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Weathering and Source Rock Characteristics of the Upper Disang Sedimentary Rock of the Indo-Myanmar Ranges, NE India

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Abstract

The Eocene Disang Group occupies a vast area of Manipur and extends in parts of Tista and Tirap valley in Arunachal Pradesh, Nagaland Hills, and small portions of North Cachar Hills (Assam) and continues up to Chin Ranges of Myanmar Ranges. The Disang Group is characterized by a group of monotonous sequences of dark grey to black splintery shales and has intercalation of siltstones and light to brownish grey, fine- to medium-grained sandstones of especially in the upper horizons, occasionally giving rise to rhythmic character. ICV vs. CIA, K_2O/Na_2O vs. Fe_2O_3+MgO and TiO_2 vs. Al_2O_3 diagrams reveal that sediments from the Tista and Tirap river valleys in Arunachal Pradesh and towards the central portion of the Naga Hills in Nagaland are more weathered and recycled than sediments from the study area (most of Imphal valley or Manipur valley in Manipur). The sediments for the study area were dominantly derived from the unweathered rising Indo-Myanmar Ranges. The pre-Himalayan rocks might have been supplied sediments for the Disang Group. Sediments were also possibly derived from the uplifted fold thrust belt of Myanmar's landmass comprising of igneous and metamorphic basement complex with older sedimentary sequences with minor contributions of detritus from Mishmi Hills region lying to the NE of the Arunachal Pradesh. The Disang sediments were deposited in different sedimentary environments from tidal flat to nearshore lagoon and neritic shallow marine environment and different in composition might have been related to variation in source rock for these sediments which was deposited in the Indo-Myanmar basin formed by rifting and crustal stretching on the continental margin of the Myanmar landmass.

Keywords: Depositional Environment, Tectonic Setting, Upper Disangs, Indo-Myanmar Ranges, NE India

INTRODUCTION

Geochemical data can provide valuable information about the weathering, composition of sediments, the source area characteristics and the environment of the depositional basins (Pettijohn et al., 1972; Taylor and McLennan, 1985; Floyed et al., 1991). Geochemistry of the sediments provides clues for provenance interpretations (Bhatia, 1983; Taylor and McLennan, 1985; Armstrong-Altrin et al., 2017; Chaudhuri et al., 2020). Geochemistry is, therefore, more suitable for the interpretation of provenance of both sandstone and shale (Wronkiewicz and Condie, 1987; Garver and Scott, 1995; Fedo et al., 1995). Discriminant plots based on the oxides of Ti, Al, Fe, Mg, Ca, Na and K are useful for distinguishing different provinces (Roser and Korsch, 1988; Saha et al., 2018). Being immobile, titanium oxides, alumina and Fe are particularly useful for provenance interpretations (Hayashi et al., 1997, Devi, 2021). Different binary and ternary plots of major element oxide (Si, Al, Ti, Fe, Mg, Ca, Na, K) provide significant information about palaeoweathering, palaeoclimate, nature of source rocks, tectonic setting and depositional basin environment (Potter et al., 2005; Suttner and Dutta, 1986; McLennan et al., 1980; Schieber, 1992; Roser and Korsch, 1986; Roaldest, 1978).

The Indo-Myanmar Ranges (IMR) have been considered as an accretionary prism evolved due to subduction of the Indian plate below the Myanmar plate (Soibam 1998; Singh, 2012). The Indo-Myanmar Ranges comprise of Disang Group (Eocene), Disang-Barail Transition sequence (Late Eocene-Early Oligocene) and Barail (Oligocene), Ophiolites and associated Upper Cretaceous sediments. In front of the rising IMR, a basin called Surma Basin was formed and Surma Group of rocks was deposited. The Disang Group occupies a vast area of Indo-Myanmar Ranges, Northeast (NE) India comprises of Naga-Patkai Hills, Manipur Hills, Mizo-Chin Hills and Arakan-Yoma Hills and extends towards Eastern Himalaya (Arunachal Pradesh). The Disang Group is subdivided into two formations namely, Lower Disang and Upper Disang formations. The shales and sandstones of the Upper Disang were deposited in a shallow marine basin during Eocene under tropical warm humid climate condition (Singh et al., 2017a). Detailed study on Disang Group can highlight how the Indo-Myanmar basin, in turn, IMR was developed and tectonic activity that occurred during Eocene or earlier. However, no detailed study has been carried out on the Disang Group as a whole from north to south of Disang exposure. The available works were confined on small area like Tista and Tirap river valleys in Arunachal Pradesh (between 95^{O} 20$^{/}$E, 26^{O}50$^{/}$N and 95^{O}11$^{/}$ E, 26^{O}40$^{/}$N,), the central portion of the Naga Hills in Nagaland (94^{o}12$^{/}$E, 25^{o}30$^{/}$N and 94^{o}30$^{/}$E, 25^{o}41$^{/}$N) and some parts of Manipur (93.29°E, 24.37°N, 94.15° E, 25.37° N, 94^{O}11$^{/}$ E , 24^{O}41$^{/}$ N and 93°39'39.6"E , 24°20'40.4"N, most of the Imphal valley of in Manipur). Therefore, in the present paper the geochemical data from north to south of Disang exposure from Tista and Tirap river valleys (Majumder and Chetia, 2011; Gogoi and Sarmah, 2013), the central portion of the Naga Hills (Imchen et al., 2014) and study area (Figure 1) are compared to infer depositional environment and source area characteristics of the Indo-Myanmar Ranges.

