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Basement configuration and structural style in OIL's operational areas of Upper Assam.

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Abstract

The Upper Assam basin in northeast India is a passive continental margin characterized by Mesozoic and Cenozoic hydrocarbon systems. Regional Basement structure in basin consists of tensional horsts and grabens active since at least late Permo-Carboniferous (Gondwana) time. The trends of these Basement features in general are normal to the active continental margin. The general trend directions are caused by Mesozoic and Tertiary deformations. Thickness and facies distribution of Tertiary units in Upper Assam basin are closely related to syn-sedimentary relative motions of Basement.

Significant geoscientific data has been generated since last fifty years of exploration in the basin. Basement configuration and Structural style of Upper Assam Basin has been a very imperative need with the available datasets. In this efforts have been made to interpret 230 drilled well data, along with seismic data of 4550 sq km of 3D and 1400 GLKM of 2D seismic data has enabled an understanding the structural style of the Basement. Interpretations suggest that two distinct faults patters (Eocene and Post Eocene) occurred in this study area. Eocene fault patterns are dominantly E- W regional and semi regional faults present in the central part of the study area which is parallel to the Jorhat fault. Regionally Jorhat fault culminates as Basement structural nose of Mikir Hills and it divides Upper Assam Basement high with a saddle in between. Post Eocene fault patterns are dominantly of NE-SW trends. Other semi regional faults are segmented in nature. The major E-W trending faults of Eocene age are extending upward and became segmented to two different parts extending from Dibrugarh to Jorajan oilfield. All the NE-SW trending faults at Oligocene level are extending upwards to Middle Miocene level and became segmented. Less number of faults is extended upward at Upper Miocene level with minor northward swing in fault direction. The E-W and NE-SW longitudinal faults and the associated structures acted as major areas of entrapment for hydrocarbons. Inter play of extensional, compressive and lateral movement clearly explains the hydrocarbon accumulation pattern in the area. In general, Basement is dipping to the South, SE, and NE directions and maximum depth of Basement in the shelf part of the basin is around 7.0 km.

Key words: Basement, Configuration, structural pattern, Upper Assam Basin

Introduction

The Upper Assam Basin is a composite foreland basin which is situated in the far northeast of India, within the curve of the Assam Syntaxis which is a major orocline in the Himalayan Orogenic Belt (Fig.1a&b). The basin has thrusted margins on three sides; to the south the Naga Hills Thrust Belt and Manipur ophiolite belt; to the east and north the Main Frontal Thrust of the Himalayas, which was active from the mid Miocene to present-day, bends around the Assam Syntaxis. In the subsurface, a ridge of Precambrian rocks known as Brahmaputra arch roughly bisects the Assam Basin. The arch plunges northeast ward from outcrops in the Mikir Hills to the northeastern part of the basin, where the plunge of the arch becomes northerly. The Paleocene and Eocene units thin and lap out against the arch, overlying Oligocene and Miocene units thin over it. Sediments on the south flank of the arch are cut by normal faults that roughly parallel and deep away from the axis of the arch (Bhandari et al. 1973; Das Gupta and Biswas, 2000). The Basin comprises of about 7000m thick sediments of mostly Tertiary and Quaternary age. Worldwide, > 56% of conventional oil reserves is in foreland basins (Hunt, 1996). Such basins accumulate huge amounts of hydrocarbon by lateral secondary migration from large drainage areas.

Basement configuration is very important for deciding exploration strategies in a basin. An integration of subsurface geological and regional geophysical data allows the definition of regional Basement structures in spite of lack of Basement outcrop data across the basin. Based on subsurface information from drilled wells and seismic data are used to describe the Basement configuration and its structural style in this study area.

Geological Setting

The Basement of N.E. India comprises various Gondwana fragments, mainly Peninsular India (Indian Craton) and the West Burma Block, with the Lhasa and Sibumasu Blocks framing the regional picture. Terrine, or block, boundaries, as well as major structural elements are shown in Figure 1b. These continental fragments rifted and drifted from Gondwana across Tethys during the late Paleozoic to late Mesozoic, with the current configuration in place by the Eocene, from which time strong deformation affected the area in the Himalayan Orogeny. Since then ongoing movement of the Indian plate and West Burma Block has led to major differential movement along block boundaries, resulting in basin formation and structuration which continued into the Quaternary. The present-day Basin, a cratonic margin, reflects three distinct tectonic phases. The earliest was Late Cretaceous to Eocene block faulting and development of a northern easterly dipping shelf. During the second phase, in Oligocene time, uplift and erosion occurred north of the Dukai fault; many Basement faults were reactivated; and many Basement-controlled structures became prominent (Naidu and Panda, 1997). Late Miocene through Pliocene extensive alluvial deposition followed Oligocene uplift and erosion (Pahari et al.2008).

