GEOLOGY, STRUCTURE AND TECTONICS OF SHILLONG PLATEAU

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Abstract-Shillong Plateau is located in the north eastern part of India. It exposes almost all kinds of rocks from Precambrian to recent. It is tectonically and seismically very active**.** The 1897 Great Shillong earthquake occurred at western edge of the Shillong Plateau and it uplifted the northern part of it about 10m. It captures the attention of many geoscientists. Geoscientists have been investigating the Shillong Plateau using many tools and techniques for better understanding of geology, structure and tectonics as major earthquakes are related to tectonic movements. Interestingly, it gives different results about the mechanism of upliftment of Shillong Plateau and how it detaches from Indian Shield and moves towards east to its present position. In this paper, we are presenting a brief review about geology, tectonics and structural features of Shillong Plateau. A detailed stratigraphic succession is compiled based on different sources.

Keywords: **Shillong Plateau, Indian Shield, Precambrian, Tectonics, Upliftment**

Introduction

Shillong Plateau which is also known as Meghalaya Plateau is a part of the Indian Shield (Evans 1964). This plateau is bounded by the Dauki fault to the south, Kopili fault to the east, Brahmaputra fault to the north and Dhubri fault to the west. It covers an area of about 25,000 km^2 (Chen and Molanar, 1990) and criss-crossed by many faults. It is separated from Indo-Myanmar Mobile belt by NE-SW trending belt of Schuppen and from Eastern Himalayas by Brahmaputra River. It behaves like an independent entity and shows its own nature of faulting and seismicity that is distinct from Himalayan thrust front (Rajendran et al., 2004). Shillong Plateau lies between Himalaya belt (north) and Indo-Myanmar mobile belt (east) and has experienced compressive tectonic forces from orthogonal directions of two orogenies (Devi and Sarma, 2010; Rao and Kumar, 1997). Geologically, Shillong Plateau comprises of rocks from the oldest Precambrian gneissic complex to the recent alluvium formations. Bouger anomaly map shows gravity high over Shillong Plateau (Verma and Mukhopadhyay, 1977). It indicates presence of high density basement rocks at shallow depths. About 1.5-3.5 mm/yr of the present-day N-S convergence in the Eastern Himalaya is accommodated in Shillong Plateau (Mukul et al. 2010). The 1897 Great Shillong earthquake occurred at western edge of the Shillong Plateau and it uplifted the northern part of it about 10m (Oldham, 1899; Bilham and England, 2001). The Shillong Plateau is tectonically very active due to the collision of the Indian plate with Tibetan landmass in the north and subduction process between the Indian plate and the Shan Tenasserim block in the east (Le Fort 1975, Valdiya 1992). Shillong Plateau detached from Indian Peninsula by a large scale Garo Rajmahal tectonic basin (Pascoe, 1950). It is also believed that within the Shillong Plateau an intracratonic depression formation took place in the central and eastern part of Meghalaya during Proterozoic time where mainly Shillong Group of rocks were deposited over gneissic complex (Mohon Singh, Kh., 2016; Sarma et al., 2014 and Duarah & Phukan 2011). This rift related basin is named as Shillong basin. Later, these rocks were metamorphosed into metavolcanic and metasedimentary rocks (fig. 7). The evidence of K/T volcanism in this plateau is Sylhet Trap where it occurs at southern margin of the plateau through E-W trending Dauki fault. After Sylhet Traps eruption, marine transgression took place and sedimentary rocks of Upper Cretaceous-Cenozoic deposited. Shillong Plateau started upliftment since Tertiary period (Dasgupta et al., 1982 and Murthy,1970) and moved horizontally eastwards along Dauki fault from the Indian peninsular Shield to its present position during Miocene to Pliocene (Evans, 1964). A detailed stratigraphic succession of Shillong Plateau is given in the Table no. 1.

