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Detailed Geological Setting of Bodi-Bodimettu Ghat Section, Theni District, Tamil Nadu*

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***Abstract*— Bodi-Bodimettu road section located on the southeastern slope in the study area falls on eastern part of the Western Ghat. The Western Ghat around this area is characterized by high grade metamorphic rocks, which are generally weathered close to surface. The study area lies on Bodi-Bodimettu ghats section, Theni district, Tamil Nadu. The regional geology setting of the study area has done by Geological Survey of India. With the help of regional geology and investigation of field work and mapping, detailed geological setting of the area has prepared by this research. The study area mainly consists of Charnockite and Granitic Gneiss. The charnockite rocks are mostly found in the upper slope. The granite gneisses are exposed in the middle and lower part of the study area and show well developed foliations in addition to three sets of joints and few random joints.**

Keywords*— Regional Geology, Detailed Geology, Charnockite and Granitic Gneiss

I. INTRODUCTION

Bodi-Bodimettu road section located on the southeastern slope in the study area falls on eastern part of the Western Ghat. The Western Ghat around this area is characterized by high grade metamorphic rocks, which are generally weathered close to surface. The metamorphic rocks exposed in and around study area have well developed foliations in addition to joints. In this research, Geological setting of this area has been discussed under Regional Geology (Anon, 2005) and Local Geology (from field check).

Bodimettu being a town located on Tamil Nadu – Kerala border within Tamil Nadu limit, is a beautiful hill station situated on the top of a NE-SW trending ridge on Megamalai hills of Western Ghats. The ghat section starts from Mundal area in Bodi and runs along the southeastern slope till Bodimettu, which is located on the top of the ridge. Bodi (Latitude: N 10°00'53" and Longitude: E 77°15'04") to Bodimettu (Latitude: N 10°03'11" and Longitude: E 77°18'53") is located in Bodinayakkanur Taluk of Theni District, Tamil Nadu **(Fig 1)**. The study area includes approximately 10.09sq.km and falls in Survey of India Toposheet No. 58 F8/SW (1:25,000). Bodi town located in the plains is connected to Bodimettu by a 19km long hill road (NH 85) having 17 hairpin bends **(Fig 2).** This road further connects Munnar hill town (Kerala) and ultimately going upto Cochin town in Kerala.

Bodi-Bodimettu hill road is located on the southeastern slope of NE-SW trending ridge. The hill slopes on southern sides are fairly steep ranging upto 55°. The steep slope is generally barren with sparse vegetation cover in the middle and lower slopes. Intense coffee cultivation is being practiced on the western slope with minor streams flowing towards East.

On the Southeastern slope, where the study area is located, has few water courses, the important one being the east flowing Puliuttu River. A number of small streams are joining this river on the both the banks. Many of the landslides in this area can be attributed to the erosional activity associated with drainage. The hill slopes are drained by perennial and non-perennial streams, which form Puliuttu river system. The water courses start from top of the ridge, flow initially toward southeastern direction and ultimately turning towards east. The river systems show first, second and third order streams depicting a perfect dentritic drainage pattern**.**

