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DETACHED CARBONATE BLOCKS IN THE NORTHERN DANG AREA LESSER HIMALAYA (NEPAL)

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ABSTRACT

The process of movement of roof thrust in the northern Dang Lesser Himalaya gave rise to the deformation of various incompetent beds of limestone and dolomite from the underlying Gwar Group. Some of them are also disrupted from the footwall ramp and produced a stacked imbricate antiform of carbonates. In this process the floor thrust of the duplex became more active and later the displacement continued along the same. Afterwards, another larger duplex has formed beneath the stacked antiform. As a result, underneath the roof thrust consisting of the low-grade metamorphic rocks of the Sharda Group are found the detached and haphazardly distributed carbonates from the underlying Gwar Group. Characteristic feature and mode of occurrence of the detached carbonates, their lithology, and possible mechanism of thrusting are discussed here.

INTRODUCTION

The Lesser Himalayan region between Dang, Sallyan and Piuthan exhibits typical features of thin-skinned tectonics and the evidence comes from the following observations:

- the Main Boundary Thrust (MBT) and many other thrusts and reverse faults of the region are parallel to the strike of the beds in the hangingwall as well as footwall.

- the geometry of the MBT is almost the same for a distance of more than 60km.

- there is a good correlation between the topography and structural relief.

It has already been reported that this region is characterized by the presence of a duplex in the Lesser Himalaya as an imbricate zone in the Siwalik (Dhital and Kizaki, 1987b, Dhital, 1989). The duplex consists of an upper thrust fault (Kapurkot Thrust) constituting the roof thrust, and a lower thrust fault (Main Boundary Thrust) representing the floor thrust (Fig. 1). In between the two thrusts are many imbricate faults which bound a number of complexly deformed horses. The rocks above the roof thrust are made up of low-grade meta-sedimentaries of the Sharda Group, while the sedimentary rocks between the Kapurkot Thrust and the Main Boundary Thrust (MBT) belong to the Daban Supergroup (Dhital and

Kizaki, 1987a). The rocks overlying the roof thrust underwent extensive erosion in the past and hence produced three major klippen and a tongue-shaped synclinal core (Fig. 1).

While mapping the western Nepal Lesser Himalaya, Fuchs and Frank (1970) mentioned the occurrence of limestone blocks under their Chail Nappe. In the process of detailed mapping of the territory, it was found out that various detached carbonate rocks of the region are found either immediately below the roof thrust (and are covered by the metasedimentaries) or are exposed in the form of klippen after extensive erosion of the latter. Their present size ranges from tens of metres to hundreds of metres. The various formations of the region are shown in Figure 2 and the main formations containing carbonate rocks are discussed below.

CARBONATE ROCKS

Figure 2 shows that the carbonate rocks of the area are concentrated in the upper part of the Gwar Group as they are found in the Dhorbang Khola Formation, the Sirchaur Formation, and the Ranibas Formation (from bottom to top respectively).

a. Dhorbang Khola Formation

The Dhorbang Khola Formation comprises medium to thick bedded, light gray and green-gray stromatolitic dolomite, thinly laminated green and red shale, calcareous calystone, and a few beds of sandstone.

The Lower Member of the formation begins with a 18m thick sequence of thick-bedded dolomite with thin clay slate and a few fine-grained sub-litharenite interbeds. This sequence is followed upwards by another 20m thick succession of thick-bedded gray dolomite and dark-green shale. The latter is followed by a 3m thick massive bed of dolomite containing dome-shaped stromatolites (Dhital and Kizaki, 1987a). Upwards are many interbeds of gray stromatolitic dolomite, green slates, black slate, light orange or pink calcareous quartzite and orthoquartzite. Lenticular beds, mud cracks and ripples are very common. The Upper Member is dark gray to black coloured slate (Fig. 2). In otherwords, the Dhorbang Khola Formation is made up of interbedded competent dolomite and sandstone beds separated by claystone partings or intercalations.

b. Sirchaur Formation

Black slates of the Upper Member of the Dhorbang Khola Formation grade into dark-green calcareous argillites with rare lenticular beds of blue-gray dolomite of the Lower Member of the Sirchaur Formation (Fig. 2). Gradually the green calcareous argillites pass into the Upper Member containing parallel laminated purple-red and dark-green calcareous claystone alternating with pink and light-green limestone. Interlaminated nature of the claystone and limestone makes this formation one of the most incompetent rocks of the region and occasionally it is intensely deformed.

