Mizoram Educational Journal
ISSN (P) :2395-731X

Volume XII, Issue 2, June 2026
doi.org/10.67067/MEJ.2026.XII207

A Study of the Palaeoclimate and Tectonic Setting of Bhuban Sandstone of Surma Basin in the Indo-Burmese Tectonic Collision Zone of Mizoram

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Abstract

The Bhuban sandstones of the Surma Group in Kolasib District of Mizoram constitute an important sedimentary unit within the Indo-Burmese Ranges. This study integrates detailed petrographic observations with major and trace element geochemical data to reconstruct the provenance, paleoredox conditions, paleosalinity and tectonic setting of the Bhuban sandstones of Surma Group. Major oxide geochemistry was employed to calculate the C-value which ranges from 0.24 to 1.15, indicating deposition under semi-arid to warm humid climatic conditions with moderate to intense chemical weathering of the felsic source rocks. Paleosalinity conditions was determined using Sr/Ba ratios (0.22-0.59) and the Sr-Ba discrimination diagram suggesting a transitional brackish to freshwater environment with dominant continental influence, consistent with a near-shore fluvio-deltaic depositional system. Redox-sensitive trace element ratios such as V/Ni (1.0-2.21), V/Cr, U/Th (0.05-0.29) and Ni/Co versus V/Ni discrimination plots, indicate predominantly oxic- to sub-oxic depositional conditions, reflecting well-oxygenated shallow-water environments. Tectonic discrimination diagrams based on major and immobile trace elements, including QFL and QmFL plots, La-Th-Sc ternary diagrams, La/Sc versus Ti/Zr bivariate plots indicated that the Bhuban sandstones were primarily derived from Active Continental Margin. The petrographic characteristic predominated by quartz along with fewer presence of feldspars and rock fragments inferred recycled orogenic provenance.

Keywords: *Bhuban sandstone, Mizoram, Surma group, palaeoclimate, palaeodepositional environment, tectonic setting*

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Introduction

Sandstone petrography and geochemistry provide robust tool for reconstructing provenance, palaeoclimate, palaeodepositional environment and tectonic settings of sedimentary basins. The elemental compositions of clastic sediments reflect the nature of source rocks, intensity of chemical weathering, transport history and depositional processes, thereby serving as an important archive of basin evolution and regional tectonics (Bhatia, 1983; Bhatia and Crook, 1986; Dickinson and Suczek, 1979). In tectonically active regions, such as convergent plate margins, integrated petrographic and geochemical studies are particularly effective in unraveling complex sedimentary histories.

The Surma Basin (Evans, 1932), a significant sub-basin of the Bengal Basin serves as an archive of the geological evolution that is related to the uplift and unearthing of the Himalayas and the Indo-Burmese Ranges. It formed as a result of oblique subduction and collision of the Indian Plate with the Burmese arc covering Bangladesh, Mizoram, southern Assam, and Tripura. Miocene deposits formed in envionments ranging from deep marine to shallow marine conditions and subsequent Pliocene delta progradation resulted in the development of the modern delta (Mahmood Alam, M.Mustafa Alam, Joseph R. Curray, M.Lutfar Rahman Chowdhury, M.Royhan Gani, 2003). Ongoing deformation may have diverted the Brahmaputra westward around the rising hillong plateau (Johnson & Alam, 1991; Govind, G., Najman, Y., Copley, A., Millar, I., van der Beek, P., Grujic, D., and Davenport, J. 2018). Stratigraphic evidence reveals an evolution of facies from delta front to intertidal and fluvial settings, marking shifts in deposition work shows facies evolving from delta front to intertidal to fluvial, marking depositional changes (Sincavage, R. S., Paola, C., & Goodbred, S. L., 2019). Ultimately resulting in the deposition of the Tipam Group during the regressive phase (Shrivastava, P. K. , Ganesan, S and Roy, D. 1974; Wanderley, M. M., Depalle, P, 2004).

The Surma Group of the Indo–Burmese Ranges (IBR) represents one of the most extensive Cenozoic sedimentary successions in Northeast India. Among the lithostratigraphic units of Surma Group, Bhuban Formation constitutes thick succession of sandstones, shales and siltstones that record the evolution of fluvio-deltaic to shallow-marine depositional systems under active tectonic influence (Lalnunmawia et al. 2021, Hauhnar et al 2021, Orizen M. S. Dawngliana, Jimmy Lalnunmawia, Malsawmtluangkima Hauhnar, Jehova Lalmalsawm Darngawn, Santanu Ghosh, V. Vanthangliana, 2025). Despite its regional significance, the geochemical application for the determination of palaeoclimate, redox conditions, salinity and tectonic provenance of the Bhuban sandstones in Mizoram have not been thoroughly investigated. Previous studies on the Surma Group have largely focused on sedimentology and structural aspects, while the systematic application of major and trace element geochemistry for palaeoenvironmental and tectonic discrimination has received less attention to previous workers. Major element ratios such as Al_2O_3/SiO_2, K_2O/Na_2O, and (Fe_2O_3 + MgO), along with immobile trace element proxies (e.g., La, Th, Sc, Ti, Zr), are widely used to infer provenance characteristics and tectonic settings, minimizing the effects of post-depositional alteration (Bhatia, 1983; Bhatia and Crook, 1986). Similarly, elemental ratios such as Sr/Ba, V/Ni, V/Cr, and U/Th serve as reliable indicators of palaeo-salinity and depositional redox conditions (Jones and Manning, 1994; Galarraga et al., 2008; Wang et al., 2021). In addition, palaeoclimate conditions exert strong control on intensity of chemical weathering in the source areas which is reflected in the geochemical composition of clastic sediments. The C-value, derived from major oxide proportions, has been successfully applied to discriminate climatic regimes ranging from arid to humid conditions and provides insights into sediment generation and transport under varying climatic settings (Zhao et al., 2007; Cao et al., 2012; Moradi et al., 2016). Therefore, the integration of petrography and geochemistry of sandstones allow comprehensive reconstruction of sedimentary processes that operated during basin development.