The IMR is about 1250 km long and about 100-150 km wide. However, geochemical data of Disang Group of IMR are very meagre. Disangs exposed in the Tista and Tirap river valleys in

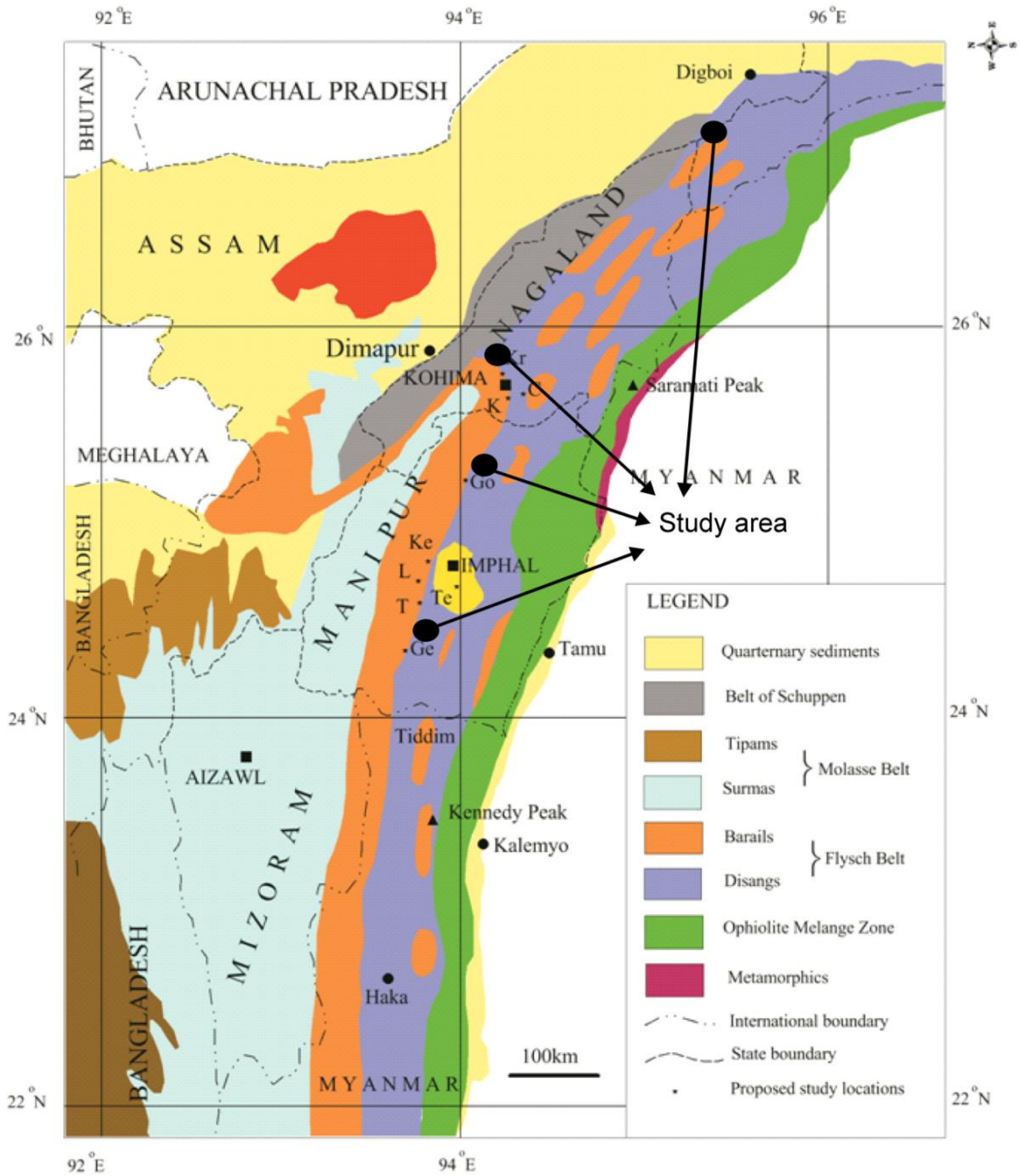

Figure 1: Geological map of Northeast India (Soibam et al., 2015) showing study areas i.e. Arunachal Pradesh, Nagaland and Manipur.

Arunachal Pradesh is undifferentiated, samples from the central portion of the Naga Hills in Nagaland and the study area in Manipur represents the Upper Disang Formation. This paper can also highlight the usefulness of geochemistry in the study of weathering and source rock characteristics of the Upper Disang sedimentary rocks of the Indo-Myanmar Ranges, NE India.

Geological Setting

The crustal stretching on the continental margin of the Myanmar landmass led to the formation of a basin, Indo-Myanmar basin, followed by the deposition of Disang and Barail sediments having thickness of an order of about 6-10 km. The Disang Group consists of a monotonous sequence of dark grey to black splintery shales with occasional rhythmic shales and siltstones/fine grained sandstones (Figure 2), especially in the upper horizon, forming the principal lithounits (Table 1) of the Imphal valley of Manipur. Disang sandstone and shales show sedimentary structure of ripple marks (Figure 3), tidal bundles and planner-beds. The Upper Disang shales also yielded foraminifera, *Modiscus sp., Trachommine sp., and Bulnina sp*. which are indicative of a shallow marine environment (Rao, 1983). Evidently, the Upper Disang

Figure 2: Field photographs showing succession of the of Disang Group.

Figure 3. Outcrop showing ripple marks on shale exposure Sandstone-shale alteration