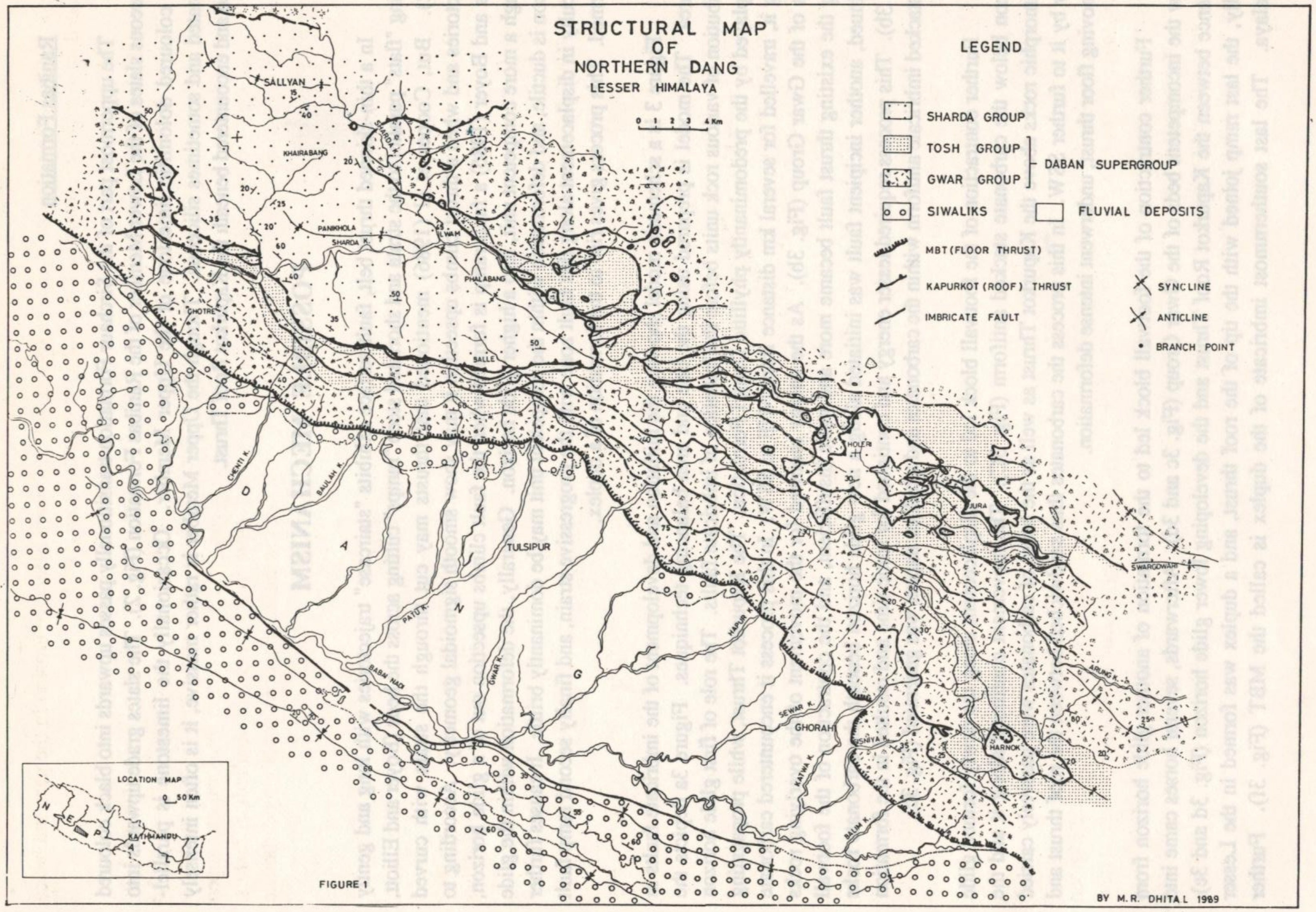
STRUCTURAL MAP
OF
NORTHERN DANG
LESSER HIMALAYA
0 1 2 3 4 Km
LEGEND
SHARDA GROUP
TOSH GROUP
GWAR GROUP
DABAN SUPERGROUP
SIWALIKS
FLUVIAL DEPOSITS
MBT (FLOOR THRUST)
KAPURKOT (ROOF) THRUST
IMBRICATE FAULT
SYNCLINE
ANTICLINE
BRANCH POINT
SALLYAN
KHAIRABANG
PANIKHOLA
SHARDA K.
PHALABANG
SALLE
GHOTRE
HOLERI
JURA
SWARGDWARI
TULSIPUR
D
A
N
G
GHORAHI
HARNOK
LOCATION MAP
0 50 Km
KATHMANDU
BY M.R. DHITAL 1989

