Exploration and Prospecting of Petroleum in Western Rajasthan – A Review

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ABSTRACT

Today, petroleum remains our primary source of energy. To reap the maximum benefits from petroleum developments, we need to understand this new industry in Rajasthan state. By educating ourselves as individuals, we can be in a better position to take advantage of the resultant employment and business opportunities.
Methods of petroleum exploration and production typically involve expensive, technologically driven approaches. During the prospecting phase, petroleum exploration includes the uses of subsurface geological evaluation, seismic data and large computing power to process the geophysical data. Drilling exploratory wells is also an expensive and risky undertaking. All decisions about investments made in exploratory drilling, development and production are weighted against the potential economic return anticipation from the investment.
This review paperexplore about petroleum origin, properties of crude oil, parameters controlling the occurrence of petroleum and different methods of explorations in detail. It focus on the petroleum reserve in world, India as well as in Rajasthan.This Paper also emphasis on the exploratory work going on in Rajasthan and the involvement of various companies in that work.

Keywords: Petroleum, Crude oil, Exploration, Natural gas, Prospecting.

INTRODUCTION

In areas where oil is found in shallow reservoirs, seeps of crude oil or gas may naturally develop, and some oil could simply be collected from seepage or tar ponds. Historically, we knowof tales of eternal fires where oil and gas seeps would ignite and burn. One example1000 B.C. is the site where the famous oracle of Delphi would be built, and 500 B.C.Chinese were using natural gas to boil water.But it was not until 1859 that "Colonel" Edwin Drake drilled the first successful oil well, for the sole purpose of finding oil.
Soon, oil had replaced most other fuels for mobile use. The automobile industry developed at the end of the 19th century, and quickly adopted the fuel.Even now gas production is gaining market share as provides an economical way of transporting the gas from even the remotest sites.Oil and natural gas originate in petroleum source rocks. Source rocks are sedimentary rocks that formed from sediments deposited in very quiet water, usually in amps on land or in deep marine settings (Devold, 2009).
The petroleum industry is now major component of the global economy. Most petroleum products derived from refining crude oil are combusted to provide energy as in diesel fuel, jet fuel, kerosene, fuel oil and gasoline. The burning of fossil fuels (coal, natural gas and oil) provides the vast majority of energy today and dependence on petroleum products is anticipated to continue into the foreseeable future. There is a great deal of risk associated with investing money in oil and gas exploration because petroleum deposits are generated by natural processes that commonly occurs at great depth and are poorly understood and predicted by earth scientists. Financially there is a lot

at stake often cost millions to hundreds of millions of rupees in deep and harsh environment. The goal of the investor/ shareholder or company is to make money at desired return on investment, not just to find oil and gas. The methods and tools that geologist may use include conducting rock studies, constructing maps and cross-sections, making chemical and physical measurements, developing conceptual and numerical subsurface models, developing databases and making calculations. Geologist also provides input into business and economic models, drilling operations and planning of facilities like oil and gas production platforms (Bohi., 1998;Taylor, 2004; Imaduddin, 2008).

This paper aims to discuss the scientific and technological development of petroleum exploration and briefly about origin of petroleum, source rocks, reservoir rocks, traps and migration of petroleum.

The review paper also gave detail information about the petroleum industry in Rajasthan State. Rajasthan has a vast tract of rock formations spread over to 1,50,000 sq. km in Barmer-Sanchore Basin, Jaisalmer Basin & Bikaner-Nagaur Basin, which has the potential of hydrocarbon and lignite deposits. These three petroliferous basins are now recognized as Category-Ion the basis of their proven commercial productivity.

BASIC INFORMATION ABOUT PETROLEUM FORMATION

If the organic materials within the source rock are mostly wood fragments, then the primary hydrocarbon generated upon maturation is natural gas. If the organic materials are mostly algae or the soft parts of land plants, then both oil and natural gas are formed. As the name suggests, hydrocarbons are made from hydrogen and carbon. The basic building block is one carbon with two hydrogen attached, except at the ends where threehydrogen are attached.

a. When the chain is between 5 and 9 carbons, the hydrocarbon is gasoline.
b. About a dozen carbons and it is diesel.
c. Around 20 carbons is motor oil.
d. A chain of hundreds to thousands of carbons and hydrogen make plastic.This particular plastic is polyethylene.

Properties of crude oil

Crude Oil is a complex mixture consisting of up to 200 or more different organic compounds, mostly hydrocarbons. Different crude contain different combinationsand concentrations of these various compounds.

