

Diligent Approach To Exploration In India - Frontier, Nearfield And Unconventional

Debnath Basu¹

¹Schlumberger SIS, Kuala Lumpur, Malaysia

ABSTRACT

Exploration in India in the last decade, has been lukewarm at best. Reserves replacement ratio, domestic demand for an ever-growing India has been sub-optimal. Exploration success in order to feed major growth initiatives is essential and already somewhat critical. Recently however, several steps have been undertaken and implemented in concert with Government directives that are starting to show early results.

Play Based Exploration (PBE) is a holistic approach to hydrocarbon exploration, when done diligently makes a big impact and should be applied in frontier areas as well as re-looks in already producing areas incorporating new well and seismic data. PBE is founded upon a broad yet focused understanding of the pertinent largescale aspects of the Basin which has a bearing on hydrocarbon generation, migration and entrapment. With this broad and regional founding basis, explorationists working in a multidisciplinary context home in on Play Analysis, practically defined as finding petroleum accumulations for a profit and hence has an economic bearing. Leads and Prospects are further outcomes where existing data analysis provides a portfolio of targets which are either drill-ready (Prospect) or nearly ready (Lead) pending certain uncertainties. Before we plan and execute a data acquisition program with a similarly well-planned series of studies to follow based on PBE for Indian Basins, none of the areas should be written off for hydrocarbon potential, unless conclusively closed.

In the context of hydrocarbon exploration in India there is ample scope in two major categories:

(A) Frontier exploration: Frontier exploration plays in current deepwater settings await objective and diligently executed exploration programs, with specially designed seismic, fit for purpose processing and in-depth studies. Exploration and some development activity is already ongoing in Indian deepwaters, however large areas of both the Western and Eastern Offshore areas remain largely unexplored. This is especially true with deepwater settings globally continuing to give discoveries, including SE Asia. Myanmar offshore especially, which saw the biggest seismic acquisition spend in the world in 2016, in proximity to the Bengal Fan had discoveries in deepwater turbidites some of which are already producing from the Rakhine Basin, adjoining the Bangladesh sector of the offshore Bengal Basin. Here the reservoirs with proven potential, discovered by Daewoo and partners are fan-fringes of the N-S oriented lobes of the Bengal Fan and not the smaller fans emanating from the Myanmar hinterland to the E and NE. Other fans of Mio-Pliocene age from the Myanmar hinterland have also provided discoveries in the SE part of the Rakhine basin in the acreage held by Woodside and partners. Flexes in the shelf/coast orientation have important implications in the stacking of various fans with diverse provenance in the slope and beyond by overlapping vertically and laterally. An analogous flex is present around the western rim of the Bengal Basin towards the Mahanadi Basin. Smaller paleo-equivalents of the Subarnarekha, Baitarani rivers amid the larger Mahanadi to the SW and the much larger Ganges system to the E indicates likely presence of stacked reservoirs in the deepwater during paleo-lowstands of the Mio-Pliocene and is worth looking into. There is likely to be both biogenic

and/or thermogenic potential that remains to be fully explored, some of which may lie in present day nearshore and shallow water depths, as well as in the deepwater.

Similarly in the Western offshore, around the Kerala-Konkan, Kutch and Saurashtra Basins in-depth exploration is yet far from covering the entire area effectively in the hunt for working petroleum systems and reservoir presence. As an example, the eastern fringes of the Indus Fan are likely to impinge on the western margins of deepwater Kutch and Saurashtra Basins. Here, fans oriented roughly N-S from the Indus axis are likely to have potential embeds from a more easterly provenance from the Indian hinterland and is worth detailed exploration as this area has a proven working petroleum system.

Frontier exploration does not always have to be geographically frontier, it can be a basin in our backyard which may not have seen any, if much, exploration activity. In this category can be exploration for unconventional in Tertiary, Proterozoic or Gondwana age basins, where shale gas or CBM potential or both may be high. KG, Cauvery, Cambay Basins are attractive for Tertiary/Mesozoic potential whereas the Vindhya and Pranhita-Godavari Basins are locations with late Proterozoic potential.

(B) Nearfield exploration: Having explored, developed, and produced from numerous basins in India over several decades, O&G companies are at an interesting crossroad in the classical E&P cycle, both technically and fiscally. Pure exploration though possible even now is an activity that finds little traction when pitched against commercial decisions. The quest however, around producing fields, is to target (a) infill opportunities, (b) near-field opportunities and (c) deeper play potential, which are highly viable options even under today's fiscal regime. Initiatives (a)-(c) has less risk and are fairly well constrained, as opposed to green frontier exploration. However, as we go from options (a) to (c), risk and potential costs escalate. Rewards from near-field exploration has less risk as relatively inexpensive studies can address uncertainties, as the portfolio of opportunities get hedged with apt mitigation of risk.

Being a development activity we eliminating (a), i.e. infill opportunities from discussions here, and discuss (b) near field exploration and (c) deeper play objectives only, as a focus for exploration for the current market conditions, within the context of Indian petroleum systems. The following broad categories outlined, may be called over-looked plays, representing (1) younger post-rift, (2) older and deeper syn/pre-rift sections, and (3) foreland and orogenic belts.

