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GEOLOGY AND SOIL OF DHANKUTA AREA EASTERN NEPAL

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ABSTRACT

A geological map of 200 sq km of Dhankuta area is presented. Mapped geological formations recognized include Dhankuta and Mulghat formations of Precambrian–Lower Paleozoic age. The Dhaukuta Formation comprises of garnet–biotite–muscovite–quartz schist and gneiss with conspicuous beds of grey and white quartzite. The Mulghat Formation is differentiable into three members and includes schistose phyllite and actinolite schist with carbonates, garnetiferous phyllite with sills of amphibolite, and phyllite and quartzite. The general strike of the formation is east west and dips northerly in order of 20° to 60°. The east–west trending Tamar fault passes to the south of Dhankuta Bazar. The nature of the soil present in Dhankuta Bazar is non-plastic and is formed by insitu weathering of the parent rock. The deep gullies are prominent feature caused by an intensive erosion and denudation of the soil and the instability of the surface could largely be attributed to this factor. A few stone quarries can be operated around Dhankuta Bazar for the supply of building and dimension stones to minimise the immediate brick problem.

INTRODUCTION

The present paper deals with the geological setting of the Dhankuta area. The map area lies in the Mahabharat zone and is traversed by the north–south flowing Dhankuta Khola and Tamkhuwa Khola which join the Tamar River flowing along the east–west trending valley to the south. The region north to the valley is a rugged mountainous country with altitudes up to 2,200m. The Dhankuta town (under planning) area embraces the top and slope of the Dhankuta Ridge, it measures 15 sq. km. approximately and the altitude varies between 900 m. and 1200m, the western slope is having comparatively steeper gradient. The area has undergone extensive physical weathering, erosion and denudation.

GEOLOGY

The Dhankuta district as a whole is comprised of Midland meeta-sediments. The rocks of the area have undergone some degree of change in their textural, and minerological composition due to metamorphism and due to the effect of granite intrusives (Fig. 1 & 2)

Table 1: Lithostratigraphy of the metamorphic rocks of Dhankuta area.

Age	Formational Units	Lithology
Precambrian (?) to Lower Paleozoic (?)	2. Dhankuta Formation	Schists and gneisses: Medium to coarse textured garnet-biotite muscovite quartz schist, and gneiss with conspicuous beds of grey and white micaceous quartzites, calc silicate rocks and pegmatite veins.
	1. Mulghat Formation	1c. Schistose phyllites and actionolite schists: Grey to brownish grey, calcareous schistose phyllites and greyish white quartzites with thin intercalation of actinolite schists, carbonates and amphibolites.
		1b. Garnetiferous phyllites: Grey to lead grey garnetiferous phyllites with subordinate beds of grey and white quartzites, and sills of amphibolites.
		1a. Phyllites and quartzites: Grey to dark grey and greenish phyllites profusely impregnated with quartz lenses and interbedded with grey, white and greenish quartzites, dolomites, carbonaceous slates, and lenses of amphibolites.