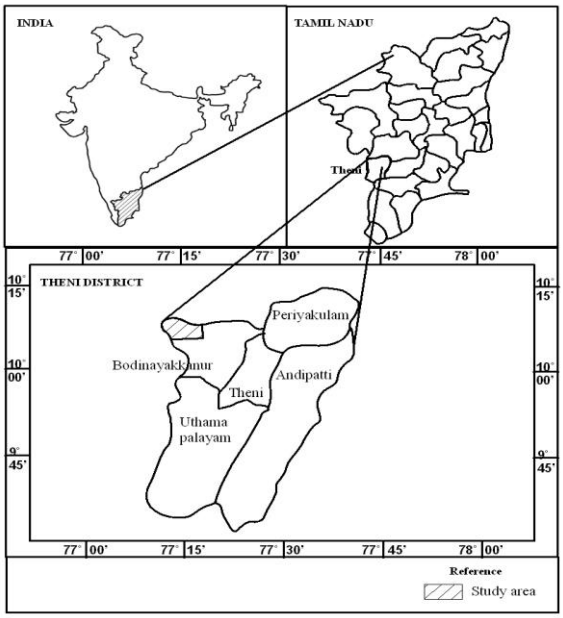

Figure 1. Location Map of study area

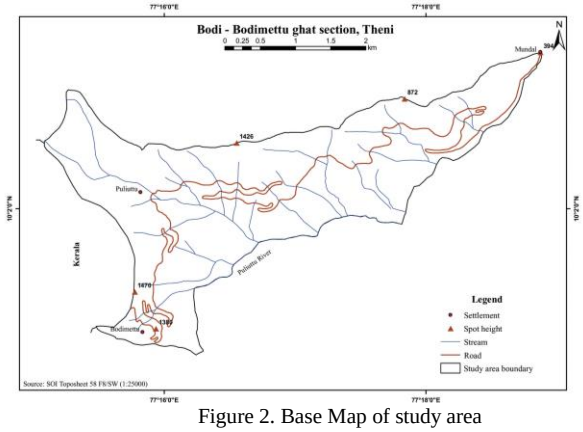

Figure 2. Base Map of study area

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II. REGIONAL GEOLOGY

The high grade metamorphic rocks are well exposed in southern Tamil Nadu (Theni district) on the moderate to steeply sloping hills. These rocks are characterized into three Groups (Krishnan, 1949; Anon, 2005), namely

i. Khondalite Group comprises quartzite, pyroxene granulite, calc gneiss / crystalline limestone, garnet-sillimanite / garnet-cordierite ± spinel gneiss, minor garnet-cordierite gneiss and garnetiferous quartzo-feldspathic gneiss (leptynite).
ii. Charnockite Group consisting of acid charnockite and pyroxene granulite.
iii. Migmatite Complex, represented by hornblende-biotite gneiss, grey granitic gneiss and pink migmatite.

The Regional Geology map of the study area is shown in **Fig 3.**

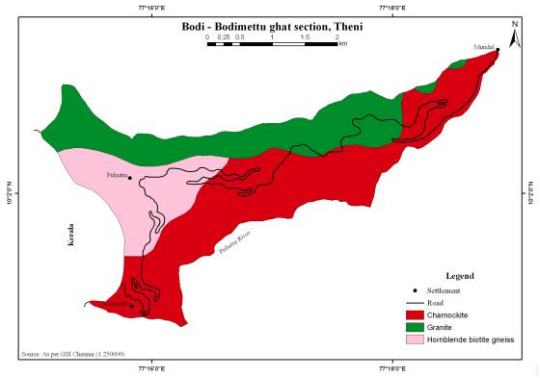

Figure 3. Regional Geology map

A. *Khondalite Group*

Khondalite Group (Krishnan, 1949; Anon, 2005) consists of meta-sedimentary rocks of arenaceous, calcareous and argillaceous composition metamorphosed under granulite facies and represented by quartzite, calc gneiss / diopside marble, garnet sillimanite gneiss with minor bands of garnetiferous quartzo-feldspathic gneiss (leptynite), garnet cordierite gneiss. These rocks occur as either individual bands or as a set of sequence as 'enclaves' or as tectonic slices within the predominantly charnockite-migmatite country.

Quartzite is the important member of Khondalite Group occupying the crest of linear ridges. The thickness varies from less than a metre to 150m. The quartzite is white or dirty white in colour and composed essentially of interlocking grains of quartz and feldspar, which is often kaolinised.

Mafic granulite is dark grey medium grained, evenly granular rock of thickness from 3 to 20m, which is interbanded with quartzite. It consists of mainly diopside, hypersthene, feldspar and quartz.

Calcareous gneiss is grayish white, medium grained, granular or gneissose rock with typical ribbed weathering. It consists mainly of green diopside, white calcite and quartz with pinhead size garnets, green apatite and magnetite as accessory minerals. The thickness of calc gneiss varies from a meter to 30 m. With the decrease of silicate minerals and increase of carbonates, the calc gneiss grades into crystalline limestone at a few places.

