Mitigating Risk in Oil Exploration - A Keynote Address

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Introduction

Hydrocarbon exploration has come a long way since the days, when, if the explorer’s truck broke down, they just began drilling a well. Until well into the twentieth century, the search for hydrocarbons was confined to the deposits directly observable in the form of surface seeps. When all the accumulation in an area that could be discovered by such simple means had been exploited, it became necessary to deduce the presence of hydrocarbon indirectly by downward projection of geological information observable on the surface. When this technique reached the point of saturation, new methods were needed to explore beneath the surface.

Throughout history, innovative tools, techniques and ideas in exploration geophysics have continually enhanced the effectiveness of exploration. This progress has been in response to an unrelenting pressure to develop new capabilities after existing ones have become inadequate to find new reservoirs. In addition to the areas newly opened for exploration, most geophysical surveys are undertaken where previous ones have failed because the instrument, field technique, processing or interpretational methods were not able to image sub surface to the desired precision. Reservoirs that could be located with the existing technology are the only ones that will be discovered and remaining will not be found until the technology improves sufficiently. Thus the exploration geophysicist finds him self on the accelerating treadmill who must run faster and faster just to stay where he is and this has to be accomplished under the disturbing background that nature’s endowment is after all finite. The explorationist’s dilemma is best summed by the famous quote:

We usually find oil in a new place with old ideas,
Sometimes we find oil in an old place with a new idea
But we seldom find oil in an old place with an old idea.
Several times in the past we have thought that we were running out of oil, When actually we were running out of ideas Professor Parke A Dickey.

In the domestic scenario, conversion from resources to in-place oil is progressively becoming difficult with easy finds being exhausted. The recent new finds have been in deeper stratigraphy and in grabens in the known petroleum provinces, in east coast, and in logistically difficult areas. To remain economically competitive and fulfil our commitments, there is need to innovate and grab opportunities to overcome so called exploration fatigue. Mitigating the risk.

Facing growing demand of hydrocarbons, the oil industry is aggressively pursuing the exploration programs with increased exploration investment in the deep waters where the potential for significant reserve discovery exists. At the same time the challenges in the deepwater exploration programs lies in accurate imaging of the sub surface, predict reservoir and in most cases even predict presence of hydrocarbon from p-wave data for drilling of deepwater well is expensive. Keeping this in view the theme “Geophysics in mitigating risk has been aptly chosen”. Broadly risks can be classified in the following heads:

- Political Risk
- Environmental Risk
- Business Concerns
- Geo-scientific Issues

Turbulent political situation in the Gulf, in West Africa, in Latin America and in the erstwhile Soviet Union have greatly contributed to the recent oil price hike. An uncertainty looms large and major players in the political arena, OPEC and leading geoscientists need to come out and remove this perception of uncertainty in supplies against growing demand. A climate of growing E and P activity needs to be created in all these areas for most of the yet-to-find hydrocarbons are expected in these areas. In India the political situation in some parts of north east are still not conducive for hydrocarbon exploration. In the west coast the fishermen’s lobby has to be kept in good humor before offshore surveys can be conducted.

Environmentalists have rightly become active for ensuring a safe earth for gen next. We are in the business of fossil fuel and unless and until carbon emission is controlled, Earth will become Venus. Similarly strict environmental norms need to be followed in all our operations. In India regulatory bodies like DGH may provide environmental...
Biogenic gases have also been discovered in relatively floor fans and within sub salt areas like Gulf of Mexico. Collapse due to overloading and gravity sliding, in basin-over structures providing entrapment, in areas of Shelf hydrocarbon habitats have been found in the following plays in emerging nations.