In the light of the above research gaps, the present work aims to reconstruct the palaeoclimate, palaeodepositional environment, redox state and tectono-provenance of the investigated Bhuban sandstones of the Indo-Burmese region. This can be achieved through integrated approach involving petrographic and geochemical analyses, and the constructive linkages between various elemental ratios in unraveling sedimentary history. Thus, the present work will help better understanding of the Cenozoic evolution of the Indo–Burmese sedimentary basin and the provenance of the Surma Group in Northeast India. The Bhuban formation of the Surma group was deposited during the early to middle Miocene under predominantly warm and humid climatic conditions. Sedimentological characteristics such as sandstone-shale alteration and abundant fluvial deltaic deposits, indicate high sediment supply driven by intense chemical weathering in the hinterland. The resulting depositional environments range from shallow marine and fluvial settings, reflecting interaction between monsoon driven sediment supply, tectonic uplift and basin subsidence (Uddin & Lundberg, 1998; Alam *et al*, 2003; Rahman & Suzuki, 2007)

Study Area

The study area of Kolasib is located in the north western part of Mizoram, India. It is part of Surma Basin in the Indo-Burmese tectonic belt. The geological set up comprises of sandstone, siltstone and shale of Surma and Tipam Group having a thickness of about 560 m. The study area lies in the Survey of India Toposheet No. 83D/12, falling within the geographic coordinates of latitudes 24°15’N to 24°12’N and longitudes of 92°40’E to 93°41’E. The location and geological map of the study area is given in Fig. 1.

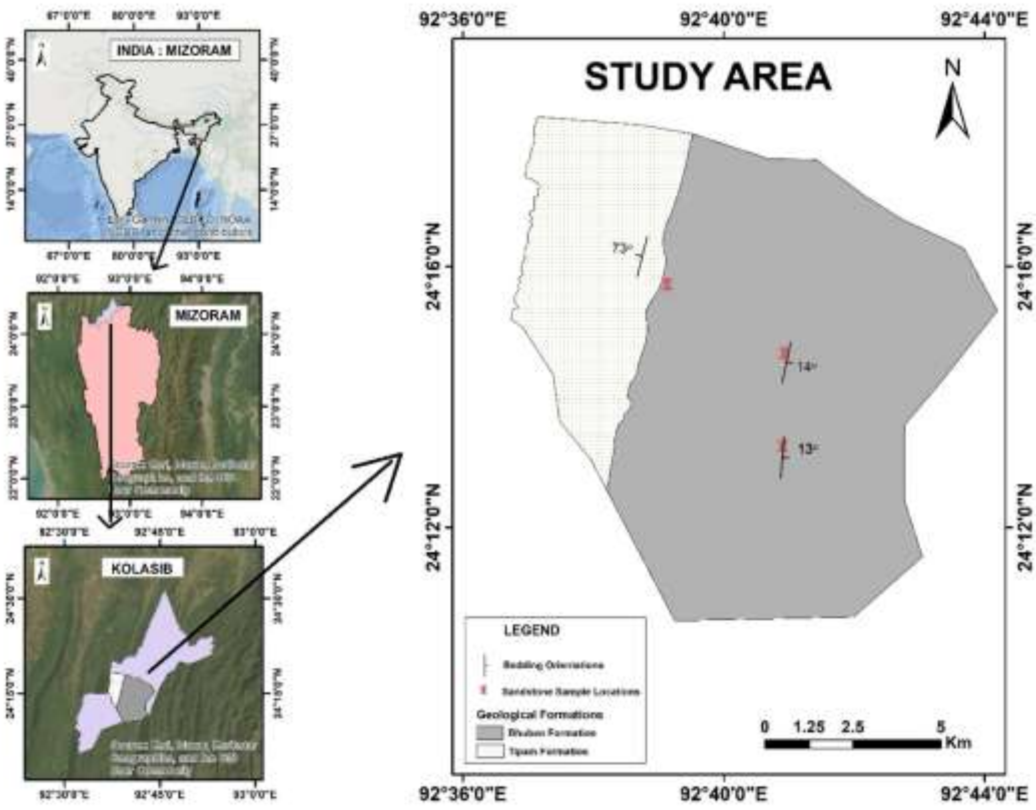

Fig 1: Location and geological map of the study area.

Materials and Methods

Extensive geological field work was carried out in and around Kolasib. Thirty (30) sandstone samples were collected with seventeen samples from Kualmawi Quarry to Kolasib labeled as RK, five (5) samples from Rengtekawn to Zero Point labelled as RB and four (4) samples collected within Kolasib town which were labelled as K. Out of the thirty (30) samples, 24 representative sandstones were prepared into thin sections using Petro-thin thin sectioning equipment in the Department of Geology, Mizoram University. Identification of detrital components of the rocks and modal analysis were carried out using Leica DM2700 P Polarization Microscope equipped with motorized stepping stage PetrogLite, image analysis software and microphotographic imaging system in the Department of Geology, Mizoram University. During modal analysis, Gazzi-Dickinson method (cf. Ingersoll *et al*., 1984) was followed. A minimum of 300 counts for each sample was taken for identification and textural classifications. The detail procedure of geochemical analysis is available in Roy *et al*. (2007). Sedimentological software used for data processing and plotting is OriginPro 9.0 software. The major/minor oxides analysis was done using Philips model PW2440 MagiX PRO wavelength dispersive X-ray Fluorescence spectrometry (WD-XRF) equipped with automatic sample changer and software super Q 3.0 in Wadia Institute of Himalayan Geology, Dehradun. The sandstones were manually powdered into 200 ASTM mesh size. Pressed pellets were prepared from the powdered sandstone samples with the help of boric acid in collapsible aluminium cups which were pressed at hydraulic pressure of 25 tonnes in two cycles (5 sec each). The pressed pellets were analysed using WD-XRF. In geochemical analysis of trace element and REE, 0.05 g of powdered sandstone samples were put in a Savillex. Acid mixture of HF and HNO_3 in the ratio 7:3 was added. The Savillex vessels were closed and kept on a hot plate at 150 °C for 48 hrs followed by the addition of 1 to 2 drops of $HClO_4$ and left for evaporated to near dryness. The residual paste of the samples was dissolved by adding 10 ml of 1:1 HNO_3. After the dissolution, the samples were again heated on a hot plate for 40 min at 80 °C to dissolve all suspended particles and later transferred into 250 ml standard flask. 10 ml of 1:1 HNO_3 and Rhodium (Rh) solution was added again in the standard flask with Millipore water. The Rhodium (Rh) solution is used as an internal standard. Finally, 5 ml was taken out from 250 ml solution of the samples and then made the volume into 50 ml with Millipore water and the final solution was stored in Eppendorf tubes for High Resolution-ICPMS analysis. The HR-ICPMS was calibrated with Chinese geochemical standard GSR-4. In the present study, two standards i.e. GSR-4: Chinese sandstone standard GSR-4 (Geochemical standard reference for sandstone) after Xeujing *et al.,* 2007 and Upper Continental Crust (UCC) after Rudnick and Gao (2003, 2005) values were used for comparison.

