

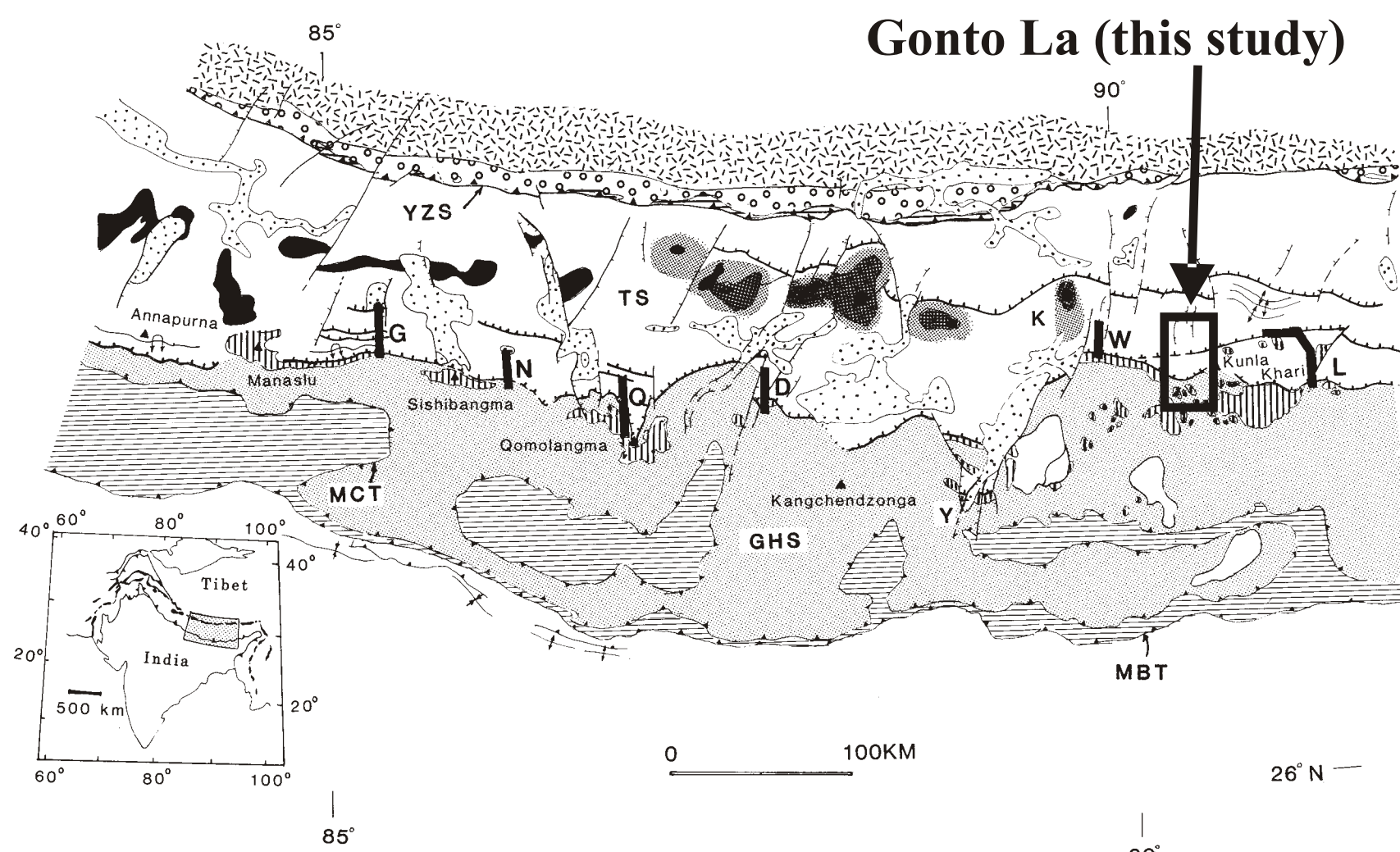
Influence of the Khula Kangri pluton on the evolution of the Southern Tibet Detachment System (STDS): new data from Gonto La

¹Edwards, M., ¹Kidd, W., ²Li, J., and ³Clark, M.

