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# Role of Remote Sensing and GIS to Provide Geological Input for Hydrocarbon Exploration – A Case Study on Godavari Basin Rajahmundry

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**Summary**

Hydrocarbon exploration is a systematic analytical procedure of various scientific surveys such as geological, geophysical, geochemical, etc. All these scientific methods investigate origin, occurrence, migration, and trap etc. Remote Sensing (RS) refers to the science of identification of earth surface features and estimation of their geo-biophysical properties using electromagnetic radiation as a medium of interaction. It helps in identification of geological and geomorphologic features of the surface which gives an idea to project our view towards the internal geological arrangement. Petroleum geologists worldwide have used orbital and airborne remotely sensed data for a number of applications.

GIS is built upon knowledge from geography, cartography, computer science and mathematics and can be applied in any field, directly or indirectly. GIS is a tool which helps in analyzing various sets of data, based on overlaying various sets of images. Hydrocarbon exploration is a costly affair for conducting geophysical surveys, so we cannot conduct survey unless we get any imprints about the existence of hydrocarbons, so here comes the role of Remote Sensing in Hydrocarbon exploration for mapping surface geological features, which is very low cost comparing to other geophysical surveys. The study deals with integration of Remote Sensing and GIS in Godavari basin located at the centre divergent of the Indian plate.

## Introduction

Remote sensing is no more than a tool, which, along with more conventional exploration techniques such as geophysics and reconnaissance field mapping, can help to establish regional geologic relationships, to extract major structural features and to pinpoint anomalous patterns. There are a number of remote-sensing systems that now are operational. Under ideal circumstances onshore oil exploration begins with regional geological reconnaissance and progresses to more detailed and expensive exploration methods. Oil and gas exploration activities for large areas require airborne magnetic or ground gravity surveys to facilitate detailed geological interpretations for subsurface features. In the present area the coastal plain rise gradually from the Bay of Bengal to the west ward in order to merge with the irregular alignment of the outcrop portions of Rajahmundry sandstone, Upper Gondwana rocks and Easternghat gneisses. The coastal plain is the widest near the axial portion of the Godavari delta nearly 70kms from Rajahmundry. The western and north western portion of the area to the National highway is highly undulated with Easternghat hill ranges and is covered with dense forest. The general elevation of the area varies from the sea level to more than 1200 ft. The general slope of the area is towards south and southeast. The location map of study area is shown in Fig.(1).

The deltaic part of the area is almost flat and is exceedingly fertile. The area offers a very picturesque landscape varying from the coastal plains in the east to gradually rising deltaic plains in the east to gradually rising deltaic plains to the west until it reaches the Rajahmundry sandstone and Easternghat scrap portions. The upland portion mainly consists of cuesta slopes and mesas of Rajahmundry sandstone and metamorphic rocks.

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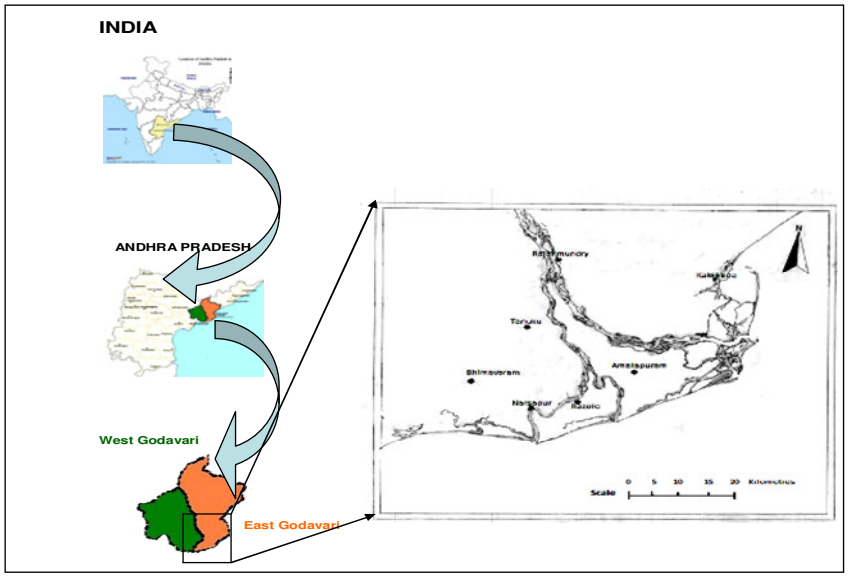