of Manipur and adjoining regions of Naga Hills and river valley in Arunachal Pradesh (Table 2) witnessed tectonic instability with episodic relatively deep-water condition followed by uplift and shallowing of the basin under oscillating tectonic impulses related to complex tectonic activities of the region (Soibam et al. 2013). The Disang-Barail transition sequence consists of siltstone, sandstone and shale. The Barail Group of fine to medium grained, multi-storeyed, thickly bedded sandstones, are intercalated with siltstone and shale overlying the Disang-Barail Transition. The Surma Group of rocks overlies the Barail Group (Soibam, 1998; Soibam, 2000; Singh et al., 2017). These groups are characterised by intercalation of massive sandstone and shales with siltstone. The Tipams are moderately coarse grained, ferruginous, massive, sometimes faulted sandstones and overlies the Surma Group with stratigraphic break (Soibam, 2000; Singh et al., 2017; Singh et al., 2019). The stratigraphic succession of the Manipur is shown in the Table 1.

Methodology

Major element oxides for 21 (twenty-one) samples from Tista and Tirap river valley in Arunachal Pradesh (between 95^{O} $20^{/}$E, $26^{O}50^{/}$N and $95^{O}11^{/}$ E, $26^{O}40^{/}$N) were analysed by X-ray fluorescence spectrometry (XRF) at USIC, Guwahati University in PAN analytical make, Model Axios, using beads prepared from the powdered sediment samples (1 g of each sample), mixed with 4 g lithium tetraborate and 1g lithium carbonate and analytical software X-40 was utilized for data management (Majumder and Chetia, 2011).

Table 1. Stratigraphic succession of Manipur (after Soibam, 2000)