Materials and methods

Drilled well data and Seismic data are not evenly distributed in Study area. A 230 drilled well data, about 4550 sq km of 3D data and 1400 GLKM of 2D (areas with less data of drilled wells) is considered for gridding to prepare depth map on top of Basement. The data are scanty, therefore, the minor structural events are smoothened and the major structural events are considered in this study, as it has less bearing in regional configuration of structures. Fault patterns are picked from seismic data The 2.5 km X 2.5 km grid pattern was used for generating regional Basement depth map.

Basement fault patterns and structural style

There are two distinct fault patters (Eocene and Post Eocene) occurred in this study area. Eocene fault patterns are dominantly East- westerly regional and semi regional faults present in the central part of the study area which is parallel to the Jorhat fault (Fig. 2). Regionally Jorhat fault culminates as Basement structural nose of Mikir Hills and it divides Upper Assam Basement high with a saddle in between. The E-W trending fault divides Moran, Shalmari, Sapekhati and Nahorkatiya to the south and Central Basement High (CBH) to the north. CBH comprising of Chabua, Tengakhat, Dikom, Kathaloni and Balijan, separates Baghjan, Barekuri and Makum regional high by a set of NNE- SSW trending faults. A number of semi regional N-S and E-W trending faults are present within these three different regions.

Post Eocene fault patterns are dominantly of NE-SW trends. One of the regional faults is Rajgarh fault to the south of the area extending from Dipling to Bogapani area. Other semi regional faults are segmented in nature. The major E-W trending fault of Eocene age is extending upward and became segmented to two different parts extending from Dibrugarh to Jorajan oilfield. In general, all the NE-SW trending faults at Oligocene level are extending upwards to Middle Miocene level and became segmented. Less number of faults is extended upward at Upper Miocene level with minor northward swing in fault direction.

Basement Configuration

The Basement surface has been affected by a number of major and minor faults with dominant E-W and NE-SW trend. Two N-S trending major faults are running across the southern part of the area. Other two NNE-SSW trending faults divide CBH and adjoining area, Baghjan, Barekuri and Makum oilfields. Most of the major Eocene oilfields are lying north of E-W trending faults. CBH area extends from Dikom, Chabua to Balijan II & Dinjan areas to the NE (Fig.2). Few E-W trending minor grabens are present within CBH area. Basement depth in the area is in the range of 3600 m to 3700m. Barekuri and Baghjan areas are (eastern part of the study area) structurally down dip at Basement level (depth range is in the order of about 3700 m to 3800 m). The Barekuri and Baghjan High area has lateral shift north compare to the CBH area. It might have been due to sinistral movement along the NNE-SSW trending faults during later phase of plate movement. In general, Basement is dipping to the South, SE, and NE directions. Maximum depth of Basement in the shelf part of the basin is around 7.0 km.

Regional geological sections were prepared in two directions (NE-SW and NW-SE) to understand the geological setting of the basin. Profile A-A' is passing through Kathaloni, sealkati, Chabua, Baghjan & Mechaki fields in NE – SW direction (Fig.3), which covers the northern part of the study area. Profile B-B' is NW-SE direction passing through Dikom, Salmari & Baruanagar fields and covers western part of the study area (Fig.4).

Along this profile A-A', Barails and Kopili thickness is more to the NE direction i.e. at Mechaki area. Thickness of Tipam Formation is reduced in sealkati and Baghjan areas which may be due to erosion at post Girujan time. In these two fields, Girujans are completely eroded. Girujan remnants are confined in smaller pockets in northern most areas. Namsangs are also absent or not defined. Alluvium & Dhekiajuli thickness is more towards SE areas. There are few major faults in the section. A graben has divided the CBH area and Baghjan structure. Basement is structurally high at CBH area compared to Baghjan oilfield. Profile B-B', thickness of sediments from Langpar to Tipam formation is more or less uniform. Girujans are quite thick in Baruanagar area. Namsangs are very thin or absent towards NW. Alluvium & Dhekiajuli thickness is less towards SE areas. Number of major faults in these areas is presented having to SE.

