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Geophysical Exploration From Textural Features Generated Images Using Satellite Geoid/Gravity Data Over the Krishna-Godavari Offshore

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Abstract

Krishna-Godavari (KG) Basin is a peri-cratonic passive margin basin in India. It is spread across more than 50,000 square kilometers in the Krishna River and the Godavari River basins in Andhra Pradesh. High resolution satellite geoid/gravity maps have been generated over the Krishna-Godavari offshore. A big geoidal low ranging between -4 m and -5.5 m could be observed in the middle of the basin. The Entropy map generated over the area of interest using textural analysis shows a number of features matching with the existing anomalies along with the existing faults; a number of new features could also be extracted. The Bouguer gravity anomaly over the KG offshore has been generated along with various fault patterns as well as the locations of oil seepages. Most of the seepages are lying in the Bouguer anomaly low.

Keywords: Textural features, Krishna-Godavari Offshore, Satellite geoid/gravity, Entropy, Geoidal low

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1. Introduction

Texture is an important spatial feature, useful for identifying objects of regions of interest in an image. The concept of texture is closely associated to tone, as texture represents the spatial pattern of tone in an image. There are a number of methods for identification of textural parameters e.g. edgeness, frequency domain analysis, gray tone co-occurrence approach etc. (Haralick, 1976; Majumdar and Mohanty, 1999). Texture is one of the most important visual cues in identifying various types of homogeneous regions. Image textures can be used to help in segmentation or classification of images. Textural analysis of satellite geoid/gravity field using different methods including gray-level co-occurrence matrices (GLCM) can be used for enhancement of subtle features (Cooper and Cowan, 2007; Su *et al.* 2013).

2. Data Sources & Study Area

Krishna-Godavari (KG) Basin is a peri-cratonic passive margin basin in India. High resolution satellite geoid/gravity maps and their spectral components have been generated over the Krishna-Godavari offshore area. With an areal extent of approximately 45,000 sq km, this proven petroliferous basin has potential reservoirs ranging in age from the Permian to the Pliocene. Exploratory drilling of more than 350 wells in more than 160 structures has resulted in the discovery of 42 oil and gas bearing structures (Rao, 2001). Map showing the structure and tectonic framework of the Krishna-Godavari basin, east coast of India along with gas/oil fields/strikes is shown in Fig. 1 (after Chatterjee and Mukhopadhyay, 2002). Most of the oil and gas deposits are found in the areas of Kaza Horst, Tanuku Horst, Narsapur, Razole, Amlapuram and Ravva field falling within this linear basin (Fig. 1) (Rawat, 2015).The study area comprises the KG Offshore (latitude 13^{o}N–17^o N, longitude 79^{o}E–84^{o}E, approx.) (Fig.1). Other data include the ETOPO-1 bathymetry using ship-borne survey, tectonic map over the region, etc.

3. Methodology

The Radar Altimeter is a nadir-viewing instrument, which transmits short-duration radar pulses (frequency ~ 13.0 GHz) with known power in a pencil beam towards the earth's surface and then measures the reflected energy. The time delay (i.e. the two way travel time of the pulse) when coupled with a knowledge of the velocity of propagation through the ionosphere and wet troposphere can be converted into a highly accurate measurement of the altitude of the satellite and, therefore, a measurement of the sea surface height/topography (Fu *et al.* 1988). Geosat GM (Geodetic Mission), ERS-1/2, TOPEX/Poseidon and Seasat altimeter SSH data have been used to generate high-resolution satellite geoid/gravity over the study area (Hwang *et al.* 2002; Majumdar & Bhattacharyya, 2004). Because of being very high in density by nature (off-track resolution ~ 3.33 km), sea surface parameters as well as geoid/gravity derived from these data are very accurate and detailed. Details of the methodology for obtaining geoid and gravity from altimeter-derived sea surface height have been discussed elsewhere (Hwang *et al.* 2002; Majumdar and Bhattacharyya, 2004).

