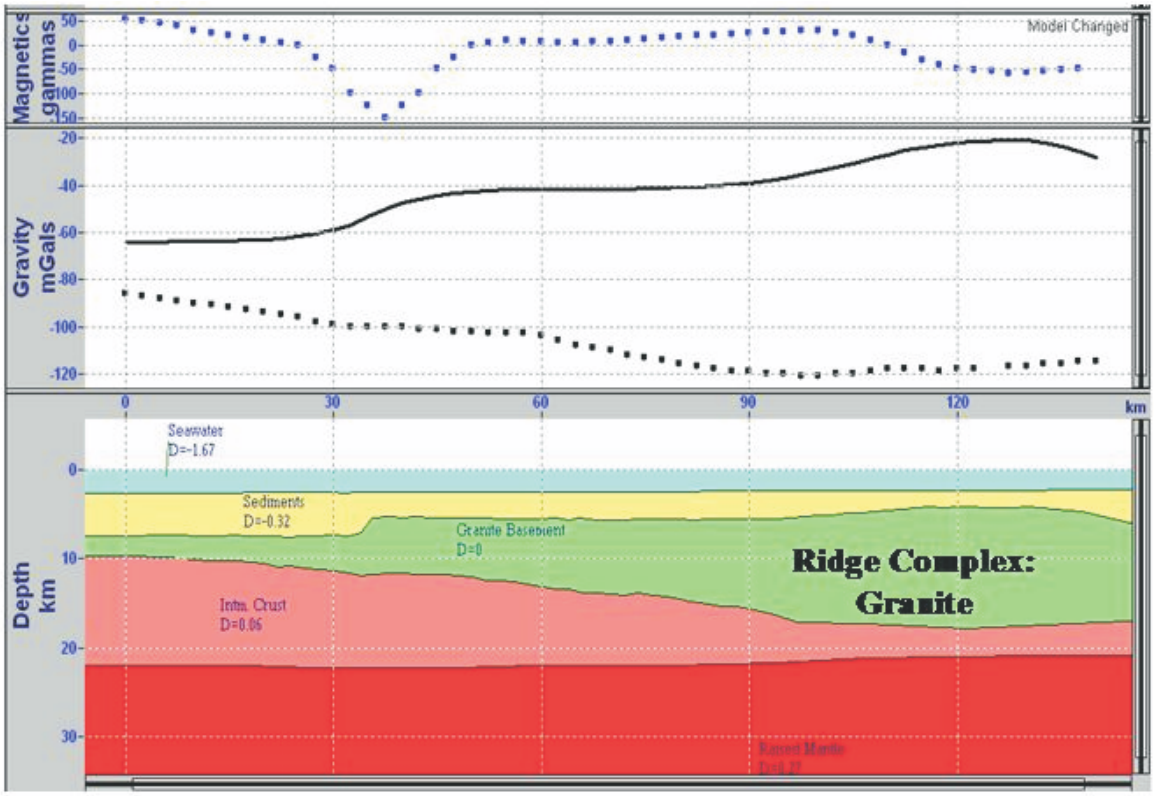

Fig.13 Deeper layers considered as basalt

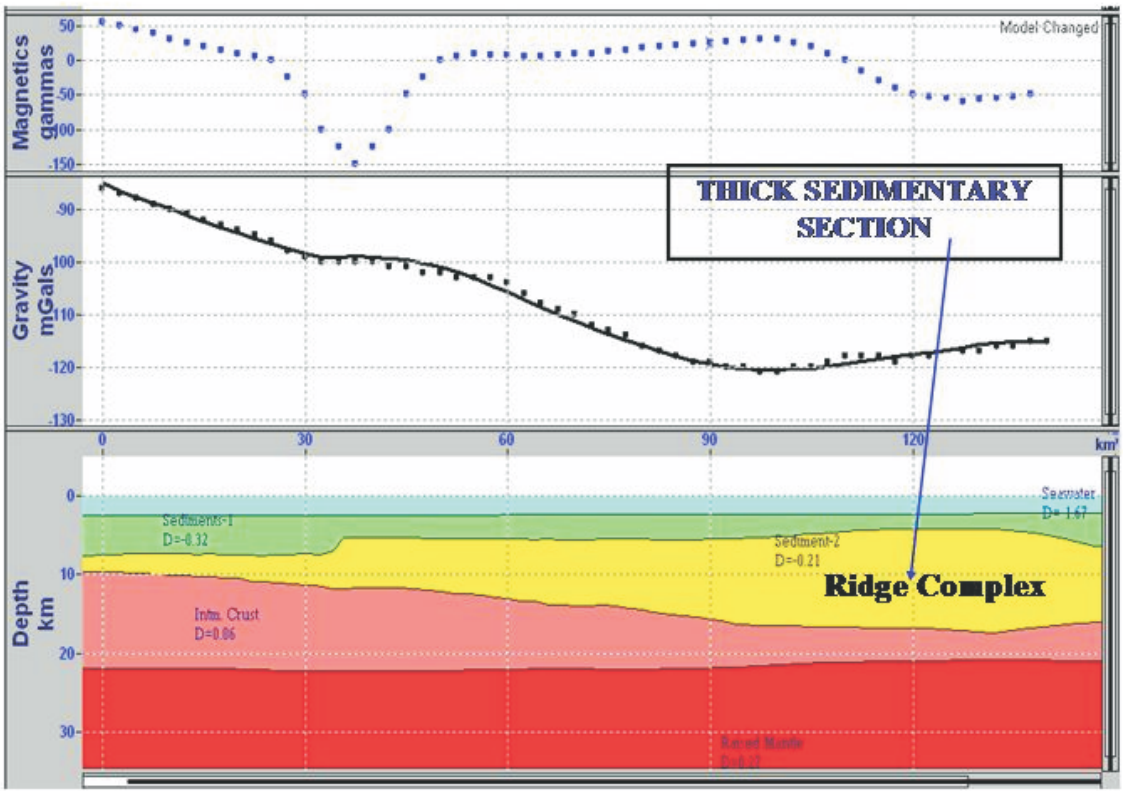

Fig.14 Deeper layers considered as basalt

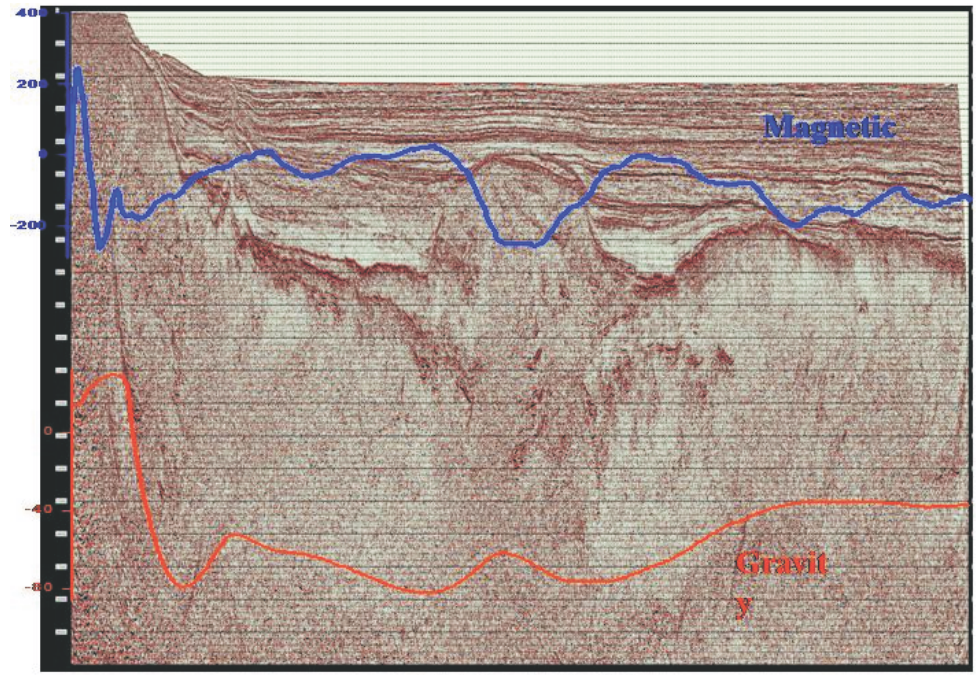

Fig.15 A regional seismic profile over ridge showing sedimentary nature of ridge

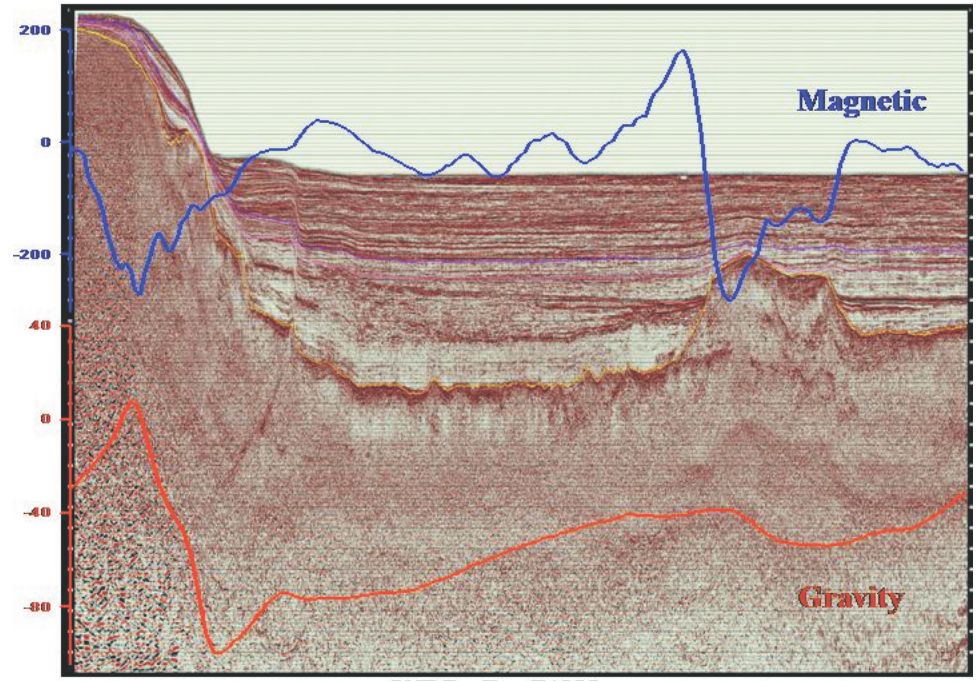

Fig.16 Another regional seismic profile over ridge showing sedimentary nature of ridge

The computed gravity signature compares well with onserved gravity only if the ridge has a density which is comparable to, but a marginally higher value than the density of the surrounding sediments (Fig - 14).

Subsequently, GXT profiles acquired over the ridge in 2007 has clearly shown the sedimentary nature of the ridge (Fig - 15 & 16).

Earlier Gopala Rao, et al., 1997, showed convincing signature of continent - oceanic crust boundary off Cauvery, KG & Mahanadi basin in continental slope / rise area. We can thus conclude that 850 E Ridge appears to be a continental sliver, important for hydrocarbon exploration.

References

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