Recent-Pleistocene	Alluvium		Clay, silt, sand, gravel, pebble, boulder deposits
Late Miocene	Tipam Group		Mottled clay, mottled sandy clay, sandy shale, clayey shale and sandstone.
Miocene to Late Oligocene	Surma Group	Bokabil Formation (~1400m) Bhuban Formation (~1400m)	Shale, sandy shale, siltstone, ferruginous sandstone, massive to bedded ferruginous sandstone. Alternations of sandstone and shale with minor conglomerates.
-- Unconformity-------------------------------			
Oligocene to Late Eocene	Barail Group	Renji Formation (~800m) Jenam Formation (~1200m) Laisong Formation (~1200m)	Massive to thickly bedded sandstone. Alternations of shale and sandstone with carbonaceous matters. Intercalation of bedded sandstone with shale. Flysch sediments.
Late Eocene to Late Paleocene	Disang Group	Upper Disang Formation (~2000m)	Splintery shale and intercalation of shale, siltstone and sandstone showing occasionally rhythmite characters with fossils. Flysch sediments.
?Late Paleocene to Late Cretaceous		Lower Disang Formation (~2000m)	Dark grey to black shale with minor sandstone bands. Flysch sediments
-- Unconformity ----------------------------			
?Early Eocene to Cretaceous	Ophiolite Mélange Zone		Ultramafics with minor mafic - felsic rocks and marine sediments comprising radiolarian chert and limestone along with podiform chromitites.
---Unconformity ---------------------------			
(Pre-Mesozoic or Older)	Metamorphic Complex		Low to medium grade metamorphic rocks of various composition-phyllitic schist, quartzite, micaceous quartzite, quartz-chlorite-mica-schist and marble.
--- (?) Unconformity ----------------------			
?Early Mesozoic rocks or Pre-Cambrian rocks	Basement Complex		Unseen

For geochemical analyses, samples of 15 (fifteen) sandstones and 10 (ten) shales from the central portion of the Naga Hills (94º12/E, 25º30/N and 94º30/E, 25º41/N, Nagaland) were thoroughly washed, dried and homogenized and finely ground (<250 ASTM mesh) and analyzed using pressed powdered pellets glued with polyvinyl alcohol. Element oxides analyses for bulk chemical composition of the samples were determined using an X-ray fluorescence spectrophotometer (Imchen et al., 2014).

Bulk mineral composition of 6 (six) shale samples from the Upper Disang Formation of Gelmoul area (Figure 1, GPS 24°20'40.4"N: 93°39'39.6"E) were determine by X-ray powder diffraction (XRD) at the Wadia Institute of Himalayan Geology (WIHG), Dehradun. XRD analysis was carried out on a PAN alytical, X'pert PRO X-ray Diffractometer at room temperature, using a rotating Cu target with a voltage 45 kV and a current of 40mA. The mineral identification was carried out comparing the measured data to a reference database, viz., Inorganic Crystal Structure Database (ICSD) in PAN alytical X'Pert High Score (Plus) v3.X database.

Table 2. Comparison of the Disang Group from different area of NE India.

	Arunachal Pradesh Majumder and Chetia, 2011; Gogoi and Sarmah, 2013	Nagaland Imchen et al., 2014	Manipur Soibam 1998; Rajkumar and Klein, 2014; Singh et al., 2017b
1.Location	$26^{O}50^{/}$-$26^{O}40^{/}$ N $95^{O}20^{/}$-$95^{O}11^{/}$E, $27^{0}0^{/}$ -$27^{0}10^{/}$N $95^{0}20^{/}$-$95^{0}30^{/}$ E	$25^{o}30^{/}$-$25^{o}41$ N $94^{O}12$-$94^{O}30^{/}$E	$24^{O}20^{/}$-$40^{O}4$N $93^{o}39^{/}39.6$"E
2.Thickness	300m	1800m	(~2000m)
4.Field investigation	Presence of sediments with characteristic framboidal structure and enrichment in organic matter	Small pyrite crystals, flute casts, ripple marks, etc.	Planner-bedded, ripple marks, tidal bundles, mud flasers.
3. Sediment	Recycled	Recycled	Fresh (Juvenile)
4. Source rock type	Igneous rocks of andesitic composition, volcanic and/or granitic	Granite/granite gneiss with basic and ultrabasic sources	Phyllite, chlorite schist, mica schist, gneisses with mafic and ultramafic rocks
5. Redox condition	Reducing	Reducing	Oxidising
6.Depositional basin	Shallow marine	Shallow marine	Shallow marine
7. Tectonic setting	Active continental margin to passive continental margin	Active-margin	Active margin

Table. 3. Major element oxides of the Upper Disang shale of Manipur (northern part, Singh 1995).

