

Oil and gas Exploration Activities in Nepal

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SUMMARY

Systematic geological investigations in Nepal started late in comparison with the start of such studies in other countries. The topographical feature of Nepal varies from 100 meters in south to 8848 meters in altitude in north. Physiographically, Nepal is separated into four zones similar to the geological zones. They are Terai plain (Indo Gangetic plain), Siwalik range (Churia range), lesser Himalaya and higher Himalaya region. The Terai and Siwalik region in the foreland of Nepal Himalaya are known for sedimentary basins with considerable thickness. These regions are targeted for hydrocarbon exploration.

In this paper, we describe the possibility of occurring oil and gas in Siwalik, Surkhet, Gondwana and Lakharpata (Vindhya) groups of rocks based on the results from field investigation and geochemical analysis of collected samples.

The seismic interpretation of Terai region indicate the evidence of unconformities between Siwalik sediments and the under lying meta sediments group of rock which are equivalent to the oil bearing formation of unnamed formation in the northern India. This group contains potential source and seal rocks. One exploration well drilled though dry gave valuable information to petroleum exploration.

INTRODUCTION

Nepal is a landlocked country situated in the central part of Asia between India to the south and China to the north with a dimension of 800 km length and 150 to 230 km width. The evidence of regional hydrocarbon occurrence in Bangladesh, Pakistan and India encouraged the oil and gas exploration in Nepal. A systematic petroleum investigation in Nepal began since 1979 with the evidence of oil and gas seeps in the north of Main Boundary Thrust (MBT) throughout the country. Active oil and gas seeps occur in the western part of Nepal. The geochemical analysis of these seep samples indicates that these oil and gas has geological origin from a mature source rock [Source and Seal study, 1993, Al Consult, Canada]. The presence of oil and gas seeps in western Nepal is analogous to its presence in the basins of Potwar and Assam.

The seeps oil and gas was noted in the western part. The geochemical analysis of the collected data from the western region indicated the occurrence of oil and gas. This encouraged the start of exploration activities in Nepal.

Potwar basin in Pakistan and Assam basins in India have similar geological condition to Nepal. The Ganga basin of Nepal is on a similar trend to the Potwar and Assam basins. These basins consist of hydrocarbon bearing with a long history of successful exploration, production and operation. The Gandak depression, Sarda depression and Purnea basin observed in the south of Nepal border are in the process of oil and gas exploration. The oil found from the drilled data of Purnea well and Purnpura well are correlated with the oil bearing formation observed in Nepal. Based on these facts, it leads us to believe the possibility of hydrocarbon occurrence in Nepal. The terrain region is divided into ten Exploration block each covering an area of 5,000 sq. km. for hydrocarbon exploration.

The southern flat land (Terai plain) is composed of fluvial deposits. The youngest deposit is underlain by a thick flat-lying sequence of middle Miocene to Pleistocene molasses (Siwalik group of rock). The Siwalik group of rock is unconformably overlies sub-basins comprising of Proterozoic to early Tertiary sediments and rock of the Indian shield. The subsurface study in Terai area has revealed favorable condition of oil and gas accumulation, encouraging further exploration in the region [O.R. Friedenrich et. al., 1989]. The geological map shown in Figure 1 illustrates the position of different formation and lineaments.

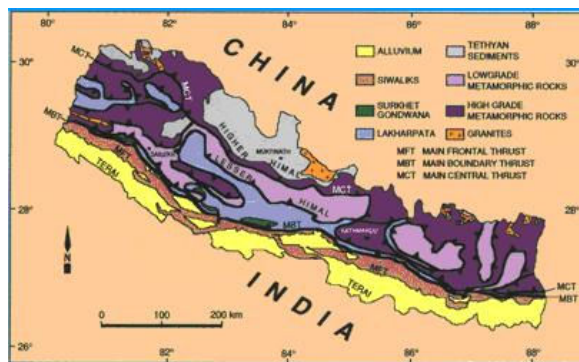


Figure 1. Regional geological map of Nepal.

The movement of Indian plate towards the north against the Tibetan plate results uplifting of Himalaya. The southern foot hill region of lesser Himalaya is known by thick sedimentary sequence known as Siwalik sediments and the southern flat plain extending up to the India boarder is known as Terai plain (Indogangetic plain). The Terai and Siwalik area are in the foreland of the Nepal Himalaya.

The schematic geological cross-section along north – south direction cover through out the country, Figure 2 illustrates the position of different group of rocks and the role of lineaments to bring the rock in present situation.