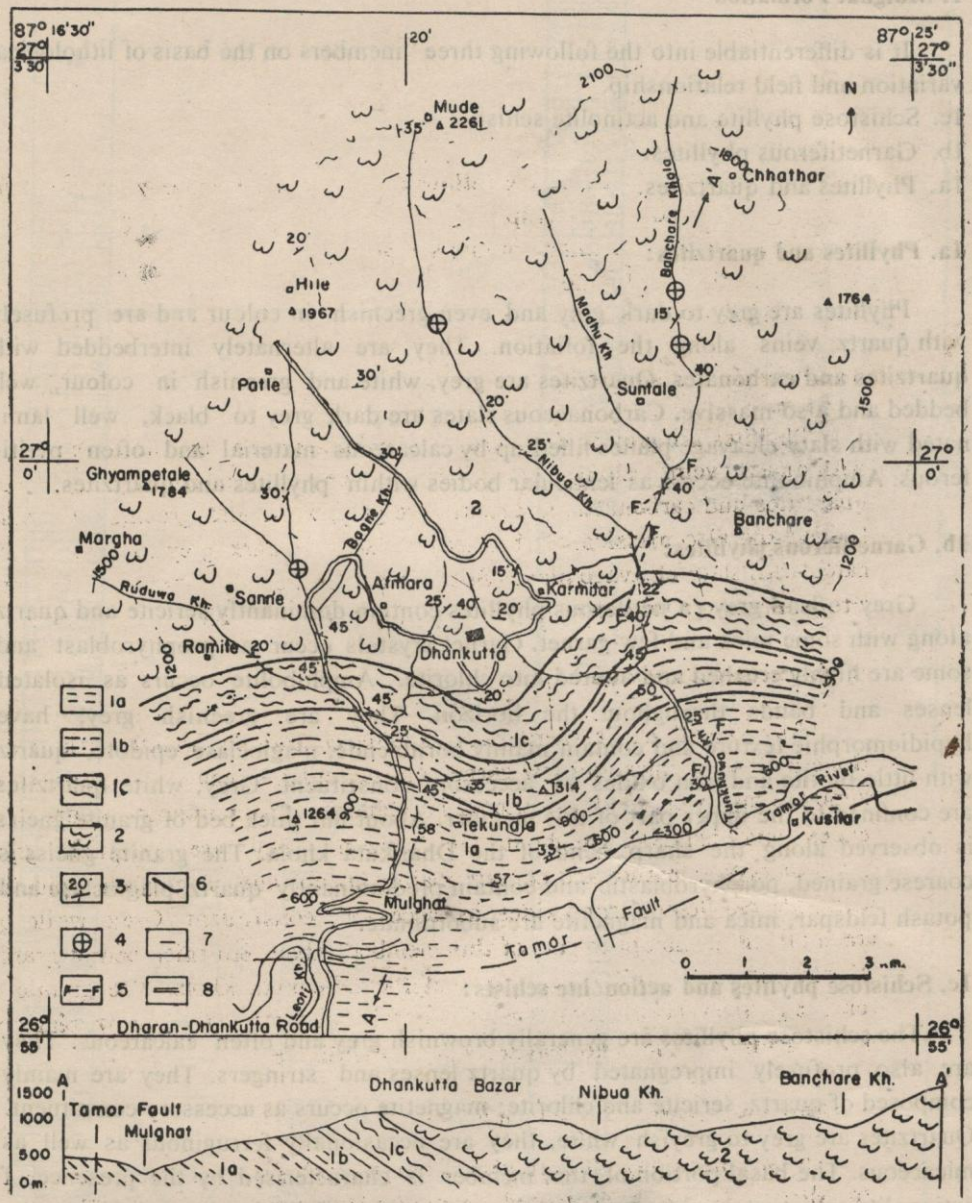

Fig. 1. Geological Map and Profile of Dhankuta Area 1a: Phyllites & Quartzites 1b: Garnetiferous Phyllites, 1c: Schistose Phyllites & Actinotite Schist, 2: Garnet – biotite – muscovite – quartz – schist and gneisses, 3: Strike and dip, 4: Horizontal bed, 5: Fault, 6: Contact line, 7: Section line, 8: Road.

1. Mulghat Formation

It is differentiable into the following three members on the basis of lithological variation and field relationship.

1c. Schistose phyllite and actinolite schist.
1b. Garnetiferous phyllites.
1a. Phyllites and quartzites.

1a. Phyllites and quartzites:

Phyllites are grey to dark grey and even greenish in colour and are profusely with quartz veins along the foliation. They are alternately interbedded with quartzites and carbonates. Quartzites are grey, white and greenish in colour, well bedded and also massive. Carbonaceous slates are dark grey to black, well laminated with slaty cleavage planes filled up by calcareous material and often pyritiferous. Amphibolite occurs as lenticular bodies within phyllites and quartzites.