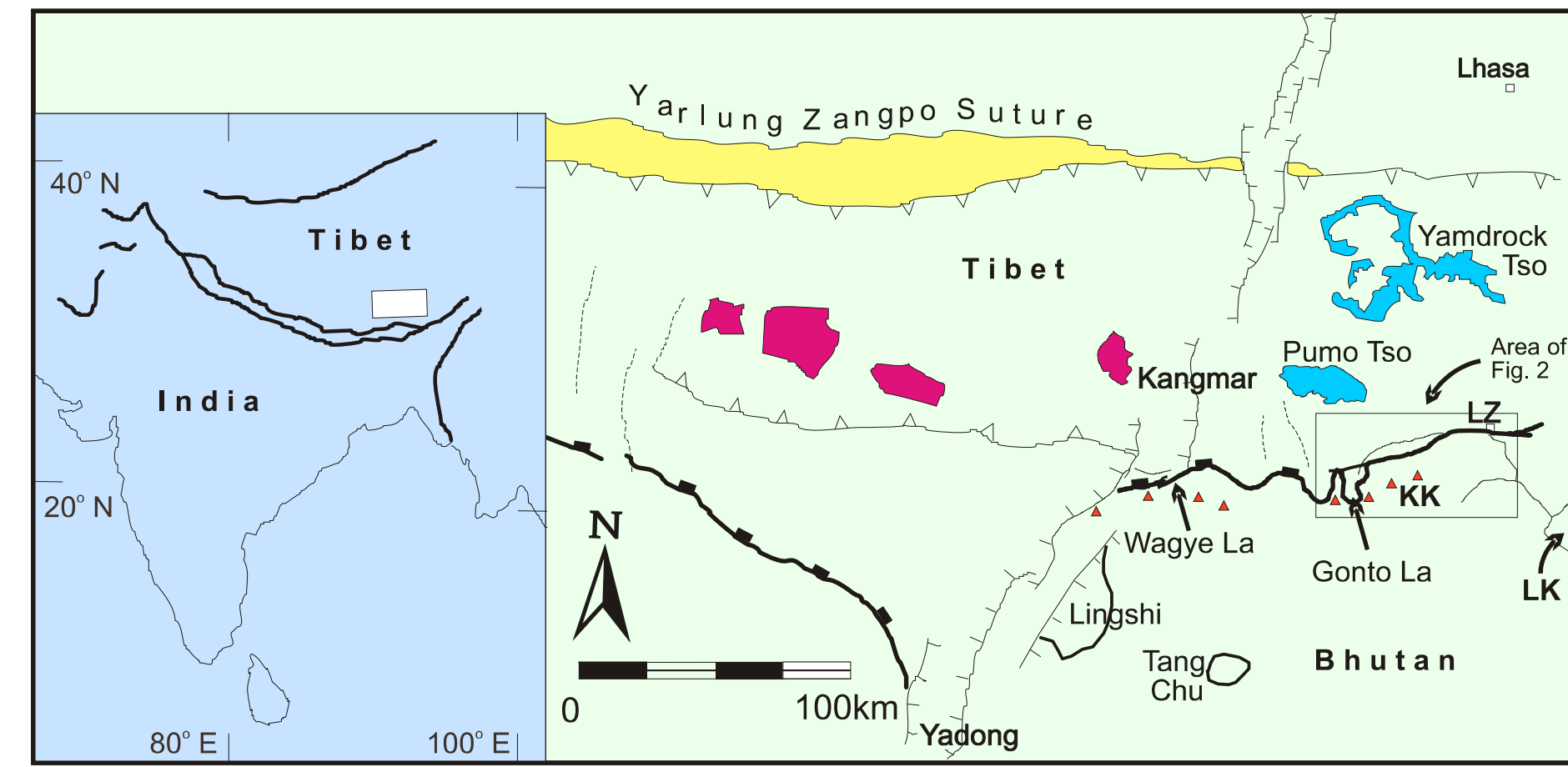
¹- Dept of Geological Sciences, SUNY at Albany, Albany, NY 12222

²- Chinese Academy of Geological Sciences, Baiwanzhuang Road 26, Beijing 100037, PR China