Garnet-silimanite gneiss represents metamorphosed pelitic sediments. This rock shows a thickness varying from 1 to 50m. Development of garnet is very profuse and at times, garnet rich layers of 1 to 2cm thick are found alternating with quartz-feldspar rich layers. Silimanite occurs in varying amounts. Biotite is a common associate mineral. Development of cordierite is noticed in the garnet-silimanite gneiss in a few places.

Minor bands of a few centimetres to a couple of metres wide whitish looking quartzo-feldspathic gneiss (leptynite) with unevenly distributed pink garnets occurs as inter-bands within garnet-sillimanaite gneiss. This rock represents the metamorphosed psammitic sediments within the predominant metapelitic rock.

B. *Charnockite Group*

The Charnockite Group consists of acid to intermediate charnockite and the associated thin interbands and lenses of pyroxene granulite. The pyroxene granulite is dark grey granular to gneissic, medium grained and occurs mostly as unmappable bands within charnockite and hornblende biotite gneiss.

The charnockite is grey, greasy, medium to coarse grained massive rock and occupies a major part of Theni district. It occurs over the hills as well as the plains underlying the metasediments. The rock is chiefly made up of quartz, K-feldspar, plagioclase and hypersthene with apatite and magnetite as accessories. Pink garnets upto 1 to 2mm diameter are developed in places (Krishnan, 1949; Anon, 2005).

C. *Migmatite Complex*

The charnockitic rocks have been extensively migmatised due to later quartzo-feldspathic influx resulting in banded hornblende-biotite gneiss which with change in intensity of migmatisation grade into granitic gneiss and grey hornblende granite

The hornblende biotite gneiss is medium to coarse, pale grey coloured rock and show banded structure with alternating quart-feldspar rich layers and hornblende-biotite rich layers with individual layers ranging from 1mm to 1cm width imparting a well developed gneissosity to the rock. (Krishnan, 1949; Anon, 2005).

Granitic gneiss is grey, medium grained, well foliated rock with colour and compositional banding. It occurs mostly as band upto 15m wide, cofolded along with the metasediments. The rock is chiefly made up of quartz and orthoclase, which is mostly perthitic with plagioclase and biotite as the main accessories. The hornblende granite is a medium grained massive, grey coloured rock and is made up of quartz, K-feldspar, and plagioclase with hornblende and biotite as accessories. Minute sulphide minerals mainly pyrite and pyrrhotite and rare chalcopyrite are seen embedded within hornblende and biotite in hand specimen.

A small band of carbonatite is exposed at the foot hills to the west of Cumbum. Younger intrusives that are noticed in the Theni district are thin veins of pegmatite seen cutting all the rocks. Pegmatite is coarse grained, mostly pink

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coloured with orthoclase and quartz as the main minerals. Biotite and magnetite occur in small amounts.

Quaternary sediments up to 10 to 30m thick occur in the Cumbum valley occupying the NNE-SSW troughs formed due to block faulting (graben). The Quaternary sediments of Theni district comprises gravity slided deposits and boulders and cobbles overlain by sheet wash and slope wash materials like medium sized boulders, pebbles and coarse sands. Colluvial deposits of assorted pebbles and sand are deposited at the bread in slope, which are overlain by a graded sequence of alluvial deposits of medium sands, find sand and slit. It is overlain by basal boulder bed, siliceous limestone, calcareous and ferruginous sandstone with calcrete and kankar layers and coarse sandstone interbedded with partly lithified sandstone and thin layers of kankar and sand-silt-clay admixtures.