1b. Garnetiferous phyllites:

Grey to lead grey garnetiferous phyllites contain dominantly sericite and quartz along with some mica and few garnet. Garnet crystals occur as prophyroblast and some are highly crushed and altered into chlorite. Amphibolite occurs as isolated lenses and bands throughout the horizon. They are greenish grey, have hypidiomorphic texture and contain mainly hornblende, plagioclase, epidote, quartz with little biotite and iron oxides as accessory constituent. Grey, white quartzites are confined to the upper part of this member. About 8m thick bed of granite gneiss is observed along the sharp bend of the Dhankuta khola. The granite gneiss is coarese grained, porphyroblastic and contain predominantly quartz, plagioclase and potash feldspar, mica and magnetite are subordinate.

1c. Schistose phylites and actionclite schists:

The schistose phyllites are generally brownish grey and often calcareous. They are also profusely impregnated by quartz lenses and stringers. They are mainly composed of quartz, sericite and chlorite; magnetite occurs as accessory constituent. Quartzites are grey to greyish white, they are occasionally ferruginous as well as micaceous. The basal portion of the member is characterised by the presence of actionolite schist, carbonates and occasional graphitic phyllites. At places actionlite marble bands are present.

2. Dhankuta Formation

The schist and gneiss are medium to coarse textured, and comprise of quartz, feldspar, biotite, muscovite, garnet, and occassionally tourmaline of schoral