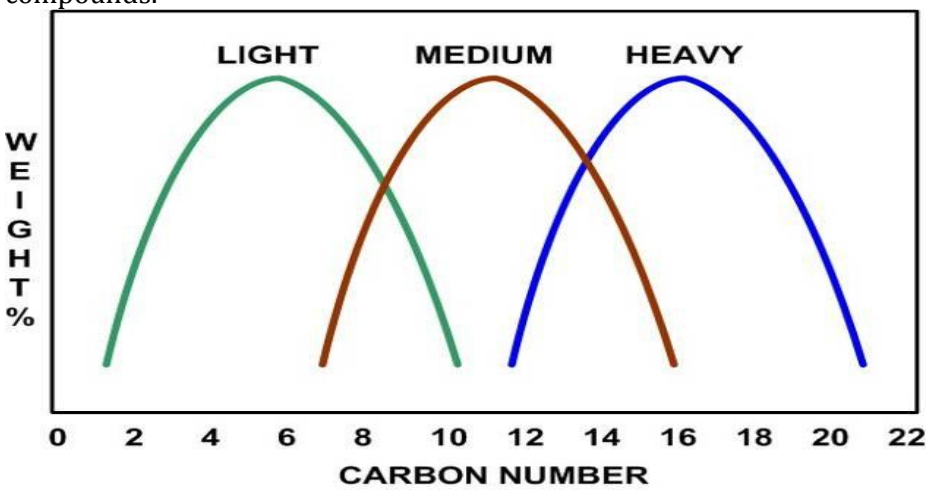


Figure 1: Yield graph (After Devold, 2009)

The API (American Petroleum Institute) gravity of particular crude is merely a measure of its specific gravity, ordensity. The higher the API number expressed as degrees API, the less dense

(lighter, thinner) the crude. Vice-versa, the lower the API number, the more dense (heavier, thicker) the crude. Looking at the chemical composition of crude, as the crude gets lighter than 40-45 degrees API, it contains shorter molecules, or less of the desired compounds useful as high octane gasoline and diesel fuel, the production of which most refiners try to maximize.Likewise, ascrude gets heavier than 35 degrees API, it contains longer andbigger molecules thatare not useful as high octane gasoline and diesel fuel without further processing.
The figure 1 illustrates that themediumblend is desired because ithas the composition that will yield the highest output of high octane gasoline anddiesel fuel in the cracking refinery

Parameters Controlling Petroleum Occurrence

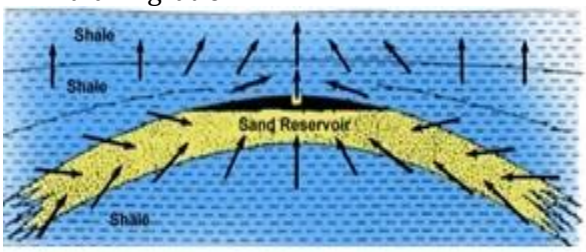
Source Rock
Fine grained sediment that in its natural setting has generated and released enough hydrocarbons to form a commercial accumulation of oil and gas. Source rocks are clay or carbonate organic rich muds deposited under low energy, reducing conditions. The most important factor in the generation of petroleum in source rock is temperature. The action of heat on the insoluble organic matter (kerosene) contained in source rocks leads to the formation of oil and gas (Hamid and Sulaiman, 2010).

Reservoir Rocks
A petroleum reservoir is a porous and permeable rock in communication with a mature source bed. Sandstones and carbonate rocks form the overwhelming majority of reservoirs world-wide. Under special circumstances, igneous and metamorphic rocks can also act as petroleum reservoirs.

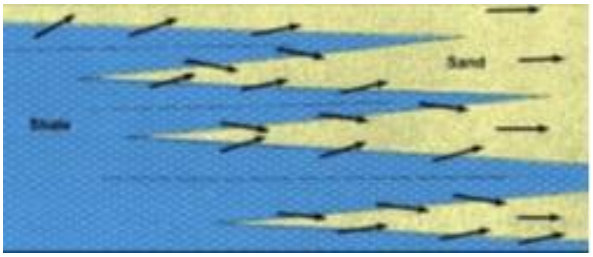
Migration of Petroleum(Figure 2)

Oil and gas move out of the source beds and accumulate in the reservoir rocks.

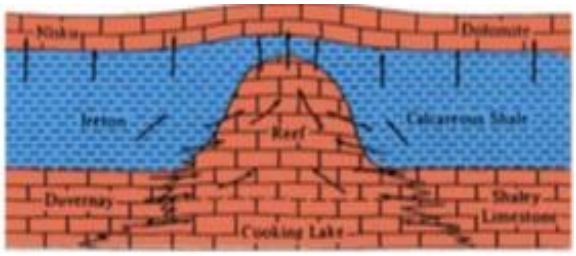
- The transfer from source rocks to reservoir rocks is called primary migration.
- Movement of petroleum within the porous and permeable reservoirs beds is known as secondary migration.
- The primary cause of movement of fluids is compaction.
- The more permeable silt and sand bodies within compacting muds are the main channels of fluid migration.