FIGURE 1

c. Ranibas Formation

The uppermost part of the Sirchaur Formation transitionally passes upwards into black coloured calcareous slates of the Lower Member of the Ranibas Formation (Fig. 2). The slates grade upwards into gray coloured dolomitic limestone of the Upper Member. Occasionally the limestone is parallel-laminated and sometimes siliceous. Though the Upper Member is rather massive, it is often intensely folded and encountered beneath the Kapurkot Roof Thrust.

POSSIBLE MECHANISM

In a thin-skinned thrust belt, fault surface exhibits "staircase" trajectories with long and gently dipping "flats" parallel to the strata and short and steep "ramps" cutting across the beds (Boyer and Elliott, 1982). But, Cooper et al (1986) mentioned that thrusts may cut through the strata with curved trajectories and when a thrust climbs upsection it may show smooth sigmoidal geometry. According to Mitra and Boyer (1986) a fault ramp is formed when the fault climbs upsection out of a glide horizon, through a more competent unit, into a higher glide horizon. Generally, the deformation within the glide horizon is ductile, and deformation within the competent unit may be dominantly brittle. It causes further difficulty in displacement along this fault zone with the progressive strain, and finally second ramp fault is formed. This process gives rise to the formation of a duplex.

Figure 3 is a schematic model showing the initiation and development of the imbricate faults in the area. The model is prepared using the line and area balancing techniques. Figure 3a depicts the distribution of various rock units before the initiation of imbricate faults. The role of first glide horizon was played by the predominantly phyllitic Dangri Formation. The Kapurkot Thrust, while propagating along it, travelled for several km distance from NNE to SSW. In this process it encountered carbonate rocks of the Gwar Group (Fig. 3b). As the energy required for the movement of the overlying rocks along the existing thrust fault became more and more insufficient, and the contraction of the footwall continued, another incipient fault was initiated along a new glide horizon beneath the carbonate rocks (Fig. 3b). This process required lesser energy and continued for some time and resulted in the formation of a stacked imbricate antiform within the carbonates and a hidden duplex was generated (Fig. 3c).

Further contraction of the footwall block led to the displacement along the newly formed glide horizon below the carbonate stacked antiform (Fig. 3C). The movement continued along it and the metamorphic rocks above the Kapurkot Thrust as well as the horse of carbonates were passively carried away by it to further SSW. In this process the carbonates thus sandwiched between the roof thrust and the moving floor thrust, underwent intense deformation.

Further contraction of the footwall block led to the formation of another glide horizon from below the incompetent beds of the Gwar Group (Fig. 3c and 3d). Afterwards, several horses came into existence between the Kapurkot Roof Thrust and the developing lower glide horizon (Fig. 3d and 3e). Finally, the last ramp joined with the tip of the roof thrust, and a duplex was formed in the Lesser Himalaya. The last southernmost imbricate of the duplex is called the MBT (Fig. 3f). Further

