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Methodology for Recovering Missing and Low Resolution Seismic Data using Dips from Microresistivity Images

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Summary

Delineating the reservoir geometry of geologically complex settings like synrift basins pose immense challenges. Existing seismic imaging of such a disturbed zone in the Krishna –Godavari basin fails to correctly portray high resolution reservoir geometries. To address this challenge, this paper presents a novel methodology that delivers a high-resolution reservoir model. In this method, dip data from both image logs and petrophysical data are combined to obtain a high-resolution model of the reservoir geometry. The workflow begins with the processing of image and manual dip interpretation. This is followed by the filtering of structural dips to obtain in-sequence dips and exclude the out-of-sequence dips that are borehole-centric or very localized. The next step includes the computation of structural dip and subsequent delineation of the structural axis. Based on regional geological information and petrophysical character, well tops are identified. These tops are further used to create isopach maps of each stratigraphic zone. The well tops are projected away from the wellbore, and the model is completed with surface and edge creation. The model provides high-resolution structural units and their petrophysical characteristics. The result was used to further modify and complete missing interpreted seismic surfaces.

***Keywords**: Krishna-Godavari Basin, Reservoir Modeling*

Introduction

Synrift sediments are promising hydrocarbon exploration targets for operations around the world (Arun Kumar Arya et al. 2011). A synrift sedimentary sequence is encountered onshore the Krishna-Godavari basin, which is located in Andhra Pradesh, India. The synrift phase of the basin represents a complex structural and sedimentary regime. In such complex regimes, delineation of reservoir geometry using low resolution and missing seismic data poses immense challenges. To address the challenge, a new methodology involving high-resolution dip-derived surface modeling is used to overcome such reservoir delineation problem.

Study Area

The study has been carried out in Krishna-Godavari basin, which is located in the central part of the eastern passive continental margin of India. The Krishna-Godavari basin comprises numerous northeast-southwest trending horst and grabens (Arun Kumar Arya et al. 2011). Tectonically, the basin can be divided into their subbasins: the Krishna, West Godavari, and East Godavari subbasins, separated by the Bapatala and Tanuku Horsts, respectively. The west Godavari subbasin is further separated by Kaza-Kaikalur Horst into Bantumilli and GudivadaGrabens (Fig. 1) Theonland part of the East Godavari sub basin has been further differentiated into Mandapetasubbasin on the West and Narsapursubbasin to the east by the Yanam Ridge. The onshore part of the East Godavari subbasin is the Godavari Offshore subbasin.

The depositional environment of Krishna-Godavari Basin is controlled by a series of rifting phases. The early rift phase in the Permo-Triassic produced a fluvial and brackish-water environment and the sediments formed the floor of the divergent margin settings. The main rift phase was during the Early Cretaceous, which resulted in deltaic to fluvial conditions. The initiation of main rift phase in the middle Jurassic resulted in the formation of a northeastsouthwest trending West Godavari subbasin, which was filled with synrift sediments. The Early Cretaceous period was dominated by continual continental-dominated deposition, although marginal marine conditions became increasingly common towards the end of the rift phase (Barremian age) The end of rifting is marked by an erosional unconformity flowed by a

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basinwide flooding and blanketing of the synrift sediments by the marine Raghavapuram Shale. The generalized stratigraphy of the Krishna Godavari basin is given in Fig.1.