Chemicals and plastics and due to increased consumption continue to increase due to reliance on its supply for energy, leap in the present scenario as world demand for petroleum the last 25 years, yet the new challenges have taken quantum technological innovations and business development during shows that the industry made great strides through. The review of past events in light of Backus challenges – and some problems remain. The review of past events in light of Backus challenges shows that the industry made great strides through technological innovations and business development during the last 25 years, yet the new challenges have taken quantum leap in the present scenario as world demand for petroleum continue to increase due to reliance on its supply for energy, chemicals and plastics and due to increased consumption in emerging nations.

In the recent past, most of the deepwater hydrocarbon habitats have been found in the following plays channel levee complexes associated with deltas, and roll over structures providing entrapment, in areas of, Shelf collapse due to overloading and gravity sliding, in basin-floor fans and within sub salt areas like Gulf of Mexico. Biogenic gases have also been discovered in relatively younger strata with reservoirs deposited through fluvial channels. In India biogenic and thermogenic gases have been discovered within channel levee complex.. Some of the recent technological developments viz, Pre-stack depth imaging with anisotropy, Full waveform inversion, Direct hydrocarbon indicators, Time lapse seismic, Single sensor technology, Multi-component seismic, Common reflection surface processing, Neural network and fuzzy logic, Controlled source electromagnetic surveys (SBL), Immersed visualization, Digital fields etc. have potential of providing realistic visualization of the sub-surface, thereby reducing the risk of exploration. In the endeavor to find more oil in cost-effective manner, Indian Industry has been making efforts to adopt technological changes from time to time and move along the technological accelerations. The newer risk mitigating technologies such as Single sensor technology and SBL in offshore areas and multi-component 2D surveys on land in addition to massive offshore 3D campaign in deep water are underway by major Oil companies in India. The advent of Geophysical technology has however diminished the creative thinking of the geologists and even the traditional geologists have taken to the easy route of being mainly a reservoir hunter through seismic attributes and not dwelling on plausible petroleum systems integrating all geoscientific data. Future Technologies

3D full-waveform inversion has a potential to determine rock properties. Also full elastic, finely sampled 3D & 4D forward modeling should become feasible. Such systematic data will be invaluable for developing and testing the data processing algorithms of tomorrow besides greatly mitigating risks in direct hydrocarbon detection in varied geological situation.

Providing data suitable for these grandiose data processing schemes will require improvements in data acquisition technology. Despite recent advances, current data set remain under-sampled in different spatial domain limiting current data processing applications such as 3D multiple prediction. Future predictions are growing use of MEMS technology, seafloor acquisition system wide azimuth and multi-component surveys with 100,000 channels. Speculating about the future of seismic is awesome because human knowledge doubles every 10 years and computer power double every 18 months. Multi-component technology will probably have full vector wave field imaging with composite display differentiating fluids and lithology. Neural network will be able to train geophysical, geological and petro-physical data and make prediction and estimations. Because of broad band data transmission
capability beyond what is available today; data will be instantly transmitted from field to processing center enabling key decisions quickly.

Nano-technology and miniaturization of microprocessor will be so plentiful that intelligent system will be everywhere leading to creation of the Intelligent Oil Field.

In the immediate future, efforts will concentrate on developing “joint inversion” of engineering, geologic and geophysical data. Further progress in geosciences is likely to be based on “coordinated advances” involving geosciences and petroleum engineering in the development of oil fields. This definitely has a potential of mitigating technological risk. However to my mind the biggest technological risks today comes from stretching P wave seismic data beyond what it can deliver. Summary: Fundamentally, oil companies compete on two cost categories: lowest finding/recovery cost and lowest cost of capital. The common denominator is always a cost. Minimizing cost and risk through implementation of cutting edge technologies is very important to spur the exploration activities especially deepwater exploration. The industry has been continually equipping itself with the new technologies, techniques and expertise needed to deal with the challenges of the future. It possesses reserves to meet society’s immediate future energy needs and by moving into deepwater petroleum exploration, it offers the hope of significantly increasing those reserves

The pursuit is demanding and its course uncertain, but for the companies with imagination and flexibility to reach for it, the prize to be obtained will be a great reward