Sp.No.	30	63	90	93	123	125	129	127	137
SiO_2	69.92	67.98	66.71	64.85	71.45	74.08	78.10	79.52	74.14
TiO_2	0.70	0.97	0.72	0.64	0.77	0.62	0.42	0.60	0.64
Al_2O_3	15.00	20.55	16.87	15.15	14.29	13.35	10.36	10.47	14.26
Fe_2O_3	7.76	7.13	5.14	9.25	3.14	3.70	4.21	3.11	2.97
MnO	0.13	0.64	0.08	0.61	0.19	0.10	0.02	0.03	0.62
MgO	1.20	0.84	0.52	0.61	1.51	1.15	0.35	0.40	0.74
CaO	0.07	0.66	0.04	0.13	0.98	0.15	0.13	0.04	0.23
Na_2O	3.40	1.88	8.51	8.32	6.21	5.09	2.33	4.53	5.22
K_2O	0.91	0.96	0.38	0.99	1.85	1.18	1.05	0.40	0.63
ICV	0.95	0.64	0.91	1.36	1.03	0.90	0.82	0.87	0.77
CIA	69.09	79.42	53.81	50.26	50.49	57.40	66.58	56.79	59.54

Table 3 continued

Sp.No.	141	153	166	148	Average	UCC
SiO_2	53.66	78.48	73.95	75.48	71.41	66.52
TiO_2	0.86	0.30	0.48	0.52	0.63	0.5
Al_2O_3	32.60	9.96	13.17	12.15	15.24	15.2
Fe_2O_3	7.54	4.77	4.34	4.01	5.16	4.5
MnO	0.42	0.07	0.05	0.15	0.24	
MgO	0.61	0.42	0.83	0.94	0.78	2.2
CaO	0.15	0.01	0.10	1.58	0.33	4.2
Na_2O	6.65	3.65	6.61	4.37	5.14	3.9
K_2O	0.70	0.43	0.65	0.81	0.84	3.4
ICV	0.52	0.97	0.99	1.02	0.90	
CIA	73.15	60.56	52.84	52.62	60.20	

Major element oxides of 28 (twenty-eight) samples from the study area were analysed by Atomic Absorption Spectrophotometer (AAS). For this analysis, 0.5 g of the powder sample is weighed into a 50 ml mouth plastic bottle and 20 ml of concentrated HCL was added. The mixture was allowed to stand for 35 minutes with occasional shaking. 4 ml of 40 p.c. HF was added and the solution maintained at 50-60ºc for 15 minutes. 4ml of conc. HNO_3 was added and the solution maintained at 50-60ºc for 30 minutes. 0.5 gm of boric acid was added, and the solution kept for cooling. The solution was transferred to a 100 ml volumetric flask and made upto the volume (Athanasopoulos, 1986). It was run into the AAS and ppm values were recorded for different elements. SiO_2 and Al_2O_3 were analyses gravimetrically in the Department of Chemistry, Manipur University, using the procedure suggest by Basset et al. (1978). Out of 28 samples, only 13 (thirteen) samples were used for this study. Lithostratigraphic column of the Upper Disang Formation from the study area showing the sample locations is presented in figure 4. The results of geochemical analysis of the rock samples from the study area is presented in Table. 3.

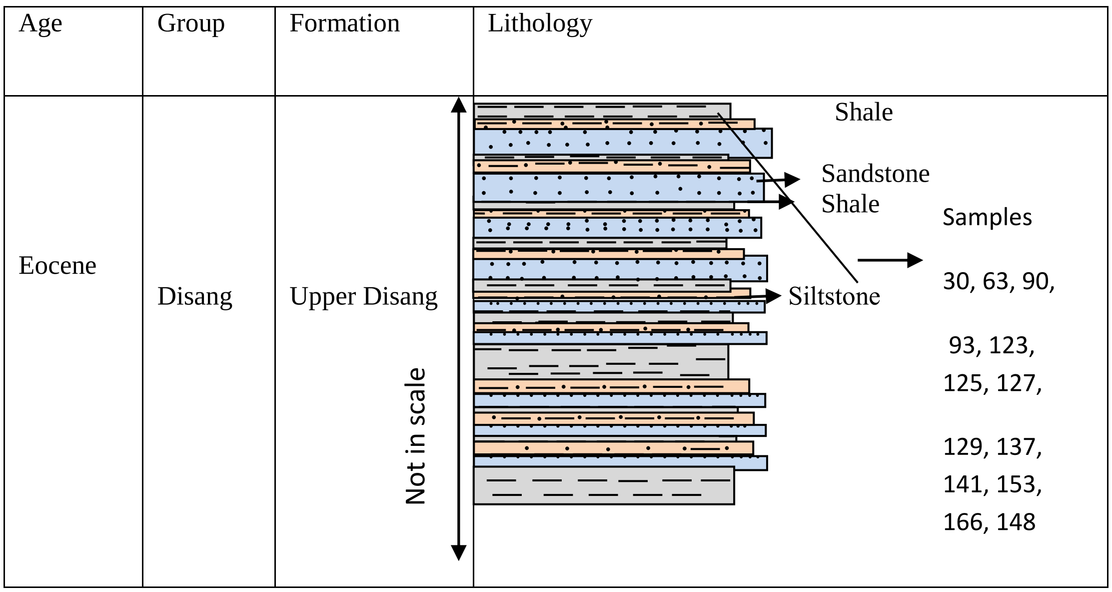

Figure 4: Lithostratigraphic column of the study area.

