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Active Faults in Southwestern Kathmandu Basin, Central Nepal

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ABSTRACT

Two active faults running in NW-SE direction are discussed in the southwestern margin of the Kathmandu Basin . The fault morphology is expressed by isolated mounds, scarps, and depressions. The faults dislocate the colluvial slopes and terraces of the late Pleistocene. The Quaternary sediments in the vicinity of the fault zone are tilted. The field evidences suggest the downthrow of the foot wall along the southwestward dipping fault plane. The vertical rate of displacement along the fault exceeds 1.0 mm/yr. The right-lateral slip, which is characteristic of the NW-SE trending faults in the Nepal Himalaya (Nakata 19 88), is not recognised in this area.

INTRODUCTION

A large number of active faults occur in the Nepal Himalaya. The crustal shortening due to the collision of the Indian and the Eurasian plates produced these active faults. Nakata (1982) pointed out that most of the active faults in the Nepal Himalaya are distributed along the major tectonic boundaries such as the Main Central Thrust (MCT), the Main Boundary Thrust (MBT) (his Main Boundary Fault) and the Himalayan Frontal Thrust (HFT) (his Himalayan Front Fault). He also classified the active faults into four groups, viz. 1) the Main Central Active Fault System, 2) the active faults in the Lower Himalayas, 3) the Main Boundary Active Fault System, and the active faults along the Himalayan Frontal Thrust (Fig.1).

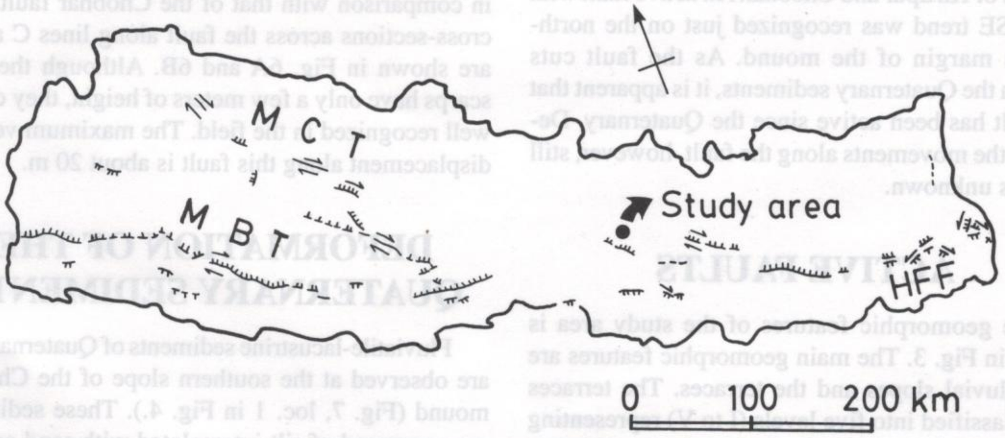

Fig. 1 Location map of the study area and the distribution of active faults in Nepal (Nakata 1982)

According to Nakata (1982) and Nakata et al. (1984), the active faults except for those associated with the HFT, show northward downthrow with a right-lateral slip component along the NW-SE trending faults. They also noted that the active faults located north of the MBT do not favour the upheaval of the Himalaya. However, it may not be appropriate to evaluate the role of the active faults only in terms of the Himalayan uplift. Their role in the formation of such regional structures like intramontane basins seem to be very important and studies on such problems have been scarcely carried out so far.

This paper deals with the active faults in the southwestern part of the Kathmandu basin lying in the Lower Himalaya of Nepal.

GEOLOGICAL SETTING

The Kathmandu valley is an intramontane basin developed concomitantly with the formation of the Kathmandu nappe. The surrounding ridges (1500 m to over 2700 m in height) are composed of the rocks of Precambrian to Palaeozoic age, and the basin is filled by a thick sequence of lacustrine sediments of Pliocene to Pleistocene (Yonechi 1973, West and Munthe 1981, Yoshida and Igarashi 1984, Dongol 1985,1987).