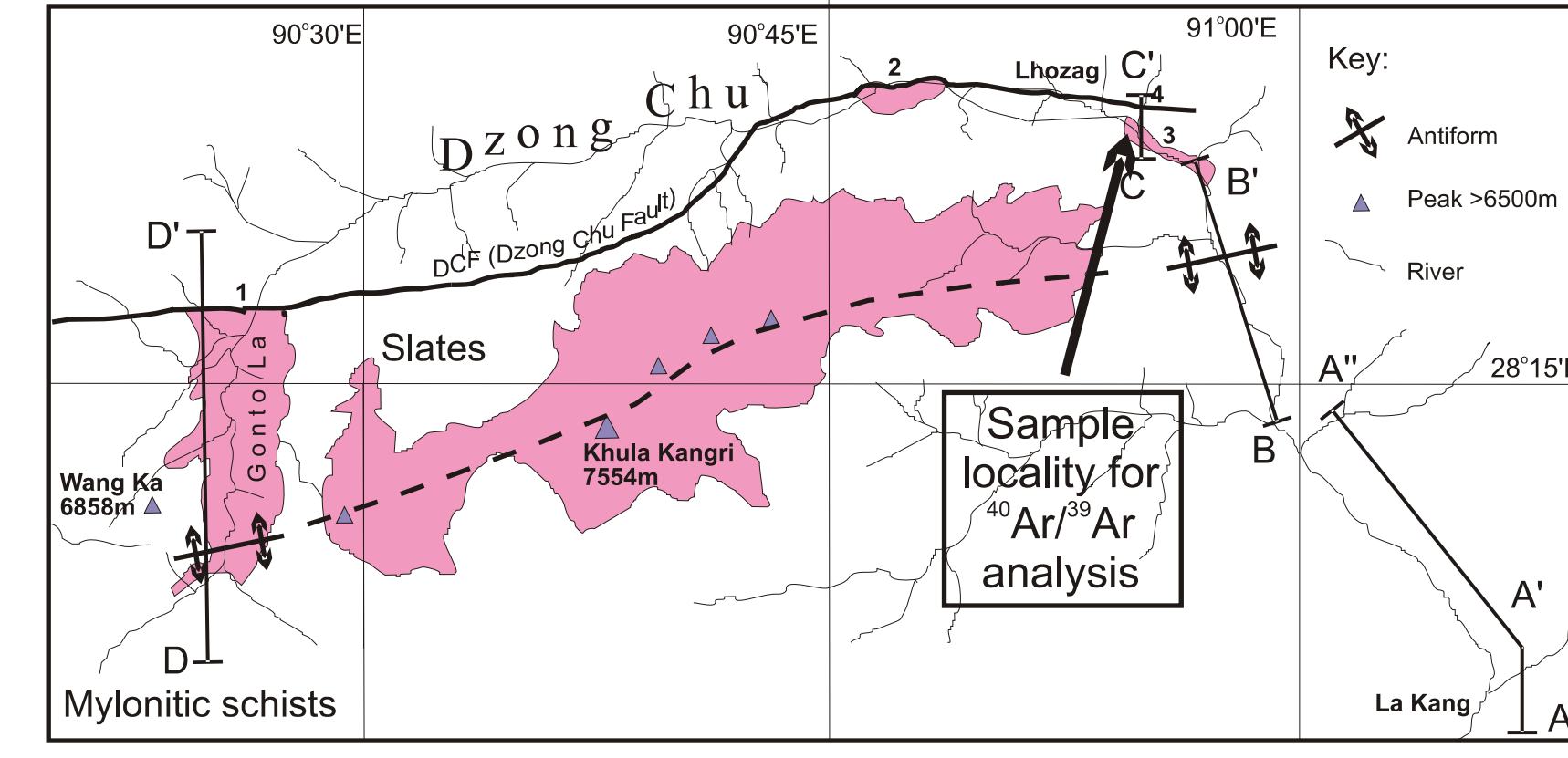
³- INSTOC, Snee Hall, Cornell University, Ithaca, NY 14853



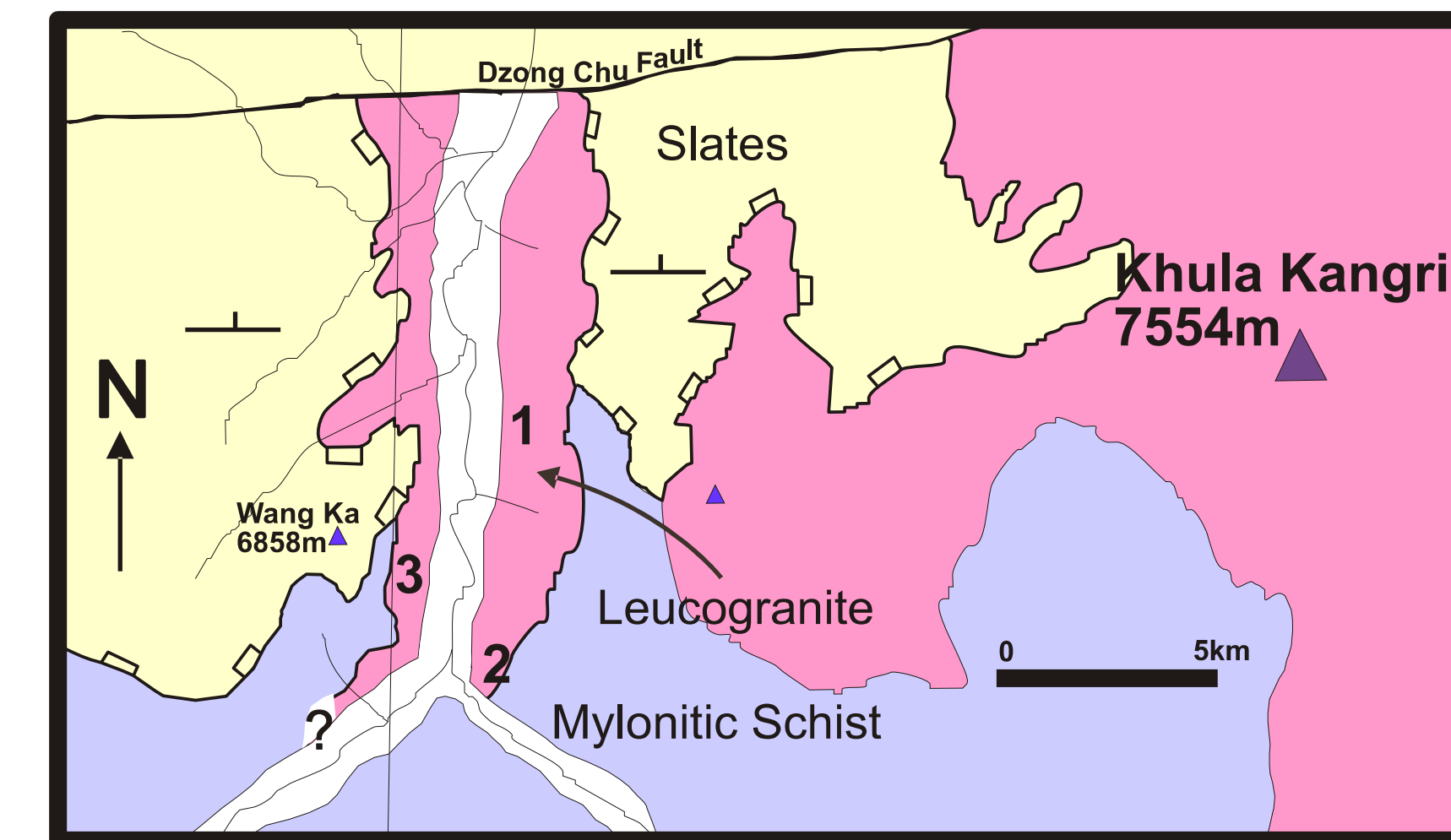
Regional map of the eastern Himalaya showing the location of the Gonto La map of this study. From Burchfiel et al. (1992). K - Kangmar; W - Wagye La; L - Lhozag-La Kang section