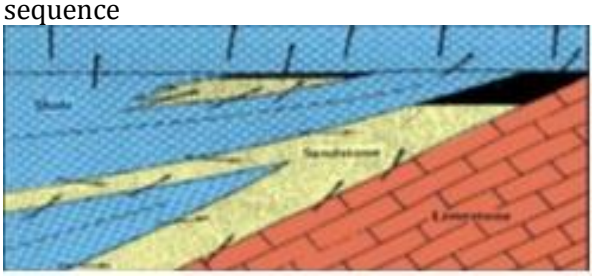
Direction of fluid migration into anticline



Migration from an inter bedded shale-sand sequence



Migration into a pinnacle reef



Migration into stratigraphic traps

Figure 2: Migration of petroleum

Entrapment of Petroleum

Oil, gas and water slowly migrate through permeable rocks, driven by natural forces of gravity (buoyancy) and pressure gradients.

- When they meet an impermeable barrier, they can go no further, so oil and gas accumulate. This barrier is generally referred to as a trap.
- Varying densities make the gas phase rise, while the water settles to the lowest point, and the oil remains in the middle.
- Traps may be classified according to the manner in which they are formed, and categorized as structural trap, stratigraphic trap and combination trap.

Traps

A traps is a an arrangement of rock layers that contains an accumulation of hydrocarbons, yet prevents them from rising to the surface. The trap consists of an impermeable layer of rock above a porous, permeable layer containing the hydrocarbons. Various types of traps are shown in figure 3. It can be structural traps or stratigraphic traps or combination of these factors. Structural traps occur when the reservoir formation deforms. Stratigraphic traps are those where porosity or permeability has changed within a formation.

Structural Traps

By far the greatest number of fields discovered world-wide and the largest proportion of total proven reserves are associated with structural traps.

- Structural traps result from a local deformation such as folding and/or faulting of the rock layers.
- Faulting can also produce traps by juxtaposing a reservoir against an impervious stratum.

Stratigraphic Traps

Resulting truncated beds, and buried erosional or constructive surfaces such as reefs, hills, barrier sand bars, channels, and other related geologic phenomena which form the basic requirements for the creation of stratigraphic traps.

- Stratigraphic trap is a general term for traps that are chiefly the result of a lateral variation in the lithology of the reservoir rock, or a break in its continuity. A permeable reservoir rock changes to a less permeable or to an impermeable rock.
- Two common types of stratigrapic traps are Pinchout Type and Truncated Type.