Geology of Shillong Plateau

Shillong Plateau exposes different kinds of rocks. Precambrian rocks of Gneissic composition are the oldest rocks found here and considered to be basement complex. This basement complex consists of biotite-gneiss, biotite-hornblende gneiss, granitic-gneiss, mica-schist, biotite granulite-amphibolite, pyroxene granulite, gabbro and diorite. It is unconformably overlain by Shillong Group. Shillong Group is named after the capital city of Meghalaya i.e. Shillong. CGWB (2009) classified Shillong Group into Upper Shillong Formation (mid-Proterozoic) and Lower Shillong Formation (early Proterozoic). Upper Shillong Group is also known as Upper Quartzite Formation or Shillong Formation (Barooh and Goswami, 1972) or Mawphalang Formation (Battarcharjee and Rahman, 1985) or Shillong Formation (Ahmed, 1981). It is well exposed at Mawphalang and it consists of mainly quartzites intercalated with phyllite and conglomerate. The Lower Shillong Formation comprises mainly schists with calc-silicate rocks, carbonaceous phyllite and thin quartzite layers, slate and conglomerate (fig. 1). Lower Shillong Formation is also known as Tyrsad Formation (Barooh and Goswami, 1972) or Barapani Formation (Ahmed, 1981) or Manai formation (Battarcharjee and Rahman, 1985) or Lower Metapelitic Formation.

Khasi Greenstone consists of epidiorite, dolerite, amphibolite and pyroxene dykes and sills. These rocks are mainly green in colour and hence, they are commonly known as Khasi Green stone which is named after the major tribal group "Khasi" in Meghalaya. Its exposure is reported at south of Laitiyngkot and N-W of Sohiong. It unconformably overlies Shillong Group and it is considered to be mid-Proterozoic age (Table no.1). Granite Plutons of Proterozoic age overlies Khasi Greenstone. It is classified as Kyrdem granite (479±26Ma), Nongpoh granite (550±15Ma), Mylliem granite (607±13Ma) (fig.4) and South Khasi granite (690±26Ma) based on the age, composition and the place where they exposed.

Granite Pluton is unconformably overlain by Lower Gondawana. GSI (2009) classified Lower Gondawana Group into Karharbari Formation and Talchir Formation. Talchir Formation is composed of basalt, tillite with sandstone bands, siltstone and shale. Karharbari Formation (≈ Damuda Formation) is made up of very coarse to coarse grained sandstone with conglomerate lenses, siltstone, shale, coal and carbonaceous shale. Talchir formation consists of basalt, tillite, with sandstone bands, siltstone and shale. Lower Gondawana Group is exposed in and around Singrimari hills. The time range of this group is carboniferous to Permian.

Sylhet trap of Lower Cretaceous age is exposed in and around Therriaghat river section (fig. 2). It is named after Sylhet city of Bangladesh. It mainly consists of vesicular basalt. It unconformably overlies Lower Gondawana group. Sung Group overlies Sylhet trap unconformably. Sung Group is exposed at Sung valley. The main rocks consist of Pyroxene –serpentinite, melilite pyroxene rocks, syenite and carbonatite. The age of Sung Group is mid-cretaceous (?).

Khasi Group unconformably overlies the Sung Group. Khasi Group is named after "Khasi tribe" of Meghalaya. It is divided into three formations- Mahadek (Upper cretaceous), Basal Conglomerate or Bottom Conglomerate (Medlicott, 1869) or Weilloi Conglomerate (Bhahttacharya and Bhattacharya, 1981) (fig. 6) and Jadukuta Formations (mid-cretaceous (?)). Jadukuta Formation consists of Conglomerate grit and sandstone grit. It is well exposed in Jadukuta river section. Conglomerates with minor felspathic sandstone lenses are the components of Basal Conglomerate. It is exposed at Tyrsad-Weilloi road section. Hence, it is also known as Weilloi Conglomerate. Basal conglomerate is overlain by Mahadek (also known as Mahadeo: Garg et al., 2006) Formation. It comprises arkosic sandstone (often glauconitic & uraniferous). It also contains grey shales, mudstones and calcareous sandstone. The exposure is seen along Weilloi-Mawsynaram road section.