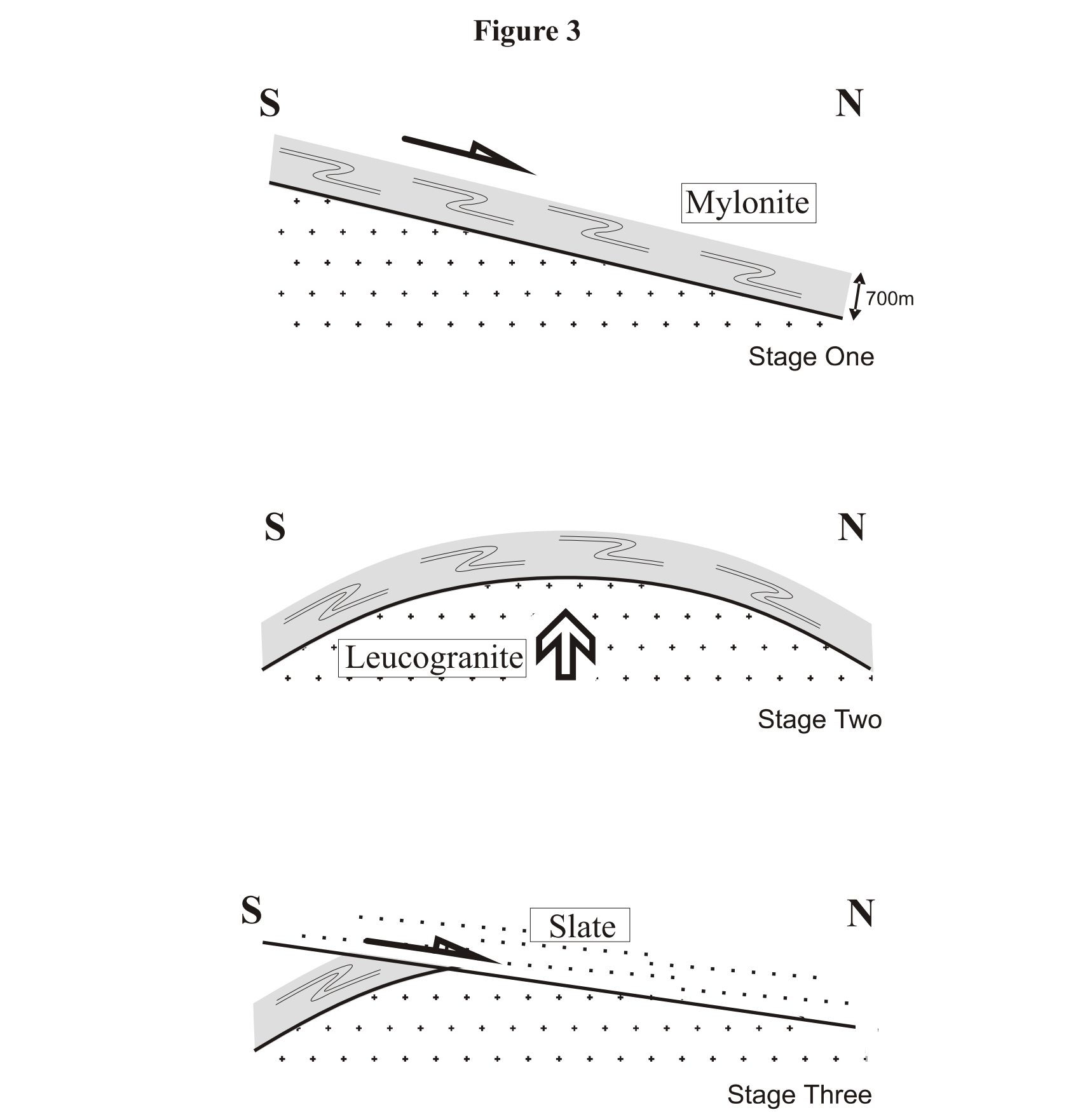
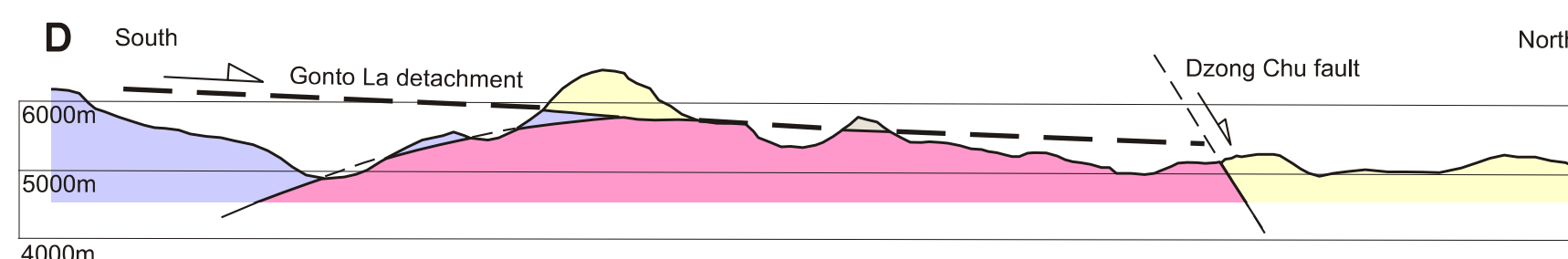
Map 1. Shows regional location of Gonto La and surrounding areas. Note the Lingshi and Tang Chu basins in central Bhutan. These are klippen of Tethyan sequences thought to represent areas of early extension on the STDS. It is noteworthy that they occur along strike from areas where the STDS has been recognised to the W on the N flank of the High Himalaya. Map based on Burg et al (1985).