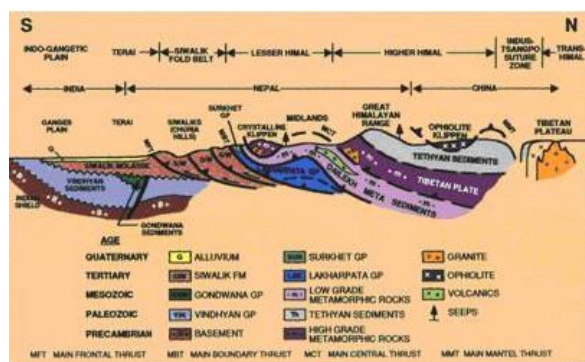


Figure 2. Schematic geological cross section of Nepal.

FIELD INVESTIGATION

There are four groups of rock units interesting for hydrocarbon exploration in Nepal. These are the Siwalik, Surkhet, Gondwana and Lakharpata (Vindhya) group. The surface geology of Siwalik formation indicates thick and multichannel sandstone of reservoir quality and the lower part of Siwalik formation provides thick and good quality of seals rocks. From the analysis of seismic and Aero-magnetic data the structure and stratigraphy traps are noted in the Siwalik region. However, the possible source rock sample collected from the Siwalik group shows immaturity for oil and gas exploration.

The Terai plain which is a part of the Ganga basin lies between the southern margin of the Himalayan foothills and the northern part of the Indian shield. This extensive alluvial plain composed of recent fluvial deposits. The Terai plain constitute with considerable thickness of sedimentary formation in the subsurface has revealed favorable condition of oil accumulation, encouraging further petroleum exploration in the region. Surkhet group of rock that are exposed in the north of Main Boundary Thrust are correlated with the oil and gas formation in Assam and Potwar basins. The outcrop of Surkhet group and subsurface evidence are equivalent to the unnamed formation in the northern India. This group contains potential source and seal rocks. Sample collected from this group are subjected to geochemical analysis and the result shows 2 % to 20 % of Total Organic Carbon (TOC) content in the rock. Thus, Surkhet group is the most targeted group for exploration.

The Gondwana group of rock is divided into two groups: the basal upper Paleozoic series containing both tillites and coal, and the higher upper Paleozoic to lower Mesozoic marine sequence with significant development of shale and limestones. It is believed that the Gondwana is both the source and the reservoir for the Manihari Ghat gas-

condensate which is discovered in the eastern Ganga plain. Gondwana beds are prospective for both oil and gas since the facies in Gondwana are favorable and these facies also subcrop over significant areas in the southeastern part of Nepal. Analytical result of the sample collected from this group contain up to 10% TOC. The Lakharpata equivalent to Vindhyan in India is continuously exposed along the Main Boundary Thrust and occurs in the subsurface unconformably beneath the Siwaliks with thickening in the centre and thinning in the west. The Sangram formation at the base of the Lakharpata group has good source rock with 7% to 9 % TOC obtained from the analysis of collected sample.

The stratigraphic correlation between lesser Himalaya section with the Terai and Siwalik fold belt shows the thinning and thickening of formation reflecting the surface geology of the area.

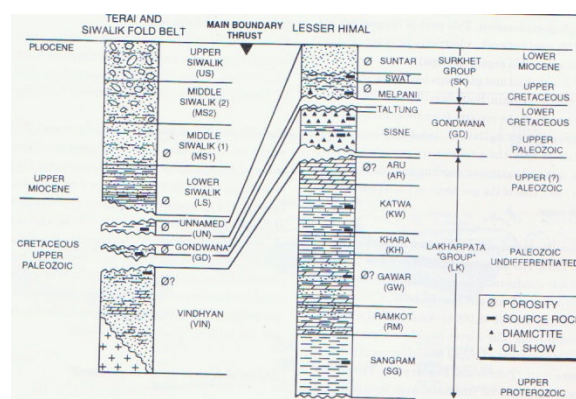


Figure 3. Stratigraphic diagram of the central – southern Nepal.

EVIDENCE OF OIL AND GAS SEEPS

There are two confirmed seeps lying north of the Main Boundary Thrust in Nepal. They are the oil and gas seep in Dailekh region of western Nepal and the gas seep in Muktinath region of higher Himalaya.

A series of oil and gas seeps is located at Paduka and Nabi Khola in the Dailekh region of western Nepal. The seeps samples collected from this region were analyzed by Shell and Chinese petroleum investigation team (CPIT). The analyzed result revealed the thermogenic gas migrating from the depth. The structural interpretation suggested that the evidence of oil and gas seeps associated with faulted anticline, which encourages exploring of oil and gas within the sedimentary formation of Ganga basin. The flame 25 to 30cm high fed by gas coming from a pipe that goes into the ground Figure 4. In the river, just below the temple, gas bubbles were observed at many different sites.