The geology of the southwestern part of the basin is shown in Fig. 2. In this area, the Palaeozoic limestone forms the NW-SE running Chandragiri ridge. Parallel to the Chandragiri ridge, there is an elliptical mound made of bedrock on which lies the villages of Kirtipur and Chobhar. An active fault with a NW-SE trend was recognized just on the northeastern margin of the mound. As the fault cuts through the Quaternary sediments, it is apparent that the fault has been active since the Quaternary. Details of the movements along the fault, however, still remains unknown.

ACTIVE FAULTS

The geomorphic features of the study area is shown in Fig. 3. The main geomorphic features are the colluvial slopes and the terraces. The terraces were classified into five levels (I to V) representing from the highest (I) to the lowest levels (V). The lacustrine sediments underlying the colluvium gave a ^{14}C age of 25,000 yr. B. P. (Saijo 1991) indicating that the colluvial slope started forming since that time. A large landslide block occurs in the southeastern part of the study area. Although several levels of terrace surfaces are also recognized within the landslide block, their correlation with other terraces of the study area is difficult.

CHOBHAR FAULT

This active fault marked by the northeast facing fault scarp and a few isolated mounds lining up in a NW-SE direction is newly named as Chobhar Fault after the name of a nearby village (Fig. 4). This active fault was already recognized by pervious workers. The trace of the Chobhar Fault is more or less undulating and can be traced for about 4 km. The fault trace shows convexity towards NE near Chobhar hill. Two cross-sections (A and B) drawn perpendicular to the fault are shown in Fig. 5. Fig 5A shows that the Terrace surface I has warped above the fault with a vertical displacement of 20 m.

CHANDRAGIRI FAULT

Another active fault which is characterized by a few northeast facing fault scarps and depressions is recognized at the foot of the Chandragiri ridge and is named as Chandragiri Fault. It also runs along a NW-SE direction and can be traced for about 3 km. The trace of the Chandragiri Fault look rather linear in comparison with that of the Chobhar fault. Two cross-sections across the fault along lines C and D are shown in Fig. 6A and 6B. Although the fault scarps have only a few meters of height, they can be well recognized in the field. The maximum vertical displacement along this fault is about 20 m.

DEFORMATION OF THE QUATERNARY SEDIMENTS

Fluviatile-lacustrine sediments of Quaternary age are observed at the southern slope of the Chobhar mound (Fig. 7, loc. 1 in Fig. 4.). These sediments are composed of silt intercalated with sand and an-