Map 2. Showing outcrop of Khula Kangri leucogranite and drainage of Khula Kangri massif. Sample locality is that of Maluski et al. (1988).



Geological map of Gonto La and surrounding area



Questions arising from previous work

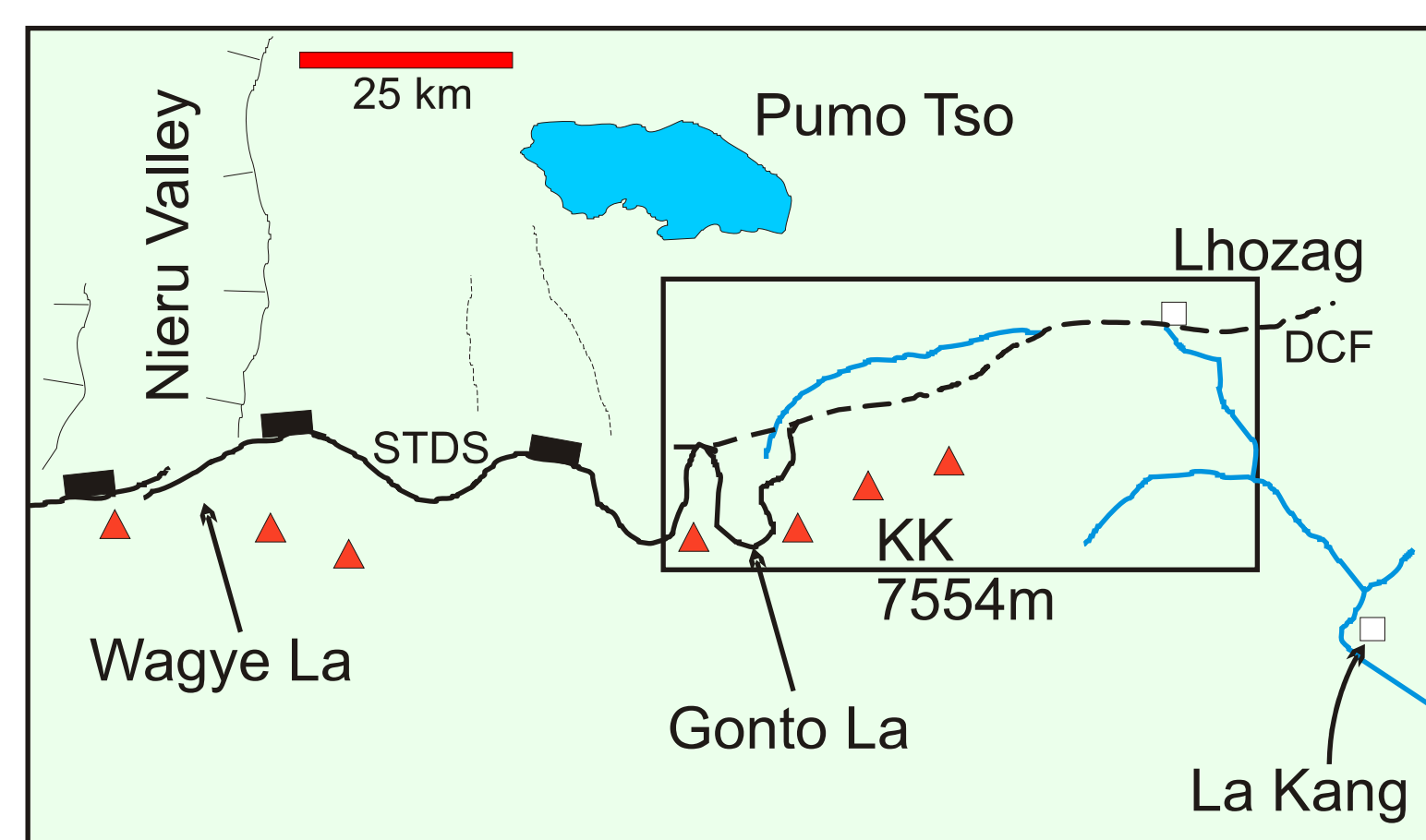
The STDS is a north-dipping, low-angle detachment system in southern Tibet, first identified by Burg (1983). It typically juxtaposes Tethyan sediments above a footwall of crystalline basement, on the north flank of the high Himalaya. The detachment system, as described by Burchfiel et al. (1992) from locations along the Tibet Himalaya (see map above), includes a several hundred meter thick, leucogranite-injection-rich, N-dipping mylonitic horizon within the footwall. Offset on the STDS is thought to be at least several 10's of km. Extension was apparently contemporaneous with shortening at structurally deeper levels and there is evidence that this mechanism operated along the entire length of the Himalaya (Burchfiel et al. 1992).

