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Upholding or fatally altering the boundary conditions for channel flow of the Southern Tibet middle crust

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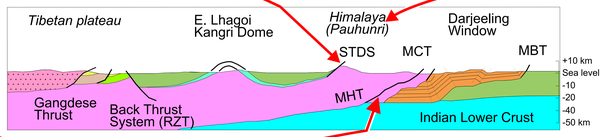
What is of interest?

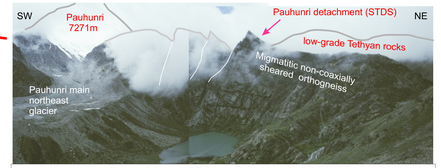
Project INDEPTH results indicate a partially molten middle crust beneath southern Tibet. This has been suggested (Beaumont et al. 2001) to be associated with ductile extrusion via channel flow bounded by coeval normal- and thrust-sense shear zones. These are the STDS & MCT respectively.

Channel flow explains many (but not all) of the features observed in the Himalaya. Channel flow is however highly sensitive to boundary conditions. Characterising the geology of these boundaries is crucial to test whether channel flow may have operated and for how long. We present new 3D data for the STDS, the upper boundary.

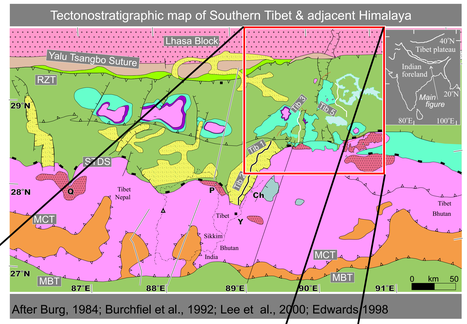
Background

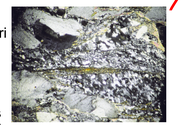
The Southern Tibet Detachment System (STDS) is a series of normal sense shear zones in the structurally higher regions of the Himalayan orogenic wedge that have operated at a range of deformation conditions. Little- to un-metamorphosed Tethyan sedimentary rocks are juxtaposed upon sillimanite grade gneisses or mid-crustal leucogranites. In the area between Everest and eastern Bhutan, the predominant Tethyan rocktype juxtaposed by the STDS upon the crystallines is phyllite.





Upper channel boundary (STDS) at Pauhunri, Sikkim. View to west. (cliffs in middle field of view are ~250m high). Photo: WSFK



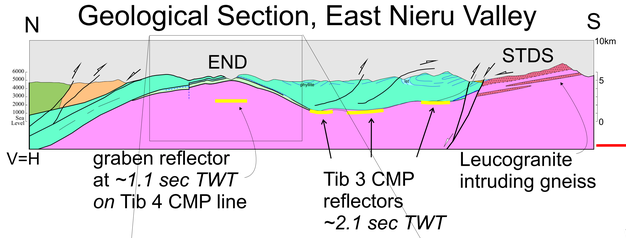


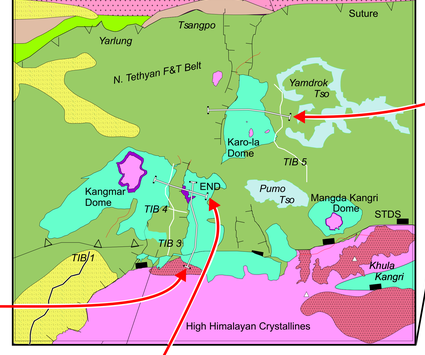
Typical granite mylonite fabric for STDS exposed at high Himalaya (here, at Pauhunri detachment). Grain boundary migration of quartz only, with brittle deformation of feldspars and late-stage fluid assisted grain boundary sliding along micas indicate relatively low temperature deformation, thus rapid cooling following granite emplacement. This suggests any upper channel boundary was operative only for a short period.
Base of image is 4 mm, crossed polars

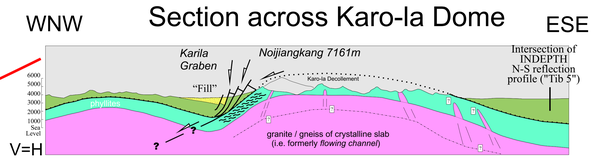
Our studies show....