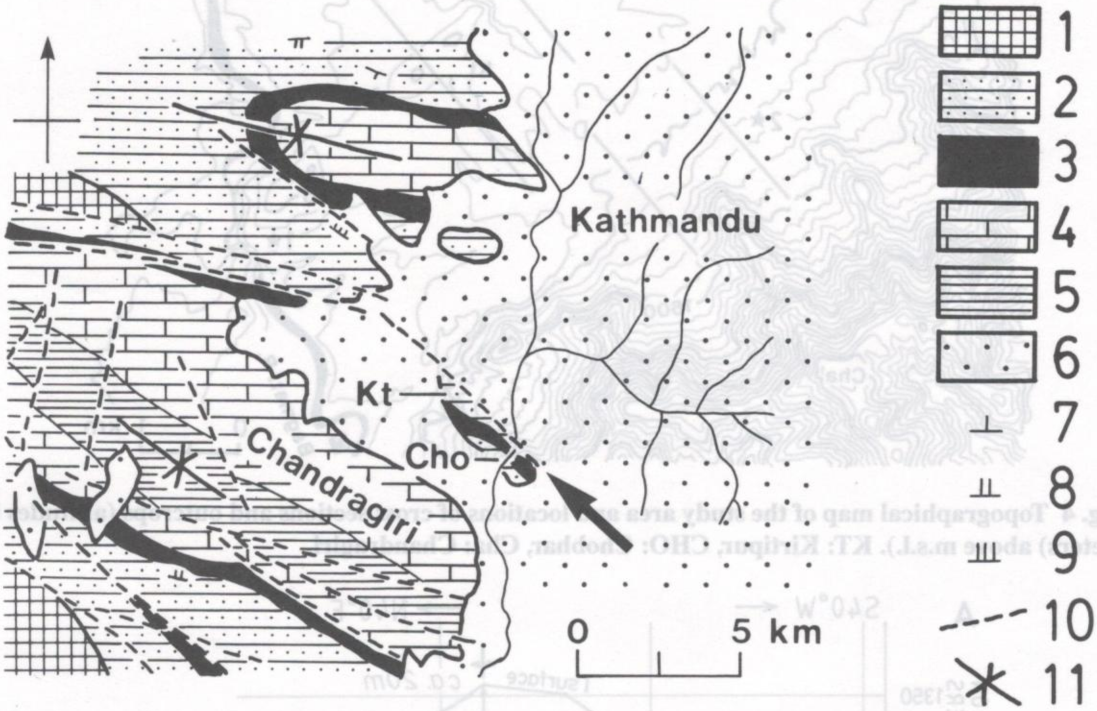

Fig. 2 Geological map of the study area (compiled from the geological map of the Kathmandu area and Central Mahabharat range, scale:1:250,000 after Stocklin and Bhattarai 19 77, with cntributions by V.S. Chhetr and, A.N. Bhandari). 1. Kulikhani Formation and Markhu Formation (Precambrian micaschist, lquartzites, marble), 2. Tistung Formation (Paleozoic slate, phyllite).

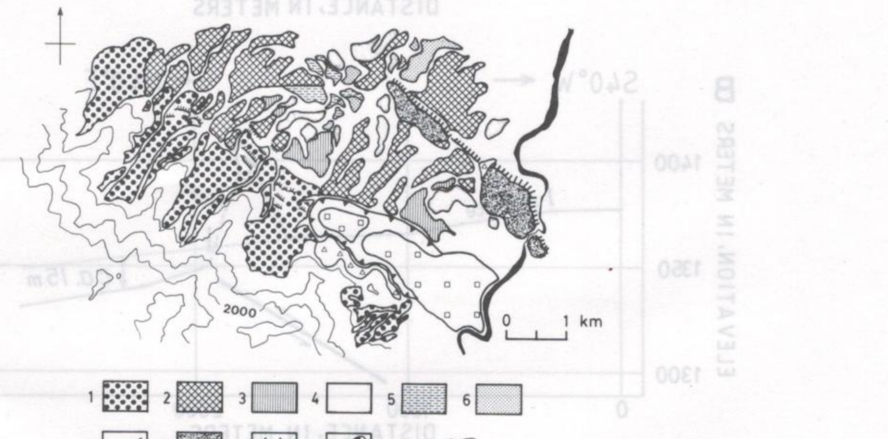

Fig. 3 1: Colluvial slope, 2: I surface, 3: II surface, 4: III surface, 5: IV surface, 6: V surface, 7: Fault scarp, 8: Isolated mound, 9: Talus 10: Landslide block, 11: Contour line (m).