Near Lhozag, in the Dzung Chu valley (see above and map 1a), the contact between crystalline rock and low metamorphic grade Tethyan sediments is intrusive. There is no extensive mylonitic injection complex and no major structural discontinuity is found at or near this contact; there is no STDS here. The STDS is last recognised by Burchfiel et al. (1992) at Wagye-La to the west (see above).

We have recognised the STDS at Gonto La, where the field relationships show an apparent explanation for the confusion at Lhozag.

Wagye La STDS recognised Lhozag-La Kang STDS not recognised

The map below (Map 1a) shows the relationship of Gonto La to Wagye La and Lhozag-La Kang where the STDS was investigated by Burchfiel et al. (1992). The region is located east of the "Yadong Cross Structure", a >70km offset in the Himalayan chain.



Map 1a. Locations and traces of the South Tibet Detachment System (STDS) and major faults in the area east of the Yadong-Gulu graben. Box is area of Map 2.

Gonto La

Gonto La is a 5450m high pass between Tibet and Bhutan, located about 100km south of the Yarlung-Zangpo suture. The glacial valley cuts a ~13km long N-S trough deep (>2km) into the local topography. The main part of the valley floor has a gentle gradient (<1.4°) at an average height of 4700m. To the east is the Khula Kangri chain of peaks which range from >6800m to 7554m at Khula Kangri itself. To the west is Wang Ka, 6858m, beyond which the chain continues west to Jiabu (7270m), near Wagye La.