Fig. 1 Location Map of Study Area

**Geology of the Area**

In the present area the exposed rocks include the gneisses of Easternghat, sandstone and shale sequence of upper Gondwanas, Trappean Basalts and Mio-pliocene Rajahmundry sandstone with laterite cappings besides recent to subrecent alluvium and other recent deposits. Easternghats are a series of rather detached hill ranges of heterogeneous composition which stretch intermittently from northern part of Orissa to Nilgiris through coastal Andhra Pradesh. Easternghats are largely made up of Khondalites, Charnockites, Crystalline limestones and Kodurites. According to Fermer, they represent a belt of block uplift as they contain rocks of high grade metamorphism at depth. The Easternghat organic cycle took place around 1670 million years back. In the present area the Easternghat hills are constituted with Khondalites, the paraschists of Fermer. They are garnetiferous, sillimanite gneisses and were originally called as Bezawada gneisses, Kailasa gneisses etc, locally. The Khondalites of this area from ridges, trending in NE-SW direction which is the regional strike of these rocks. The Khondalites are the oldest rocks exposed in this area and are forming the basement on which younger sediments have been deposited. The rocks are white, pink and light brown coloured.

**Method**

In the present study Remote Sensing data interpretation were done for the Godavari Delta. The main aim was to study the geomorphology of the delta systems with the intervening inter-deltaic area so as to understand the distribution of the landforms and the lineaments. On mapping the landforms and the lineaments attempts are made to bring out the geomorphic evolution and the neotectonics in the present day Godavari deltas. To study the costal geomorphic landforms and land systems high resolution LANDSAT satellite images were downloaded from the site "www.glcff.umiacs.umd.edu". For mapping the regional lineaments of the area, lower resolution Landsat Multi Spectral Scanner (MSS) data was also used.

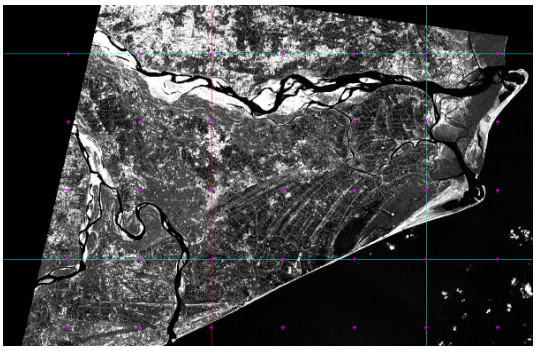

Fig. 2 Original Landsat Mss Band 7 Image of Godavari Subgodavari

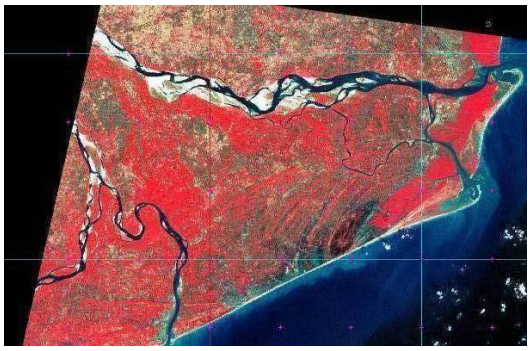

Fig. 3 Fcc Of Visible Band 4,3,2 Of Sub Basin Basin

Standard Image processing techniques were followed in preparing false colour composite (FCC) and other products were shown in fig(2) and fig(3).

The basic method adopted was visual interpretation of FCC and B&W data. From the image interpretation characters as tone, texture, colour, form and shape various landforms and land units were distinguished. The response of materials in the different wave length bands are also used to identify surface materials as water bodies, moist areas, chlorophyll rich or poor areas, high reflecting sand bar or beach ridges etc. For example at the mouth of Godavari River, in the B&W dark mangrove swamps (high chlorophyll) show high reflectance or white tone, whereas on FCC.

Satellite image data of the Godavari basin was used as a plane raster data. Landsat high resolution data are used.

Satellite data is recorded pixel by pixel and therefore is inherently raster data. At a high resolution all major geological features such as lineament, tectonics, gas reserves, gas fields, and geomorphological anomalies and various geomorphic features as beach ridges sediment dispersal patterns, etc. are clearly visible are shown in fig. 4. The source for the data is given along with the map. A generalized geomorphological map was prepared for the Godavari basin. Therefore, data integration by overlaying procedures or by multilayered grid to grid basis integration assists in interpretation and decision making.