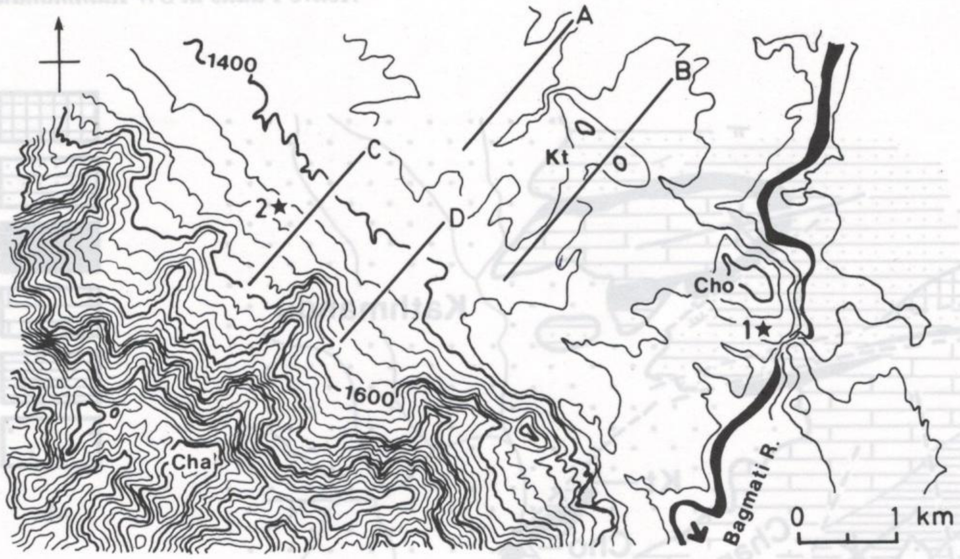

Fig. 4 Topographical map of the study area and locations of cross sections and outcrops (altitudes in meters) above m.s.l.). KT: Kirtipur, CHO: Chobhar, Cha: Chandragiri.

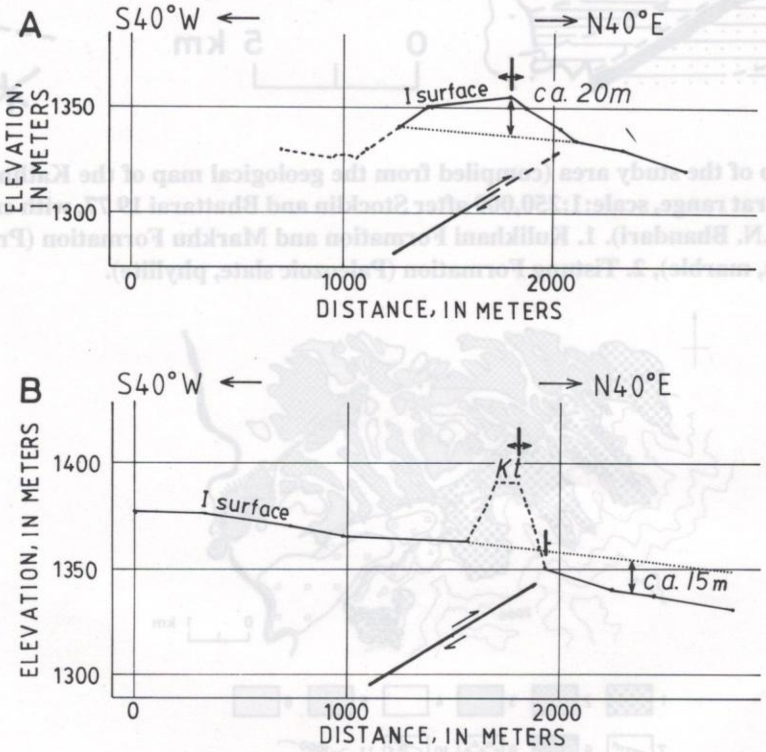

Fig. 5 Geomorphic profiles along the lines A and B. prepared from the topographic map of the Kathmandu Valley (scale: 1:10,000). Dotted lines indicate hypothetical original profiles. KT: Kirtipur