(1) Plays in Post-Rift sections for Stepout or Nearfield exploration (NFE) covers satellite opportunities outside the areal limits of a producing field proximal to a known asset. The approach to nearfield exploration will have elements of the petroleum system which is known from the control field, especially for seal, source and timing, with variations in traps and reservoir within reasonable bounds. Solutions to challenges from years of experience from the developed field will short-circuit time to first oil/gas and efficiently fast-track appraisal/development. Clubbed here are such analogous plays of the producing reservoir in the Post-Rift Section with suspected upside potential in subtle structural traps, stratigraphic traps, or combination thereof, with step-outs without having to move far afield.

a. Structurally and stratigraphically complex plays, NFE require modern 3D seismic for maturation of plays to prospects, benefitting from modern seismic imaging. These plays are founded upon PBE done as part of historical studies over the years that promoted the main field whereas the current target is expressed nearby. In India this category typically will include structural traps and combination traps, with depositional systems ranging from deepwater to shallow/fluvial systems, even carbonate reservoirs, compartmentalized by reactivated tectonics like local faulting with or without inversion that typically

overprints trapping configurations. Highly compartmentalized reservoirs primarily in the Miocene sections of onshore to deepwater KG and Cambay Basins are examples. Stratigraphic traps, though less likely to mature (not because of lack of presence but difficulty to identify and characterize) should never be ruled out provided a working petroleum system exists, for example the meandering channel belts of deepwater turbidites in the Pliocene clastics of the KG, Mahanadi and Mannar Basins. They are appropriately addressed when current and future 3D seismic of modern vintages become available over large swathes of the offshore area.

b. Shallow drill hazards as prospects include, shallow gas anomalies of variable provenance and occurrence. Elements of the shallow subsurface that could be hazardous pockets to avoid during drilling operations are often being considered as potential resources these days, with novel multidisciplinary ways to make the pain a gain by means of proactive operational design. These include, shallow gas, potential free-gas under BSRs etc., often considered these days as secondary targets to some material targets at depth. This category also includes gas-hydrates in deepwater which are still a subject of research in not so much as finding it but more so in producing from it with operational success with commercial viability and safety. Several such objectives have been piloted around the world especially in the North Sea (shallow gas) and Japan (gas-hydrates). Some stages of activity have progressed in India, led by research institutes and operating companies, especially in the KG and Mahanadi Basins.

(2) Plays in Syn-Rift or Pre-Rift, Deeper ‘frontier’ exploration (DFE): in relation to existing developed shallow/mid-levels DFE could often be attractive and viable. Several play-types in this category from Indian Basins include:

a. Syn-rift clastics, typically comprised of interbedded sand-shale sequences in synclinal lows and flanks such as on the ramp margins of half-grabens. They are often associated with lacustrine source and seals in close proximity and benefit from relatively direct charge, into well-developed reservoir rocks of fluvio- deltaic/lacustrine origin. Some later inversion may provide structuration in the synclinal lows, which is good for prospectivity. Examples could be in the syn-rift plays of the offshore KG and Mahanadi Basins, as well as their onshore equivalents, similarly in the West, esp in Cambay, Kutch and Rajasthan.

b. Fractured basements are potential plays in many Asian Basins (Yemen, Vietnam, Thailand etc.) expressed as basement highs and rift-shoulders and may be comprised of lithologies ranging from carbonates to igneous as well as low-grade metamorphic rocks. Expressions of basement are generally in the form of horst blocks or gentle to tighter inversion structures and typically well positioned to benefit from lateral charge in adjacent lacustrine syn-rift kitchens. Analogues are present in the Permo-Triassic Carbonates of the Sim Phu Horm Basin, Khorat Plateau, onshore Northern Thailand, expressed as a regional play-fairway from Malaysia, Vietnam to southern China, through Thailand.

Plays within (2) may also include basalt and sub-basalt clastics/carbonates as part of undifferentiated deeper ‘basement plays’ within Cretaceous or older successions. Prospect assessment and maturation in such challenging settings have been performed in many places already around the world and also in India, but we are yet to ‘crack-the-code’ as an overall initiative that works holistically. This requires differentiating seismic survey design and acquisition/processing with the newly acquired data subjected to interpretations with significantly improved imaging and illumination of deeper targets.

(3) Plays in Orogenic Settings in Foreland and Arc Settings in the Northeast and in the Andaman Nicobar Island chains have potential that are yet to be all fully explored areally, though especially in Assam we have some of our oldest oil-fields. Andaman and Nicobar has however been fairly well explored and so far success has been illusive for a proven petroleum system. As is already well known however, a working petroleum system in the Northeast is proven, though step out and regional exploration initiatives are yet to be completed especially (into Manipur, Tripura, Arunachal Pradesh and Nagaland) with difficult terrains and political instability being inhibiting factors. The hunt for regionally working petroleum systems and new play-types in deeper sections is also applicable in the orogenic/foreland settings.

As the current industry trend is to drum up interest, dusting our portfolio for low hanging fruits of neglected/overlooked plays are mostly highlighted here. These overlooked plays may see the light of the day for future exploratory drilling, as opposed to frontier high-risk high-reward and significantly more expensive options alone. The maturation of these targets (1) and (2) above, will at the very least facilitate farm-in/-outs by providing technical uplift for those blocks/ acreages that are calling out loud in the deal space.

Innovation, application of new technology and expertise while using lessons learnt comes in extremely handy in exploration strategies needed to address nearfield and deeper potential in existing fields. And it is appropriate to quote a renowned Geologist here, Parke Dickey, as saying "... seldom do we find much oil in an old place with an old idea". Also to be noted that, the best prospects/fields for a new venture occurring next to an old one is very likely to hold true (often used as a guide in the mining industry and apt for our industry as well), so we should stick to our zone of comfort but step out some and also go deeper, as we have not yet explored the nearfield (NFE) and deeper (DFE) potentials fully.