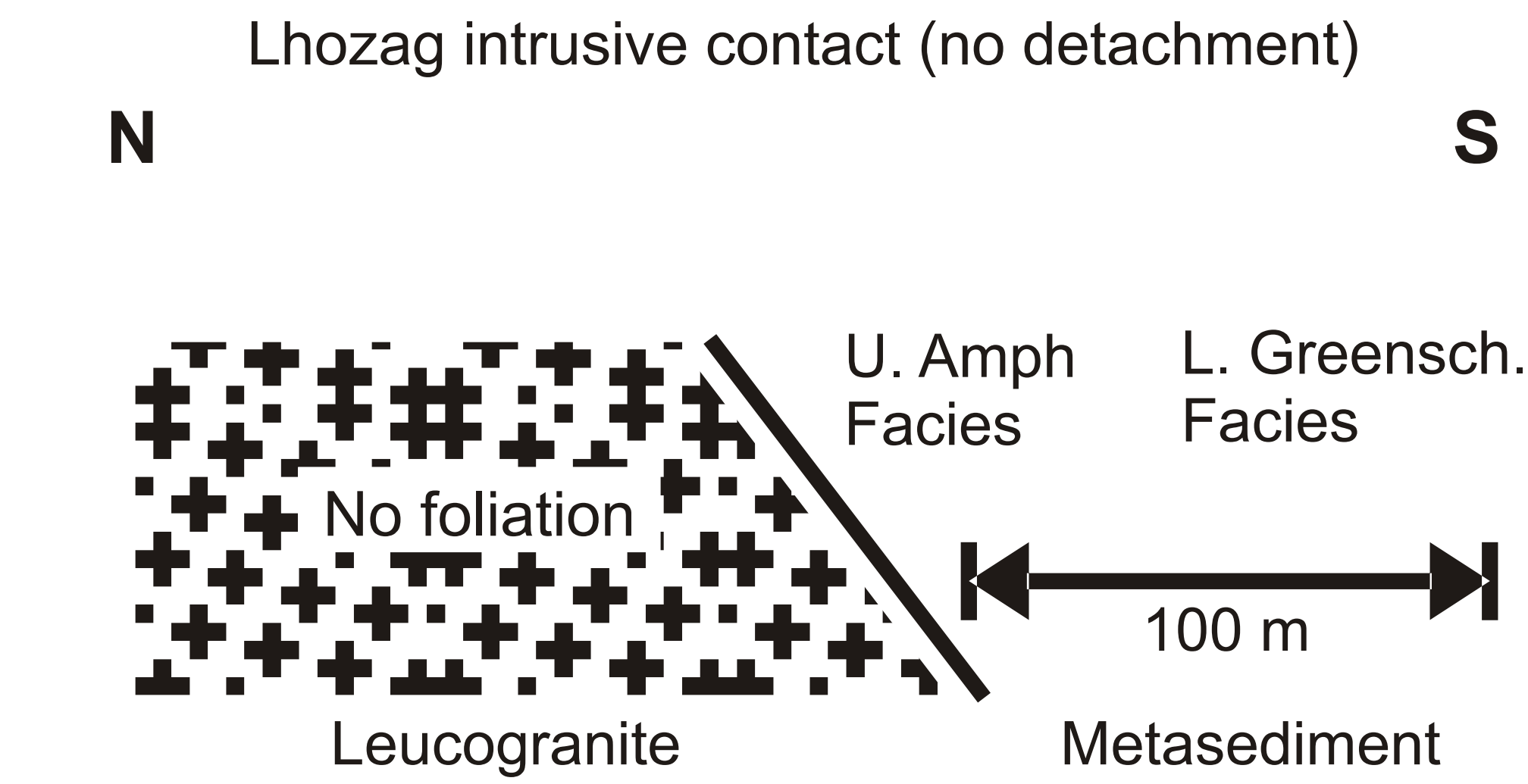
Geology

Leucogranite makes up the lower portions of the valley walls in the central and northern parts of the valley. Mylonite, including a mylonitic injection complex, forms a >800m thick unit in the south. The structurally lower parts of the valley as a whole are mylonite/ultramylonite infested with deformed sills and dykes of injected leucogranite. The volume of injected leucogranite decreases upwards and the unit passes into pale brown and grey marble at the top. The higher regions of the valley walls in the central and northern portions are made up of a series of black and pale grey to brown slates which are part of the well-cleaved slate sequences widespread across this region of the Tethyan Himalaya.

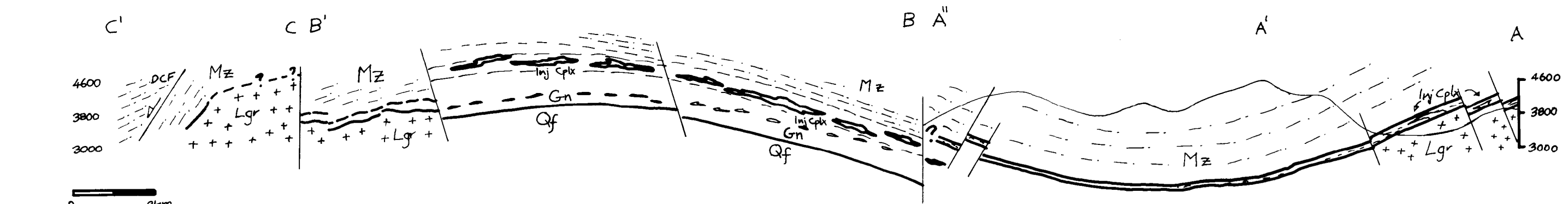
Structure

(see Fig. 3 opposite)

The leucogranite body approximates a dome. Its northern flank is a low angle detachment fault, dipping north, overlain directly by the slates. The southern contact to the mylonitic injection complex is curved, and parallel with the pervasive foliation of the mylonite. The curve of the contact, (and, hence, the mylonitic foliation) defines the southern part of a dome. The northern and upper (top) parts of the dome are truncated by the detachment. This extends along the central and northern Gonto La valley and juxtaposes the gently north-dipping, low metamorphic grade Tethyan slate sequences above both the leucogranite and the mylonite. Asymmetric folds of injected leucogranite sills and sigmoidal tension gashes filled with vein quartz in the (south-dipping) mylonitic layer show top-to-north (thrust) shear sense. Areas are also found where undeformed leucogranite cuts the mylonitic foliation at a low angle.



