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Exploring Beneath the Deccan: Analysis of Mesozoic Prospectivity in the Western Indian Offshore

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Introduction
Exploration in the Indian offshore has attracted considerable attention in recent years, with successful exploration of Cenozoic plays in both the Krishna-Godavari region and the Bombay Platform. Mesozoic plays have been successfully targeted in the Krishna-Godavari and Cauvery basins and this has generated interest in whether similar plays may be present in the Western offshore, where pre-Deccan stratigraphy has remained elusive due to a relative lack of data.

This study investigates the Mesozoic prospectivity of the frontier Kerala Konkan region of south-west India. Exploration of the Cenozoic strata began in the area in the early 1980s, with the drilling of K-1-1, CSP-1, CH-1-1 and Quilon-1 (Nathaniel, 2013). Gravity, magnetic, and 2D and 3D seismic surveys have been undertaken and 15 exploratory wells have been drilled across the Kerala Konkan region, but no discoveries have been made as yet. Modern re-processing of seismic lines in the Western offshore (Roberts et al. 2008) strongly suggests the presence of significant Mesozoic sedimentary strata beneath the volcanic succession, sparking a drive to better understand the pre-Deccan stratigraphy of this frontier region.

Methodology
In this study, the location of Mesozoic source and reservoir facies in the frontier Kerala Konkan region is predicted using publicly available data and analogue studies. A global sequence stratigraphic model is used to interpret facies in the context of sea level change (maximum floods and low-stands) on gross depositional environment maps. Potential petroleum plays are identified in a structural context, and the risks associated with these plays are assessed.

An understanding of the geodynamics of the Indian Peninsula is crucial to an investigation of the Mesozoic prospectivity of the Western Offshore. The impact of rifting events involving the breakup of India and Antarctica, India and Madagascar, and India and the Seychelles is analysed using a geodynamic model and reconstructions of key time intervals. The location of the boundary between attenuated continental crust and oceanic crust formed during the breakup of India and Madagascar is critical in defining the limits of any potential Mesozoic fairway in the Kerala Konkan, and this contentious issue is considered in detail.

Results
The identification of appropriate analogues is vital in assessing the Mesozoic prospectivity of the study area, and a series of case studies is used here. Global geodynamic context and palinspastic evolution are utilised to highlight key analogue systems separated from Western India during the Mesozoic fragmentation of Gondwana, and to assess whether Western India offshore stratigraphy may contain counterparts to Triassic and Early Jurassic source rocks reported in Madagascar and the Seychelles. Evidence from the adjacent Cauvery Basin is also used, to highlight potential Cretaceous source rocks and low-stand reservoir facies. Intersection of Late Cretaceous sands by nearshore wells in the Kerala Konkan is interpreted within a sequence stratigraphic framework to be further evidence of Late Cretaceous turbidite sands down systems tract. Furthermore, knowledge of Mesozoic deposition onshore India within Proterozoic mobile belts (defined in Raval and Veeraswarmy, 2003) is used to indicate potential sites of Mesozoic deposition in the south-west offshore. Publicly available seismic, sediment thickness maps (e.g. Campanile et al. 2008), and depth to basement information is integrated and utilised to constrain interpretations.

Regional knowledge of the impact of global events is considered when modelling the distribution of Mesozoic petroleum elements in the Kerala Konkan. The impact of global ocean anoxic events upon the development of regionally extensive Toarcian and Early Cretaceous source rocks is considered, and the effects of globally and regionally significant eustatic lows upon the distribution of Cretaceous lowstand reservoir deposition are analysed.

Organic-rich deposits in the Kerala Konkan are modelled in Induan and Toarcian lacustrine environments, and in Aptian restricted marine facies. Potential reservoir intervals occur in predicted Jurassic continental sands, Early Cretaceous deltaic sands, and Late Cretaceous turbidite facies. Traps are predicted to be primarily structural, with some stratigraphic elements. Potential seals are likely to consist of intraformational continental and marine mudstones. A series of potential plays are highlighted for the Mesozoic stratigraphy of the Kerala Konkan, and a risk matrix is presented. The presence and maturity of potential source rocks is a critical risk to all Mesozoic plays, and the unknown effects of two volcanic plume events (the Marion and the Reunion) and two phases of inversion in the study area are significant factors.

Conclusions

A detailed understanding of palinspastic evolution and the identification of appropriate analogues are of key importance in assessing the exploration potential of frontier regions. This study uses an integrative workflow to predict a series of Mesozoic plays in the Kerala Konkan, and to assess the risks involved with the exploration of sub-Deccan strata in this region. More work to constrain the location and effects of igneous rocks in the basin, and to better characterise potential source rocks, is crucial for future successful exploration in this region.

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