RESULTS

Major element oxides (wt %) and the Chemical Index of Alteration (CIA) with Index of Compositional Variability (ICV) of Disang shale of Imphal Valley of Manipur Hills are presented in Table 3. The shale samples have relatively higher SiO_2 concentrations than upper Continental Crust (UCC). Immobile oxides like Al_2O_3 and TiO_2 show slightly higher values compared to UCC. In comparison to upper Continental Crust (UCC), the Disang shales are characterized by slight enrichment of Fe_2O_3 indicating an increase in the abundance of Fe-bearing clay minerals or iron oxide minerals like magnetite, leucoxene that can result in high concentration of Fe_2O_3 and Na_2O.

Three bivariant diagrams were used to know the type of the sediments and probable source rock composition. ICV vs. CIA (Index of compositional variability vs. Chemical Index of Alteration) diagram (Potter et al., 2005, Figure 5) was used as important tools to know the relationship between degree of weathering and original source rock composition. If CIA (Chemical Index of Alteration) is very low and ICV (Index of compositional variability) is high, it indicates that the sediments are unweathered and derived from source rocks which were mostly of the juvenile igneous rocks and if, CIA is high and ICV is low, source rock is highly weathered Potter et al., 2005; Cox et al., 1995; Barshad, 1966). The samples

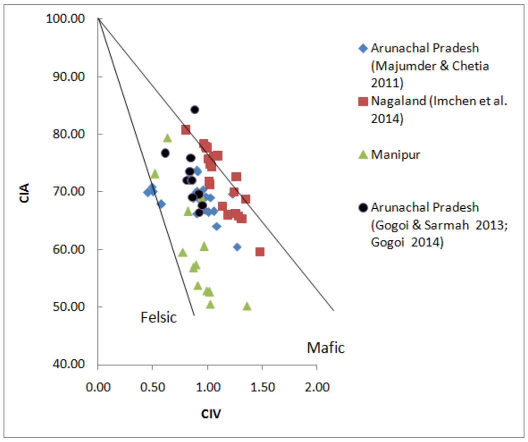

Figure 5: ICV vs. CIA diagram (Potter et al., 2005).

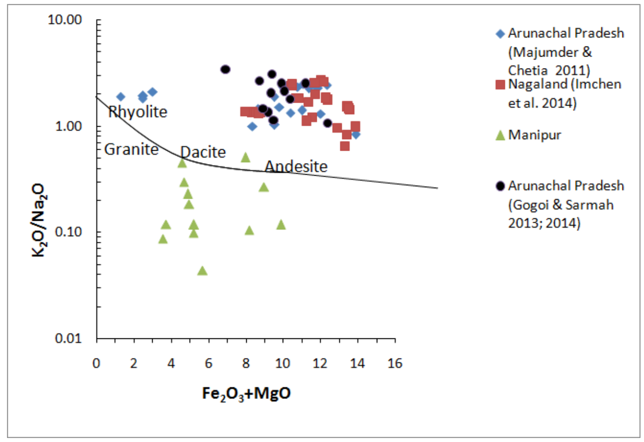

Figure 6: K_2O/Na_2O vs. Fe_2O_3+MgO diagram (Roser & Korsch, 1988).