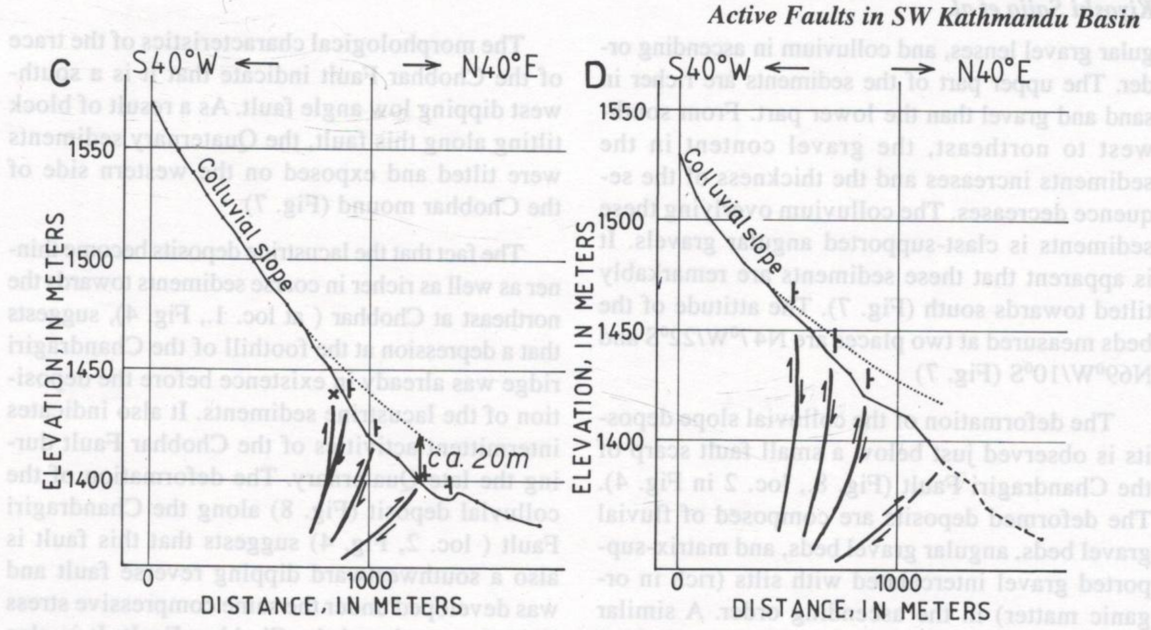

Fig. 6 Geomorphic profiles along the lines C and Dprepared from the topographic map of the Kathmandu Valley (scale: 1:10,000)

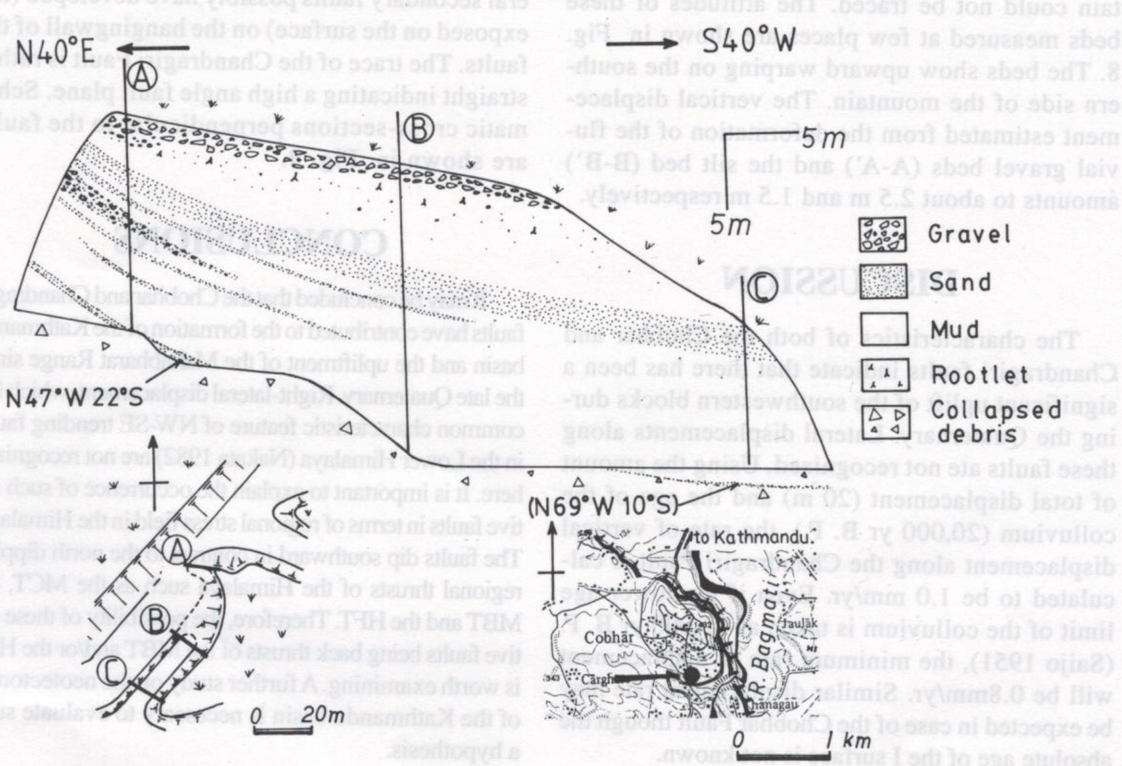

Fig. 7 Schematic sketch of the outcrop at location 1 (Fig. 4)