Results and Discussion

Paleoclimatic Conditions

The geochemical data are presented in Table 1. To elucidate palaeoclimatic conditions, the C-value is used, following the methodology proposed by Cao et al., (2012), Moradi et al. (2016) and Zhao et al. (2007). The results were shown in Table 2. The C-values ranges from 0.09 to 0.23 with an average of ~0.16. The Sr/Ba ratio ranges between 0.22 and 0.59 in the Bhuban sandstones (Figure 2). The study shows that the sediments were deposited in brackish to fresh water transition (semi-saline) environment (Table 3, following Tiwari et al., 2023) and more specifically in a near-shore terrestrial freshwater environment as observed from micro-petrography.

Table 1: Major/minor oxide data of Bhuban Formation of Surma Group of the study area in the Indo-Burmese tectonic belt, Mizoram

SN	Sample	Na_2O %	MgO %	Al_2O_3 %	SiO_2 %	P_2O_5 %	K_2O %	CaO %	TiO_2 %	MnO %	Fe_2O_3 %
1	K-1	0.67	1.85	16.28	62.75	0.15	2.91	0.37	0.79	0.13	6.49
2	K-2	0.84	1.68	15.74	64.73	0.15	2.80	0.20	0.76	0.04	5.84
3	K-3	1.70	2.12	12.85	70.87	0.09	2.31	0.68	0.60	0.04	4.13
4	K-4	1.66	1.67	13.72	68.56	0.11	2.47	0.40	0.65	0.10	4.51
5	RB-2	1.10	1.64	14.02	71.26	0.10	2.77	0.34	0.72	0.03	4.32
6	RB-3	1.45	2.37	15.17	65.04	0.12	3.12	1.78	0.75	0.08	5.65
7	RB-6	1.53	2.21	14.70	66.46	0.13	2.98	0.97	0.75	0.06	5.77
8	RB-7	1.11	1.96	14.79	67.79	0.11	2.90	0.44	0.68	0.04	4.84
9	RB-10	1.58	2.06	12.73	69.53	0.08	2.61	0.32	0.69	0.06	6.76
10	RK-1	1.49	2.23	12.86	68.76	0.13	2.66	1.00	0.78	0.05	5.74
11	RK-3	1.54	2.90	14.04	65.68	0.10	2.95	1.20	0.73	0.06	6.18
12	RK-4	1.49	2.68	13.74	66.52	0.11	2.92	1.39	0.73	0.06	6.02
13	RK-5	1.53	2.61	13.35	67.21	0.11	2.87	1.36	0.72	0.06	6.06
14	RK-7	1.01	1.05	10.88	76.71	0.06	1.96	0.15	0.47	0.05	3.32
15	RK-8	0.82	2.02	17.21	61.09	0.09	3.19	0.18	0.77	0.46	6.79
16	RK-9	1.34	2.09	14.90	66.87	0.10	2.84	0.29	0.74	0.05	5.41
17	RK-10	1.64	2.48	13.81	66.80	0.12	2.80	1.13	0.79	0.05	6.17
18	RK-11	1.23	2.02	14.86	66.98	0.10	2.70	0.30	0.69	0.04	4.97
19	RK-13	1.45	2.33	13.62	67.75	0.13	2.81	1.44	0.82	0.08	6.19
20	RK-14	1.60	2.26	14.47	67.16	0.11	2.92	0.49	0.79	0.05	6.21
21	RK-15	1.10	1.65	13.06	70.12	0.08	2.43	0.40	0.59	0.05	4.85
22	RK-17	1.23	3.01	14.32	60.95	0.14	3.00	4.24	0.70	0.10	5.82
23	RK-18	1.28	2.33	13.39	69.56	0.09	2.76	1.04	0.66	0.06	4.86
24	RK-19	0.78	2.22	17.65	62.23	0.12	3.35	0.18	0.81	0.07	5.93
Std	GSR	0.06	0.06	3.55	90.31	0.20	0.64	0.28	0.24	0.02	3.24
Std	UCC	3.27	2.48	15.40	66.60	0.15	2.80	3.59	0.64	0.10	5.04

Table 2: Discrimination of Climatic conditions of Bhuban Formation of Surma Group of the study area in the Indo-Burmese tectonic belt, Mizoram after Zhao *et.al.* (2017)

C- Value	K-1	K-2	K-3	K-4	RB-2	RB-3	RB-6	RB-7	RB-10	RK-1	RK-3	RK-4
	0.49	0.48	0.27	0.43	1.15	0.45	0.45	0.75	0.43	0.35	0.34	0.33

Table 2 (cont.….):

C- Value	RK-5	RK-7	RK-8	RK-9	RK-10	RK-11	RK-13	RK-14	RK-15	RK-17	RK-18	RK-19
	0.32	0.47	0.49	0.36	0.30	0.39	0.33	0.36	0.49	0.24	0.30	0.36