Conclusion

Based on integration and interpretation of drilled well data, along with seismic data suggest that two distinct faults patters (Eocene and Post Eocene) occurred in this study area. Eocene fault patterns are dominantly E- W regional and semi regional faults present in the central part of the study area which is parallel to the Jorhat fault. Regionally Jorhat fault culminates as Basement structural nose of Mikir Hills and it divides Upper Assam Basement high with a saddle in between. Post Eocene fault patterns are dominantly of NE-SW trends. Other semi regional faults are segmented in nature. The major E-W trending fault of Eocene age is extending upward and became segmented to two different parts extending from Dibrugarh to Jorajan oilfield. All the NE-SW trending faults at Oligocene level are extending upwards to Middle Miocene level and became segmented. Less number of faults is extended upward at Upper Miocene level with minor northward swing in fault direction. The E-W and NE-SW longitudinal faults and the associated structures acted as major areas of entrapment of hydrocarbons. In general, Basement is dipping to the South, SE, and NE directions and maximum depth of Basement in the shelf part of the basin is around 7.0 km.

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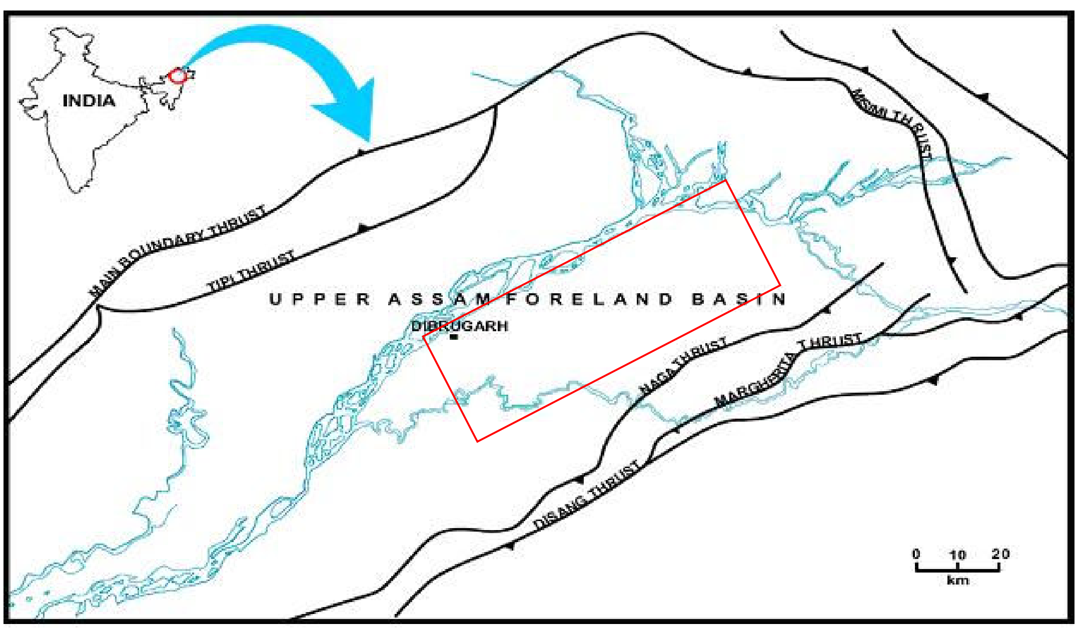
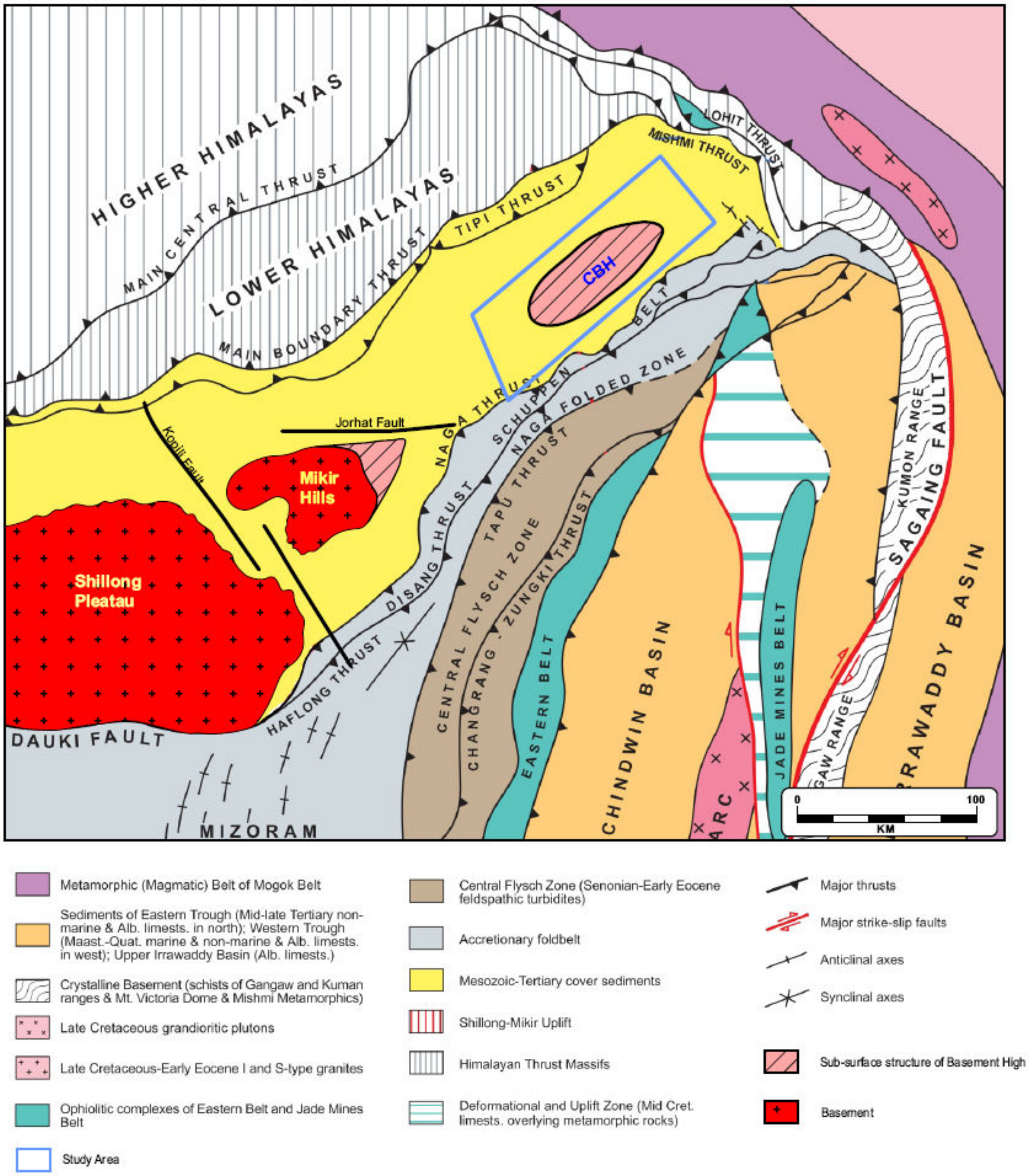
Figures:



(A)



(B)

Fig.1 (A) Location map of the study area;

(B) Major Tectonic elements of Assam-Arakan Basin.

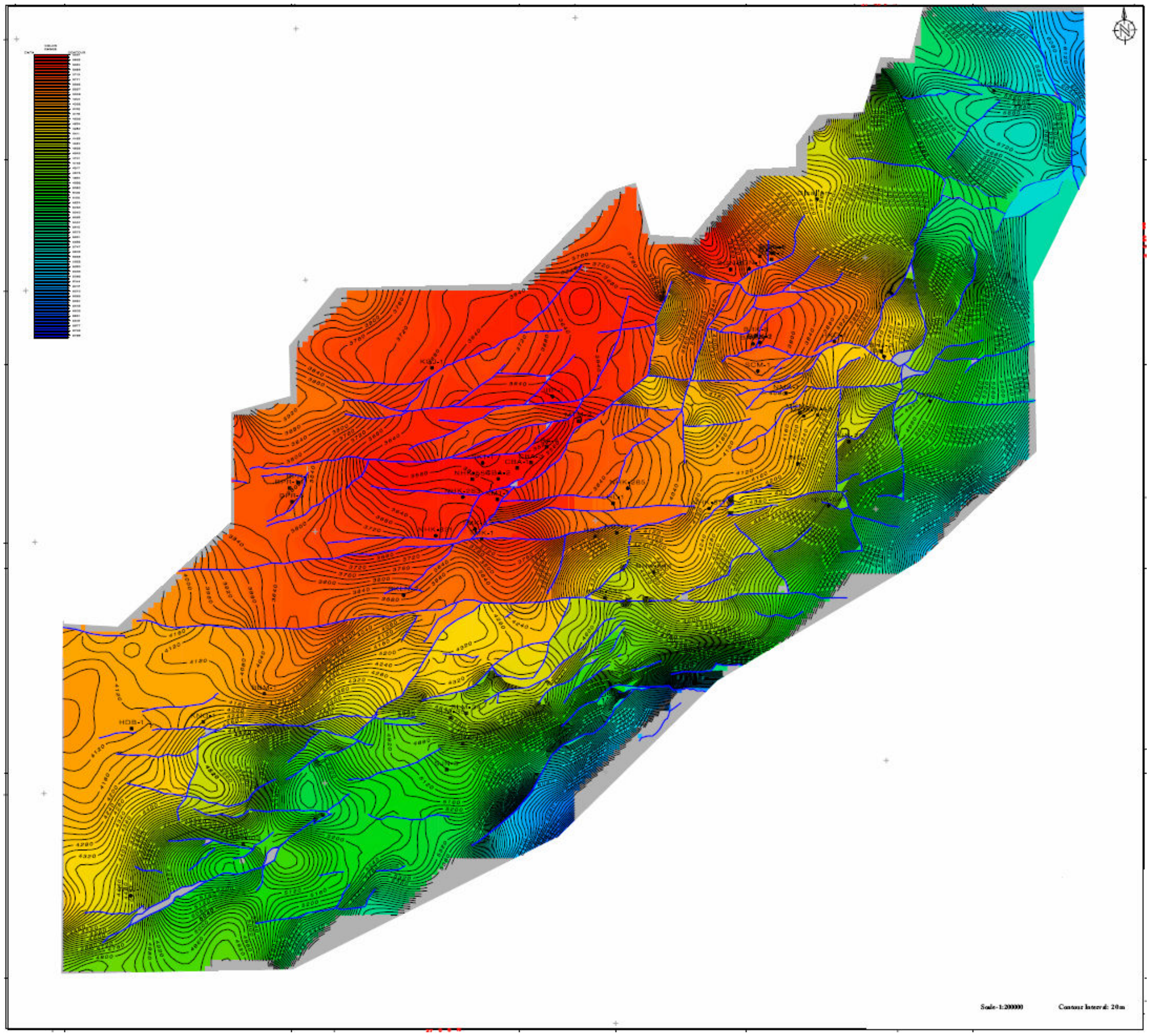


Fig.2 Depth contour map on a Horizon close to Basement Top of Upper Assam Basin.

