Transient character of the South Tibetan Detachment: microtectonic documentation from the Bhutan Himalaya

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The Greater Himalayan Sequence (GHS) of the Bhutan Himalaya is a complex, highly deformed unit of gneiss and migmatite that has been intruded by leucogranite. Several shear zones play a major role in the deformation of the GHS; from south to north these are the Main Central Thrust (MCT), the out-of-sequence Kakhtang thrust, and the South Tibetan

Detachment (STD). The Bhutan Himalaya differs from the rest of the Himalayas by the presence of low-grade sedimentary rocks on top of the GHS. These sediments are found in cores of several synclines. The metamorphic facies present in the GHS range from upper greenschist in the south, increasing upward to upper amphibolite-granulite facies in the north, indicating an inversion of the metamorphic sequence. In the uppermost part of the GHS the metamorphic sequence is again right way up, as the metamorphic grade decreases rapidly across the STD and disappears in the hanging wall rocks within a hundred metres of the contact.

The aim of this study is the structural analysis of a contact between GHS rocks and sedimentary rocks found in a syncline in central Bhutan. Field observations indicate that a ductile shear zone soles the sediments. Oriented thin sections of rocks that form this shear zone were analyzed under optical microscope for their kinematic indicators. These data were used to determine the sense of shear and the geometry of strain (whether simple or pure shear) within the shear zone. The kinematic data were compiled with published geological maps and new field observations using GIS software.

The map shows the inferred movements in the study area. Because the shear zone at the bottom of the sediments contains top-to-the-north shear sense indicators, the sedimentary units were interpreted as a klippe, i.e. as erosional remnants of the STD. Accordingly, it is proposed that the STD in the Bhutan Himalaya extended further to the south than its today's trace at the border with Tibet. In addition, microtectonic studies indicate that the north-directed shearing along the STD was preceded by a south-directed shearing. These observations have major implications in interpretation of tectonics of the Himalayas during the Miocene when the STD was active as a ductile shear zone, and when leucogranite was emplaced and then deformed along the STD. This new interpretation of the STD helps to explain the intrusion mechanism of the leucogranite units and their relationship to the inverted metamorphic sequence.