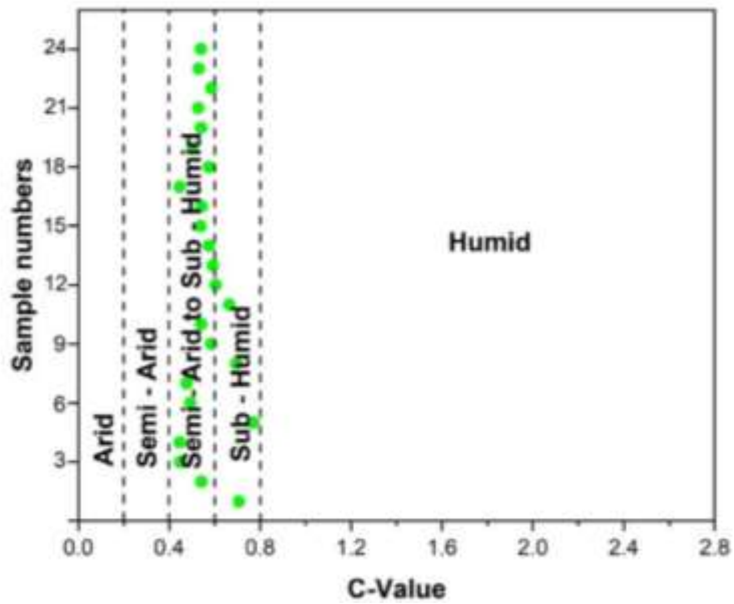

Figure 2: Paleodepositional environment of Bhuban Formation of Surma Group of the study area in the Indo-Burmese tectonic belt, Mizoram after Zhao *et.al.* (2007).

A low Sr/Ba ratio (< 0.2–0.6) suggests freshwater or continental environments (Wang *et.al*, 2021). It is suggested that the Bhuban sandstones of the study area were deposited predominantly under humid to semi-humid paleoclimatic conditions, characterized by moderate to intense chemical weathering. These values reflect significant leaching of mobile elements and enrichment of relatively immobile components, consistent with warm, humid climatic conditions during the deposition of the sediments. The micro-petrographic and geochemical observations in this study support a near-shore terrestrial/fluvio-deltaic freshwater depositional environment for the Bhuban sandstones.

Table 3: Paleosalinity indicator of Bhuban Formation of Surma Group of the study area in the Indo-Burmese tectonic belt, Mizoram after V.M Goldschmidt (1937).

Sr/Ba Ratio	K-1	K-2	K-3	K-4	RB-2	RB-3	RB-6	RB-7	RB-10	RK-1	RK-3	RK-4
	0.22	0.23	0.24	0.27	0.29	0.3	0.3	0.31	0.32	0.32	0.33	0.33

Table 3 (cont.….): Paleosalinity indicator of Bhuban Formation of Surma Group of the study area in the Indo-Burmese tectonic belt, Mizoram after V.M Goldschmidt (1937).

Sr/Ba Ratio	RK-5	RK-7	RK-8	RK-9	RK-10	RK-11	RK-13	RK-14	RK-15	RK-17	RK-18	RK-19
	0.34	0.34	0.35	0.35	0.36	0.36	0.37	0.38	0.39	0.42	0.45	0.59

The V/Ni ratio of studied sandstone ranges from 1.0 to 2.21 (Figure 3), which indicates mostly sub-oxic condition to transitional oxic and anoxic environments. Further, the V/Cr ratio, another proxy for palaeo-redox conditions, it was discovered oxic depositional conditions (Figure4) based on the discrimination range as suggested by Galarraga et al. (2008). In the studied sandstone samples, the U/Th ratio ranges from 0.05 to 0.29 (Table 4), pointing towards an oxic environment

ISSN (P) :2395-731X doi.org/10.67067/MEJ.2026.XII207

(Jones & Manning, 1994). This further supported the interpretation of predominantly oxic conditions during sediment deposition. The low Strontium and high Barium is an indicator of fresh water input. The Ni/Co versus V/Ni discrimination plot indicated that majority of the samples fall within the oxic field, indicating the abundant availability of oxygen during accumulation of the sediments (Figure 4). The Sr-Ba discrimination diagram after Wang *et.al.* (2021), with the effective concentration ranges of Ba (300-700 ppm) and Sr (0-25 ppm), showed that the Bhuban sandstones clustered in the continental freshwater field. The low Sr and high Ba contents indicated dominant terrigenous input, suggesting deposition under fluvio-deltaic to near shore terrestrial conditions (Figure 5).

Table 4: Depositional Oxygenation Conditions after Jones & Manning, 1994.

	K-1	K-2	K-3	K-4	RB-2	RB-3	RB-6	RB-7	RB-10	RK-1	RK-3	RK-4
U/Th	0.24	0.20	0.00	0.00	0.20	0.17	0.18	0.19	0.14	0.26	0.22	0.20

Table 4 (cont.….): Depositional Oxygenation Conditions after Jones & Manning, 1994.

	RK-5	RK-7	RK-8	RK-9	RK-10	RK-11	RK-13	RK-14	RK-15	RK-17	RK-18	RK-19
U/Th	0.06	0.00	0.08	0.14	0.29	0.15	0.19	0.20	0.05	0.08	0.06	0.00