The Tethyan over high grade juxtaposition is also exposed in parts of the central Tethyan belt (75-125 km north of the High Himalaya) in the form of a series granitoid domes. The phyllites dome up where granite bodies approach or intersect the surface, yet the phyllites are intrusively cross-cut by the granites only infrequently and in very small volumes; the phyllites form an apparent barrier to granite ascent! INDEPTH data indicate that the phyllite-granitoid boundary is present throughout the southern Tibet plateau at depths of <15 km. The phyllites have a polyphase deformation history; they acted as the primary thrust detachment during the thin-skinned fold & thrust contraction during early collision before being reactivated as the normal sense shear zone (the STDS) - both senses of shear are preserved.

All 2D sections to same scale

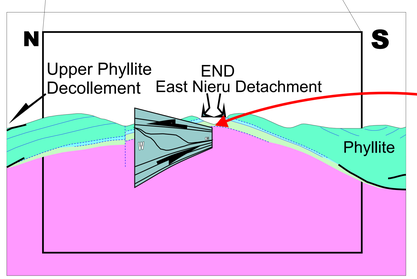


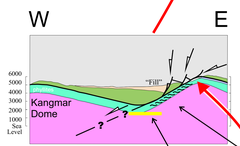




Legend to all maps

- Gandese Batholith
- Xigaze Gp
- Crystalline slab [channel?]
- High strain "mantle" of gneiss domes
- Phyllite decollement (multiple reactivation)
- Tethyan fold & thrust belt (general)
- High Himalayan leucogranites
- Quaternary

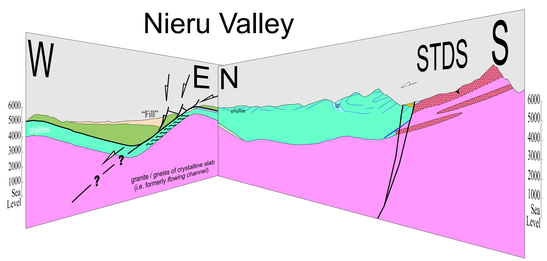


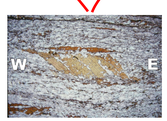


Transverse Section, Nieru Valley (route of Tib 4 INDEPTH CMP line)

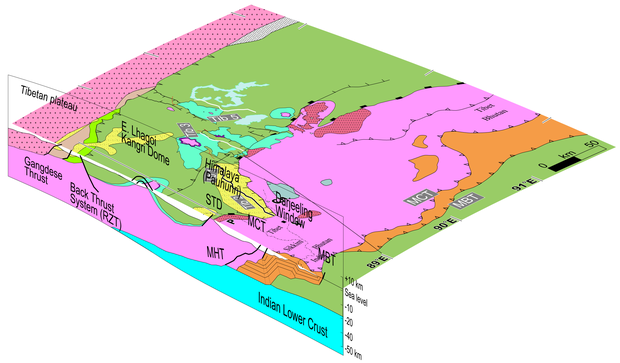
Tib 4 CMP reflectors ~1.6 sec TWT

Graben fill geometry from shot refractions inverted for depth (Cogan et al., 1998)





Late stage kinematic biotite growth in fine-grained phyllite reflects re-activation of decollement (upper channel boundary?) in growth of E-W graben.
This represents 3rd! reactivation of phyllite;
D1 is shortening; decollement horizon of thin-skinned fold & thrust deformation of Tethyan sequence on leading edge of India.
D2 is normal-sense, STDS activity with any channel wedge extrusion.



This work is in memory of K. Douglas Nelson

Vehicle repair in Central Tibet. L-R are: KDN, MAE, WSFK & Li Jixiang. Photo: Martin Staiger