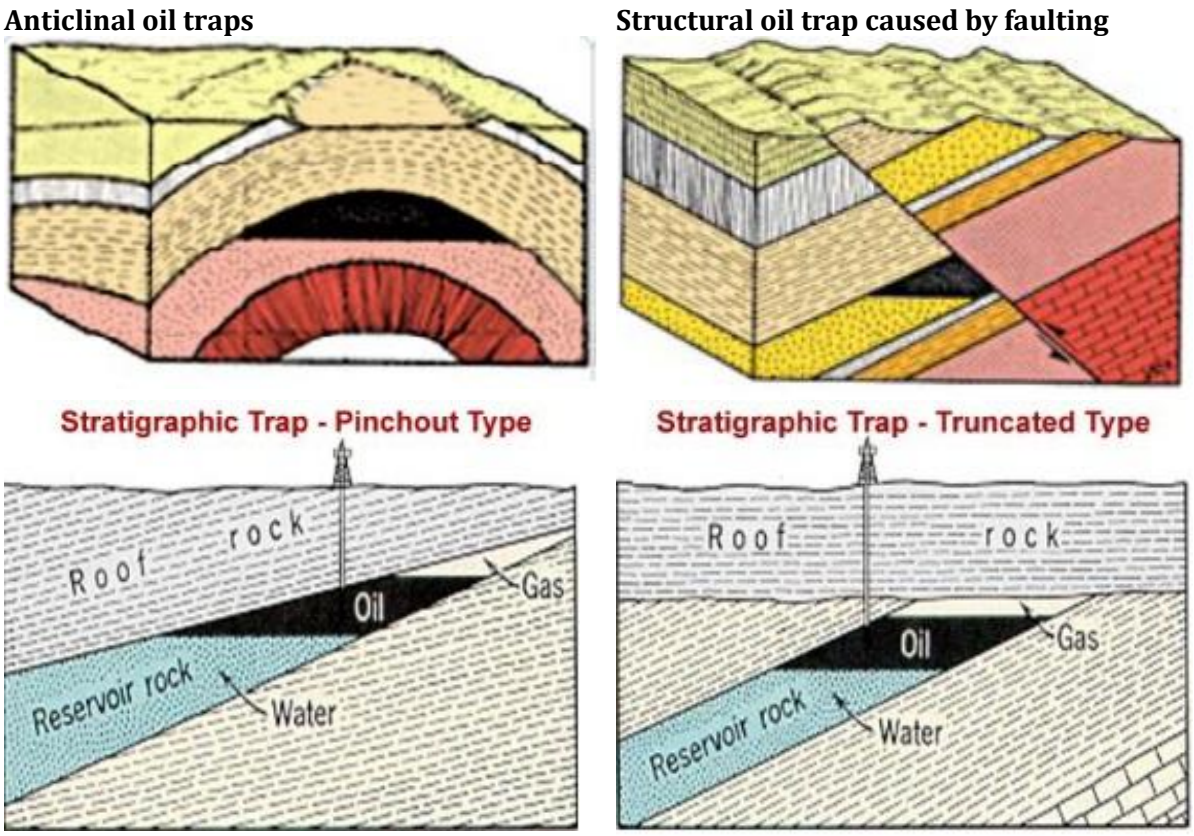


Figure 3: Different types of traps

Combination Trap

The geometry of this type of trap is the result of a combination of tectonic processes and changes in lithology.

- A common trap that would be an example of a Combination Trap is a salt dome.
- Oil Exploration Method
- In the early days of petroleum, most oil finds were the result of digging or drilling near known oil and gas seeps or of accidental finds while drilling for water.
- A good definition of a seep is ''the surface expression of a migration pathway, along which petroleum is currently flowing, driven by buoyancy from a sub-surface origin''.
- At the most basic level, this demonstrates that the basin contains a generating source rock and hence a viable petroleum system

Reservoirs

The oil and gas bearingstructure is typically a porous rock such assandstone or washed outlimestone. The sand mighthave been laid down asdesert sand dunes orseafloor. Oil and gasdeposits form as organicmaterial (tiny plants andanimals) deposited in earliergeological periods, typically 100 to 200 million years ago, under, over or with the sand or silt, is transformed high temperature and pressure into hydrocarbons.For an oil reservoir to form, porous rock needs to be covered by a non-porous layersuch as salt, shale, chalk or mud rock that can prevent the hydrocarbons from leakingout of the structure. As rock structures become folded and uplifted as a result oftectonic movements, the oil and gas bearinghydrocarbons migrates out of the deposits and upward in porous rocks and collects in crests under the non-permeable rock, with gas at the top, then oil and fossil water at the bottom. (Pant, 2010)

EXPLORATION AND PROSPECTING TECHNIQUES

Hydrocarbon deposits found through natural seepages of oil, outcrops of oil-bearing rocks and various forms of gas seepages such as mud volcanoes. However it does not necessarily prove that oil exists in commercial quantities. A petroleum geologist's main job is to select promising site for the drilling of exploratory wells based on his prediction of an area's subsurface stratigraphy and structure (Asia et al, 2007; Aniefiok et al, 2013).The selection of effective exploration targets is an important step to achieve success in oil exploration.

Geological Exploration Methods

Surface Geology

This method is used to study the basic of petroleum geological conditions.
Subsurface maps are a necessary part of any reservoir engineering study; and petroleum engineers, as well as geologists, must be completely familiar with their construction and interpretation subsurface maps include the following basic forms:
The data for subsurface maps are obtained from a number of sources, such as
Structural contour maps: maps composed of lines connecting points of equal elevation above or below datum (normally sea level)

Isopachous maps: – maps composed of lines connecting points of equal bed thickness.
Cross sections: a form of subsurface presentation which depicts the position and thickness of various strata.

Well logs: representations of some rock property of properties versus depth.

Core drilling: shallow, small hole drilling for information purposes only. The formations encountered are core, i.e., obtained as small cylindrical samples which are readily and accurately identified.

Strat tests: deep exploratory holes drilled primarily for information.
The construction of subsurface maps requires great interpretive skill

Remote Sensing Method

The remote sensing techniques are more effective and useful for understanding and studying those basins in the out-of-the-way mountains and remote deserts.

- Remote sensing refers to using infrared or other means to map an area.
- The remote sensing images have characteristics of realty and provide accurate visual data for directly determining geometric shapes of sedimentary basins.
- Remote sensing equipment's can be carried by airplanes or by satellites.
- Companies using remote sensing data, however, still need traditional exploration information to pinpoint the location of commercial deposits.

Geophysical Exploration

Geophysical methods are includes the gravitational method, magnetic method and seismic method.

Magnetic Methods

Magnetic prospecting is used to explore for both oil and minerals. It gives information to determine depth to basement rocks, locate and define the extent of sedimentary basins. This information is of

importance in previously unexplored areas such as continental shelves newly opened for prospecting. Sedimentary rocks generally have a very small magnetic susceptibility compared with igneous or metamorphic rocks, which tend to have much higher magnetite (a common magnetic mineral) content. By conducting a magnetic survey over a given area, a prospector can determine where oil-bearing sedimentary rock is more likely to be found. The magnetometer is used to measure the magnitude of the earth's total magnetic field over a large area.A magnetometer can be towed behind a ship or an airplane to cover large areas. It transmits data to a device on board which records the information onto paper or magnetic tape.