Jaintia Group is divided into five formations- Langpar, Therria /Cherra, Tura, Shella and Kopili formations (Sarmah & Borgohain, 2012; Mallick et al., 1988; Saxena and Tripathi 1982 and Dutta, 1982). It is named after the "Jaintia tribe" of Meghalaya. Jaintia Group unconformably overlies Khasi Group. Langpar Formation is the lowermost part of the Jaintia group. It is exposed in Therriaghat (fig. 5). Calcareous shale, sandstone and limestone are the main components of Langpar formation. It is overlain by Therria Formation (Cherra Stage by Evans, 1932) at Therriaghat and Tura formation at Tura. Therria formation consists of arkosic sandstone with limestone, shale and coal whereas Tura Formation is made up of coal bearing poorly sorted sandstone. Both Formations are overlain by Shella Formation. Shella Formation consists of five members-Lakadong limestone, Lakadong sandstone, Umlatadoh limestone, Nurpuh sandstone and Prang sandstone (Sarmah & Borgohain, 2012 & Garg et al, 2006). Lakadong limestone is grey to pink massive crystalline limestone, highly ferruginous and traversed by calcite veins. It also contains silty shales and partings in upper part. It is exposed at Lakadong plateau. Lakadong sandstone is fine to medium grained ferruginous, well bedded sandstone with clays and coal seams. It is exposed at Jathang hill. Umlatadoh limestone is grey to pinkish, well bedded highly jointed, hard and compact fossiliferous limestone. It is exposed at South of Siropi village. Nurpuh (Narpuh) sandstone is ferruginous, medium to coarse grained sandstone. Sometimes it also contains pyrite nodules and thin calcareous shaly bands. It is exposed at Narpuh Reserve forest. Prang sandstone is generally grey to bluish grey and sometimes reddish in colour and breaks in rectangular. It is exposed at Prang River section.


Fig. 1 Conglomerate exposure at Tyrsad


Fig. 2 Contact between Mahadek Sandstone & Sylhet Trap


Fig. 3 Boulder (alluvium) deposit at Dawki


Fig. 4 Mylliem Granite Pluton

Fig. 5 Near K/T boundary exposure, Therriaghat

Fig. 6 Weilloi conglomerate

Fig. 7 Metasedimentary rock showing Ripple marks at Elephant Fall

Fig. 8 Cross bedding structure at Dawki (River section)

Kopili Formation is the youngest formation of Jaintia Group. It is alteration of fine to coarse sandstone, grey siltstone and shales with limestone bands, sometimes coal. It is considered to be formed during Paleocene to Eocene epoch. It is exposed at Lumshnong area. It is divided into lower, middle and upper and equated to Disang Group of Assam by Dutta (1982).

Barail Group of Eocene to Oligocene age overlies Jaintia Group unconformably in Shillong plateau. This group is named after Barail range (Evans, 1932). It is classified into three formations-Renji, Jenum and Laisong (Saxena and Tripathi 1982; Sinha et al., 1982). All the formations are exposed at Jowai-Badarpur road section. Laisong Formation consists of sandstone with interbedded shale. Jenum formation comprises sandstone, shale, sandy shales and thin coal seam. Renji is made up of sandstone and shale and intraformational conglomerate.

Garo Group (named after "Garo tribe" of Meghalaya) overlies Barail group. It is again divided into three formations- Simsang (exposed at Garo hills upto Shella in Khasi hills), Baghmara (exposed at Tura-Dalu road section) and Chengapara (exposed near Baghmara to a few kilometers to the West of Barenapara) (GSI, 2009). Simsang consists of siltstone and fine sandstone and alternations of siltstone-mudstone. And it is considered to be formed during Oligocene time (Lyngdoh et al., 1999). Baghmara is made up of coarse, feldpathic sandstone, pebble, conglomerate, clay, silty clay with a fossiliferous limestone horizon at the top. It is considered to be formed during Lower Miocene. Chengapara comprises coarse sandstone, siltstone, clay and marl. The age of the Chengapara is Miocene.

Surma Group overlies Garo Group. It is named after Surma River (Evans, 1932). It has two formations-Bhuban and Bokabil. The age range of Surma Group is Miocene to Pliocene. Bhuban Formation is classified into three members-Lower Bhuban or Dona, Middle Bhuban or Umkiang and Upper Bhuban or Lubha (Saxena and Tripathi 1982). Surma is also exposed at Jowai-Badarpur road section. Dona consists of fine to medium grained, often argillaceous, fairly hard sandstone, alternating with thin carbonaceous shale. Umkiang comprises thick shale beds, medium to coarse grained sandstone and thin intraformational conglomerates. Lubha is made up of thin to fairly thick bedded sandstone with carbonaceous shales. Bokabil formation consists of shale, sandy shale and ferruginous sandstone.