gular gravel lenses, and colluvium in ascending order. The upper part of the sediments are richer in sand and gravel than the lower part. From southwest to northeast, the gravel content in the sediments increases and the thickness of the sequence decreases. The colluvium overlying these sediments is clast-supported angular gravels. It is apparent that these sediments are remarkably tilted towards south (Fig. 7). The attitude of the beds measured at two places are N47^{0}W/22^{0}S and N69^{0}W/10^{0}S (Fig. 7)

The deformation of the colluvial slope deposits is observed just below a small fault scarp of the Chandragiri Fault (Fig. 8., loc. 2 in Fig. 4). The deformed deposits are composed of fluvial gravel beds, angular gravel beds, and matrix-supported gravel intercalated with silts (rich in organic matter) in the ascending order. A similar silt bed rich in organic matter was also found below the fluvial gravel on the northeastern side, its extension in the southwestern side of the mountain could not be traced. The attitudes of these beds measured at few places are shown in Fig. 8. The beds show upward warping on the southern side of the mountain. The vertical displacement estimated from the deformation of the fluvial gravel beds (A-A') and the silt bed (B-B') amounts to about 2.5 m and 1.5 m respectively.

DISCUSSION

The characteristics of both the Chobhar and Chandragiri faults indicate that there has been a significant uplift of the southwestern blocks during the Quaternary. Lateral displacements along these faults ate not recognized. Using the amount of total displacement (20 m) and the age of the colluvium (20,000 yr B. P.), the rate of vertical displacement along the Chandragiri Fault is calculated to be 1.0 mm/yr. Even if the lower age limit of the colluvium is taken as 25,000 yr B. P. (Saijo 1951), the minimum rate of displacement will be 0.8mm/yr. Similar displacement rate may be expected in case of the Chobhar Fault though the absolute age of the I surface is not known.

The morphological characteristics of the trace of the Chobhar Fault indicate that it is a southwest dipping low angle fault. As a result of block tilting along this fault, the Quaternary sediments were tilted and exposed on the western side of the Chobhar mound (Fig. 7).

The fact that the lacustrine deposits become thinner as well as richer in coarse sediments towards the northeast at Chobhar (at loc. 1., Fig. 4), suggests that a depression at the foothill of the Chandragiri ridge was already in existence before the deposition of the lacustrine sediments. It also indicates intermittent activities of the Chobhar Fault during the late Quaternary. The deformation of the colluvial deposit (Fig. 8) along the Chandragiri Fault (loc. 2, Fig. 4) suggests that this fault is also a southwestward dipping reverse fault and was developed under the same compressive stress field that produced the Chobhar Fault. It is also suggested that the main fault planes of these active faults underlie the monoclinal scarp and several secondary faults possibly have developed (not exposed on the surface) on the hangingwall of the faults. The trace of the Chandragiri Fault is rather straight indicating a high angle fault plane. Schematic cross-sections perpendicular to the faults are shown in Fig. 9.

CONCLUSIONS

It may be concluded that the Chobhar and Chandragiri faults have contributed to the formation of the Kathmandu basin and the upliftment of the Mahabharat Range since the late Quaternary. Right-lateral displacement, which is a common characteristic feature of NW-SE trending faults in the Lower Himalaya (Nakata 1982) are not recognized here. It is important to explain the occurrence of such active faults in terms of regional stress field in the Himalaya. The faults dip southward in contrast to the north dipping regional thrusts of the Himalaya such as the MCT, the MBT and the HFT. Therefore, the possibility of these active faults being back thrusts of the MBT and/or the HFT is worth examining. A further study on the neotectonics of the Kathmandu basin is necessary to evaluate such a hypothesis.