A development of airborne magnetics is the micro-magnetic technique for oil exploration. An airplane tows a micro-magnetometer from a low altitude, normally about 300 ft above the ground. It detects micro-magnetic anomalies, or deviations from the norm. Geologist uses these data to predict the characteristics of the overlying sediments.

Gravity Methods

The Earth's gravitational attraction varies slightly from one place to another on the Earth's surface. Some of this variation occurs because the Earth is not a perfect sphere, and some is related to differences in elevation on the Earth's surface. For example, in north-central Kansas, there is an anomaly known as the Midcontinent Gravity High where the Earth's gravity is about 0.006% greater than normal. In gravity prospecting, geophysicists measure variations in the force of gravity from rocks up to a few miles beneath the earth's surface.

Different types of rocks have different densities, and the denser rocks have the greater gravitational attraction. If the higher-density rock formations are arched upward in a structural high, such as an anticline, the Earth's gravitational field will be greater over the axis of the structure than along its flanks. A salt dome, on the other hand, which is generally less dense than the rocks into which it is intruded, can be detected from the low value of gravity recorded compared with that measured on either side.

Gravity surveys carried out in search of oil are designed for reconnaissance of large, previously unexplored areas. Gravity method provides presence of sediments in a basin rapidly and economically. Field observed in gravitational prospecting is a composite of contributions from all depths within the usual range of exploration interest. Quantity actually observed is not earth's true gravitational attraction but its variation from one point to another.

The gravitational method is based on Newton's hypothesis that every particle in the universe attracts every other particle in the manner defined by the equation

Where F = attractive force

m1. m2 = masses of particles in question

r = distance between particles

γ = gravitational constant (6.67 X10-8) in CGS units.

$$F = \gamma \frac{m_1 m_2}{r^2}$$

Seismic Methods

Seismic reflection, a powerful technique for underground exploration, has been used for over 60 years. It will give more precise details on the formations beneath the surface.

Seismic waves are essentially sound waves that travel underground at velocities of 2 to 4 miles per second (3 to 6 km per second), depending upon the type of rock through which they pass. The reflections are recorded by detecting instruments responsive to ground motion (geophones). They are laid along the ground at distances from the shot point which are generally small compared with

the depth of the reflector. Variations in the reflection times from place to place on the surface usually indicate structural features in the strata below.From the geophones, the wave will be send through cables to a recorder. The recorder, a seismograph, amplifies and records the wave characteristics to produce a seismogram.Seismograms generate a seismic section, which is a two-dimensional slice from the surface of the earth downward. The information from a seismic survey indicates the types of rock, their elative depth, and whether a trap is present.

Sub-Surface Geophysical Exploration (Well Correlation)

Consists of establishing correlations by matching strata, rock hardness or softness, and electrical and radioactivity data to determine the origin, composition and distribution of rock strata. Electrical logs, radioactivity logs, and acoustic logs help geologists predict where oil bearing strata occur.Sample logs, compiled from well cuttings and cores, are used to identify key beds and lithological sequences. Core samples are taken from the top to the bottom of a well and shows rock in sequential order as it appears in the ground. Core samples also provide information on porosity, permeability, and saturation of rock in the well. Cuttings are not a continuous record like core samples, but provide a means for identifying sections within larger thick layers through fossil and mineral deposits.

PETROLEUM SCENARIO IN WORLD AND INDIA

The world proved reserves of crude oil and natural gas at the end of 2012 were estimated at 235.8 billion tonnes and 187.3 trillion cu m , respectively. The largest share of reserves of world crude oil is available in Middle East (46.4%) followed by South & Central America (21.6%), Europe & Eurasia (8.1.%), Africa (7.3%), North America (14.3%) and Asia Pacific (2.3%). The world crude oil productionin 2012 increased to 4008 million tonnes from 3985 million tonnes in 2011. OPEC countries, namely, Algeria, Angola, Ecuador, Gabon, Indonesia, Iran, Iraq, Kazakhstan, Kuwait, Libya, Nigeria, Saudi Arabia,UAE and Venezuela had a share of about 43.6% in the world crude oil production in 2012. Saudi Arabia (14%), Russia (13%), USA (8%), China (5%), Canada, Iran, Iraq, Kuwait, Mexico, & UAE (4% each) and Brazil, Nigeria, & Venezuela (3% each) were the principal producers of crude petroleum.