Three phases of folding are recognized with the earliest (F1) being tight to near isoclinal fold of reclined to recumbent type. The F2 fold is of close type with steep axial plane trending NE-SW with low southerly plunge. Third phase (F3) occur as open type along NW-SE to WNW-ESE axial trace. The main trend of the rock is NE-SW to E-W with moderate to steep dips towards SE and South. The area has undergone metamorphism of upper amphibolite to granulite facies with subsequent retrogression

III. DETAILED GEOLOGY

The rocks exposed in the area of study mainly belong to Charnockite and Migmatite Group. These rocks generally have thin (0.5 – 1.0m) overburden to very thick (> 5m) overburden materials present above the rock cover. The overburden materials are generally clayey in nature with dark brown colored and having high cohesion. The detailed geological map of the study area (**Fig 4)** shows the distribution of various litho-units in the study area. Various geological features as observed in the field are shown in **Fig 5.**

The rocks exposed in the study area mainly consist of Charnockite and Granitic Gneiss. The Charnockite rocks are mainly found in the higher slope, particularly close to Bodimettu area. They occupy a small stretch (6 km) along the road. The Granitic Gneisses are exposed in the middle and lower part of the study area. In addition numerous pegmatite veins (ranging thickness from few cm to 0.5 m) have also been noticed in many locations. They generally have a trend parallel to foliation. In addition, one meta-volcanic intrusion having thickness of 50 – 100 cm was also observed in the lower slope area near R-34 section. It runs parallel to the foliation plane.

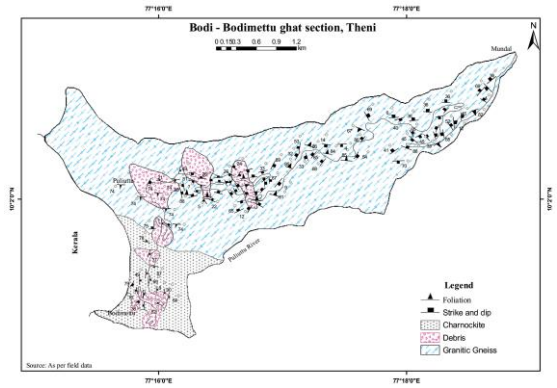

Figure 4. Detailed Geology map

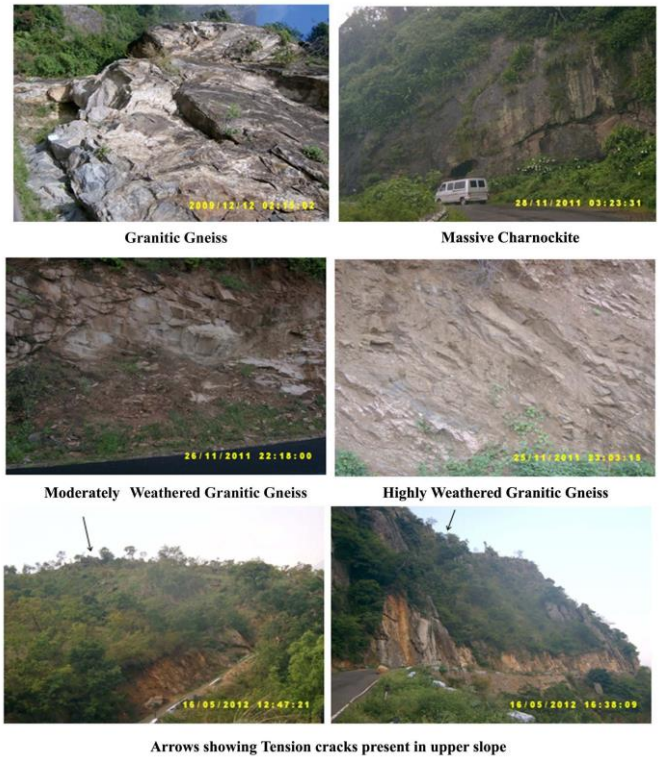

Figure 5. Field Photos for Geological Investigation

A. Charnockite

Charnockites exposed in study area are grey to dark grey coloured, medium to fine grained, widely jointed, more massive and are generally weathered close to surface. Three sets of joints are seen in the rock in addition few random joints observed at places. The feldspars and dark minerals are more weathered as compared to quartz grains. The weathering is more prominent along joint surfaces. The joints are generally spaced at few cm to more than 2m, though widely spaced joints are seen in most places. Though the joints are generally tight, the open joints can be seen at places with high weathering along the walls. Since the rocks are well jointed, the subsurface seepage through the rocks has created wet patches at many places. Minor springs have also been noticed in a few locations. The cut slopes created in these rocks due to road constructions are generally stable due to higher cohesion close to Bodimettu. This rock zone is

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generally characterized by presence of thick patches of debris seen at many places.