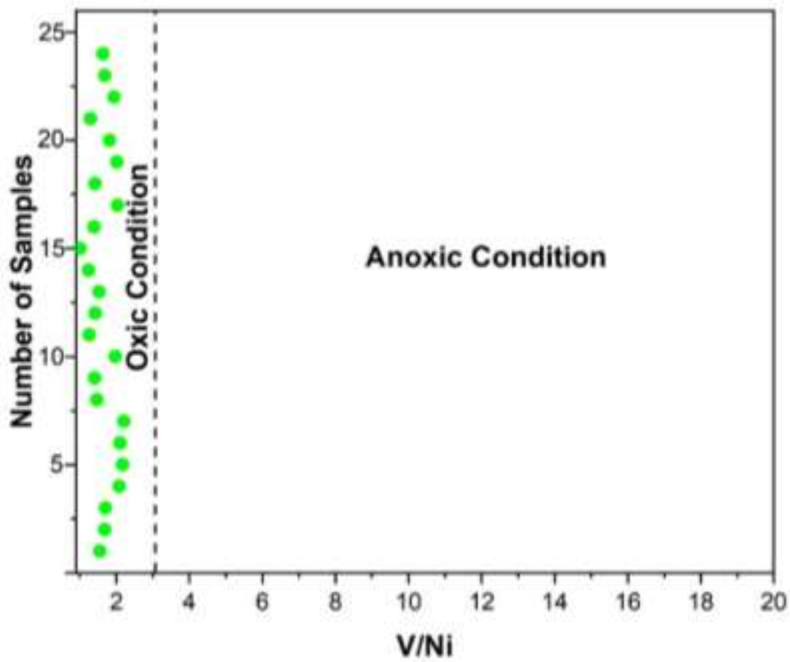

Figure 3: Paleo-redox conditions after Galaragga *et.al.* (2008).

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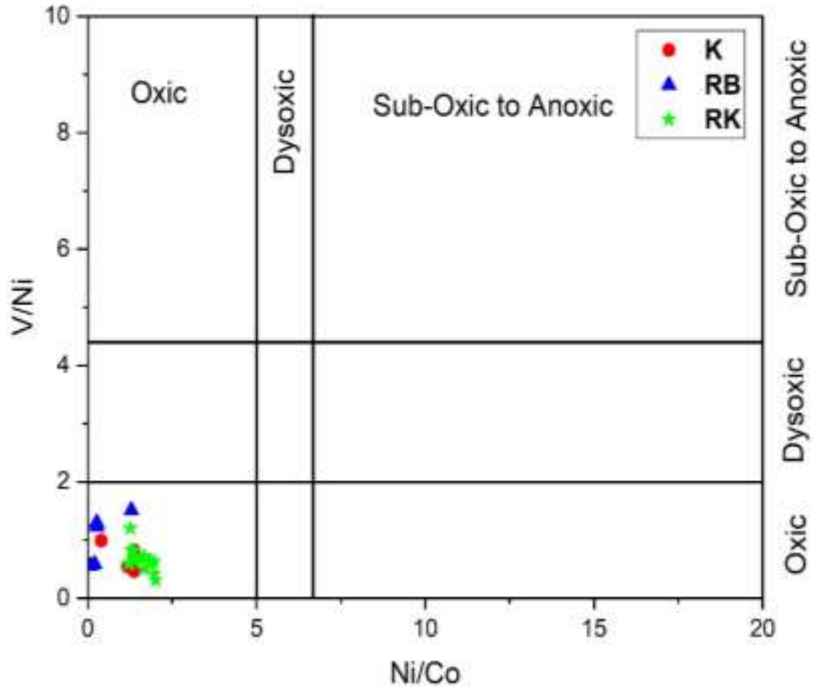

Figure 4: Cross plots of trace elements ratios (VCr vs. NiCo) after Jones and Manning, 1994.

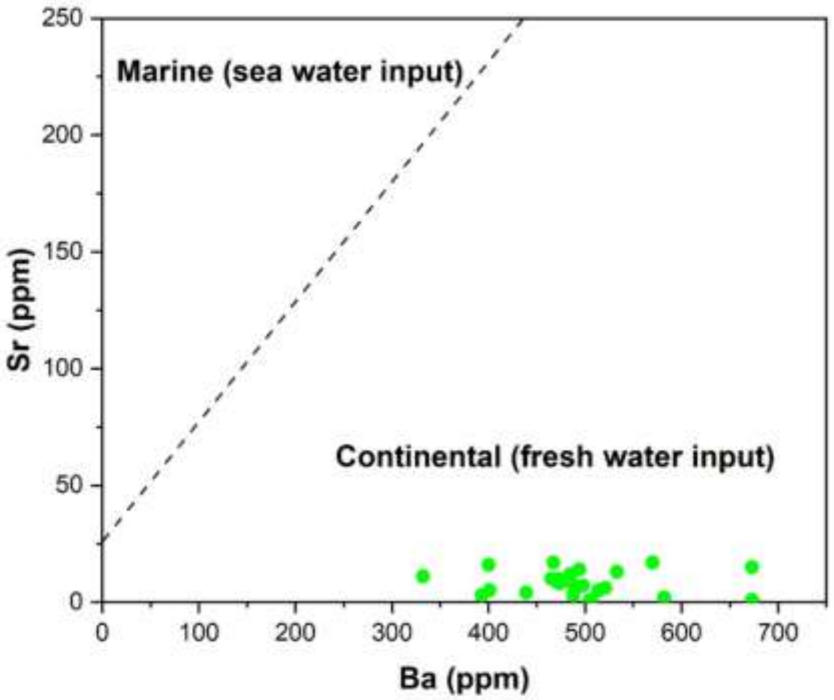

Figure 5: Sr–Ba discrimination diagram after Wang *et.al.* 2021.

Tectonic Settings

The tectonic history of the Bhuban sandstones are determined using major elemental discrimination diagrams, such as (Fe_2O_3+MgO) vs Al_2O_3/SiO_2 (Bhatia, 1983), (Fe_2O_3+MgO) vs K_2O/Na_2O (Bhatia, 1983), and immobile trace element discrimination diagrams like La/Sc vs Ti/Zr (Bhatia and Crook, 1986) and the La-Th-Sc ternary plot (Bhatia and Crook, 1986), binary discrimination diagram of Bhatia (1983), Bhatia and Crook (1986) using minor and major oxides. REE and Trace element data was used to depict in ternary discrimination diagram of Dickinson and Suczek (1979), Dickinson (1983) and Bhatia (1983). In the present study, the QFL diagram indicated

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the affinity of the Bhuban sandstones to tectonic setting of Recycled Orogeny (Figure 6), with the majority of samples clustering in the Quartzose Recycled origin, while only a few samples are related to the Transitional Recycled setting on the QmFLt plot (Figure 7). A few rounded quartz grains indicated a supplementary support for the recycled origin, whereas angular grains and the presence of rock fragments suggest the textural immaturity of the rock.