Muktinath gas seep belonging to Tethys basin has been known since the beginning of historical time. The gas flame in Muktinath is worship as Jwala Devi. The flaming area is highly protected by the religious people and priest.

Dailekh gas seeps are also worship after the name of Jwala Devi. In this region there are a number of spots where gas seeps can be observed. Out of which at present only five (5) different spots the continue burning gas flame can be observed, such as two (2) in Sristhan two (2) in Nabisthan and one (1) in Lalat area as shown in fig 4.



Figure 4. Flame of gas seeps at Lalat area close to Sristhan

EXPLORATION ACTIVITIES

Petroleum Exploration Promotion Project (PEPP) has conducted a series of Geological Geophysical and geochemical survey in the southern part of Nepal with bilateral and multilateral cooperation in the last 30 years.

The southern part of country at about 48,000 sq. km is covered by airborne magnetic survey by CGG. To understand the structure of the Siwalik fold belt 60,000 sq. km Photo-geological study was completed by Hunting Geology and geophysics Ltd. Gravity survey has been conducted by ELS consulting and covered entire Terai region. Similarly to understand the sub-surface structure 5253 line km reflection seismic survey has been completed by CGG, petro-Canada and Shell Nepal.

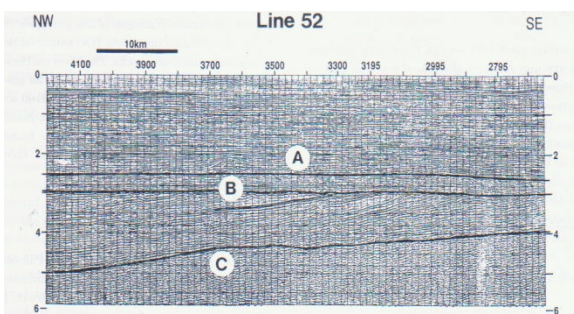


Figure 5. Migrated Line 52 showing Pre-Tertiary Unconformity (B)

The reflection seismic line Figure 5 shows the evidence of unconformities (B), between Siwalik sediments (A) and the under lying meta sediments group of rock which are

equivalent to the oil bearing formation of unnamed formation in the northern India. This group contains potential source and seal rocks. This evidence leads to explore oil and gas in this region. The seismic reflection in the lowermost formation (C) characterized the presents of basement rock. Figure 6 shows the structure cross section across Terai, Siwaliks and Lesser Himalaya of Nepal. The trapping mechanism of oil and gas in these regions is the structural trap that includes anticlines and thrust / fault developed in the Siwalik fold belt. We can also expect the structural closures associated with basement controlled faults, graben edge folds and faults closures, draping over pre-existing high and stratigraphic trap.

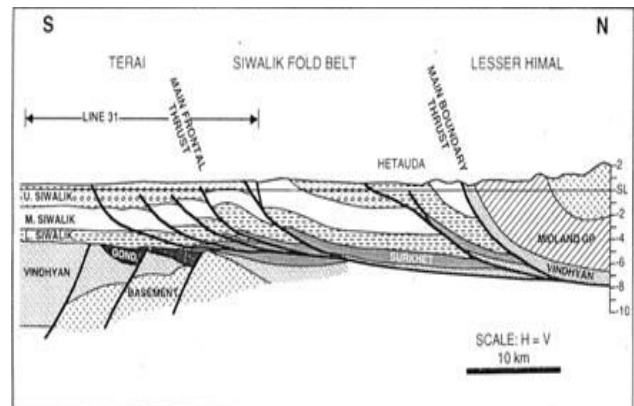


Figure 6. Structural cross section across Terai, Siwaliks and lesser Himalaya.

One exploration well of 3520 m was drilled in the eastern Nepal in Block 10 by Shell Nepal. The exploratory well was to test the hydrocarbon potential of a seismically defined anticlinal closure. The formations penetrated consist of shales and sandstone. The well not penetrated up to the basement.

CONCLUSION

The Siwalik, Surkhet, Gondwana and Lakharpata (Vindhya) group of rocks are potential for hydrocarbon exploration. Field investigation, available data interpretation and geochemical results of the collected samples reveal the existence of source, seal and reservoir rocks. Oil and gas seeps in the Western Nepal shows the evidence of hydrocarbon potential in Nepal.

Petroleum exploration activities that have been carried out by bilateral and multilateral cooperation are limited in the Siwalik fold belt and Terai region and warrants for additional exploration. The seismic results indicate the possibility of finding oil and gas in Nepal. Recently the detailed study of oil and gas seeps in Dailekh region support the evidence of oil and gas occurrences in the Terai and Siwalik that are in the foreland of the Nepal Himalaya.

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