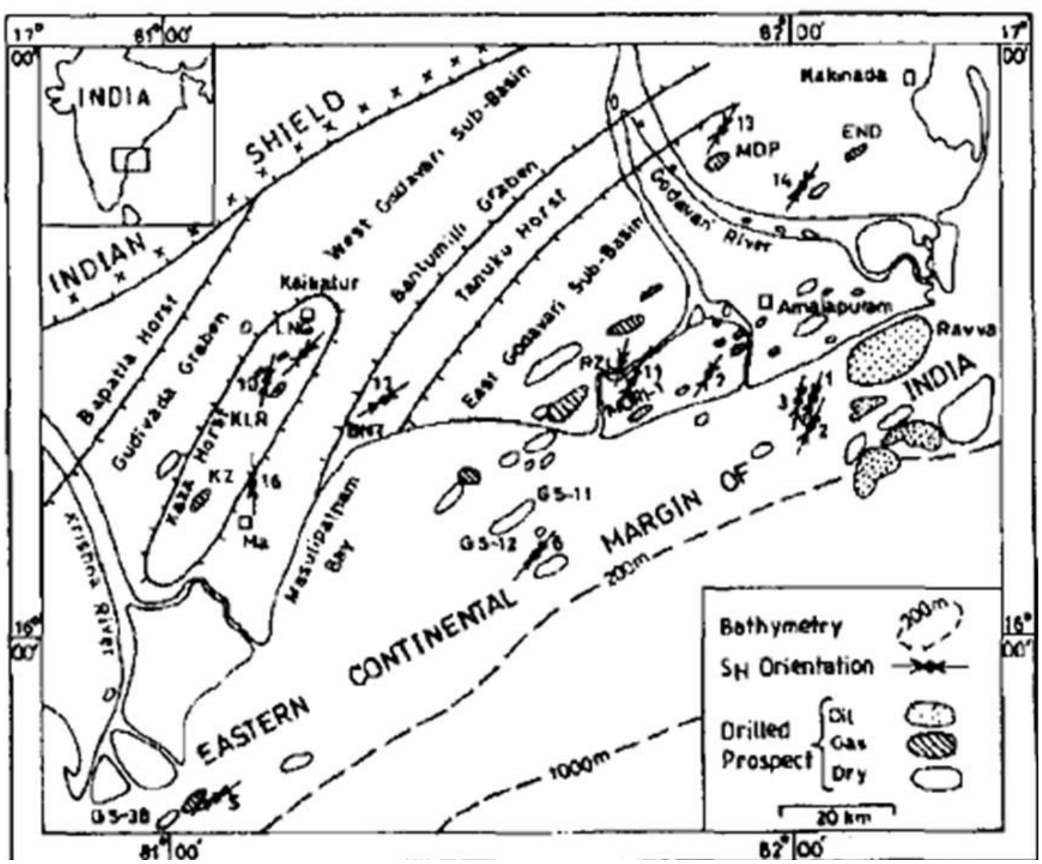

Fig. 1: Map showing the structure and tectonic frame work of the Krishna-Godavari basin, east coast of India along with gas/oil fields/strikes (after Chatterjee and Mukhopadhyay, 2002)

Texture statistical features computed from the co-occurrence matrix can be used to represent, compare, and classify textures, namely 1. Contrast Group (Contrast, Dissimilarity and Homogeneity), 2. Orderliness Group (Angular second moment and Entropy) and 3. Statistics Group (GLCM Mean, Variance and Correlation) (Su *et al.* 2013). Accordingly, few statistical textural features were generated using gravity image over the Krishna-Godavari Offshore like, Contrast, Entropy, Energy and Second Moment after generating the statistical vectors (Cooper and Cowan, 2007).

4. Results & Discussion

KG offshore residual geoid map, as generated over the study area, is shown in Fig. 2. A big geoidal low ranging between -4 m and -5.5 m could be observed in the middle of the basin. Figure 3 shows the Entropy map generated over the area of interest using textural analysis.

Comparison of Figs. 2 and 3 with Fig. 1 shows a number of features matching with the existing anomalies along with the existing faults. Also, a good number of new features could be delineated for further exploration. The Bouguer gravity anomaly over the KG offshore along with various fault patterns as well as the locations of oil seepages have also been generated. Most of the seepages are lying in the Bouguer anomaly low.

5. Concluding Remarks

Thus, textural features extraction is found to be very useful for geophysical exploration over the Krishna-Godavari Offshore.