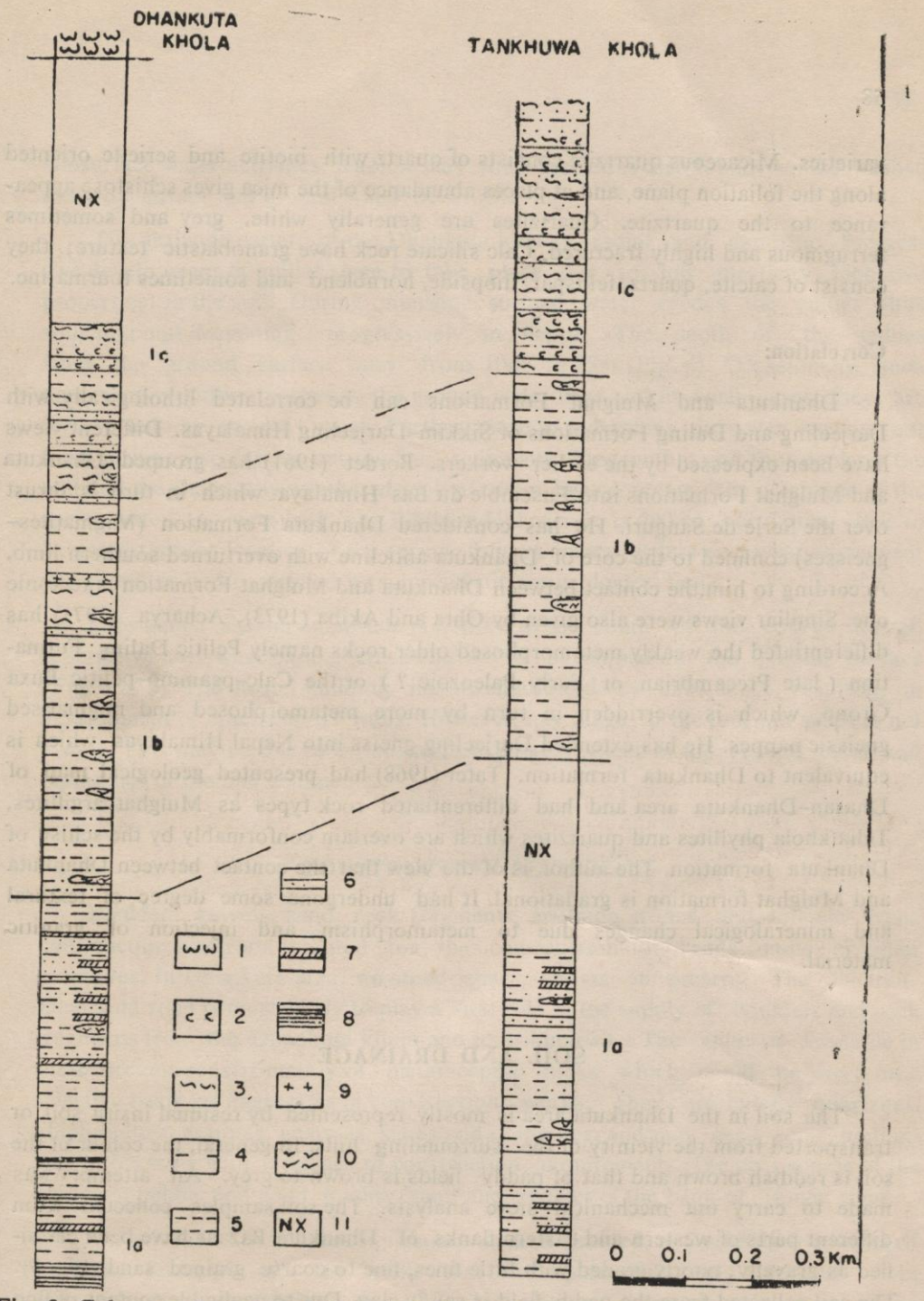

Fig. 2. Columnar Section of Dhankuta & Tankhuwa Khola. 1. Garnet–biotite –muscovite – quartz schist and gneiss, 2. Actinolite schist, 3. Calcareous phyllite, 4. Garnetiferous phyllite, 5. Phyllite, 6. Quartzite, 7. Dolomite and carbonate, 8. Carbonaceous stale, 9. Granite gneiss, 10. Basic rock (Amphibolite), 11. No Exposure.

varieties. Micaceous quartzite consists of quartz with biotite and sericite oriented along the foliation plane, and at places abundance of the mica gives schistose appearance to the quartzite. Quartzites are generally white, grey and sometimes ferruginous and highly fractured Calc silicate rock have granoblastic texture; they consist of calcite, quartz, feldspar, diopside, hornblend and sometimes tourmaline.

Correlation:

Dhankuta and Mulghat Formations can be correlated lithologically with Darjeeling and Daling Formations of Sikkim–Darjeeling Himalayas. Different views have been expressed by the earlier workers. Bordet (1961) has grouped Dhankuta and Mulghat Formations into Ensemble du Bas Himalaya which in turn is thrust over the Serie de Sanguri. He has considered Dhankuta Formation (Migmatites–gneisses) confined to the core of Dhankuta anticline with overturned southern limb. According to him,the contact between Dhankuta and Mulghat Formation is tectonic one. Similiar views were also given by Ohta and Akiba (1973), Acharya (1971) has differentiated the weakly metamorphosed older rocks namely Pelitic Daling Formation (late Precambrian or Early Paleozoic ?) or the Calc–psammo–pelitic Buxa Group, which is overridden in turn by more metamorphosed and migmatised gneissic nappes. He has extended Darjeeling gneiss into Nepal Himalayas which is equivalent to Dhankuta formation. Tater (1968) had presented geological map of Dharan–Dhankuta area and had differentiated rock types as Mulghat argillites, Telia khola phyllites and quartzites which are overlain conformably by the schist of Dhankuta formation. The author is of the view that the contact between Dhankuta and Mulghat formation is gradational. It had undergone some degree of textural and mineralogical changes due to metamorphism and injection of granitic material.

SOIL AND DRAINAGE

The soil in the Dhankuta area is mostly represented by residual insitu soil or transported from the vicinity of the surrounding hills. In general, the colour of the soil is reddish brown and that of paddy fields is brown to grey. An attempt was made to carry out mechanical sieve analysis. The soil samples collected from different parts of western and eastern flanks of Dhankuta Bazaar have been classified as gravelly, poorly graded with little fines, fine to coarse grained sand (Fig. 3). The soil collected from the paddy field is sandy clay. Due to negligible content of fine materials in the soil, they are found to be non-plastic. The soil is mainly formed by insitu weathering of the parent rock (schist and gneiss of Dhankuta Formation). The fines are washed away by rain water, especially in the form of suspension and colloidal solution. Feldspar present in the schist and gneiss are kaolinised by

subsurface water activities. Kaoline clay thus formed is also found to be washed away by surface and ground water aetivities.