from Tista and Tirap river valleys (between 95^{O} 20$^{/}$E, 26^{O}50$^{/}$N and 95^{O}11$^{/}$ E, 26^{O}40$^{/}$N, Arunachal Pradesh), the central portion of the Naga Hills (94^{o}12$^{/}$E, 25^{o}30$^{/}$N and 94^{o}30$^{/}$E, 25^{o}41$^{/}$N, Nagaland) were plot mostly on the mafic line and the samples from the study are scattered indicating the samples were predominantly derived from felsic source rock composition and some samples were from mafic source composition whereas others are of mixture of both felsic and mafic source rocks. Variation in source rocks causes different sediment chemical composition. The sediments from Tista and Tirap river valleys in Arunachal Pradesh were derive from volcanic and/or granitic source area and the provenance study also suggests that the mafic sediments were derived from rising of the Indo-Myanmar Ranges (Gogoi and Sarmah, 2013). Majumdar and Chetia (2011) suggest that the sediments (provenance) were derived from igneous rocks of andesitic composition. The bulk of the sediments from the Disang Group in the Naga Hill have been contributed from the nearby mafic and ultramafic source of the Indo-Myanmar range, which probably emerged above sea-level during the Mid-Eocene (Imchen, 2014). Sediment derived from the nearby east (IMR) were rapidly deposited on the seafloor causing rapid mixing which lead to textural and chemically immaturity and sediments from the west were transported for great distance by turbidity currents into an easterly deepening sedimentary depositional basin (Imchen, 2014). The Upper Disang sediments from the study area have more felsic composition and are chemically immature. These sediments were dominantly derived from rising of the Indo-Myanmar Ranges. The present study suggests that the pre-Himalayan gneissic and metabasic rocks presently forming the Higher and Lesser Himalaya might have also contributed felsic sediments. The pre-Himalayan rocks and Myanmar landmass with ophiolite of the Indo-Myanmar ranges might have supplied sediments for the Disang Group. Sediments were also possibly derived from the uplifted fold thrust belt of Myanmar's landmass comprising of igneous and metamorphic basement complex with older sedimentary sequences with minor contributions of detritus from Mishmi Hills region lying to the NE of the Arunachal Pradesh. During the deposition of Disang sediments, the Indian plate was sub ducted beneath the Myanmar plate and collided with Asian plate, the sedimentation occured in the sedimentary basin formed on the Myanmar continental margin. Depositional setting in which Disang sediments were deposited may be explained by pulsatic stretching of the basin and witnessed the tectonic instability with episodic relatively deep water condition followed by uplift and shallowing of the basin under oscillating tectonics on the western continental margin of the Myanmar landmass (Soibam et al., 2013).

K_2O/Na_2O vs. Fe_2O_3+MgO diagram (Roser and Korsch, 1988, Figure 6) also shows the Disang samples from between (95^{O} 20$^{/}$E, 26^{O}50$^{/}$N and 95^{O}11$^{/}$ E, 26^{O}40$^{/}$N Arunachal Pradesh and 94^{o}12$^{/}$E, 25^{o}30$^{/}$N and 94^{o}30$^{/}$E, 25^{o}41$^{/}$N Nagaland were weathered and recycled whereas those Manipur samples were fresh and unweathered. This, in turn, indicates that terrestrial or continental sediment were more in part of Arunachal Pradesh and Nagaland as compared to Manipur. The sediments from the study area were derived from the unweathered rising Indo-Myanmar Ranges. TiO_2 vs. Al_2O_3 diagram (McLennan et al., 1980; Schieber, 1992, Figure 7) indicates that the Upper Disang sediments plot between the basalt and mixed granite and basalt source rocks. Different source rocks contributed sediments to the Disang Group of sediments of the Indo-Myanmar Ranges.

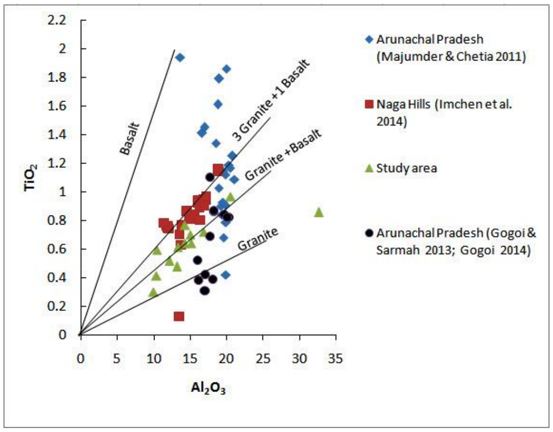

Figure 7: TiO_2 vs. Al_2O_3 diagram (McLennan et al., 1980; Schieber 1992).