B. Granitic Gneiss

The granitic gneisses exposed in the study area are mainly seen in middle and lower hill slopes, close to Bodimettu along the road. The rocks are grey colour and generally show weathering close to surface. The gneissic rocks mainly consist of alternating layers of dark and light coloured minerals. The light mineral layers include quartz and feldspar. The rocks are more weathered wherever dark minerals are dominantly present. The foliations have been observed to dip into the hill at places, while they dip towards the valley at some other locations. Accordingly the local stability conditions are mainly dependant on orientation of foliation with reference to the slope direction. These rocks are generally barren and may have thin over burden debris at places. The rocks are well foliated in nature with less developed joints. The joints have less strike continuity (< 1m).

C. Structure

The rocks exposed in Bodi-Bodimettu area show well developed structural features in the form of foliation and joints. Foliation planes are well developed in granitic gneisses with less developed joints. On the other hand charnockites have well developed joint planes with no foliation planes. The geological discontinuities observed in the granitic gneisses (about 100 Nos.) have been plotted in as stereonet and contoured. Based on maxima of pole concentration, great circles have been drawn corresponding to individual set of structural discontinuities **(Fig 6 and Table 1).**

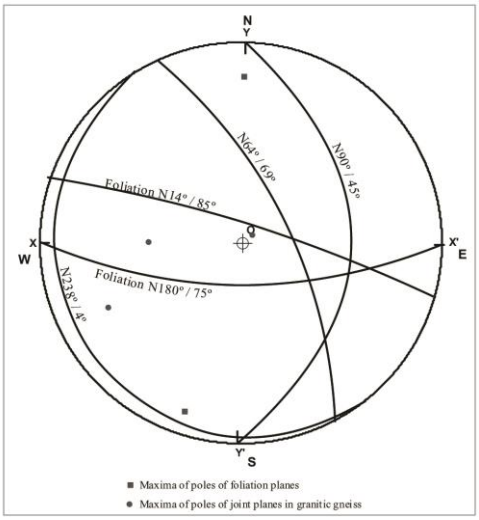

Figure 6. Stereoplot of discontinuities in granitic gneiss

Table 1. Joint sets based on Pole concentration observed in granitic gneiss

Sl.No.	Joint pole concentration	Strike; Dip/ Dip direction
1	J1	N 328°; 4°/ N 238°
2	J2	N 180°; 45°/ N 90°
3	J3	N 334°; 69°/ N 64°
4	F1	N 90°; 75°/ N 180°
5	F2	N 104°; 85°/ N 14°

The charnockite rocks are well traversed by joints though foliations are absent in this terrain. The joints observed in charnockites have been plotted in a stereonet and contoured. Based on maxima of pole concentration, great circles have been drawn corresponding to individual set of joints **(Table 2 and Fig 7).** The joints are generally spaced few cm to 2m and weathering effects are more along the joint walls. Generally no fillings are seen within the joints, though minor infillings can be seen at places.

Table 2. Joint sets based on Pole concentration observed in charnockite

Sl.No.	Joint pole concentration	Strike; Dip/ Dip direction
1	J1	Due N; 44°/ N 90°
2	J2	N 20°; 37°/ N 110°
3	J3	N 180°; 65°/ N 270°