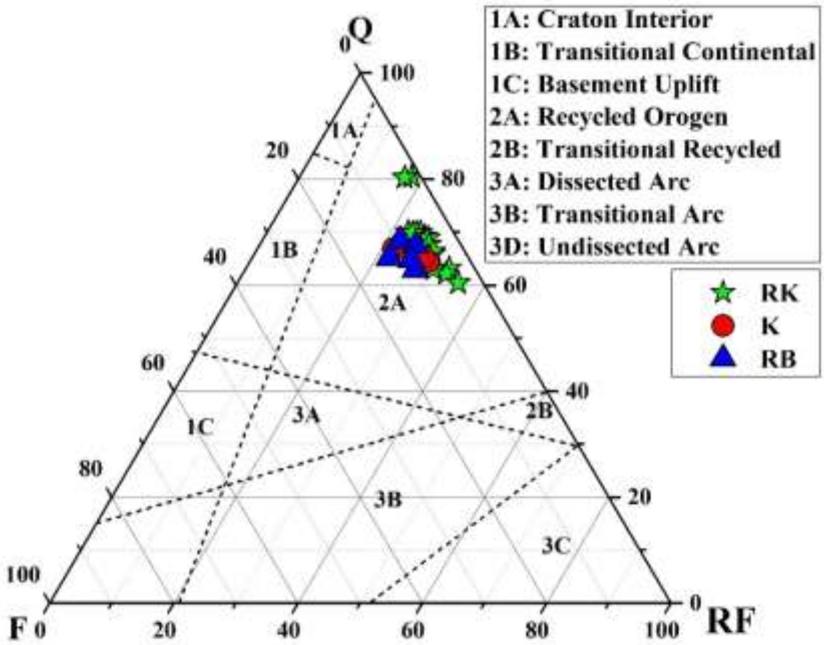

Figure 6: Q-F-L triangular plot for tectonic settings after Dickinson & Suczeck, (1979).

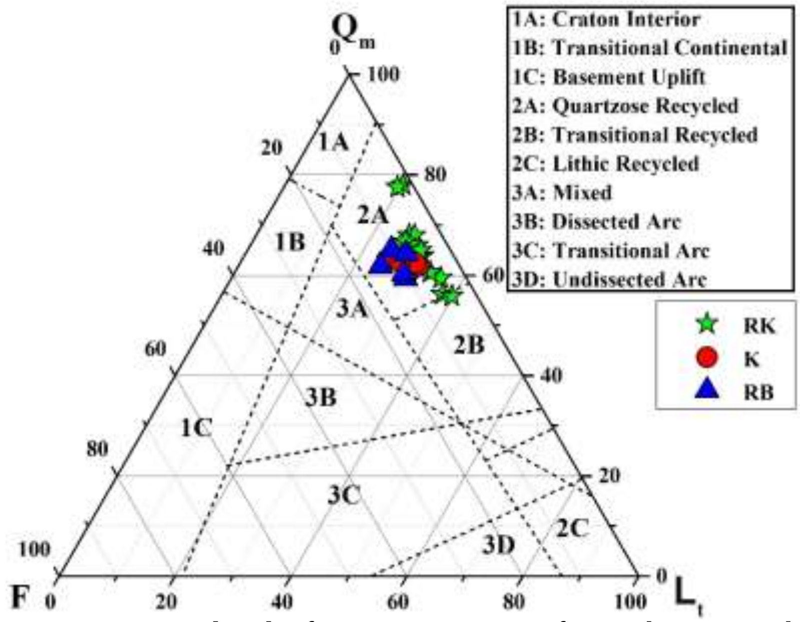

Figure 7: Q_m-F-L_t triangular plot for tectonic settings after Dickinson *et. al*., (1983).

The samples, when plotted on the La-Th-Sc ternary diagram, clustered in the fields of active continental margin (ACM) and continental island arc (CIA) (Figure 8). Plotting the samples on binary discrimination diagrams of (Fe_2O_3+MgO) vs Al_2O_3/SiO_2 (Figure 9) and (Fe_2O_3+MgO) vs TiO_2 (Figure 10) revealed that most samples fall within the continental island arc, while a few samples were observed to fall within the active continental margin and oceanic island arc (OIA). The binary discriminant function plot (Bhatia, 1983) showed that the majority of samples fall within the active continental margin. Combining geochemical data with petrographic evidence, it can be concluded that the Bhuban sandstone sediments originated from mixed environments of active continental margin settings and oceanic island arc, supporting the diversity of source rocks and suggesting a recycled orogeny environment.

The average ratio of La/Sc of the studied Bhuban sandstones is 1.56 which according to Bhatia and Crook, (1986) indicated mixed source environment. Plotting of the samples in the ternary diagram of La-Th-Sc indicated an active continental margin (ACM) and continental island arc (CIA) (Figure 8) tectonic settings. Bhuban sandstones are showing Al_2O_3/SiO_2 (Avg: 0.21), Fe_2O_3+MgO (Avg: 7.68) and K_2O/Na_2O (Avg: 2.32) which are almost similar to the values suggested by Bhatia, (1983). Plotting of the samples in the binary discrimination diagram of (Fe_2O_3+MgO) vs Al_2O_3/SiO_2 (Bhatia, 1983) and (Fe_2O_3+MgO) vs TiO_2 (Bhatia, 1983), majority of the samples fall in active continental margin and few samples clustered near active continental margins and passive continental margins.