The term 'Tipam' was coined by Mallet (1876). Tipam Group is also reported from Jowai-Badarpur road section (Saxena and Tripathi 1982). Tipam group is thought to be formed during Miocene to Pliocene. It has two Formations Tipam sandstone and Girujan clays. Only Tipam sandstone is reported at Shillong Plateau. Tipam sandstone is arenaceous coarse grained massive bedded sandstone with numerous partings of shales. Tipam Group is unconformably overlain by Dupitila Group of Mid-Pliocene time. Mottled clay, feldspathic sandstone and conglomerate are the main rocks found in Dupitila Group.

Dupitila Group is unconformably overlain by Dihing Group of Pliocene to Pleistocene epoch. Dihing Group can be classified into two formations-Dalu and Rangapani (Deshpande et al, 1993). It is reported from Dalu and Rangapani of Garo Hills. Alluvium deposits are the youngest Group of Shillong Plateau. It can be classified into two formations-Older alluvium (Pleistocene time) and Newer alluvium (Holocene) (GSI, 2009). Older alluvium consists of Sand, clay, pebble, boulder, cobbles and newer alluvium consists of mainly Sand, silt and clay. Alluviums are found at stream and rivers valleys of Shillong Plateau (fig 3).

Structure and tectonics of Shillong Plateau

Shillong Plateau is tectonically separated from Indian Peninsula and moved towards its present position. It is surrounded and transverse by many faults and lineaments which are mostly active and younger in age. Some of the major faults are- Dauki fault, Kopili fault, Dapsi thrust, Tyrsad-Barapani lineament, Umngot lineament, Raibah fault, Chedrang fault, Dudhnoi fault, Oldham fault, Dhubri fault, Jamuna (Yamuna) fault, Samin fault, Brahmaputra fault and Kulsi fault (fig. 9). Structural, geomorphological, geological and geophysical data show clear evidence that the central part of the plateau, represented by higher topographic landform is a structurally weak and tectonically active zone (Durah and Phukan, 2011).

The basement of Shillong Plateau was formed during the break up of Australia and Antarctica. Opening of Indian Ocean between India and Australia-Antarctica started in early Cretaceous. The initial exhumation of this Indian basement probably occurred during the late Paleozoic (Veevers, 2006; Veevers and Tewari, 1995). The exhumation of Shillong Plateau started at 9-15 Ma (Biswas et al., 2007). The presence of Late Cretaceous continental sediments lying on the Precambrian basement in the southern part of the plateau indicates that the basement was exposed at the surface at the end of the Cretaceous. But, during the Tertiary (3.8-3.5Ma) the basement was submerged and buried under shallow marine and deltaic sediments and surface upliftment started at Pleistocene (3-4 Ma) at the rates of 0.4–0.53 mm/a (Biswas et al., 2007). Tipam sandstone marks transition between marine and continental (Najman, 2006). The present horizontal shortening rate of the plateau is 0.65–2.3 mm/a (Biswas et al., 2007). The tectonic upliftment of the plateau led to a reorganization of the rivers. The paleo-Brahmaputra flowed to the south of the plateau until the Miocene and was deflected in the Pliocene to its present course behind the plateau (Uddin and Lundberg, 1999). According to Govin et al. (2018) Brahmaputra River was redirected north and west by the rising plateau at 5.2–4.9 Ma.

Shillong Plateau is continuously uplifting and current upliftment starts from Mio-Pliocene. The major force responsible for upliftment is N-S trending compressive force even though E-W trending compressive stress owing to Indo-Myanmar subduction also aided the upliftment (Rao and Kumar, 1997). Shillong Plateau rises 2.5cm during the period 1910-1977 (Kailasam, 1979). The upliftment is further evidenced by straight-edged scarps of older Brahmaputra alluvium within recent alluvium in Assam (Kailasam, 1980). On the other hand, it is also a highly eroded area due to high precipitation. So, both upliftment and erosion take place simultaneously and give rise to present landforms.