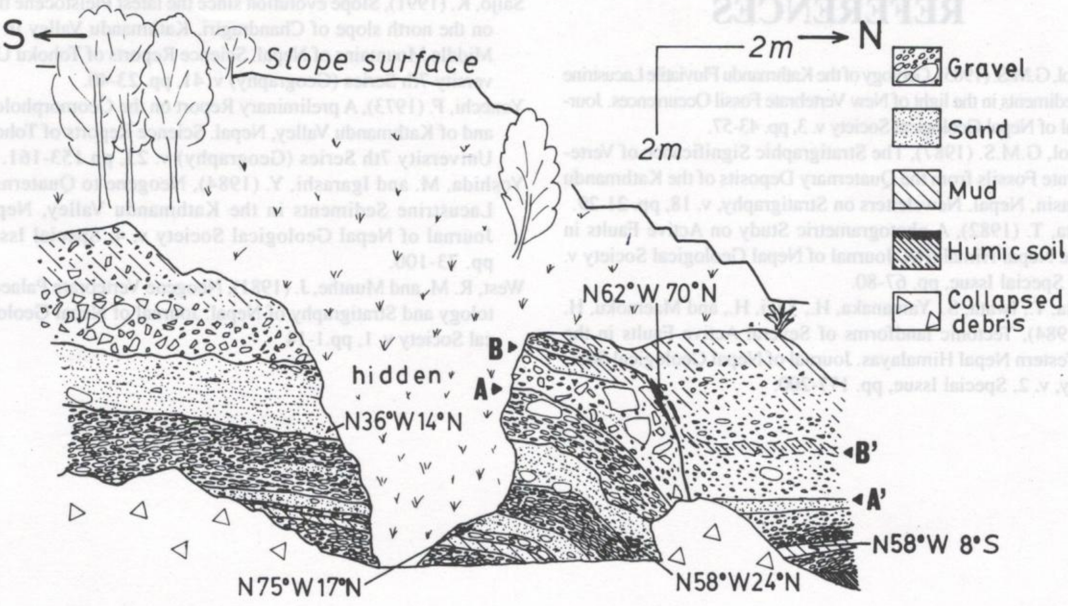

Fig. 8 Sketch of the outcrop at location 2

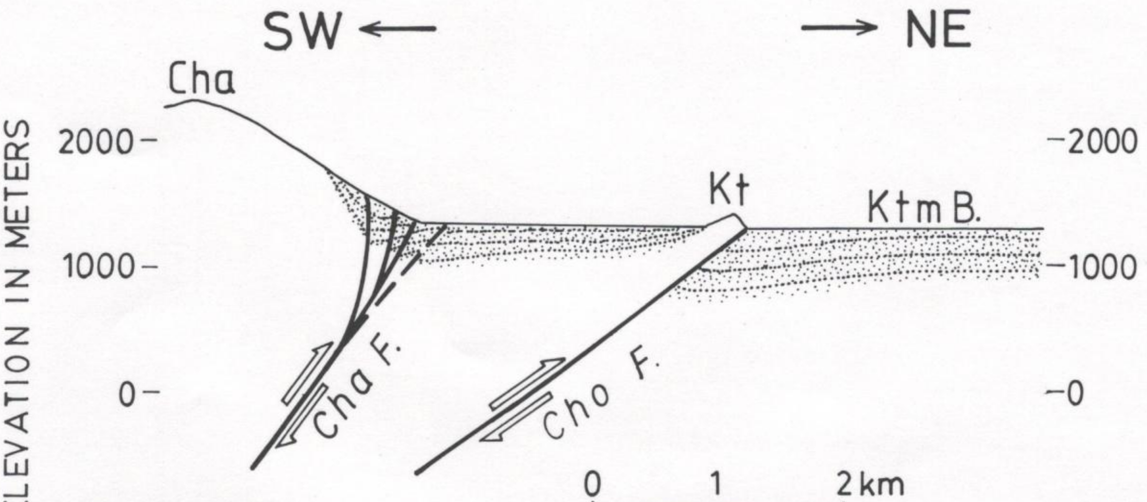

Fig. 9 Schematic cross section perpendicular to the Chobhar and Chandragiri faults. Dotted area shows Pleistocene and Quaternary deposits. Ktm B: Kathmandu Basin, Kt: Kirtipur. Cha: Chandragiri, Cho F: Chobhar Fault, Cha F: Chandragiri Fault

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