Geological Setting

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Geologically, Nepal is broadly divided into five major tectonic zones which includes Terai, Siwalik, Lesser Himalaya, Higher Himalaya and Trans-Himalayan zones from south to north respectively (Figure 1 and 2) and extends parallel to its long dimension (Frank and Fuchs, 1970; Mitchell, 1979; Stöckl in, 1980; Windley, 1983).

Collision between the Indian sub-continent and the Eurasian continent started in paleogene period and the subduction of Indian plate underneath the Tibetan plate still continues. World's most spectacular and fascinating Himalayan range and the top of the world "Mount Everest" is the result of this tectonic activity in the past. It lies within the collision zone which occupies the central and approximately one-third portion of the Himalayan arc. Nepal is commonly divided into three Physiographic areas, Mountain, Hill and Terai. These ecological belts run east-west and are vertically intersected by north to south flowing river systems.

The southern lowland plain or Terai bordering India is a part of the Indo-Gangetic plain. The outermost range of foothill called Siwalik, mark the limit of the Gangetic plain. The Terai plain and the Siwalik are the parts of foreland basin of Nepal Himalaya which extend throughout the length of the country.

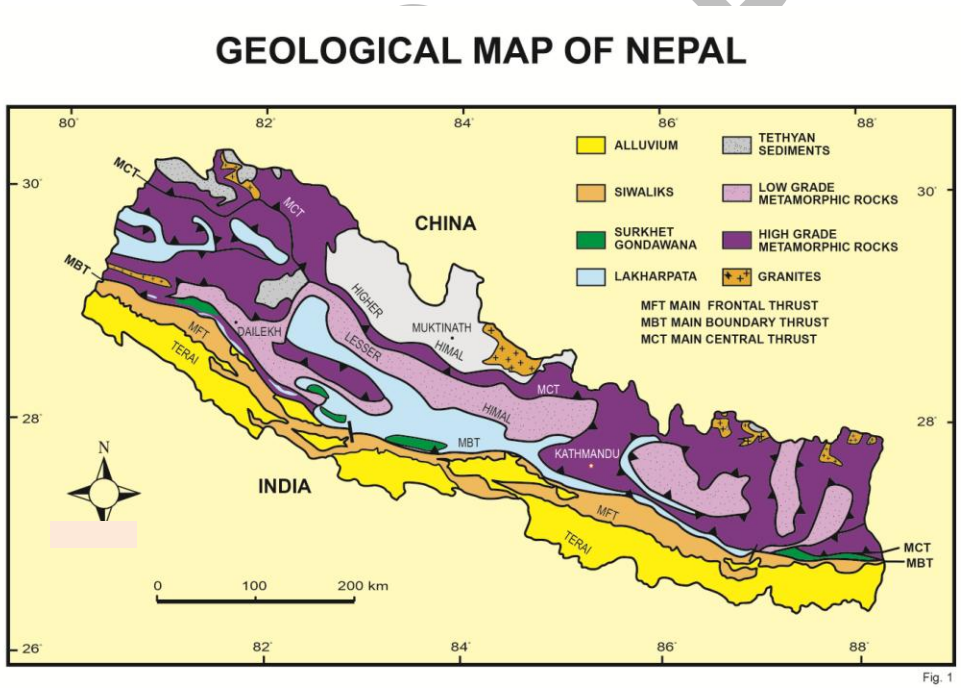

Figure 1: Geological Map of Nepal

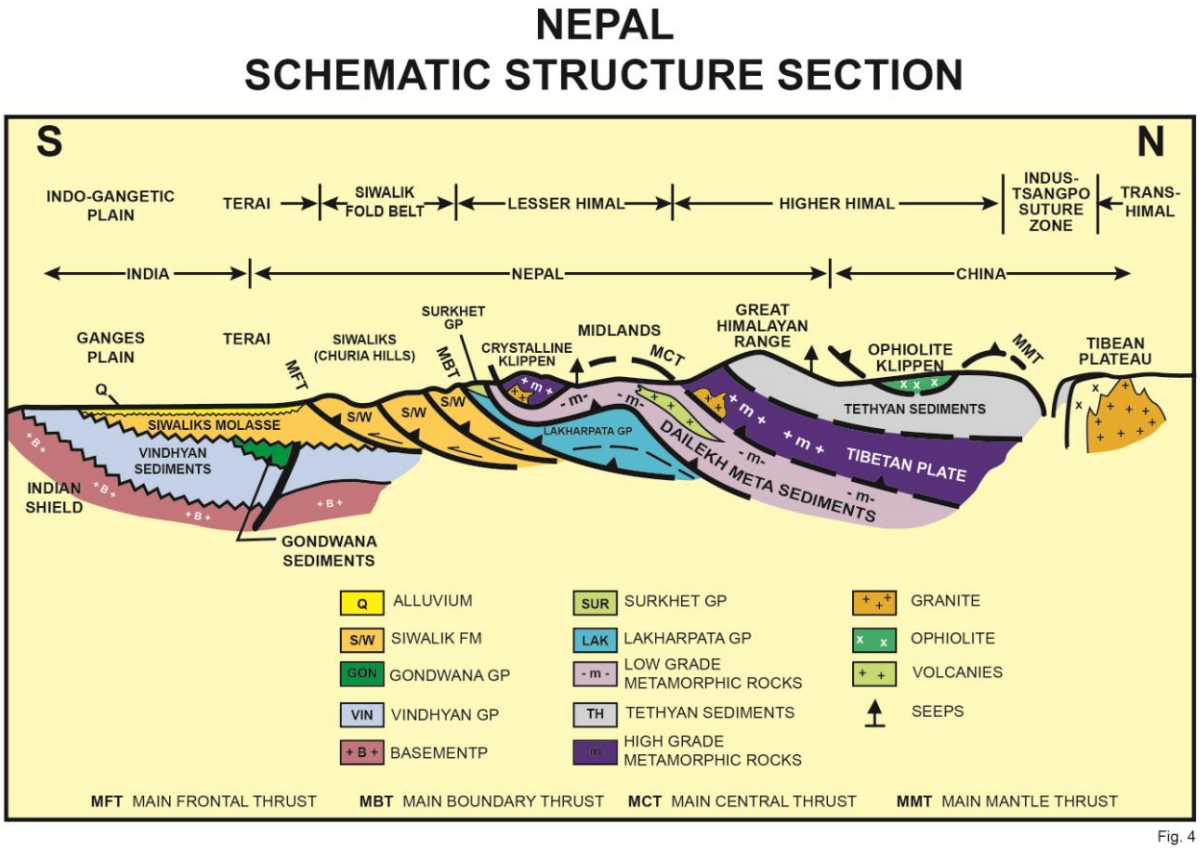

Figure 2: Schematic cross-section through Central Nepal.

Terai

