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Heavy mineral analysis of Tipam sandstone near Buhchang village, Kolasib district, Mizoram, India

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ABSTRACT

A thick succession of sedimentary rocks belonging to Tipam Group is well exposed all along the road cut sections near Buhchang village, Kolasib district, Mizoram. The heavy mineral suite of the Tipam sediments depicts a cosmopolitan nature. It comprises dominantly of non-opaque variety that includes zircon, tourmaline, rutile, staurolite, kyanite, sillimanite, apatite, epidote, garnet and hornblende. Iron oxide such as magnetite and heamatite constitute the bulk opaque variety. The Tipam sandstone has a complex provenance comprising of high grade metamorphic source as well as igneous and sedimentary sources. Further, it can be suggested that the high grade metamorphic source predominates over the other two sources with a relatively short transportation.

Key words: Buhchang; heavy minerals; provenance; Tipam sandstone.

INTRODUCTION

In spite of having a good and well exposed Tipam Group of rocks in the study area, only few workers have carried out the sedimentological investigations so far. Among those few workers, geologists from ONGC[1] have carried out the heavy mineral analysis on the Bhuban and Boka bil Formations of Surma Group, and the Tipam Group from the Rengte and the adjoining Teidukhan anticlines. They have identified and reported the different heavy mineral suites for these groups of rocks. The heavy mineral suite for the Bhuban Formation consists of tourmaline, epidote, rutile, chloritoid, garnet, staurolite and hornblende; the suite in Boka bil Formation is tourmaline, chloritoid, staurolite, rutile, zircon and garnet whereas the mineral suite of Tipam Group of rocks is characterized by epidote, staurolite, kyanite, tourmaline, hornblende, chloritoid, rutile, garnet, enstatite, zircon, chlorite and zoisite. Other workers have also identified the heavy mineral assemblages present in the Tertiary rocks of the Teidukhan anticline, Kolasib district[2] and worked out the provenance of these rocks. They have concluded that the source of the sediment were complex in nature comprising of igneous rock and pegmatite to high rank metamorphic rocks and reworked sediment supply. From the Palaeontological studies,

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they have inferred a prevalence of warm and humid climate during the time of deposition of Tipam sandstone.[3]

MATERIALS AND METHODS

Geological settings and stratigraphy

The study area is within the Kolasib district, located in the north western part of Mizoram. It is covered within the Survey of India Toposheet No 83 D/12 and falls within the coordinates of latitudes N 24° 19' 55.9" and longitudes E 92° 42' 30.5". The geological and location map of the study area is shown below in Fig. 1.

The entire sedimentary succession of Mizoram consists of a rhythmic alternation of arenaceous and argillaceous rocks of Palaeogene and Neogene age with a total thickness of around 8000 m. This Tertiary succession has been divided sequentially into three Groups namely, the Barail, the Surma and the Tipam Groups in ascending order of their age.[4-6] Silty-sandstone, siltstone, shale, mudstone, sand rock, silt and their admixture of varying proportions along with a few pockets of shell-limestone, calcareous sandstone and intraformational conglomerates are some of the rocks which are commonly found in this area. Almost all the rocks are thrown into a series of approximately N-S trending, longitudinally plunging anticlines and synclines.[4,5,7] The Surma Group is divisible into a lower Bhuban Formation and an upper Boka Bil Formation. Bhuban Formation is further divisible into lower, middle and upper Bhuban Units.[5] In general, Lower Bhuban succession is confined to the anticlinal cores of high amplitude folds while Middle Bhuban succession is mostly found on the limbs of folds and it also occupies the cores of low amplitude anticlines. The Upper Bhuban rocks form anticlines in western Mizoram but are confined to the synclinal cores in central and eastern Mizoram. Boka Bil Formation of Surmas and Tipam Group are confined to the cores of synclines in the western and northwestern parts of the state.[6,8]