Total consumption of petroleum products (excluding Refinery Boiler Fuel) increased to156.529 million tonnes in 2012-13 from 148.133 million tonnes in 2011-12. India is heavily dependent on imports to meet the rapidly growing demand of petroleum products. Current demand and supply projection indicate that the level of self-sufficiency is likely to decline to above 30% over the next few years.

As on 1.4.2013, total reserves of crude oil in India were estimated at 758.27 million tonnes (331.43 million tonnes in onshore and 426.84 million tonnes in offshore areas). Those of natural gas are placed at 1,354.76 billion cu m (353.34 billion cu m in onshore and 1001.42 billion cu m in offshore areas) The domestic production of crude oil stood at 37.9 million tonnes in 2012-13. Bulk of the total production (69.3%) was shared by the public sector companies. Private sector companies accounted for the remaining 30.7%. Offshore areas continued to be the largest producer of petroleum (crude) in 2012-13 with a share of 48.7% of the country's total output. In the onland area, the biggest contribution came from Rajasthan with 22.7% share, During 2012-13, the production of petroleum (crude) recorded increase in Rajasthan by 31.2%, Whereas, the net production of natural gas (utilized) decreased to 40,679 million cu metres in 2012-13 (IBM, 2013).

Petroleum exploration and production activities were initially carried out in India by two national oil companies, Oil and Natural Gas Corporation Limited (ONGC) and Oil India Limited (OIL). With the liberalization of economy in 1991-92, the Indian sedimentary basins were opened to private sector companies also. About 282 blocks for exploration were awarded under the liberalized policy till 2012 (NELP-X, 2014).

EXPLORATION WORKS IN RAJASTHAN

Rajasthan has significant resource potential of hydrocarbons under 4 Petroliferous Basins. Due to hydrocarbon potentiality, 3 Petroliferous Basins of Rajasthan has been upgraded into Category-I i.e. equivalent to Bombay High, Assam and Gujarat.

In Rajasthan, a total of 315 wells were drilled with an investment of Rs 2000-2500 crores till the year 2008-09. However 161 wells were drilled with an investment of Rs 1625- 1730 crores during last 4 years between 2009-10 to 2012-13. During the year 2013-14, 36 wells have already been drilled with an investment to the tune of Rs 350-370 crores till March '2014. Activities related to Oil and Gas exploration began in Barmer-Sanchore Basin in last two decades and Rajasthan has emerged on country's Oil and Gas map with the discovery of Mangla Oil field with the efforts of National and International companies. Presently, Oil, Gas Exploration is being undertaken in 21 Blocks of Rajasthan. Two Blocks are offered by Directorate General of Hydrocarbons, New Delhi for Oil & Gas exploration and production under National Exploration Licencing Policy, (NELP) ninth round by bidding. As per estimates 480 million tonnes Oil in-place reserves (3.5 Billion Barrels) have been proved in 25 discovered fields of Barmer-Sanchore Basin. Out of these 5 fields shall be categorised in commercial. Rest of the fields shall come into production after approval of Field Development Plans by Government of India.

These 4 basins falls in the 15 Districts of the State namely Barmer, Jaisalmer, Bikaner, Ganganagar, Hanumangarh, Jalore, Jodhpur, Kota, Jhalawar, Baran, Bundi, Chittorgarh and Swai-Madhopurspreaded over an area of 1,50,000 Sq.km.

Rajasthan has immense investment opportunities in Upstream & Downstream hydrocarbon sector. Pursuant to liberalization Policy in Petroleum Sector, E&P activities in the state have been increased manifold. Maximum on land exploration has been undertaken in the State covering 60,000 sq. km under 21 Blocks for Oil, Gas & CBM. Presently exploration is underway in 12 blocks after relinquishment of 9 blocks.

Ministry of Petroleum & Natural Gas, Government of India has awarded one new block of Rajasthan in Jaisalmer Basin under NELP-IX round of bidding. PEL of which is under consideration with State Government.

4 more blocks of Rajasthan i.e 2 blocks from Jaisalmer basins and 2 blocks from Barmer - Sanchor basins have been proposed in NELP- X round of bidding.

(Source: http://petroleum.rajasthan.gov.in/general.htm)

Rajasthan has four potential petroliferous basins.The Ministry of Petroleum & Natural gas has upgraded the first three petroliferous basins into category- I, i.e. equivalent to the Bombay High, Cambay Basin and Assam.

Table 1 is shown the potential petroliferrous basin in Rajasthan.

S. No	Basin	Basin Coverage
1	JaisalmerBasin (Rajasthan Shelf)	Jaisalmer – Mari Arch, Kishangarh Sub-Basin, Shahgarh Depression and Miajlar Sub Basin.
2	Barmer – Sanchore Basin	Districts Barmer and Jalore.
3	Bikaner – Nagaur Basin	Districts Bikaner ,Nagaur, Ganganagar/ Hanumangarh and Churu.
4	Vindhyan Basin	Districts Dholpur, Karauli, Kota, Jhalawar, Baran, Bundi and SawaiMadhopur etc.