Plotting of the samples in bivariant plot of La/Sc vs Ti/Zr (Bhatia and Crook, 1986) shows that majority of the samples of Bhuban sandstones clustered in the field of Active Continental Margins and (Figure 11). Moreover, plotting of the studied samples in the binary plot of discrimination function (Bhatia, 1983) also shows that all of the samples fall in the field of Active Continental Margin (Figure 12). Based on the geochemistry together with petrography, it can be inferred that the sediments of the Bhuban sandstones are derived from active continental margins and oceanic island arc which subsequently affirm the source rock diversity of the investigated sandstones indicating a recycled orogeny setup.

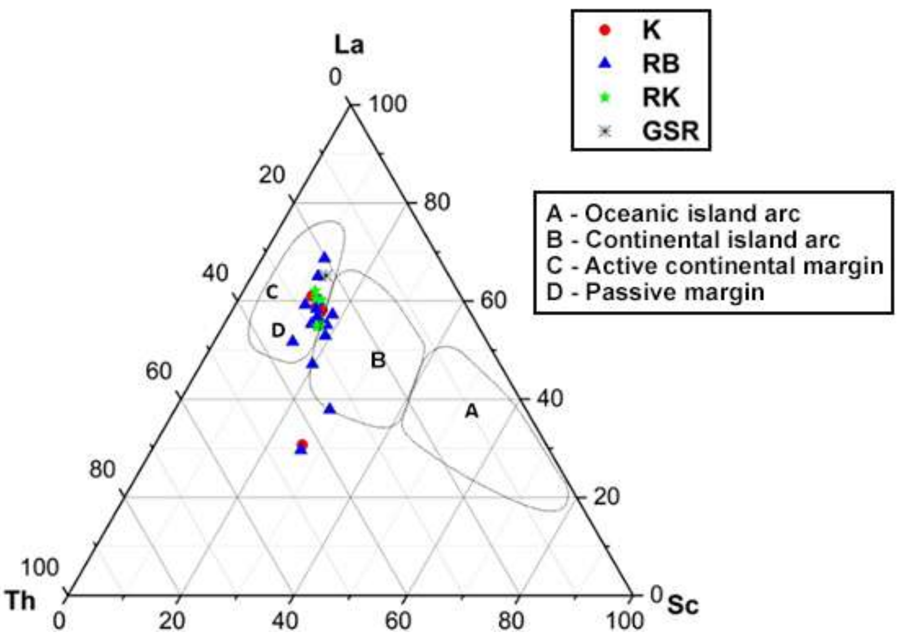

Figure 8: Ternary plot of La-Th-Sc for tectonic settings (After Bhatia,1983)

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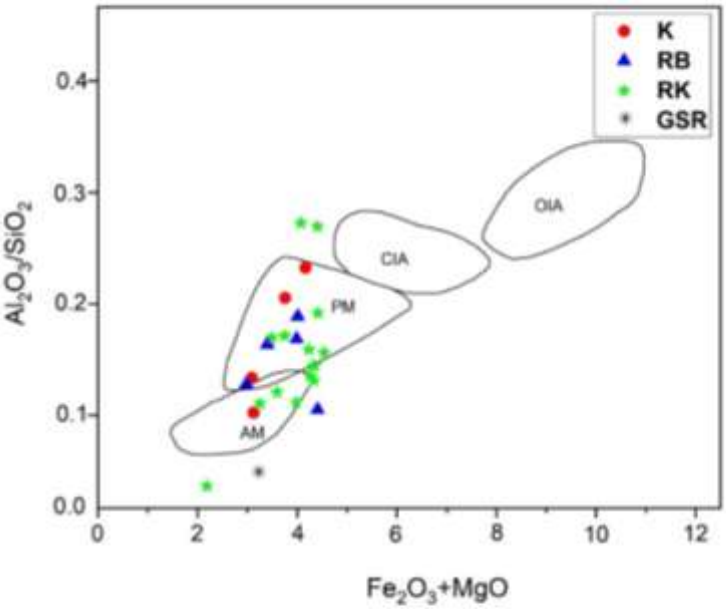

Figure 9: Discrimination plot of Fe_2O_3+MgO vs Al_2O_3/SiO_2 (Bhatia,1983)

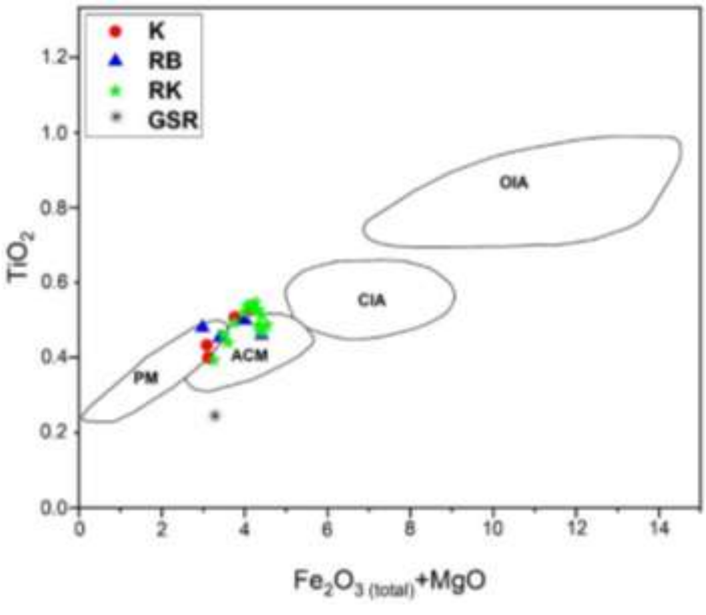

Figure 10: Discrimination plot of Fe_2O_3+MgO vs TiO_2 (Bhatia,1983)

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doi.org/10.67067/MEJ.2026.XII207