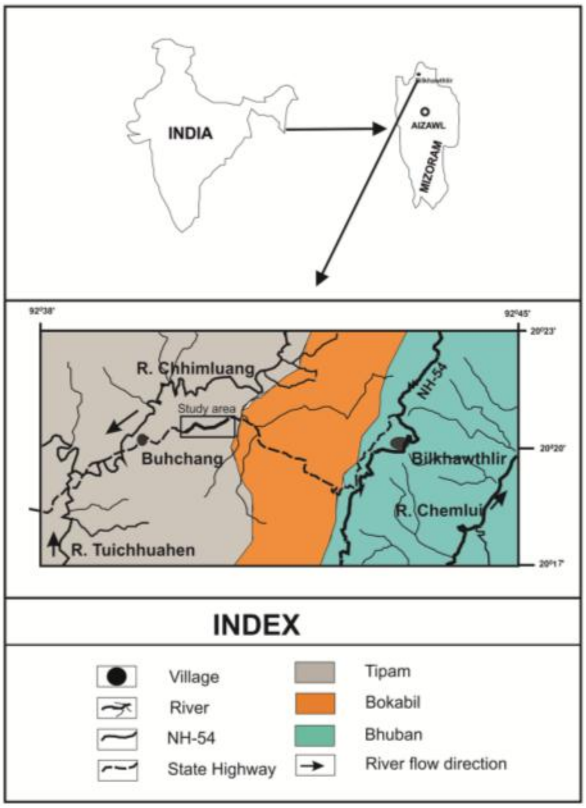
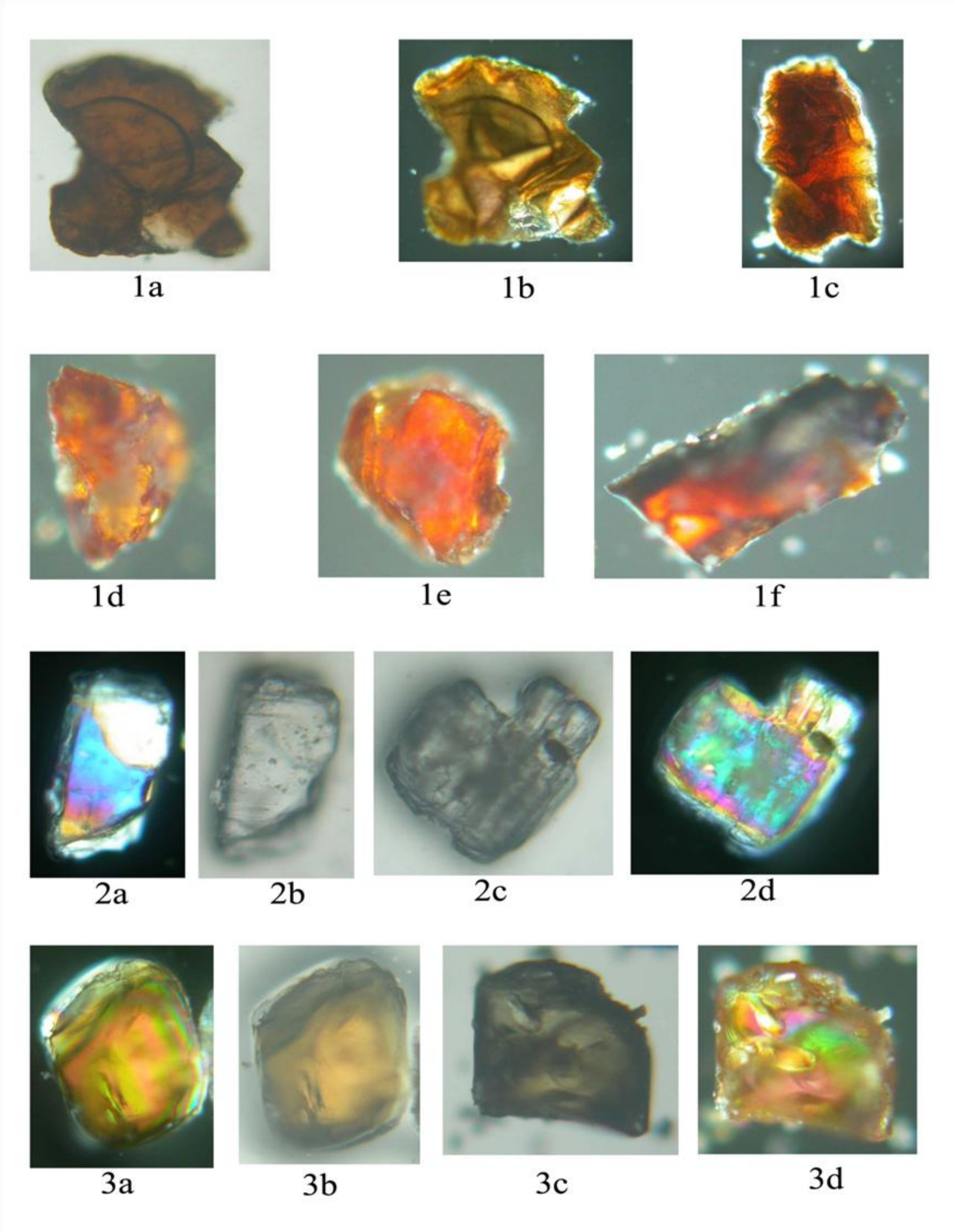