(Source: http://www.investrajasthan.com/lib/bpulse/062004/barmer_oil.htm)

Exploration Blocks awarded 1991 onwards are listed in the table 2 given below. The total area awarded for exploration is 53039.16 seq. km.

Table 2: Blocks awarded under JOINT VENTURE / NELP/CBM rounds of global competitive bidding (1991 onwards)

S. No	Basin	Block No.	Area (in sq. km)	in favour of	Status
1	Shahgarh, Jaisalmer	RJ-ON-6	3862.16	ONGCL/ Focus Energy	JV
2	Jaisalmer-Barmer	RJ-ONN-2003/2*	13195	Focus Energy Ltd. &Birkbeck Inv. Ltd	NELP-V
3	Bikaner-Nagaur	RJ-ONN-2004/1*	4613	GSPCL, GAIL, HPCL & others	NELP-VI
4	Bikaner-Nagaur	RJ-ONN-2004/2*	2196	OIL & Geo global	NELP-VI
5	Vindhyan	VN-ONN-2004/1	5801	ONGCL	NELP-VI
6	Vindhyan	VN-ONN-2004/2	4466	ONGCL	NELP-VI
7	Barmer-Sanchore	BS(4)-CBM-2005/III	1168	Geo Petrol, REL & RNRL	CBM-III
8	Barmer-Sanchore	BS(5)-CBM-2005/III	739	Geo Petrol, REL & RNRL	CBM-III
9	Jaisalmer	RJ-ONN-2005/1	1424	HOEC, BPRL, IMC, Jindal Petroleum	NELP-VII

10	Jaisalmer	RJ-ONN-2005/2	1517	OIL, HOEC, HPCL-Mittal Energy	NELP-VII
11	Jaisalmer	RJ-ONN-2005/3	1217	ONGCL, GSPCL	NELP-VII
12	Jaisalmer	RJ-ONN-2010/2	535	Focus Energy Ltd. &Birkbeck Inv. Ltd	NELP-IX
13	Jaisalmer	RJ-ONN-2010/1	480	Process of allotment	NELP-IX
14	Jaisalmer	RJ-ONN-2013/1	3523	Under consideration of GOI	NELP-X
15	Jaisalmer	RJ-ONN-2013/2	2538	Under consideration of GOI	NELP-X
16	Barmer-Sanchore	RJ-ONN-2013/3	3658	Under consideration of GOI	NELP-X
17	Barmer-Sanchore	RJ-ONN-2013/4	2107	Under consideration of GOI	NELP-X
		Total	**53039.16**		

For more blocks (RJ-ONN-2014/1(4), RJ-ONN-2014/2(5),RJ-ONN-2014/3(6) & RJ-ONN-2014/4(7)) are under consideration of GOI for exploration. 4 Blocks as shown in figure 4. Schematic geological section across Bikaner-Nagaur basin is shown in figure 5.