The Terai is the Nepalese portion of the Indo-Gangetic Plain that extends from the Indian Shield in the South to the Siwalik Fold Belt to the North. The plain is a few hundred meters above sea level and usually 400 to 600 m thick. It is composed of Recent Quaternary alluvium, boulder, gravel, silt and clay. Terai Plain is underlain by a thick, relatively flat-lying sequence of Mid to Late Tertiary molasses (Siwalik Group) which uncomformably overlies sub-basins of early Tertiary to Proterozoic sediments (Surkhet, Gondwana and Vindhyan Groups) and igneous and metamorphic rocks of the Indian Shield (Agrawal, 1977; Acharya and Ray, 1982; Raiverman et al., 1983).

Siwalik Fold Belt

The Siwalik Fold Belt is 5 to 45 km wide and rises abruptly from the Terai along the Main Frontal Thrust (MFT). It consists of a series of ridges and valleys composed of thick beds of folded and faulted Tertiary Molasses of Siwalik Group thrust to the South (Parkash et al., 1980; Herail et al., 1986). Gravity measurements and detailed field mapping indicate that the cores of at least some of these structures contain pre-Siwalik rocks that are considered to be hydrocarbon objectives (Friedenreich and Slind, 1986; Elber, 1989).

Lesser Himalaya

The Lesser Himalaya is a wide, stratigraphically and structurally complex zone that lies immediately north of the Siwalik Fold Belt and is separated from it by the south-verging Main Boundary Fault (MBT). The majority of the Lesser Himalaya is composed of thrust sheets and nappes of metasediments and metamorphic rocks with granitic intrusions of the Midland Group. The Group is of little hydrocarbon exploration interest, although the oil gas seeps of the Dailekh (Figure 9) area occur within the Midland Group (CPIT, 1973). These seeps are interpreted to have been generated in sediments below the nappes (Figure 3).