Figure 1. Geological and location map of the study area.

Tertiary group of rocks in and around Kolasib district of Mizoram is represented by the Middle and Upper Bhuban Formation, and Bokabil Formation of Surma Group, and also the Tipam sandstone and shale of Tipam Group. The present paper is confined to the Tipam sandstone, on the road cut sections near Buhchang village. The sandstones of this area are typified by its soft and friable nature because of its low degree of induration and compaction. The sandstones of the study area are associated with alternating bands of shale/mud with varying thickness from one place to another. The detail lithological characteristics of the study area are represented in the litho-column in Fig. 2.

Plate 1



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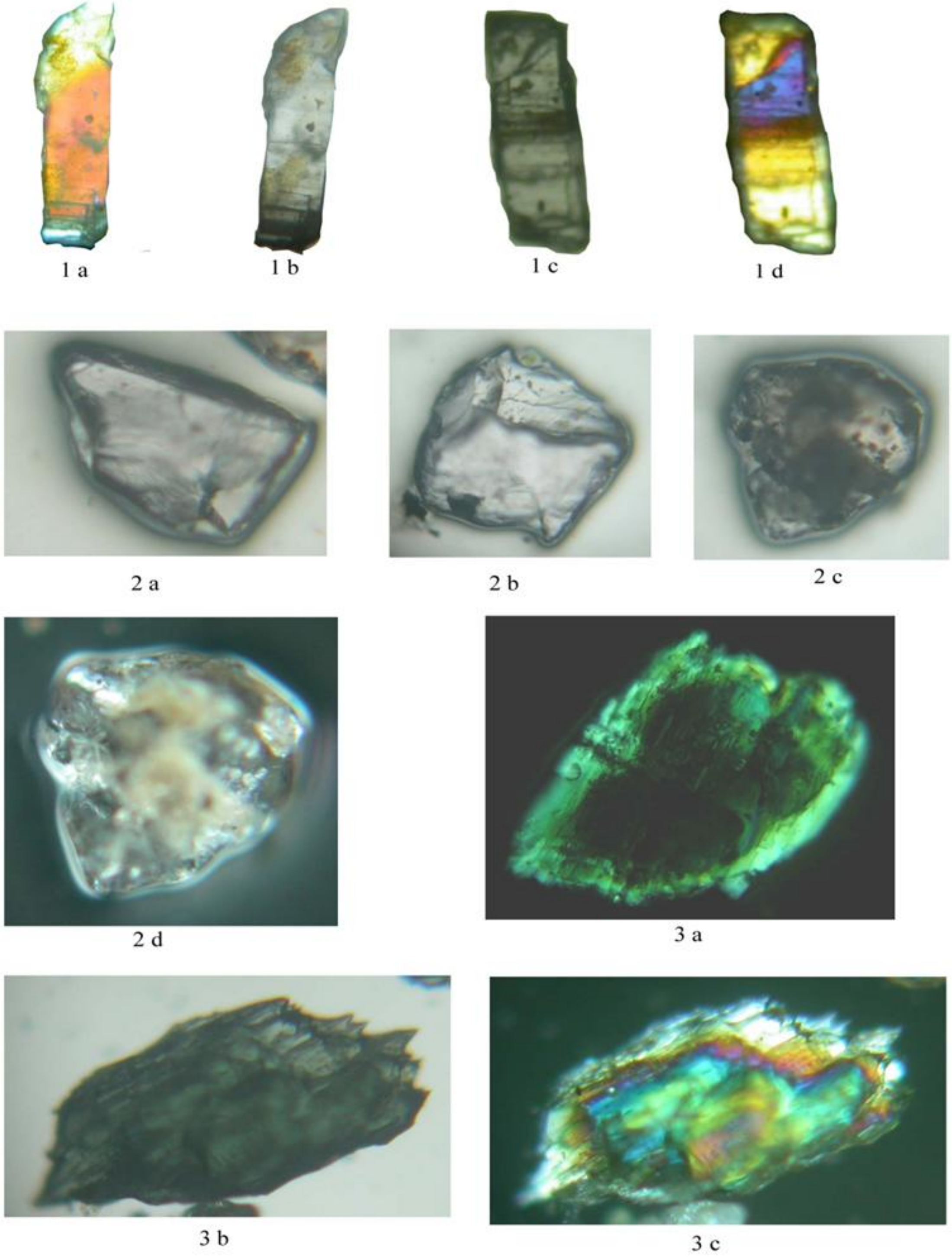