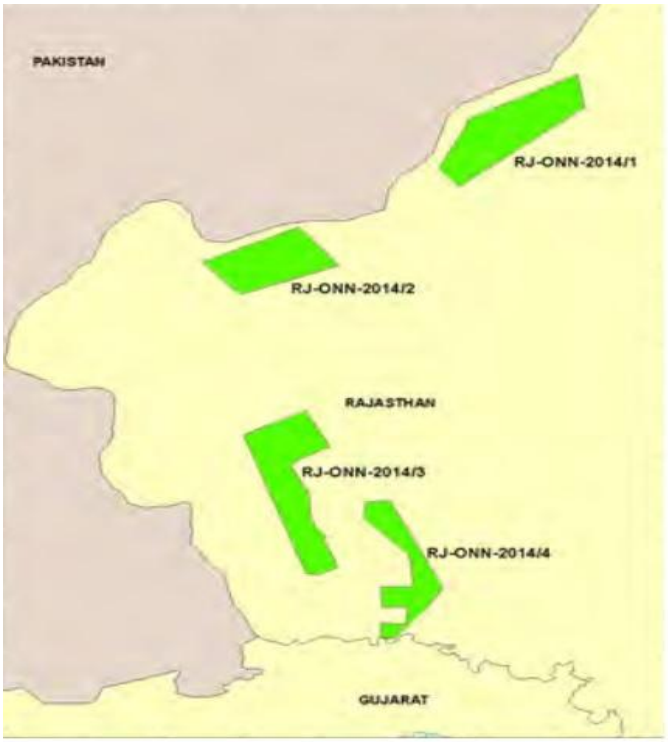


Figure 4: Location map of blocks

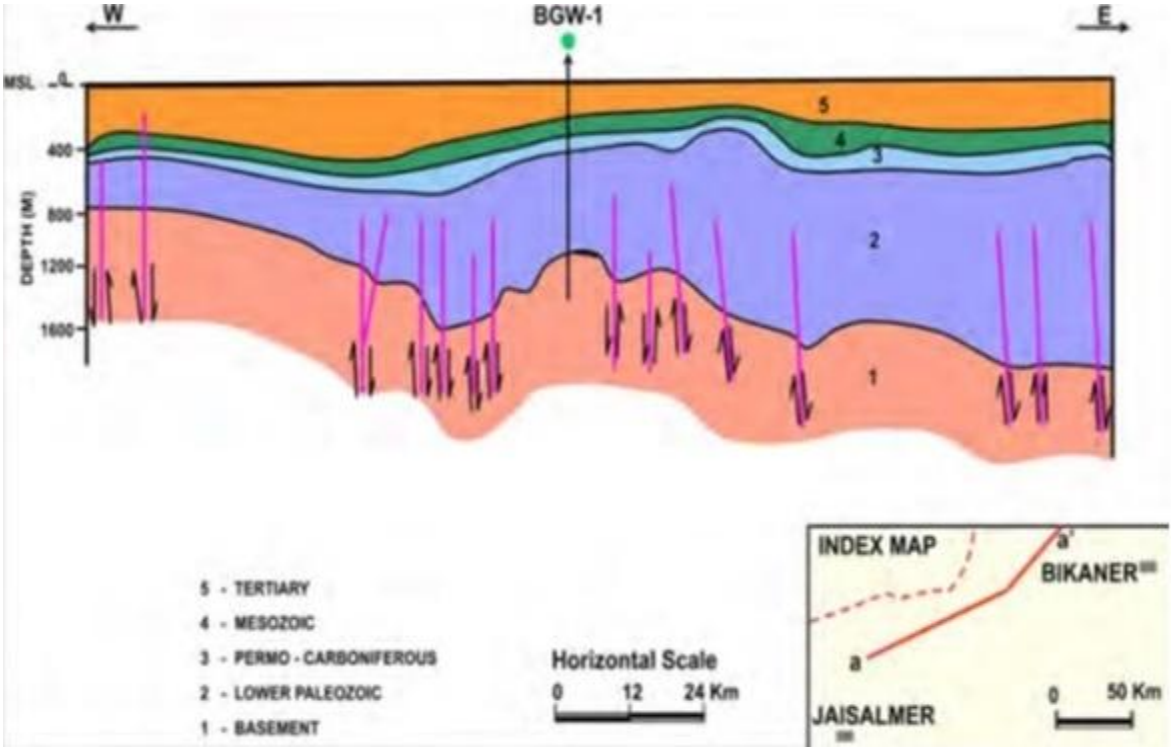


Figure 5: Schematic geological section across Bikaner - Nagaur basin

CONCLUSION

The roles and responsibilities of all the stakeholders in the monitoring and control of oil exploration and exploitation activities in the Rajasthan region must be clearly defined. Authorities should embark on aggressive enlightenment campaign by educating every stakeholder with a view to know and carry out their expected responsibilities. It is hopeful that if these measures are taken, there will be considerable improvement in the management of problems associated with oil exploration and exploitation in the Rajasthan state.

Substantial efforts are therefore, necessary to boost the level of exploration activity in the country so that new finds can be made and the level of crude oil and gas production significantly increases in the years to come. Moreover, continued economic development and population growth are accelerating energy demand faster than India can produce.

New Blocks of oil and gas would be allotted in the next rounds of NELP i.e. NELP-XI onwards). More Blocks of CBM shall be carved out in Barmer-Sanchore Basin & Bikaner-Nagaur Basin after the completion of R & D by the Directorate of Petroleum. Production of Oil & Gas shall start by year 2006-07 from Barmer-Sanchore Basin,Enhancement of Gas supply to Ramgarh Power Plant from Dandewala area of Oil India Limited and ChinnewalaTibba area of ONGC.

Strengthening of Directorate of Petroleum for more effective monitoring of exploration & exploitation work in the Statecreated a State Petroleum Corporation for availing more participating interests from the available reserves in the State & other parts of the Country.

These discoveries would affect the economy of the State significantly. Rajasthan could earn Rs.2 billion from the royalty of the reserve.In future the State's earning from royalty could cross Rs.8

billion. The reserves could be used to generate at least 20,000 MW of electricity. Gas-based power plants can be installed in the State. Rajasthan could become self-sufficient in power. Rajasthan could sell 10,000 MW of the power generated by the reserve. If more oil is found in Rajasthan then a refinery could be set up in the State. This refinery could provide employment to about 10,000 people. Fertilizer units, chemical based industries, etc. would provide employment to many in the State.

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