Higher Himalaya

The Higher Himalaya which contains the spectacular peaks of the Great Himalayan Range, Everest, Annapurna, etc. is thrust southward over the Lesser Himalaya along the Main Central Thrust (MCT). The zone is composed of a basal slab of metamorphic Proterozoic rocks overlain by a conformable sequence of Cambrian to Eocene Tethyan Sediments (Bordet et al., 1981). Gas seeps occur in the upper Tethyan of northern Nepal near the village of Muktinath (Figure 2).

2. Petroleum Exploration in Nepal

There are four major groups of rock units of prime interest for petroleum exploration in Nepal. These are the Siwalik, Surkhet, Gondwana and Lakharpata (Vindhyan) Groups (Figure 15 and 16). Several sedimentary formations of the basin could have generated petroleum and migrated into suitable traps. Terai and Siwaliks are thus target areas for hydrocarbon exploration. This part of the country is covered by dense road (Figure 6) and air networks (Figure 3), electricity lines etc. and are the most accessible region of the Country.

It is notable that oil and gas seeps have been observed to the north of Main Boundary Thrust (MBT) in different parts of the country from the time immemorial. These seepages in Dailekh, western Nepal, were subjected to preliminary analysis in the sixties, but extensive geochemical studies were done in 1993.

Siwalik Group

The surface geology of Siwalik Formation indicates thick and multi-channels of sands of reservoir quality and expected to continue into the subsurface. There is sufficient shale especially in the lower part of the section (Lower and Middle Siwalik Formations) to provide good quality seals. A few pockets of coal are present but the source rocks have not been reported from the Siwaliks. There is an effective potential sandstone reservoir. Structure and stratigraphic traps are the objectives in the Siwalik.

Surkhet Group

The Surkhet Group (Upper Cretaceous-Lower Miocene) outcrops in western Nepal and in the subsurface, its interpreted, lateral equivalent, the "Unnamed Formation" (Palaeogene) occurs in the Northen Indian wells close to the Nepal border. It is more than 1,000m thick in the Lumbini

area of the Gandak Depression. The Surkhet Group contains potential source and seal rocks in the Swat and Melpani Formations. The reservoir rocks may be developed in the Melpani and Suntar Formations. Solid Hydrocarbons have filled the porosity of the sands of the Melpani. It is also correlated with the oil and gas producing formations of the Asam and Potwar Basins. The Surkhet Group is thus most important exploration target in Nepal.

Gondwana Group

The Gondwana Group (Upper Paleozoic to Lower Cretaceous) is exposed in various locations of west central and eastern Nepal and probably occurs beneath the Siwalik Group in the subsurface of eastern and central west Nepal. From seismic analysis it is interpreted to be 1000m thick.

The Sisne Formation could be the richest potential source rock. The lower coal bearing sisne could be both a source and reservoir for gas and upper marine sediments may be a potential oil source rock. The Taltung Formation could be a reservoir potential. Gondwana sediments are considered an important exploration objective in Nepal.

Lakharpata Group

The Lakharpata (Late Precambrian-Late Palaeozoic) equivalent to Vindhyan in India, is continuously exposed along the Main Boundary Thrust. It is interpreted to occur in the subsurface unconformably beneath the Siwaliks with thickness of more than 5,000m in the centre and slightly less in the west. The pre-Siwalik sediments of Lakharpata equivalent are exposed in slices within the Siwaliks of eastern Nepal. It has proven the existence of blind thrusts and blind folds in the subsurface.

A small amount of Karst has developed in the west central region. Stromatolite zones and small non-porous build-ups occur in the Group. The unconformity at the base of Siwaliks could provide a large number of attractive carbonate as well as clastic exploration objectives.

The Sangram Formation at the base of the Lakharpata Group has good source rock potential. According to source rock basin modeling, it is in the oil and/or gas window in the subsurface beneath the Terai. The Gawar and Katuwa Formations have also source rock potential and may be considered as a promising exploration target.