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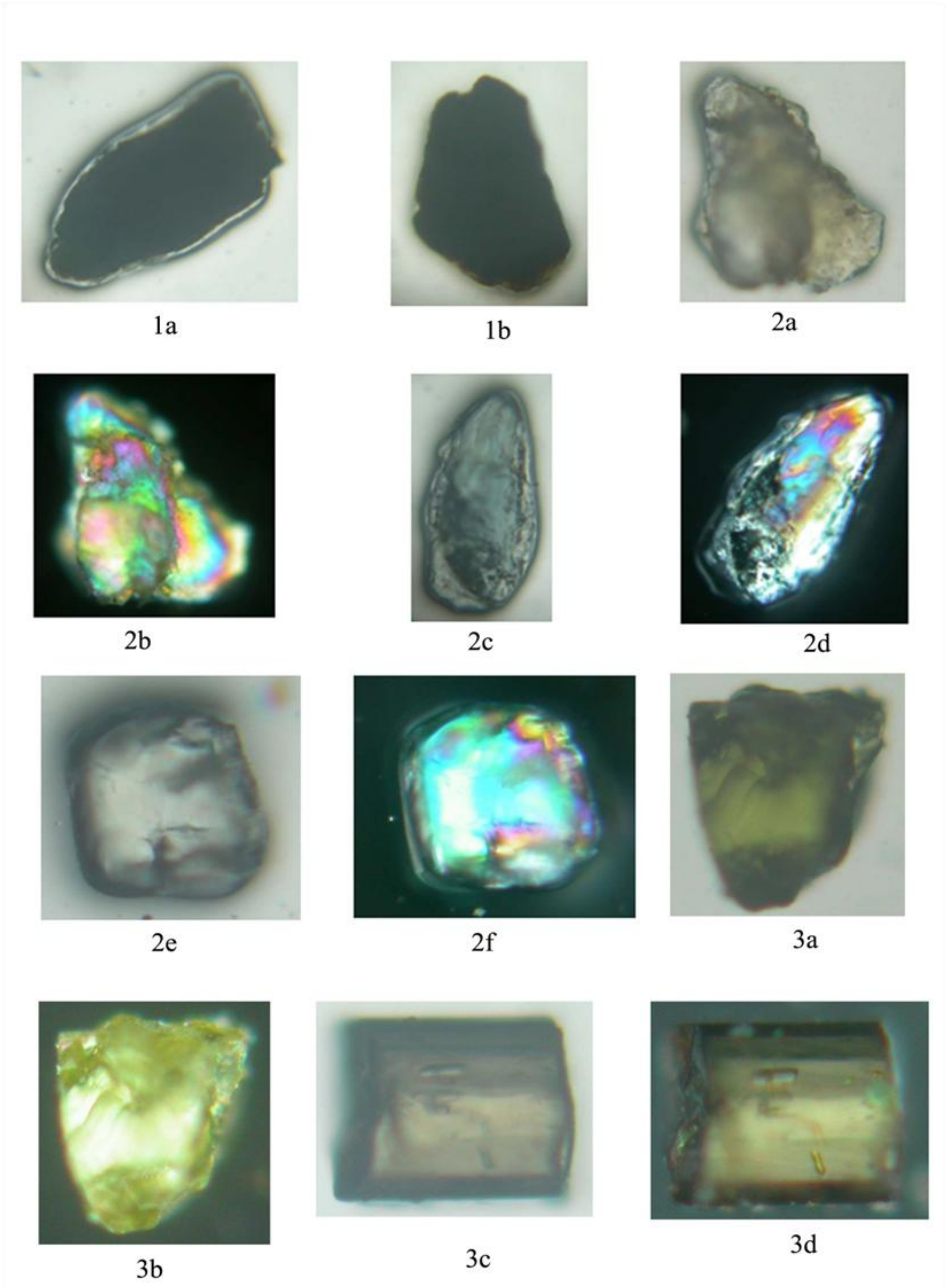