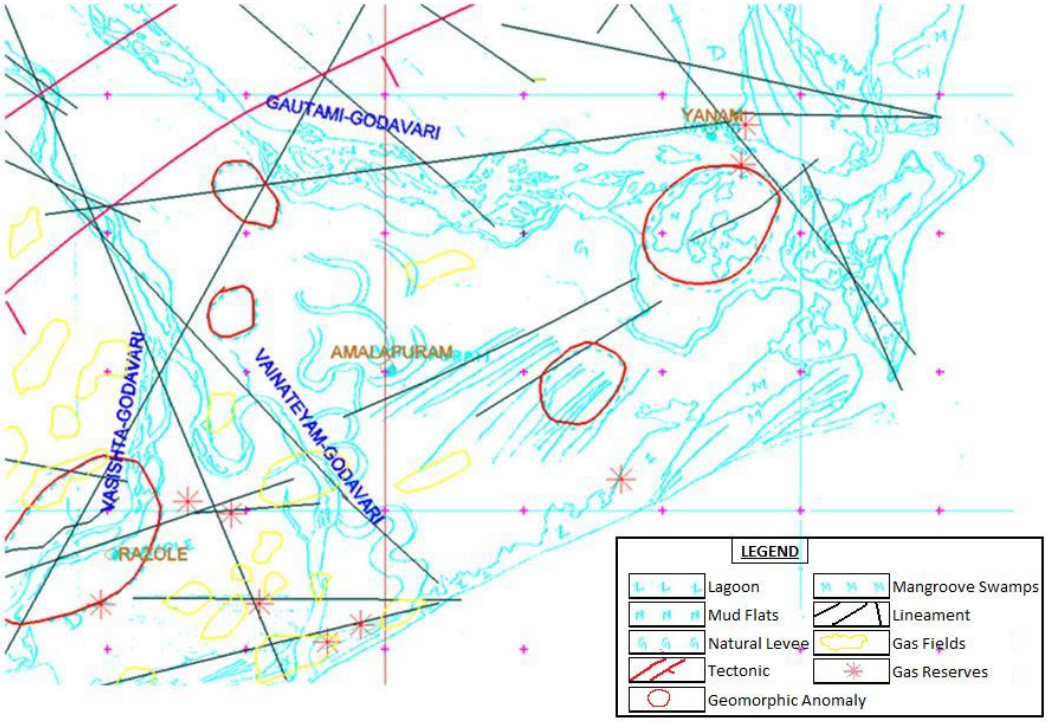


**Fig. 4** GAS FIELDS, LINEAMENT, ANOMALY, TECTONIC, GAS RESERVES AND LANDFORM MAP OF GODAVARI BASIN

**Conclusions**

1. On the basis of geomorphological studies it is seen that the Godavari delta is a wave dominated delta with low sediment input and negligible tidal energy flux.
2. The dominant lineaments run parallel to the basin margin lineament, however a few major cross trends are seen west of Rajahmundry and north of Kakinada. These trends could probably be impressions of the Pranhita-Godavari basin margin faults.
3. From the paleo-drainage and beach ridge developments, it is seen that two major depocentres are there in Godavari delta, one towards Kakinada and second south of Amalapuram.
4. The Vasishtha Godavari presently shows south west ward migration with development of about 15 km wide cuspate beach ridge complex in recent times.
5. The southwest wards migration of Vasishtha and Vainateyam Godavari is due to neotectonism felt along a lineament through Goguleru creek-Narsapur-Amalapuram.
6. Morphotectonic studies with limited study of subsurface data indicate subsurface continuation of the Pranhita-Godavari Graben the Godavari Basin bounded by Pithapuram and Kommagudem lineaments as its eastern and western basin margin lineaments. The basin marign fault of the Godavari Basin, south of Zangareddiguedm, has possibly acted as a zone of transverse left lateral movement causing the displacement of the Pranhita-Godavari Graben in the subsurface of the Godavari delta. Subsequently, tectonic elements of the Godavari Basin developed, with the drifting of the Indian plate, and were possibly superimposed over the Pranhita-Godavari Graben

accompanied by both transverse movements and vertical movements.

7. The Godavari river experienced neotectonic activity, where we can observe the meanderings of Vasishta and Vainateyam rivers of Godavari. Therefore, the delta between Vasishta and Vainateyam is having the potential of Hydrocarbons by its, Chenier plains, sand bars, lineaments, and geomorphic anomaly, and in addition to these geomorphological features, there are structural features such Tanaku horst and Draksharamam horst which acts as seal or trap for the entrapment of hydrocarbons.

**Recommendations**

1. Detailed morphotectonic studies with high resolution Landsat enhanced data products has been carried out. For further detailing of delta morphology, specialized digital image processing of delta is recommended.
2. The Godavari river before entering the deltaic plains has a long course through the Pranhita-Godavari graben and then cuts across the Charnockite-Khondalite belt of the eastern ghats. This course is followed despite easier terrain through Warangal, Ashwaraopet and Elluru. Detail studies on the course of Godavari of the upland area could lead to the identifying of palaeo-drainage systems, in the earlier depositional history of the basin, which were responsible in brining enormous volumes of sediments into the basin.
3. The basin margins of the subsurface extension of the Pranhita-Godavari Graben may be brought out by detailed study of seismic and subsurface data which will help in exploration for Gondwana prospects.

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