The drainage pattern of the Dhankuta area is radial and dendritic. Progressive development of gullies seem to take place due to low plasticity (cohesive properties) in the soil. During monsoon, surface water erodes the gullies thus widening and deepening progressively in depth. The depth of the gullies from the ground surface vary from 10m to 25m (Fig. 4). Occasionally, such deepening of gullies reaches to the ground water level and in such cases they are further fed by ground water. Further close to the gullies, the water oozing out from springs also carries out the fine sediments along with it and thus depletes the soil and the chemically weathered rock of their finer contents. The discharge of the spring water, as measured in Bihibare Hat area, is 700 cc per minute. It is to be noted that the location of the springs follows more or less east west alignement and probybly it is controlled by some subsurface geological fault.

Subsidence of 2.4m amplitude is noticed to the south of the college hostel. A series of east–west parallel cracks have also developed on the ground surface (Fig. 4 & 5). The hostel building has been affected by subsidence resulting in development of cracks on its walls. However, any bulge at the foot hill slope is not visible. This may be due to the subsurface erosion effect of the ground water and piping out of the fine sediments.

CONSTRUCTION MATERIALS

Boulders, gravels, sand, rock fragments, building stones and soil are basic construction materials required for the construction of roads, dams or other structures. In Dhankuta area, no stone quarry exists at present. The Dharan–Dhankuta road is most likely to play a vital role in the supply of boulders and rock fragments from the Dhankuta khola and its tributaries. The material available in these streams consist mainly of metamorphic rocks which could be used on a selective basis, as aggregates in construction works. They are chiefly quartzites, amphibolites, granites, gneisses, slates and dolomites, and may need some preliminary processing with reference to construction requirements. The next source of the boulders, pebble and good quality sand and pebbles is the bank of Tamar river.

The soil found in the area is mainly coarse grained, and contain fragments of quartzite, feldspar, etc. The bricks that are presently being prepared from such soil is of low quality due to low bearing strength. There are good sites for opening few stone quarries and some of them could be located along Dhankuta khola. Most of the construction works are being carried out around Dhankuta Bazar and the proposed quarry sites are approximately 2.5 km west of the Bazar. The rocks are fine grained, compact quartzites and

granite-gneisses which look suitable for use as slabs. These quarries can be operated initially for the supply of buildidg and pavement stones, thus minimising immediate brick problem.

In the region of Tankhuwa and Dhankuta Kholas, local kilns are being operated for the manufacture of lime used for construction purpose. The lime is mainly extracted from calcareous encrustations on phyllites. As the occurence of such calcareous encrustation is scattered and generally does not exceed few centimeters in thickness (Fig. 6) any large scale production of lime from such deposits is not feasible.

CONCLUSION

Present investigation has identified some of the basic geological factors that create instability in the surface condition of the town development area of Dhankuta. Regardless of tectonic setting of Dhankuta area, few immediate steps that need to be taken for restraining further erosion and gully formation are enumerated below:

1. Control of the existing gullies can be achieved by seeding or planting trees, grasses, shrubs, and vines either separately or in combinitiou.
2. Soil flow in the gullies can be checked by plugging or temporary check dams. Would, bamboo, vines either separately or in combination.
3. An organised drainage system should be developed and constructed; this will control the high velocity of runnig water responsible for intensive erosion of said and deepening of gullies