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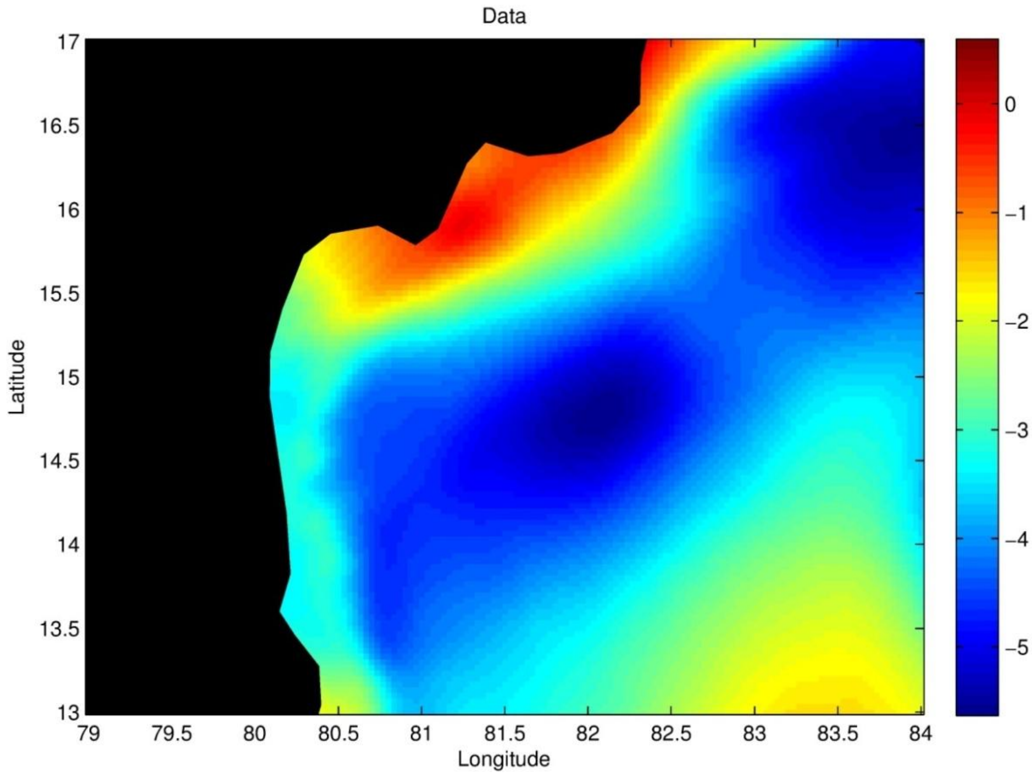

Fig. 2: Residual geoid map generated over the KG Offshore

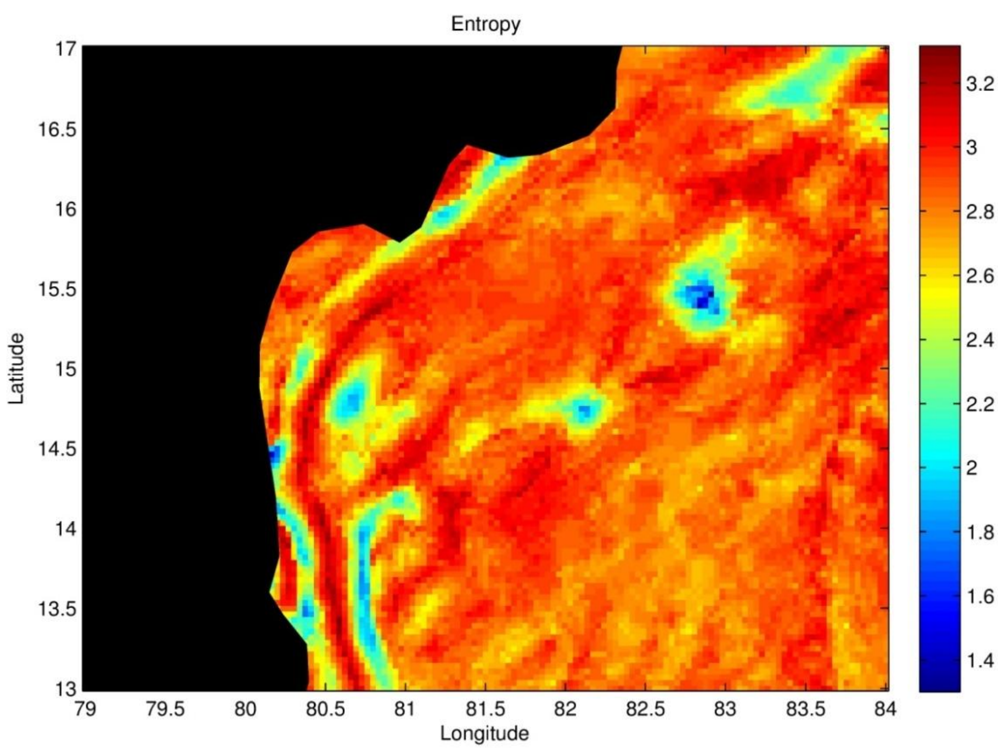

Fig. 3: Entropy map generated over the KG Offshore

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