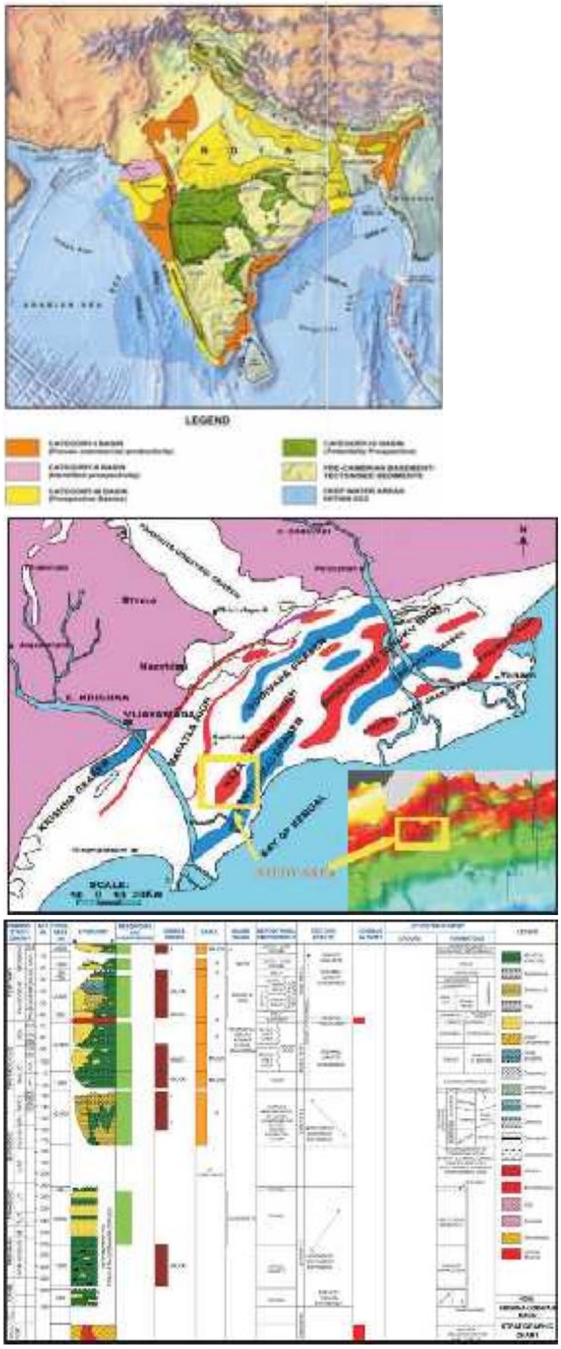

Fig. 1—Location of study area (source: DGH, India), tectonic map of the study area, and generalized stratigraphy (Arya et.al 2011)

Challenges

- Based on background geology, the study area lies in synrift setting, which indicates structurally complex reservoir dispersal.
- Limited seismic resolution cannot generate a high-resolution reservoir model (Fig. 2).

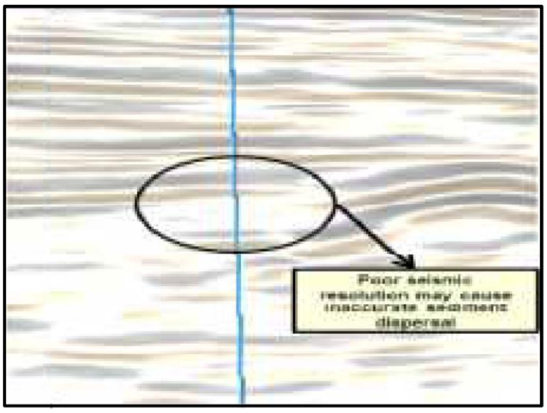

Fig. 2—Limited seismic resolution

Workflow

To overcome the above challenge, a new workflow has been adopted in dip modeling platform to achieve a highresolution model of the reservoir. The workflow presented in Fig. 3 is adopted in a single well.

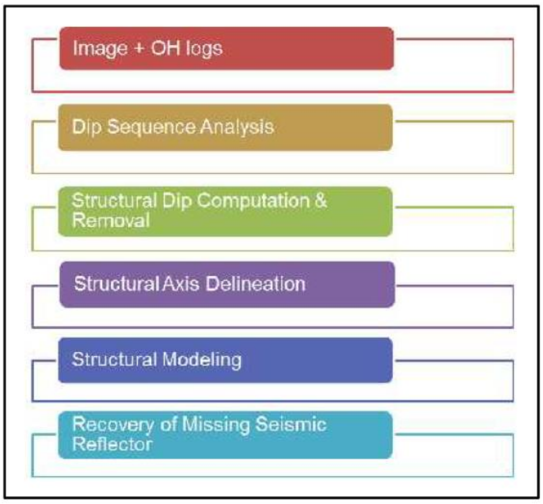

Fig. 3—Workflow of the robust methodology

At the very beginning, image processing and manual dip interpretation is performed, serving as the basic input for