Table no.1 **Stratigraphic succession of Shillong Plateau** (Modified from GSI, 2009; GSI, 1984: CGWB, 2013; Chattopadhyay and Hashmi, 1984; Deshpande et al, 1993; Chakraborty and Baksi, 1972; Saxena and Tripathi, 1982; Gosh et al., 1991; Dutta, 1982; Saxena, 1981; Sinha et al., 1982; Mallick et al., 1988; Johnson & Nur Alan, 1990; Sarmah & Borgohain, 2012 and Garg et al., 2006)

Group	**Formation**	**Member**	**Age**	**Lithology**	**Type locality / exposure**
Alluvium	Newer Alluvium		Holocene	Mainly Sand, silt and clay	Stream/river valleys
	Older alluvium		Pleistocene	Sand, clay, pebble, boulder, cobbles	Stream/river valleys
Dihing	Dalu		Pliocene to Pleistocene	Alteration of pebble beds and soft clay	Dalu (Garo hills)
	Rangapani				Rangapani (Garo hills)
……………………………Unconformity……………………………					
Dupitila	Unclassified		Mid-Pliocene	Mottled clay, feldspathic sandstone and conglomerate	It overlies Tipam group in khasi and Jantia hills
……………………………Unconformity……………………………					
Tipam	Tipam sandstone		Miocene-Pliocene	Arenaceous coarse grained massive bedded sandstone with numerous partings of shales	Jowai-Badarpur road section (180-182Km)
Surma	Bokabil		Miocene-Pliocene	Shale, sandy shale and ferruginous sandstone	Jowai-Badarpur road section (177.5-180Km)
	Bhuban	Lubha (Upper)		Thin to fairly thick bedded sandstone with carbonaceous shales	Jowai-Badarpur road section (148-151.5Km)
		Umkiang (Middle)		Thick shale beds, medium to coarse grained sandstone and the thin intraformational conglomerates	Jowai-Badarpur road section (151-155Km)
		Dona (Lower)		Fine to medium grained , often argillaceous , fairly hard sandstone, alternating with thin carbonaceous shale	Jowai-Badarpur road section (155-177Km)
Garo	Chengapara		Middle-Miocene	Coarse sandstone, siltstone, clay and marl	Near Baghmara to a few kms. West of Barenapara
	Baghmara		Lower-Miocene	Coarse, feldpathic sandstone, pebble, conglomerate, clay, silty clay with a fossiliferous limestone horizon at the top	Tura-Dalu road section
	Simsang		Oligocene	Siltstone and fine sandstone and alternations of siltstone-mudstone	Garo hills upto Shella in Khasi hills
……………………………Unconformity……………………………					
Barail	Renji		Eocene-Oligocene	Sandstone and shale and intraformational conglomerate	Jowai-Badarpur road section (143.2Km)
	Jenum			Sandstone, shale, sandy shales and thin coal seam	Jowai-Badarpur road section (144-145.6Km)
	Laisong			Sandstone with interbedded shale	Between Sonapur and Umkiang road section
Jaintia (≈Disang)	Kopili		Upper Eocene	Alteration of fine to coarse sandstone, grey siltstone and shales with limestone bands, sometimes coal	Lumshnong area
	Shella	Prang Sandstone	Middle Eocene	It is generally grey to bluish grey and sometimes reddish in colour and breaks in rectangular	Prang river section
		Nurpuh Sandstone	Middle Eocene	Ferruginous, medium to coarse grained sandstone. Sometimes it also contains pyrite nodules and tin calcareous shaly bands.	Narpuh Reserve forest
		Umlatadoh Limestone	Lower Miocene	Grey to pinkish ,well bedded highly jointed, hard and compact fossiliferous limestone	South of Siropi village
		Lakadong Sandstone	Upper Paleocene	Fine to medium grained ferruginous, well bedded sandstone with clays and coal seams	Jathang hill
		Lakadong Limestone	Upper Paleocene	Grey to pink massive crystalline limestone, highly ferruginous and traversed by calcite veins. It also contains silty shales and partings in upper part.	Lakadong plateau
	Therria /Cherra; Tura		Upper Paleocene (?)	Arkosic sandstone with limestone, shale, coal (Therria /Cherra); Coal bearing poorly sorted sandstone (Tura)	Therria, Tura

