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Palynological Controls on Biostratigraphy of Barmer Basin, India*

Sandipan Dutta¹, Premanand Mishra¹, and Vachaspati Kothari¹

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¹Cairn, Oil & Gas Vertical of Vedanta Limited, India (Sandipan.dutta@cairnindia.com)

Abstract

Barmer Basin is located in northwestern part of Indian subcontinent and considered as the failed intra-cratonic rift basin analogous to Cambay Basin. Discovered by Shell & Cairn India, this rich petroliferous basin has diverse tectono-depositional history originated from multiple rift systems of Mesozoic- Tertiary ages. Primary hydrocarbon reservoirs are pre-rift Ghaggar Hakra Formation, Late Paleocene Fatehgarh and Barmer Hill Formations, Early Eocene Dharvi Dungar Formation and Middle Eocene Thumbli Formation. While the Fatehgarh Formation is a dominantly fluvial deposit, syn-rift Barmer Hill Formation is mainly lacustrine authigenic silica rich porcellanite reservoir in the central part of the basin with minor fan deltas on basin margins. Overlying Dharvi Dungar Formation consists of lacustro-marine finer clastics and shallower Thumbli Formation is a combination of fluvio-lacustrine and coastal-deltaic sediments. To establish and constrain the basin deposition history, inferences from the palynological studies (Figure 1) have been used as a major tool along with different controls from geo-chronological dating, chemostratigraphy and sedimentological inputs. The study is confined to the reservoir sections though palynological data available from Fatehgarh to Late Eocene Nagarka Formation. Rich assemblages of Dinocysts, Algae, Fungal elements, Spores and Pollens samples in 20 studied wells distributed over 6800 km² area summarize the paleoenvironmental changes in this basin.

Discussion

In Barmer Basin common dinocysts are *Apectodinium spp.*, *Cleistosphaeridium spp.* and *Spiniferites spp.* Dinocysts are mainly reproductive stage of Dinoflagellate and indicative of marine or brackish coastal influences. Two main fresh water algae species preserved are *Pediastrum spp.* and *Botryococcus spp.* Characteristic fungal elements are fresh/brackish water born *Pleurocystites spp.* and wetland origin *Phragmothyrites spp.* Terrestrially-derived spore and pollen species are highly abundant throughout all the formations. Within spore elements, rainforest origin indicator *Deltoidospora spp.* and *Cyathidites* minor are dominant. Abundant pollen species are mainly from palm and mangrove plants of tropical rainforest i.e. *Proxapertites spp.*, *Spinizonocolpites spp.*, *Tricolpites spp.*, *Bisaccate pollen (pinus)*, *Monocolpites/ Monosulcites spp.* etc.

Palynological zonations marked by the extinction, inception and abundance events of the palynomorphs and the associated changes in the overall palynofacies composition with paleoenvironments have been identified thoroughly using the cores and cuttings. Fatehgarh Formation has diversified assemblage of all palynomorphs along with marine/brackish dinocysts indicating lateral palynofacies changes from terrestrial fluvial setup to lacustrine-marine influenced lacustrine (?) environment. The Fatehgarh sediments deposited throughout the basin does not typically indicate any marine dominated lithology. Sharp changes in the assemblage indicated by absence of dinocysts and highly reduced amount of spore-pollen marks the initiation of Barmer Hill Formation where freshwater algae are dominant. Though the cause of the reduction of these palynomorphs is unclear, low preservation potential in rifting stage and reduction of the terrestrial flora could be probable causes. The Dharvi Dungar Formation is marked by flourishing of both freshwater and marine/brackish dinocysts and abundance of spore-pollen coming from hinterlands. Highly abundant *Pediastrum* indicates occasional lateral emergence of freshwater fluvio-deltaic setup amidst marine/brackish water dominated lacustrine environment. Thumbli Formation initiation marked with the reduction of the dinocysts (especially *Apectodinium* group) and spore-pollen assemblages while more freshwater ponding effect is indicated by the relative abundance of *Botryococcus* species in a coastal deltaic setup.

Conclusions

Entire sequence is a product of tropical/subtropical climate with periodic changes between fluvial, coastal, deltaic and lacustrine setups with occasional marine/brackish water influences. Separately conducted microfossil and nannofossil studies also corroborate to similar observations. This palynological study has been helpful at both basinal and field level contexts of lithological and chronological high-resolution stratigraphic correlations. In addition, geochemical studies of hydrocarbon and source rock maturity analysis are highly affected by the biostratigraphic observations. Analogous study from Suriname-Guyana Basin of northern South-American continent and Eastern India suggest identical paleoenvironments with similar palynological assemblages.

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