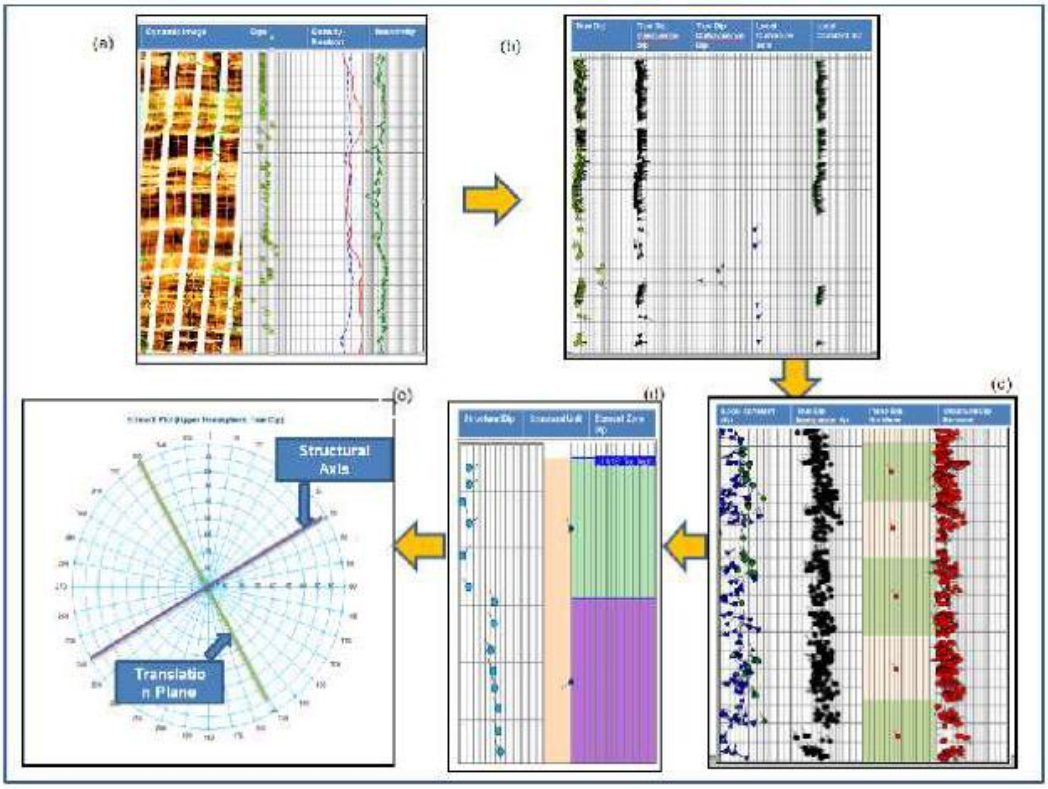

Fig. 4—Microresistivity image, dips, and conventional openhole log (a); logical dip filtering (b); structural zonations and dip computation (c); structural axis delineation, unit identification, and element identification (d); stereonet display with structural axis and translation plane (e)

the modeling process (Fig. 4a). In the next step, filtering of the structural dips was performed to obtain the in-sequence dips and exclude the out-of-sequence dips (Fig. 4b), which are locally deformed or confined to the borehole. This is followed by the structural dip zonation and computation (Fig. 4c). Subsequently, delineation of the structural axis is carried out (Fig. 4d). The main purpose of structural axis delineation is to decipher the various structural units and elements. The stereonet in Fig. 4e represents the structural axis (triangular point) and translation plane (great circle). Based on the structural trend, the entire study interval is grouped into 2 major structural entities.

This is followed by the identification of well tops (Fig. 5a) with the help of the regional geological information about the area. The well tops were further used to create isopach maps for each stratigraphic zone. At the final stage, based on principle of structural geology (Graymer et al. 2005) the well tops are projected away from the well to model (Fig. 5b). After performing the structural dip projection, the model is completed with surface creation (Fig. 5c) and the creation of edges (Fig. 5d) to construct the final model.

Result

Subseismic high-resolution surfaces are created with the existing high-resolution dip data (Fig. 6).The result reveals distinct variations within the reservoir geometry. The detailed image interpretation and dip analysis for the study well provides us with two distinct structural units, which are further identified as two different lithostratigrahic groups separated by an unconformity (Fig. 5d). Delineation of the reservoir geometry from this high-resolution 3D geological model helps in identification of a folded structure unconformably overlain by gently dipping beds (Fig. 5d). The entire modeling reveals accurate lateral extent of the subseismic reservoirs. Further, these surfaces are used to complete the seismic-derived surfaces to see the larger extent (Fig. 6).