	Langpar	Lower Paleocene	Calcareous shale, sandstone, limestone	Therriaghat
……………………………Unconformity……………………………				
Khasi	Mahadek / Mahadeo	Upper Cretaceous	Arkosic sandstone (often Glauconitic & Uraniferous). Also contains grey shales, mudstones and calcareous sandstone	Weilloi-Mawsynaram road section
	Basal Conglomerate	Mid-Cretaceous (?)	Conglomerate with feldspathic sandstone lenses	Weilloi
	Jadukata		Conglomerate grit and sandstone grit	Jadukuta river section
……………………………Unconformity……………………………				
Sung	Unclassified (alkaline ultramafic carbonate complex)	Mid-Cretaceous (?)	Pyroxene- Serpentinite with abundant development of melilite pyroxene rock, ijolite, syenite and carbonatite	Sung valley
……………………………Unconformity……………………………				
Sylhet trap	Unclassified	Lower Cretaceous	Basalt, alkali basalt, rhyolite and acid tuff	Near Therriaghat
……………………………Unconformity……………………………				
Lower Gondawana	Karharbari (Damuda)	Carboniferous – Permian	Very coarse to coarse grained sandstone with conglomerate lenses, siltstone, shale, coal and carbonaceous shale	Around Singrimari hills
	Talchir		Basalt tillite, with sandstone bands, siltstone and shale	South of Singrimari hills
……………………………Unconformity……………………………				
Granite Plutons	Kyrdem granite	Neo-Proterozoic to Early Paleozoic	Porphyritic coarse grain granite, pegmatite, apatite/quartz vein traversed by epidiorite, dolerite and basalt dykes	Kyrdem
	Nongpoh granite			Nongpoh
	Mylliem granite			Mylliem
	South Khasi granite			South Khasi hills
Khasi green stone	Unclassified (basic-ultrabasic intrusives)	Mid-Proterozoic (?)	Epidiorite, dolerite amphibolite and pyroxene dykes and sills	South of Laitiyngkot and N-W of Sohiong
……………………………Unconformity (?) ……………………………				
Shillong	Upper Shillong / Upper Quartzite /Mawphalang	Mid- Proterozoic	Mainly Quartzites intercalated with Phyllite and conglomerate	Mawphalang
	Lower Shillong / Lower Metapelitic / Tyrsad/ Barapani / Manai	Early Proterozoic	Mainly schists with Calc- Silicate rocks, carbonaceous phyllite and thin quartzite layers, schist, slate, conglomerate	Tyrsad / Barapani / Manai
……………………………Unconformity……………………………				
Basement Gneissic Complex		Archean (?)- Proterozoic	Biotite gneiss, biotite hornblende gneiss, granite gneiss, mica schist, biotite granulite-amphibolite, pyroxene granulite, gabbro and diorite	Central and Northern part of Shillong Plateau (e.g. Nongkhya, Manai, Kyrdenkulai)