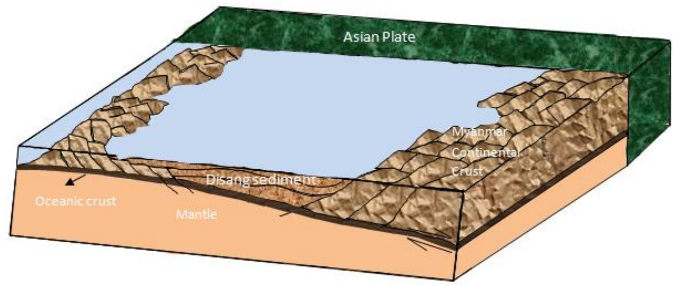

Figure 8: Cartoon showing the Disang deposition in the Indo-Myanmar basin on Myanmar Continental margin (modified from Soibam and Khuman, 2008)

DISCUSSION

Comparison of the Disang Group from different parts of NE India provides information on type of sediments, redox condition, depositional basin environment and tectonic setting of the Indo-Myanmar basin, and in turn, the Indo-Myanmar Ranges during Eocene (Table 2). The sediments from Tista and Tirap river valleys (Arunachal Pradesh) and the central portion of the Naga Hills are more weathered and recycled than sediments from study area. The sediments of the study area were dominantly derived from felsic source rocks. There are different views on the depositional environment of the Disang Group. Rao (1983), Ghose et al. (1984), Archaryya (1986), Vidhyadharan et al. (1989) considered that the Disang sediments were deposited on the distal shelf in an epicontinental sea. From petrographic and geochemical studies, Majumder and Chetia (2011), Imchen et al. (2014) suggested that the depositional environment of the Disang Group was a nearshore, shallow water lagoon. The sediments of the Disang rocks of southern Manipur were deposited in a nearshore neritic shallow marine environment (Singh et al., 2017). The depositional environment for the Upper Disang Formation appears similar to the modern tidal-flats environment (Singh, 2013). Disangs were deposited in tidal flat environment and the depositional environment of the Disang Group was a reducing and anoxic with minor fluctuations in sea-level (Majumder and Chetia, 2011). Pyrite crystals are present in various horizons of the Upper Disang Formation, indicating anoxic conditions in the depositional environment (Imchen et al., 2014). The Upper Disang sediments were deposited in an oxidising environment in shallow marine basin (Singh et al., 2017). Sediments from Nagaland and Arunachal Pradesh were recycled and weathered.

In the process of subduction and collision between Indian and Asian plates, and subsequently with Myanmar plate Figure. 8, it isbelieved that the Naga Hill segment had collided with opposite continental Myanmar plate and received major supply of sediments both from the orogenic highland, immediately north of it, associated with the Himalayan suture zone and, from Myanmar plate. Progressive development of the suture belt led to longitudinal and textural facies changes within the Group. Due to the advanced stage of collision, the Naga Hill segment exhibits reduced upper mantle activity. However, pre-Himalayan gneissic and metabasic rocks of one-time passive margin setting and presently forming the Higher and Lesser Himalaya, respectively cannot be rule out. The pre-Himalayan rocks and Myanmar landmass might also have supplied sediments for the Disang Group. Sediments were possibly derived from the uplifted fold thrust belt of Myanmar's landmass comprising of igneous and metamorphic basement complex with older sedimentary sequences with minor contributions of detritus from Mishmi Hills region lying to the NE of the Arunachal Pradesh. It is suggested that the Upper Disang of Manipur was deposited in a shallow marine basin that developed as a fault controlled continental margin basin or a second order basin. Major thrust fault may be reactivation of the ancient continental margin rifts and this rifting resulted in the formation of restricted second and third order basins (Maclntyre, 1991). The current study also records 4-5 km depth of burial and hydrothermal activity or alteration might have occurred at about 150^o (Singh et at., 2017).

Conclusions

The study was focussed on depositional environment and source rock composition during deposition of the Eocene Disang sedimentary rocks (Indo-Myanmar Ranges) of NE India. The Disang sediments were deposited in the Indo-Myanmar basin on the Myanmar continental margin. The results have revealed that sediments from Tista and Tirap river valleys (Arunachal Pradesh) and the central portion of the Naga Hills are more weathered and recycled than sediments from study area. The sediments were dominantly derived from rising of the Indo-Myanmar Ranges. The Pre-Himalayan gneissic and metabasic rocks presently forming the Higher and Lesser Himalaya also contributed sediments to the Disang sediment of Arunachal Pradesh. The Myanmar continental landmass comprising of igneous and metamorphic basement complex with older sedimentary sequences may also have supplied sediments to the Disang Group. Sediments were deposited on tidal flat, lagoons and nearshore neritic shallow marine environments. The Upper Disang basin witnessed the tectonic instability with episodic fluctuation of deep water conditions followed by uplift and shallowing of the basin under oscillating tectonic impulse.

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