Schematic relationships at location 3, map 2 (opposite)



Cross-section A-A-C' , from La Kang to Lhozag; position shown on Map 2. Based on our field observations and Burchfiel et al. (1992). Mz - low grade metasedimentary rocks; Gn - gneisses, schists; Inj Cplx - injection complex of granite in gneisses; Lgr - leucogranite; Qf - Quaternary fill covering lower valley walls; DCF - Dzung Chu Fault

Interpretation

(see Fig. 3, stage 1 and 2 - upper drawings)

The extensive mylonitic unit, with structures showing top to north (presently thrust sense and S-dipping), is interpreted to be the originally north-dipping shear zone that was active during earlier ductile extension of the STDS. Its appearance is similar to the overall character of the ductile STDS as described by Burchfiel et al. (1992). The domal nature of the leucogranite and the markedly parallel nature of its contact with the mylonitic injection complex, and the cross-cutting of the mylonitic foliation at a low angle by undeformed leucogranite suggests (1) that the thick mylonitic unit existed before the rise of the leucogranite and (2) that the south-dipping mylonitic unit has been rotated to this orientation, from north-dipping, by the rise of the leucogranite. The domed leucogranite and mylonitic layers are truncated by the detachment fault juxtaposing Tethyan slates above. This is interpreted to be the final, brittle evolutionary stage of extension on the STDS. The rise of the pluton here is thus interpreted to be late in the history of STDS movement, but before the extension on the STDS in this area ceased. Based upon interpretation of the excellent TM image of the region, and based upon leucogranite float in valleys along the north side of Khula Kangri, we interpret the leucogranite at Gonto La to be part of the regionally extensive Khula Kangri pluton (Gansser, 1983; Burchfiel et al., 1992).

Maluski et al. (1988) have found a 40Ar/39Ar age for the Khula Kangri pluton of 10.7 to 11.7 Ma. We suggest this age may reflect refrigeration through exhumation of the leucogranite by extension on the Gonto La detachment. If this is true, then the Gonto La detachment represents the youngest age of extension involving the STDS mechanism discovered to date.

Discussion

The STDS around the Khula Kangri massif has been substantially modified and, in places, obscured by the emplacement of the Khula Kangri pluton. The leucogranite of the Khula Kangri pluton outcrops east of Lhozag where it is found in intrusive contact with black schists and phyllites (location 3, map 2). There is no evidence in this area of any brittle or ductile deformation horizon within the granite, or near it within the metasediments, that could have accommodated significant offset. The STDS is not recognised in this Lhozag section and, accordingly, Burchfiel et al. (1992) proposed the hypothesis that the Khula Kangri pluton had a period of emplacement in the area of Lhozag after final movement on the STDS. Our interpretations partially support this hypothesis but the question of whether there is local diachrony in the late history of either pluton emplacement or STDS movement, between the Lhozag area and Gonto La, is unanswered. If this (the Burchfiel et al (1992) hypothesis) is not true, it may be that a late detachment, equivalent to the Gonto La detachment, is/was restricted to Tethyan sequences at Lhozag.

Abstract

The STDS is a system of north-dipping, low-angle detachments which typically outcrop on the north flank of the high Himalaya and juxtapose Tethyan sediments of the hanging wall above a crystalline basement footwall. Burchfiel et al. (1992) did not recognise the STDS on a traverse of the Khula Kangri massif (underlain by a leucogranite pluton) between Lhozag and La Kang. Here, the only major structure found, the Dzung Chu Fault (DCF) is restricted to the Tethyan sequences. We present observations of the STDS from a traverse along Gonto La: a <2km deep valley through the High Himalaya west of Khula Kangri. The field relationships here are interpreted to show how the evolution of the STDS was influenced by the Khula Kangri pluton and provide a simple hypothesis to explain the elusive nature of the STDS at Lhozag, to the east.

Leucogranite of the pluton makes up the lower portions of the valley walls in the central and northern parts of the valley and approximates a dome. Tethyan slates are juxtaposed above the leucogranite on the north side by a detachment fault dipping ~10°N. Mylonitic schist, including an injection complex, forms a >700m thick unit in the south, lying structurally above the leucogranite. The foliation of this schist is generally S-dipping, curved, and is parallel with the southern contact of the leucogranite. Locally, it truncates the mylonitic foliation at a low angle. The extensive mylonite has sense of shear structures suggesting top to north, and is interpreted to be the originally north-dipping shear zone of the STDS that was active during ductile extension. The domal nature of the leucogranite, the parallel nature of its contact with the mylonitic schist, and local cross-cutting of the mylonitic foliation by undeformed leucogranite suggests (1) that the mylonitic schist existed before the rise of the leucogranite and (2) that the south-dipping mylonitic schist has been rotated to this orientation, from north-dipping, by the rise of the leucogranite. The detachment fault is interpreted to be the final, brittle evolutionary stage of extension on the STDS. The rise of the Khula Kangri pluton here is thus interpreted to be late in the history of STDS movement, but before the extension on the STDS in this area ceased.

Acknowledgements

This work was conducted as part of Project INDEPTH field geological investigations during the summer of 1994. The authors wish to thank all the participants of the project for productive scientific intercourse whilst in the field and back home.