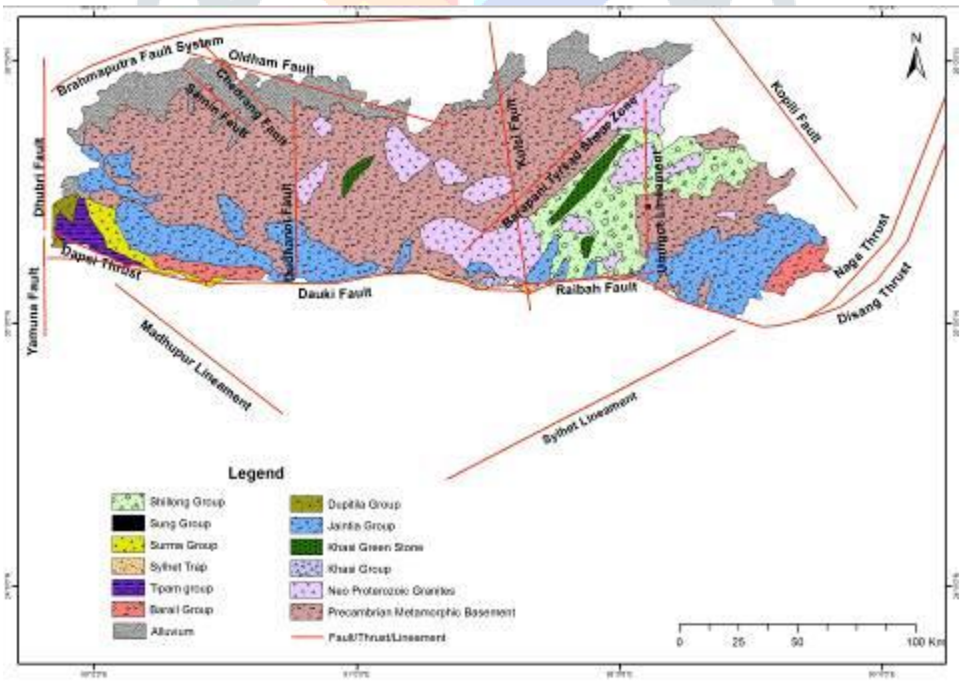

Fig. 9 Geological map of Shillong Plateau (modified from GSI, 2009; Kayal, 1998; Olympa and Abhishek, 2015; Bhattarcharya et al., 2008; Biswas et al., 2007; Govin et al., 2018 and Islam et al., 2014).

The upliftment of Shillong Plateau may be due to following mechanisms-

- thermal disturbance in the upper mantle (Khattri et al., 1983)
- isostatic adjustment (Kailasam, 1979)
- compressive tectonic forces (Rao and Kumar. 1997)
- the popping up of the plateau due to tectonic movement (Kayal et al, 2006; Biham and England, 2001; Rajendran et al., 2004; Saha et al. (2007)

Kailasam (1979) suggested isostatic adjustment of the Shillong Plateau block as a possible cause of the current upliftment. Interestingly, the positive Bouger anomaly and the strong, positive isostatic anomaly (up to +100 mGal) seen over this plateau suggested that plateau should sink. But, the plateau continues to rise. Rao and Kumar (1997) concluded that the upheaval of Shillong Plateau is a consequence of great external forces which can only be tectonic in nature. The tectonic forces from Himalayan orogeny and Indo-Myanmar subduction are responsible for upheaval of Shillong Plateau. Some authors also suggested that the plateau is uplifted due to major thermal disturbance during the Jurassic period, and has continued to rise to its present elevation (Khattri et al., 1983). This requires hot mantle beneath the plateau, but geophysical data indicate high velocity and cold mantle.

The most accepted theory for the upheaval of the Shillong Plateau is the "pop up" of the plateau due to tectonic movement. But, controversy arises that which faults are responsible for popping up Shillong Plateau. Kayal et al. (2006) opined that the pop up of the Shillong Plateau was due to the Dapsi thrust in the west and the Brahmaputra Fault in the north. Rajendran et al. (2004) claimed that the pop up structure of the Shillong Plateau was due to the presence of the Brahmaputra fault and the Dauki fault. Biham and England (2001) opined that the Indian plate below Shillong pop up between two bounding faults to its north and south i.e. Dauki Fault in the south and Oldham Fault in the north. Saha et al. (2007) and Nayak et al. (2008) claimed that two reverse faults i.e. the Dapsi thrust to the south and possibly the Oldham fault in the north are the causes of popping up Shillong Plateau.

The Shillong Plateau rotates at 1.15^0/ Ma and Assam block rotates at ~1.13^0/Ma. As a result of it, convergence between this plateau and Bangladesh across Dauki fault increases from 3mm/year to >8mm/year in the east with minor dextral shear (Vermant et al, 2014). According to Jade et al. (2007), Dauki fault has not slipped recently but Kopili fault slips at ~2.6mm/year. The slip of Kopili fault is contributing to seismic moment accumulation (~70.74×10^{15} Nm/year) sufficient enough to drive future earthquakes ($M_w \geq 5.17$) (Barman et al., 2016). That means the Kopili fault is more active than Dauki fault.