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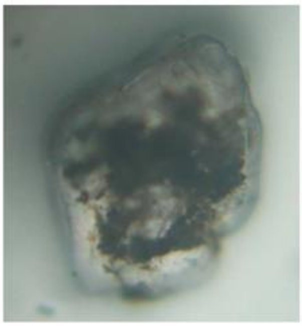

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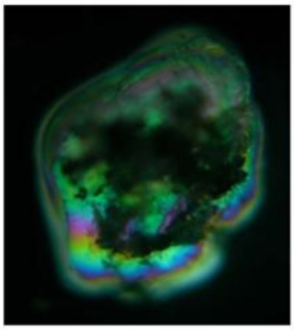

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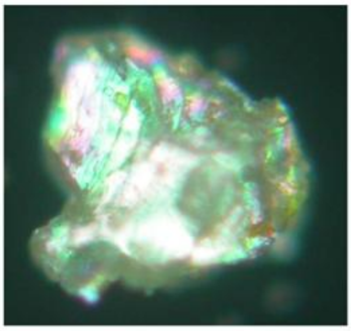

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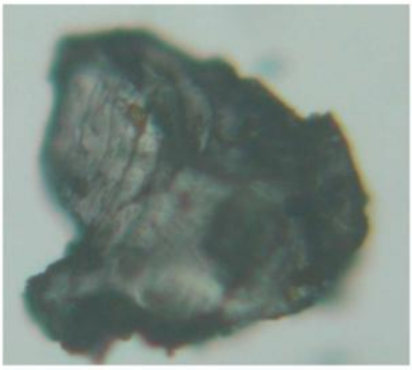

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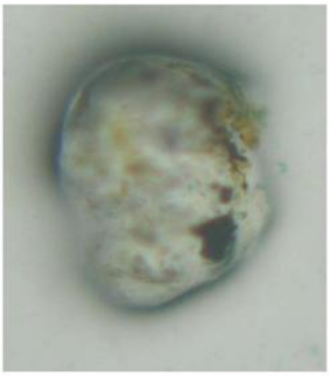

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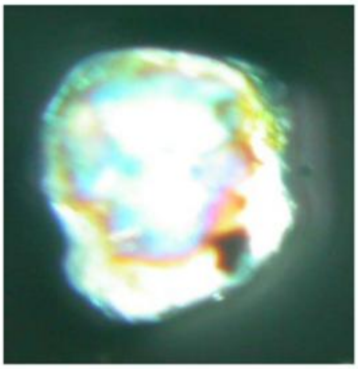

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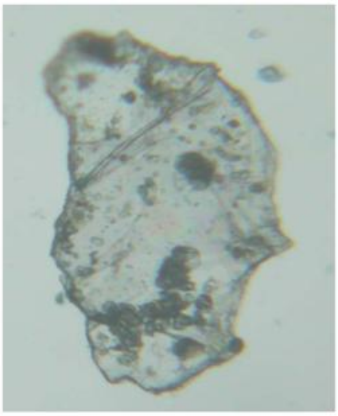

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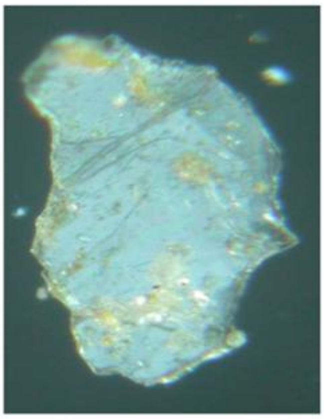

