In-sequence shearing within the Greater Himalayan Sequence in Central Himalaya: deformation and metamorphism by crustal accretion from the Indian plate

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The Greater Himalayan Sequence (GHS) is the main metamorphic unit of the Himalayas, running for over 2400 km, bounded to the South by the Main Central Thrust (MCT) and to the North by the South Tibetan Detachment (STD) whose contemporanous activity is considered to have guided the exhumation of the GHS between 23 and 17 Ma (Godin et al., 2006).

Several shear zones and/or faults have been recognized within the GHS, usually regarded as out of sequence thrusts (Mukherjee et al., 2012). Recent investigations in the GHS in Central Himalaya allowed the Authors to identify a tectonic and metamorphic discontinuity, localized in the middle-lower part of the GHS well-above the MCT, with a top-to-the SW contractional sense of shear (Higher Himalayan Discontinuity: HHD: Montomoli et al., 2013; in press).

U-(Th)-Pb *in situ* monazite ages provide temporal constraint of initiation of the HHD at 28-26 Ma (Carosi et al., 2010; Larson et al., 2013; Montomoli et al., 2013), older than the Main Central Thrust, and continuing up to 17 Ma. Data on the P and T evolution testify that these shear zones affected the tectono-metamorphic evolution of the belt and different P and T conditions have been often recorded in the hanging-wall and footwall of the HHD. Moreover the activity of the HHD resulted in different timing of the peak metamorphic conditions in its hanging wall and footwall rocks (Montomoli et al., in press). The correlation of the HHD with several other discontinuities recognized in the GHS led to propose that it is a regional-scale tectonic feature running for several hundreds kilometers dividing the GHS in two different portions and affecting its metamoprhic evolution and exhumation.

In Western and Central Nepal the occurrence of even more structurally higher contractional shear zone, with a top-to-the SW sense of shear, in the GHS (above the HHD): the Tyar shear zone in the Mugu – Karnali valley and the Kalopani shear zone in the Kali Gandaki valley, points out to an even more complex deformation pattern within the metamorphic core.

These recent findings suggest that GHS is build up by the progressive accretion of Indian crustal slices since the Eocene-Oligocene. The GHS is made up by several crustal slices showing younging deformation and metamorphism from the upper one to the lower one (Fig. 1). The youngest activity of the STDS in Western Nepal is constrained by the timing of intrusion of a large undeformed and cross-cutting leucogranite body at 23-24 Ma (Carosi et al., 2013). Considering that in the same area the MCT was active after ~ 18 Ma (Montomoli et al., 2013) there is no evidence of contemporaneous activity of the STD and MCT

The actual proposed models of exhumation of the GHS, based mainly on the MCT and STD simultaneous activities, are not able to explain the occurrence of the HHD and other in-sequence shear zones. Every model of the tectonic and metamorphic evolution of the Himalaya should account for the occurrence of the regional tectonic and metamorphic discontinuities within the GHS (HHD) and its consequences on the metamorphic paths and on the assembly of Himalayan belt.

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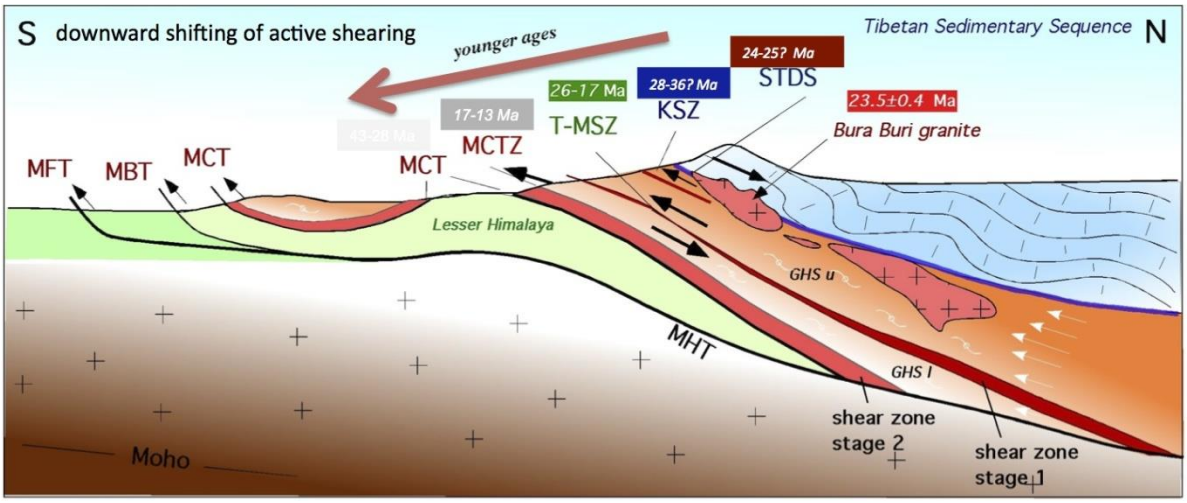

Figure 1. Schematic cross section through the Himalayas showing the localization of shear zones in the GHS (GHS u = upper, GHS l = lower) and their ages (modified after Carosi et al., 2010; 2013; in press and Montomoli et al., 2013). Ages of ductile shear zones such as Kalopani shear zone: KSZ, Tojem-Mangri Shear Zone (= Higher Himalayan Discontinuity): T-MSZ and MCT Zone and subsequent brittle faults in western Nepal indicate a deformation propagating to the foreland. Ages of STDS and MCT in central-western Nepal were taken from Godin et al. (2006) and Montomoli et al. (2013). Crosses with red background indicate Higher Himalayan granites emplaced in the hanging-wall of the HHD and cross-cutting the STDS (ages from Carosi et al., 2013).

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