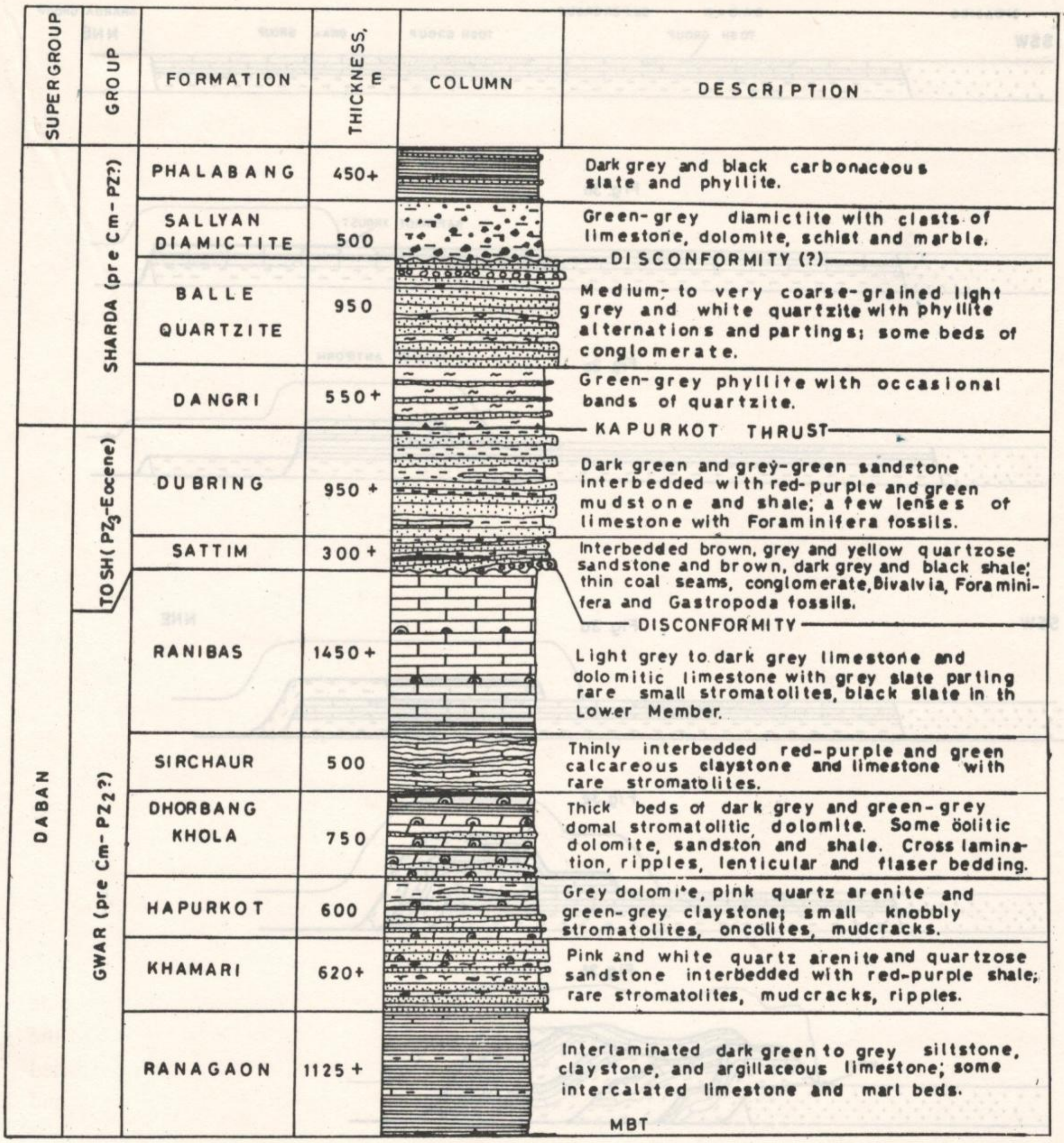

FIGURE 2: GENERALIZED LITHOSTRATIGRAPHIC COLUMN OF THE NORTHERN DANG LESSER HIMALAYA

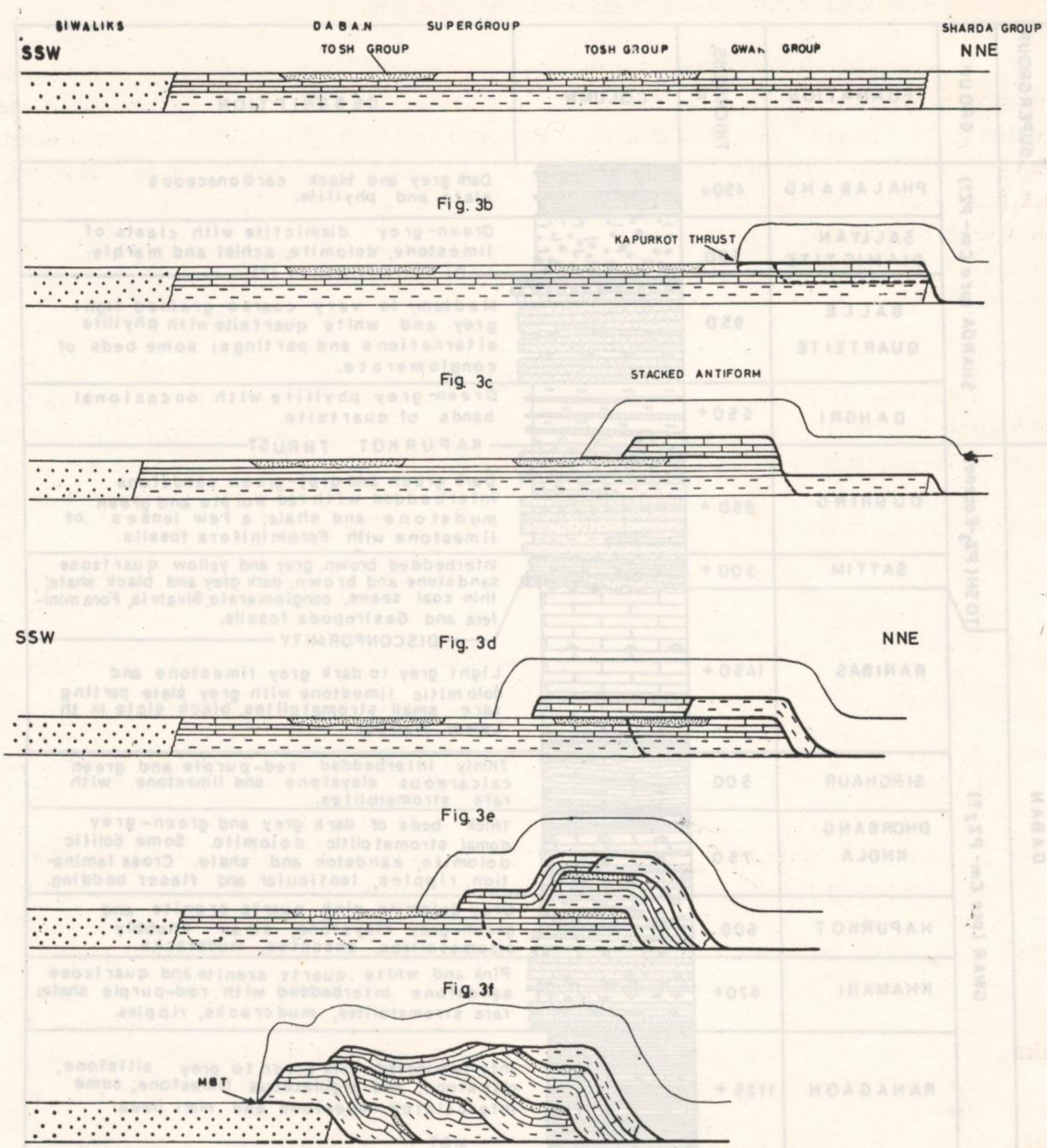

Fig. 3a
SIWALIKS
DABAN SUPERGROUP
SHARDA GROUP
SSW
TOSH GROUP
TOSH GROUP
GWAL GROUP
NNE
Fig. 3b
KAPURKOT THRUST
Fig. 3c
STACKED ANTIFORM
SSW
Fig. 3d
NNE
Fig. 3e
Fig. 3f
MBT

advancement of a sole thrust along the lower glide horizon towards the foreland gave rise to the contraction of the Siwalik Formation of an imbricate zone there (Fig. 3g).

In conclusion, it can be said that the contraction caused by the convergence of the Indian Subcontinent towards Eurasia was balanced by the movement at first of the Kapurkot Roof Thrust alone, and then by the formation of the stacked antiform together with the other horses below it. Newer thrusts were generated from lower glide horizons to upper ones, and the horses propagated in them in a piggy back fashion from hinterland towards foreland. The total displacement along the Kapurkot Thrust is calculated to be more than 28km.