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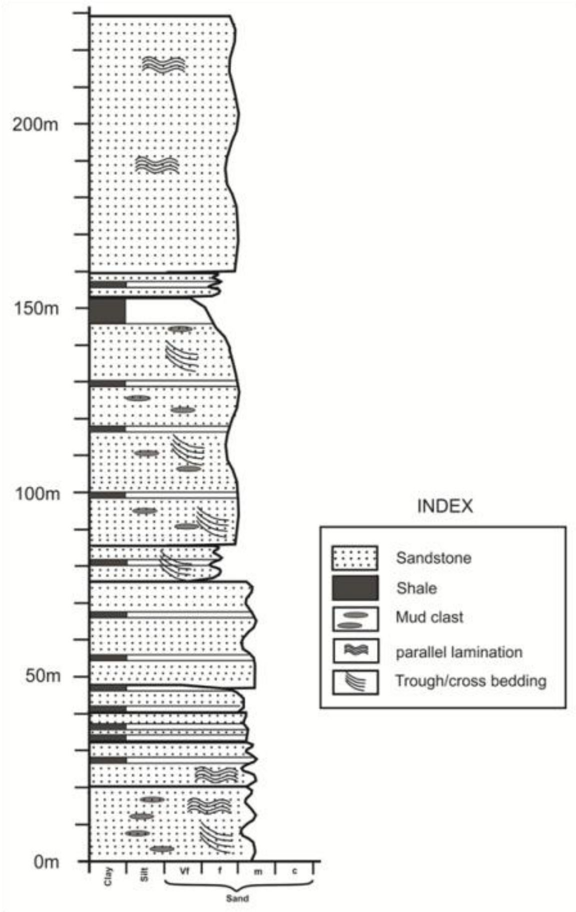

Figure 2. Litho-column of the study area.

Sample analyses

A total of 17 samples were collected from the lithological succession having thickness of about 228 m. Since Tipam sandstone are characterized by their soft, loose and friable nature; disintegration of grains was done by simply soaking the samples in the water in the containers for about 2-3 days. Samples are then thoroughly dried in the hot air oven for about 5-6 h at ~80°C. Since, the samples belong to the fine-grain sandstone, 100 mesh (ASTM) fractions were separated through sieving for the heavy mineral analysis. 50 g of each sample were weighted out for separation of heavy minerals using funnel separation method with the help of bromoform (specific gravity 2.89). The separated heavy minerals were then washed with acetone to remove the bromoform. Heavy mineral thus separated from the 17 samples were mounted on glass slides using Canada balsam for identification under the petrological microscope.

The heavy minerals assemblages identified and documented from the samples, and the physical and optical characteristics of the grains are the main criteria which are taken into consideration for ascertaining the provenance of the Tipam sandstone.

RESULTS

Description of heavy minerals

The heavy mineral suite in the Tipam sediments depicts a cosmopolitan nature. It comprises dominantly of non-opaque variety that includes zircon, tourmaline, rutile, staurolite, kyanite, sillimanite, apatite, epidote, garnet and hornblende. Iron oxide such as magnetite and heamatite constitute the bulk opaque variety.

The heavy minerals identified from the samples of the study area are described below and can also be seen in the photographic plate number 1 to 4.

Opaque Minerals (plate 1, Fig 1a-b): The only opaque minerals that can be identified in the present study is magnetite. Identification and separation of magnetite was done by using bar magnet because of its magnetic property. Other opaque minerals could not be identified under the petrological microscope.

Zircon (plate 1, Fig 2a-f): It constitutes one of the most common heavy minerals present in almost all the samples analyzed. Most of the zircon samples are colorless or slightly grayish in color under plane polarized light. High refractive index, parallel extinction, absence of cleavage, high order interference color and zoning are some of the prominent optical properties observed under the microscope. It occurs as a prismatic, sub-angular to sub-rounded grains.

Tourmaline (plate 1, Fig 3a-d): It shows an intense pleochroism from pale green to dark green and pale brown to brownish color. It exhibits a variety of color ranging from pale green, greenish yellow to pale brown. It is also one of the most abundant grains found in all the samples. Prismatic, angular and sub-rounded grains are common. Inclusions of non-opaque minerals are clearly observed in one of the specimen. Moderately high relief, parallel extinction and high order birefringence are clearly observed in the specimens.

Rutile (plate 2, Fig 1a-f): Rutile grains are fairly abundant in almost all the samples and are characterized by their blood red and pale to dark brownish yellow colors. High refractive index, faint pleochrosim and absence of cleavage are some of the distinguished optical features seen in the samples. Most of the rutiles in the present study show prismatic or elogated, irregular, and angular to sub-angular grains.