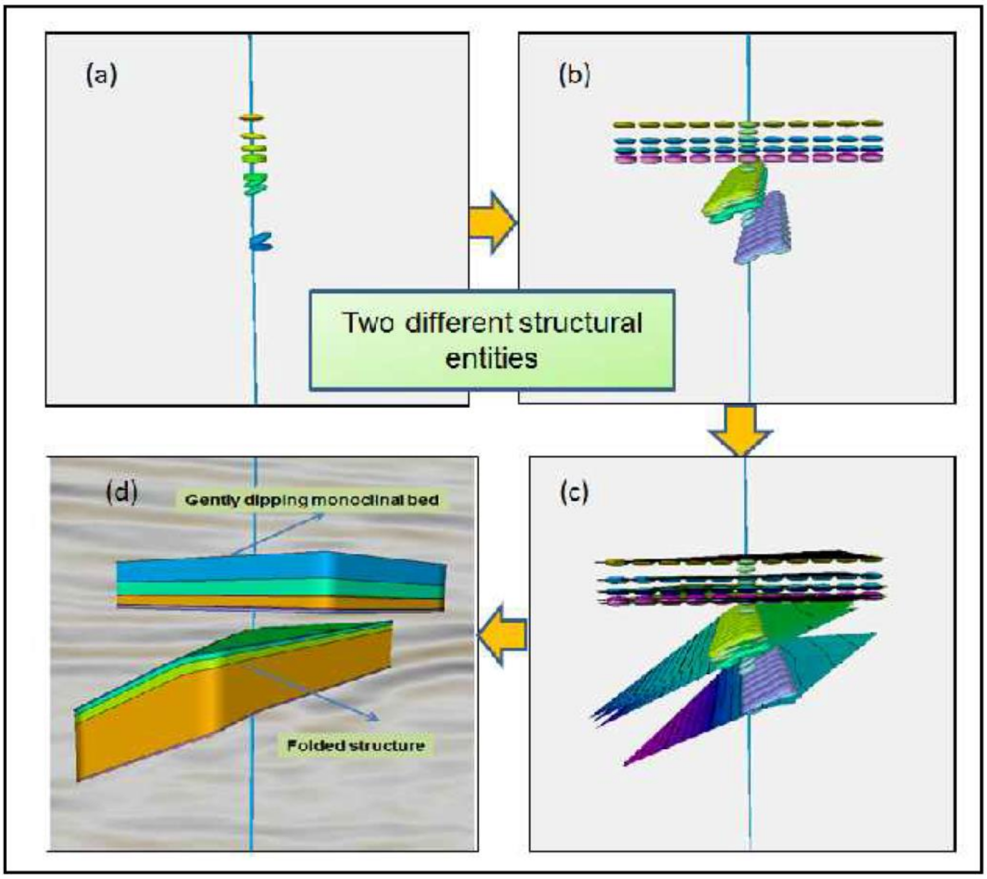

Fig. 5—Well top generation (a); Structural dip projection in 3D display (b); 3D surfaces created from structural modeling (c); 3D structural model with a much higher resolution (d)

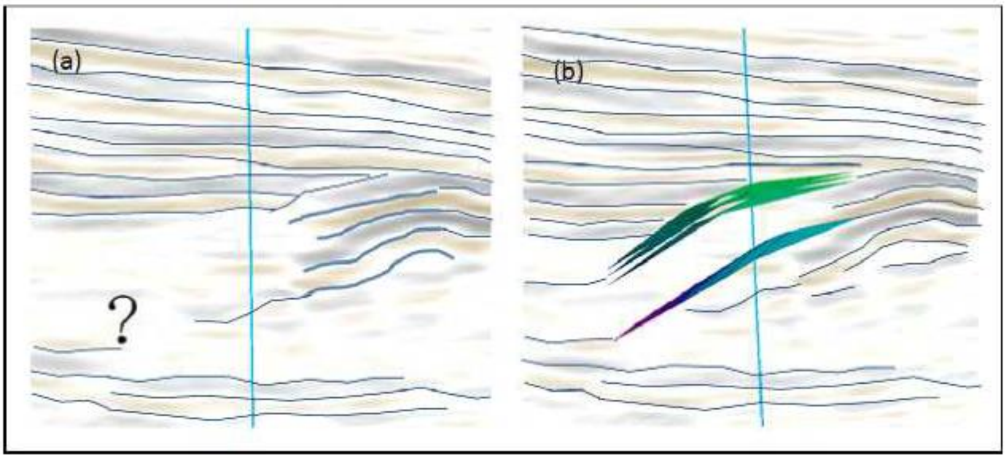

Fig. 6—Well-defined surfaces that were not prominent in seismic (a) is now seen with the help of a dip-modeling platform (b)

Conclusion

This subseismic and high-resolution model can help in identifying promising zones in terms thickness and structural trap for hydrocarbon presence and, thus, optimizing future well positioning and well placement. This model also provides complete horizon, which was missing in given seismic transect in the zone of interest. The overall result reveals better understanding of the sand body geometry and structural complexity.

Acknowledgment

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