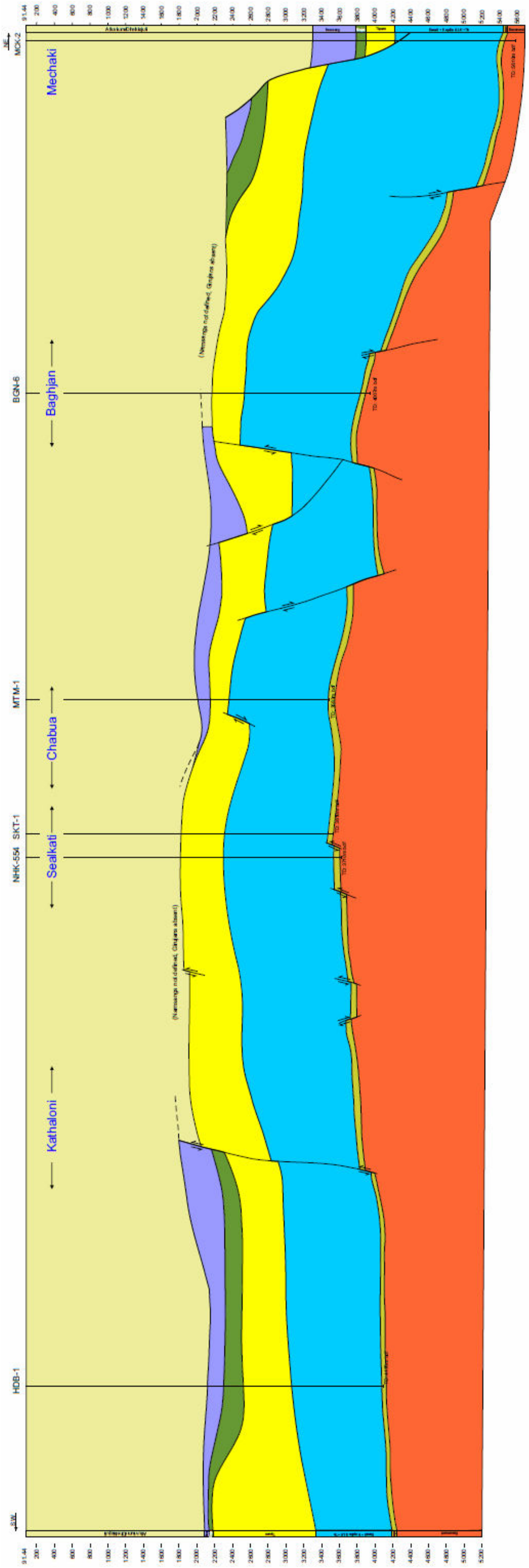


Fig.3 Regional geological section of Profile A-A'

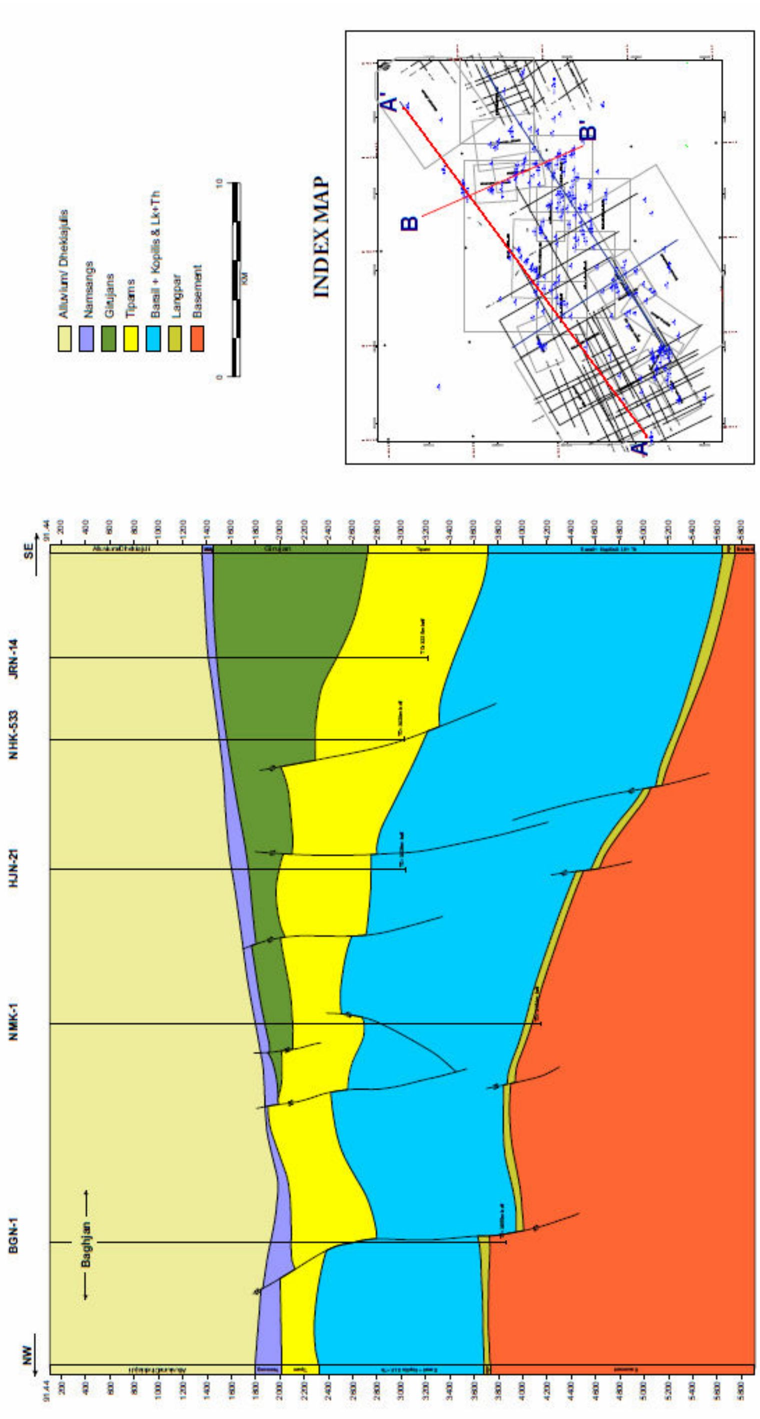


Fig.4 Regional geological section of Profile B-B'