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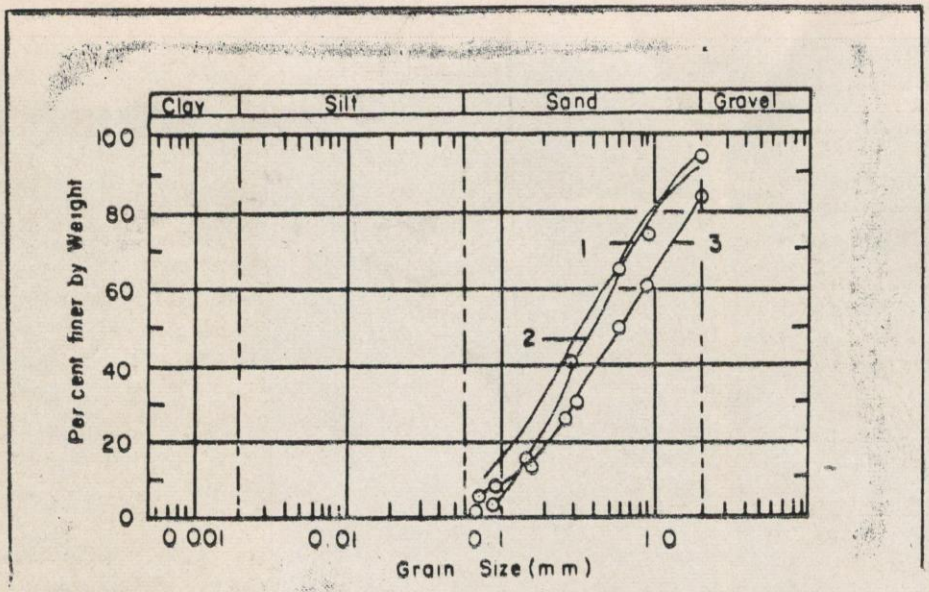

Figure 3: Gradation Curves of Soils 1 & 2 Soil Samples from Atmara and 3 from Barhara.

Figure 4: Figures showing deep incisions of the gully east of college hostel (Dhankuta Bazar).

Figure 5: Figures showing subsidence of ground surface at College Hostel (Dhankuta Bazar).

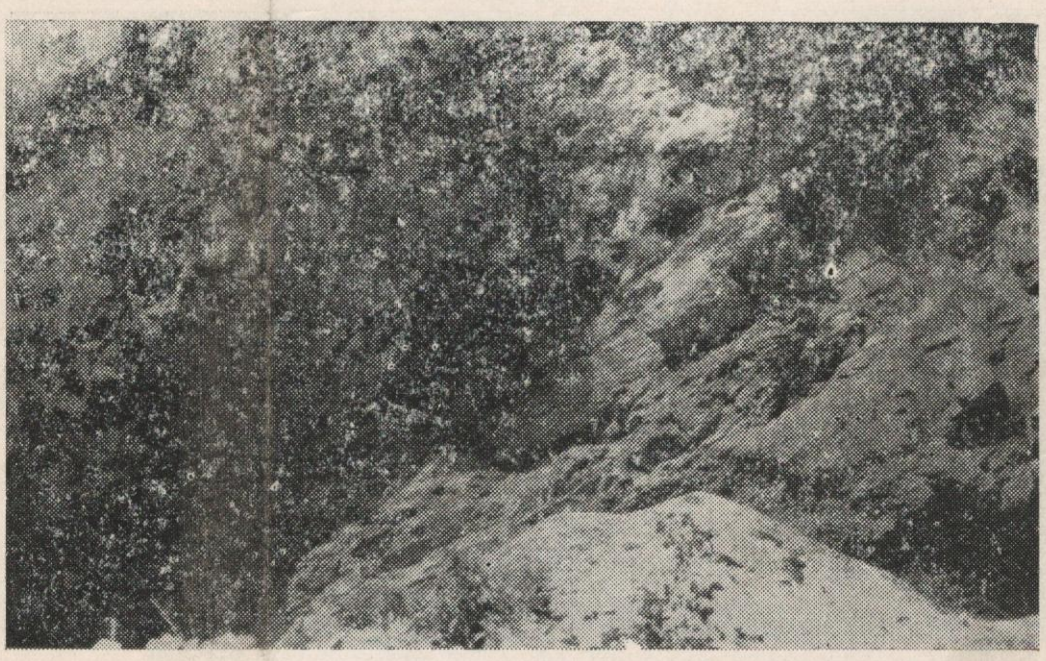

Figure 6: Calcareous encrustation in phyllite and quartzite (Tankhuwa khola).

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