Some important faults/lineaments in and around Shillong Plateau are given below-

Dauki fault- Dauki fault separates Shillong Plateau from Bengal basin. It is an E-W trending about 320Km long reverse fault dipping north (Murthy et al., 1969). Some authors also claim that it has strike slip movement. Dauki fault is thought to have started only after the Miocene (Uddin and Lundberg, 2004). Biswas et al. (2007) estimate the rate of vertical displacement along the Dauki fault to 0.77–1.25 mm/a.

Dapsi fault- It separates the sediments of Bengal Basin to southwest of Shillong Plateau. It is NW-SE trending 90-100Km long reverse fault with a strike slip component. (Srinivasan, 2005). It dips towards North at >60^0 (Kayal et al., 2006).

Kopli fault- It separates Shillong plateau from Mikir massif. It is about 300-400Km long and about 50 Km wide fault. It has both normal and strike slip character dipping towards Northeast direction. Kopili fault slips dextrally at the rate of 2-3mm/year. (Biswas et al., 2007). It is one of the most seismically active faults of the region and a major earthquake could be expected in the future. It dips towards NE at ~61^0 (Kayal et al., 2012).

Dhubri fault- It separates Shillong Plateau from Indian subcontinent. It is N-S trending fault. It is believed to be the source of 1930 Dhubri earthquake.

Brahmaputra fault system- It separates Shillong Plateau from the Himalayas. It is broadly E-W trending fault. The Brahmaputra fault is a south dipping fault located below the Brahmaputra River in the Assam valley to the north of the Shillong Plateau (Rajendra et al., 2004)

Oldham fault- It is a 110Km long fault dipping 57° to the south beneath the northern edge of the Shillong Plateau (Biham and England, 2001). Biswas et al. (2007) estimate vertical slip along Oldham fault to 0-0.68mm/a.

Umngot lineament cuts across the general NE–SW trend of the Shillong plateau. This lineament developed during the late Jurassic– Early Cretaceous period and contains several alkaline intrusive bodies, including the Sung Valley complex (Gupta and Sen, 1998).

Raibah Fault- It is E-W tending fault that separates Shillong Group from Sylhet Traps (Gour and Tapal, 2001). It is a southern dipping reverse fault (GSI, 2009).

Dudhnoi fault- It is about 6Km long N-S trending fault located at western part of the Shillong Plateau.

Barapani-Tyrsad Shear Zone (BTSZ) - It is N-E trending left lateral slip fault. It passes through central and eastern part of Shillong Plateau.

Kulsi fault /Guwahati fault – It is an active NNE-SSW trending fault that lies in the central part of the plateau. It passes through northern margin of Shillong Plateau and Guwahati city. For this reason, it is also known as Guwahati fault. (Imsong, 2018).

Conclusions

Shillong Plateau was a part of Indian Shield. After it detached from Indian Shield by Garo Rajmahal tectonic basin, it moved towards its present position. It is a plateau which is tectonically and seismically very active. The active geodynamics of Shillong Plateau is reflected in its seismic pattern in relation with the structural features. The plateau experiences highest rainfall in the world. As a result, fluvial agents play important roles to shape the present landforms. The exhumation of Shillong Plateau started at 9-15 Ma. It is continuously rising due to the reverse faulting system or compressive forces from Indo-Myanmar orogeny and Himalayan orogeny. The present upliftment starts from Mid-Pliocene. It is said that it was exposed during Cretaceous period and submerged during Tertiary and again exposed later. The Shillong Plateau rotates at 1.15^0/ Ma and Assam block rotates at ~1.13^0/Ma. As a result of it, convergence between this Plateau and Bangladesh across Dauki fault increases from 3mm/year to >8mm/year in the east with minor dextral shear. The slip of Kopili fault is contributing to seismic moment accumulation (~70.74 $\times 10^{15}$ Nm/year). So, there is possibility of occurrence of large and major earthquakes in future in this region. Installation of real time earthquake monitoring system is necessary besides giving awareness to the people to follow codes for construction of building.

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