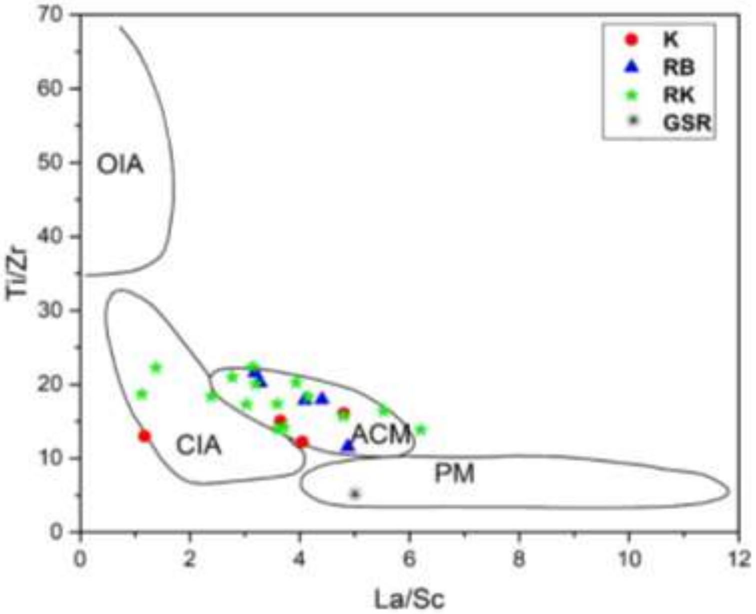

Figure 11: Bivariant tectonic setting plot using La/Sc Vs Ti/Zr (Bhatia and Crook, 1986).

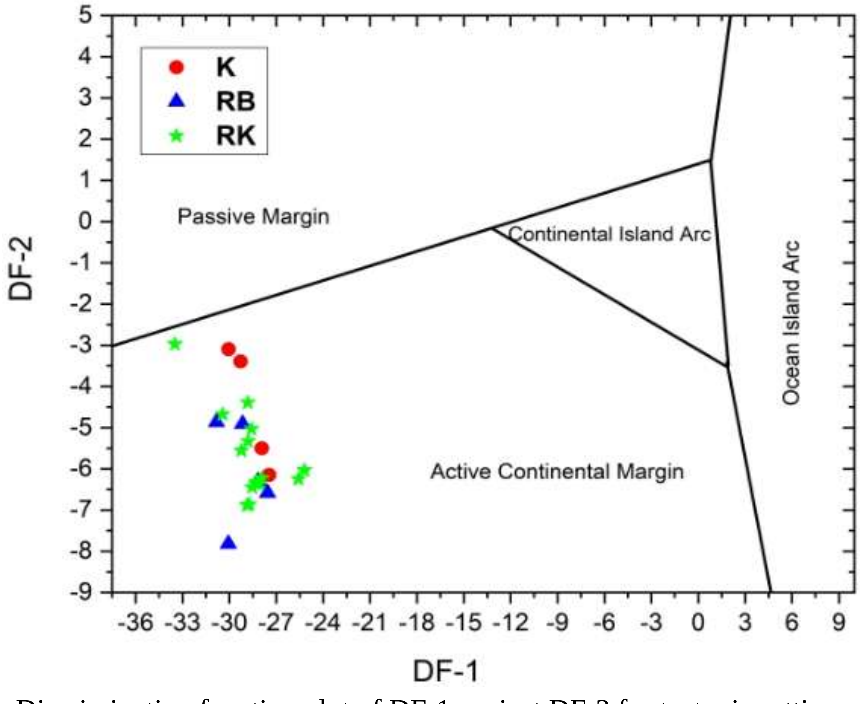

Figure 12: Discrimination function plot of DF-1 against DF-2 for tectonic settings of Bhuban sandstones after Bhatia, (1983).

ISSN (P) :2395-731X doi.org/10.67067/MEJ.2026.XII207

Conclusion

In order to shed light on the tectonic settings, palaeoclimatic conditions and depositional environment of the Bhuban sandstones of the Indo-Burmese fold belt in Mizoram, India, combined interpretation of Bhuban sandstones of in terms of petrographic and geochemical analyses were considered. It can be concluded that the sediments were deposited in semi-arid to warm, humid climates with low to moderate precipitation, according to the C-value (0.24–1.15). Due to the moderate chemical weathering of primarily felsic source rocks facilitated by these climatic conditions, the sediments underwent medium levels of physicochemical alteration before deposition. This conclusion is in agreement with the petrographic features and geochemical signatures found in the sandstones. The Sr/Ba ratios, ranging from 0.22 to 0.59, serve as paleodepositional environmental proxies for deposition in a transitional, brackish to fresh, environment. Examples of these proxies include a predominantly near-shore environment that changes from terrestrial to fluvial delta deposits that were dominated by fresh water. In addition, the redox-sensitive elemental ratios, such as V/Ni (ranging from 1.0 to 2.21), V/Cr and U/Th (0.05 to 0.29), all suggested sediments deposition under predominantly oxic to suboxic conditions in well-oxygenated shallow-water environments. Further, various tectonic discrimination diagrams using major and trace elements indicated that the Bhuban sandstones of Surma Basin in the Indo-Burmese fold belt are predominantly derived from active continental margin and continental island arc settings, with very minor contributions from oceanic island arcs. In addition to having predominantly quartzose recycled components, most samples contained a combination of rounded and angular quartz grains indicating recycled orogenic provenance. Hence, it can be stated that the sediments are having multiple tectono-provenances with mixture of source lithologies. The Bhuban sandstones were deposited in semi-arid to sub-humid climate and fluvio-deltaic warm environment. These results help elucidate the sedimentary and tectonic history of the Indo-Burmese Ranges of Surma Group in NE India. Knowledge of the depositional environments, tectonic settings and other geochemical conditions directly incorporates with hydrocarbon industries and environmental geology. The fluvio-delatic depositional environment and shallow marine conditions which is indicated by the studies Bhuban sandstones suggests favorable settings for hydrocarbon reservoir development. The moderate chemical weathering and alteration of felsic source rocks implies the preservation of primary porosity, which is essential for reserve estimation of groundwater and petroleum. The mixed tectono-provenance and recycled orogenic sources also suggests the possible accumulation of heavy minerals (zircon, tourmaline, rutile) which have high economic value in industrial applications.

‘The authors declare that there is no conflict of interest’.

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