ACKNOWLEDGEMENTS

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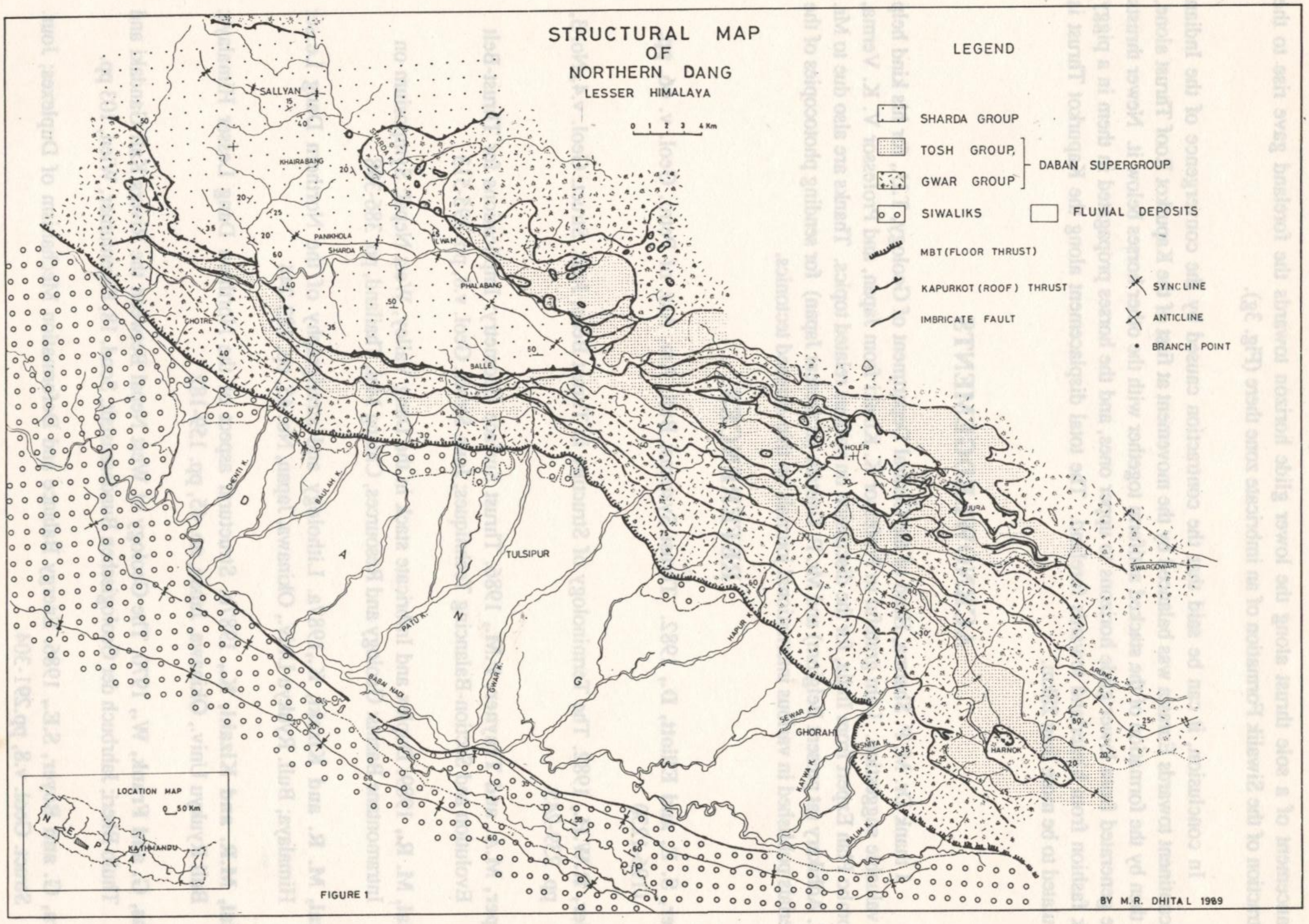
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D
A
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LOCATION MAP
0 50 Km
KATHMANDU
N
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P
A
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FIGURE 1