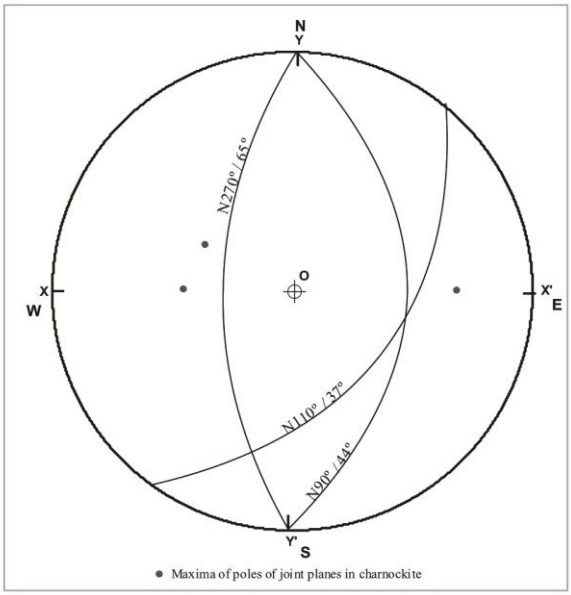

Figure 7. Stereoplot of discontinuities in charnockite

D. Lineaments

The lineament map of study area was prepared from aerial photograph and IRS 1C LISS-III geocoded satellite imagery acquired during the years 1985 and 2009. A perusal of lineament map shows the following:

1. The major lineament trends NE-SW to NNE-SSW.
2. A minor lineament of second order trends NW-SE to WNW-ESE.
3. A minor lineament of third order trends East-West to ENE-WSW.

The lineament map of the study area (**Fig 8)** shows the varying pattern of features corresponding to major tectonic orogeny (Anbalagan and Saranathan, 2001). The lineament pattern (**Fig 9)** as observed in field can be related to different features on the ground which can be better understood and correlated to the local geological and structural conditions.

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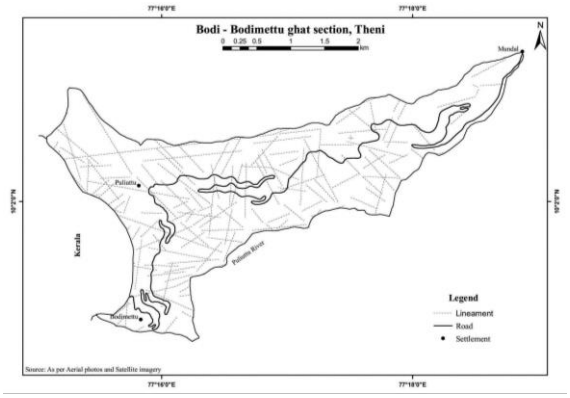

Figure 8. Lineament map

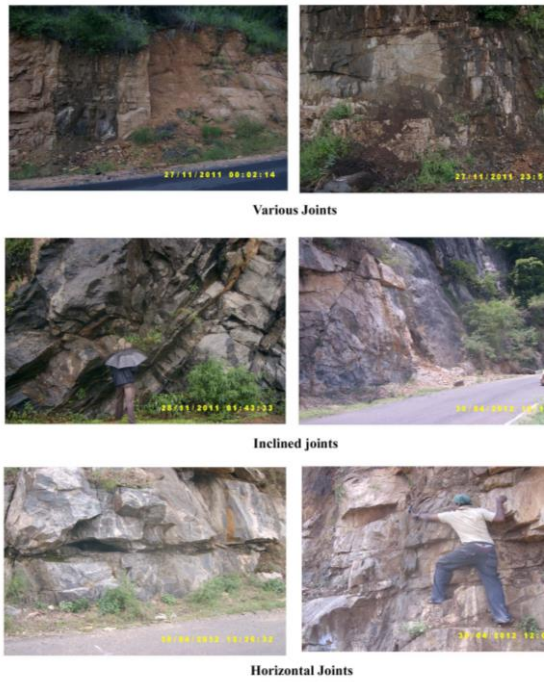

Figure 9. Photos for various Geological Joints

CONCLUSION

Geologically, Bodi-Bodimettu area falls within Charnockite Group and Migmatite Group of rocks belonging to Archean age. The rocks exposed in the study area mainly consist of charnockite and granite gneisses. The charnockite rocks are mostly found in the upper slope. The granite gneisses are exposed in the middle and lower part of the study area and show well developed foliations in addition to three sets of joints and few random joints.

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