Sillimanite (plate 2., Fig 2a-d): Sillimanite occurs as colorless, firbrous or elongated shape with a prominent cleavage parallel to the elongated grains. High refractive index, straight extinction and second order greenish/ bluish birefrengence color are the dominant optical properties observed in the present specimens.

Staurolite (plate 2, Fig 3a-d): Staurolite grains were identified by its typical shape and light yellowish color. Strong pleochroism (pale yellow to golden yellow), moderately high relief, straight extinction, low birefringence color and hackly fracture nature of the grains are some of the other important optical and physical properties observed in the grains.

Kyanite (plate 3, Fig 4a-d): Kyanite also occurs as colorless and elongated or fibrous shape, cleavage excellent producing generally rectangular grains. Diagnostic optical properties like a step-like change in the order of interference colors and inclined extinction are clearly seen in the grains.

Garnet (plate 3, Fig 2a-d): Almost all the garnets in the present study are represented by a sub-angular to sub-rounded colorless variety of garnet. Optical properties cannot be described due to its isotropic nature. Conchoidal fracture and inclusions of opaque and non-opaque minerals are common in the sample grains.

Hornblende (plate 3, Fig 3a-c): The grains of hornblende are anhedral, elongated and irregular in shape. Pleochroic nature (green to pale green), prominent cleavage, incline extinction and second order greenish interference color are the dominant properties that can be described from the samples.

Epidote (plate 4, Fig 1a-d): The grains show colorless or slightly grayish color. It also shows a moderately high relief, straight extinction and low order interference color. The grains are sub-rounded and some occur as an irregular shape.

Apatite (plate 4, Fig 2a-d): Most of the grains show sub-angular to angular shape or irregular grains; colorless and moderately high relief under plane polarized light; low interference color (first order gray/light bluish gray) under crossed nicol; straight extinction, cleavage not prominent and inclusion very common in the grains.

DISCUSSIONS

The heavy mineral suite of the Tipam sandstone of the study area comprises of zircon, tourmaline, rutile, staurolite, kyanite, sillimanite, apatite, epidote, garnet and hornblende. The opaque varieties of the heavy minerals in the samples are represented mostly by the iron oxides. Magnetite can be separated easily from the other opaque minerals by using bar magnet whereas the other iron oxides like heamatite and illmenite are hard to identify as they lack distinct diagenetic petrographic properties under the petrological microscope. The optical and physical characteristics of each heavy minerals identified from the study area are being described in detail in the preceding section.

The presence of a few euhedral (first generation) colorless zircons not only suggests an acidic igneous source[9] but possibly short distance transportation. Presence of perfect euhedral and angular shaped tourmaline may also suggest a silicic igneous source with short transportation of the sediments. Blood red as well as orange color elongated/prismatic and sub-angular to sub-rounded rutile supports derivation of sediments not only from the sedimentary source but also from acid igneous rocks and high grade crystalline metamorphic rocks.[2] Presence of staurolite, elongated sillimanite, fibrous kyanite, colorless sub-angular garnet grains and irregular shaped hornblende may indicate a provenance comprising of metamorphic source dominated by green schist and amphibolites. Occurrence of few irregular hornblende grains may also reflect an acid igneous source too. Abundance of magnetite and other opaque varieties (iron oxides) may also suggest mafic igneous source.[2]

Taking into account the nature of shapes for the different heavy mineral grains of the study area, a significant contribution from the other sources other than sedimentary source has been envisaged as euhedral, sub-euhedral and irregular grains dominate over those having sub-angular, sub-rounded to rounded ones. Euhedral and irregular shape grains generally reflect less transportation as well as a non-sedimentary. Supply of sediments from the reworked sediments however, could not be completely ruled out, as some of the mineral grains like zircon and staurolite are found to have sub-rounded to rounded shapes.

The overall heavy mineral assemblages of the samples like abundance of zircon, tourmaline, rutile, sillimanite, staurolite, kyanite, garnet, epidote and apatite in the present study may be attributed to high grade metamorphic source of the sediments.[10-12]

A close study of the nature of the above heavy minerals assemblages reveals that the Tipam sediments are derived from a mixed provenance field comprising of high grade metamorphic and igneous sources as well as reworked sediments. However, it can be concluded that, the source of the sediments of the Tipam sandstone of study area are dominated by high grade metamorphic source and mafic and silicic igneous suites with not very long transportation.

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