

## When did the metamorphic nappe cover the Lesser Himalayan autochthon? An approach from study on thermal history of Proterozoic granitic rocks and Miocene fluvial sediments

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The timing of exhumation of the Higher Himalaya Crystalline (HHC) is well dated in the Nepal Himalaya by dating of various metamorphic minerals of the MCT zone and the Higher Himalayan Crystalline. Previous studies indicate that rapid exhumation of the HHC occurred at around 25 to 13 Ma, and reactivation of the MCT occurred in Pliocene at 6 to 3 Ma. Exhumation of the HHC gave rise to southward advancement of crystalline nappe (Lesser Himalayan Crystalline: LHC) which tectonically covered the Lesser Himalayan autochthon over 100 km. However, it is not well understood when and how did the metamorphic nappe cover the autochthon and when did the metamorphic nappe reach southern margin of the Lesser Himalaya just to the north of the Main Boundary Thrust (MBT).

In order to solve these problems, we have started investigation of thermal history of the Lesser Himalayan autochthon and overlying low-grade metamorphic nappe in western and eastern Nepal Himalaya. This is the first report on the  $^{40}\text{Ar}/^{39}\text{Ar}$  and fission-track dating of the granitic rocks in the LHC and underlying Dumri Formation of Miocene fluvial sediments in the far eastern and eastern Nepal.

We collected granitic rocks and their mylonitized rocks in the Lesser Himalayan Crystalline at three different tectonic positions along a NNW-SSE section connecting Taplejung and Ilam: (1) the north of Taplejung, (2) SW of Taplejung within the Taplejung tectonic window, (3) SW of Ilam just to the north of the MBT (Figure 1 and 2). Ar-Ar dating of biotite of garnet-biotite-muscovite gneiss in the Higher Himalayan Crystalline shows an isochron age of about 28 Ma, and that of muscovite shows isochron and plateau (880-1120 °C) ages of about 11 Ma. Ar-Ar dating of biotite from augen gneiss in the LHC within the Taplejung tectonic window shows two isochrone ages: about 25 Ma (500-760 °C) and 22 Ma (920-1200 °C), and that of muscovite shows a plateau age (1020-1100 °C) of about 15 Ma.

F.T. dating of zircon and apatite indicate 2.0±0.4 Ma (Ap) age for from 1.6 Ga Kabeli Khola Granite, 4.6±0.4 Ma (Zr) and 2.5±0.3 Ma (Ap) ages for 16-14 Ga mylonitized granite just to the north of the Kabeli Khola (Takigami et al. 2003), and 5.5±0.3 Ma (Zr) and 2.6±0.4 Ma (Ap) ages for micaceous schist of their country rock (location shown in Figure 2).

A mylonitized granitic sheet at southern end of the Lesser Himalaya near MBT in Ilam yields the F.T. ages of 12.5±0.4 Ma (Zr) and 1.8±0.4 Ma, (Ap) respectively. The western extension of the mylonitic granite sheet to the south of Dhankuta yields the F.T. ages of 8.9±0.3 Ma (Zr) and 7.2±0.8 Ma (Ap).

The Dumri Formation comprising of pre-Sivalik fluvial

beds are narrowly distributed along the southern margin of the Lesser Himalaya just to the north of the MBT, around a village Tribeni (Figures 1, 2). The Miocene fluvial sediments of about 1 km thick is tectonically overlain by the LHC, and the upper part of them are weakly metamorphosed, ranging more than 300 m in thickness. In the Dumri sandstone, metamorphic muscovite was formed along the foliation plane, and its crystallinity increased upwards. Fission-track of detrital zircon grains in the upper part are reset by heating probably due to thermal effect from overlying low-grade metamorphic nappe with sheets of mylonitic granite. However, in the middle part of the Dumri Formation, fission-track of detrital zircon has been partially reset, and that of the lower part has never been reset. It means thermal effect is stronger in the upper part, just beneath the nappe. This is the same type of inverted metamorphism reported from the Dumri Formation in the Karnali Klippe area, western Nepal (Sakai et al. 1999).

One of the detrital zircon and apatite grains from the uppermost part of the Dumri Formation show fission-track ages of 13.6±0.6 Ma (Zr) and 4.6±0.6 Ma (Ap). A mylonitic granite sheet to the south of Dhankuta yielded the F.T. ages of 8.9±0.3 (Zr) and 7.2±0.8 (Ap), and its western extension to the north of Tribeni indicates the F.T. ages of 9.2±0.7 Ma (Zr) and 8.5±1.0 Ma (Ap).

These results suggest that the crystalline nappe has covered the Lesser Himalayan autochthon by 14 Ma and affected thermally (350±50 °C) the uppermost part of the autochthon. In the middle part of the Lesser Himalaya, temperature of LHC was kept about 240-300 °C till the earliest Pliocene around 5 Ma, and cooled down about 130±30 °C by the latest Pliocene around 2.5-2 Ma. The cooling rate in the frontal part of the LHC seems to have been much higher than the middle part, and the temperature at the frontal part decreased up to 130±30 °C by the late Miocene around 8-7 Ma.

### References

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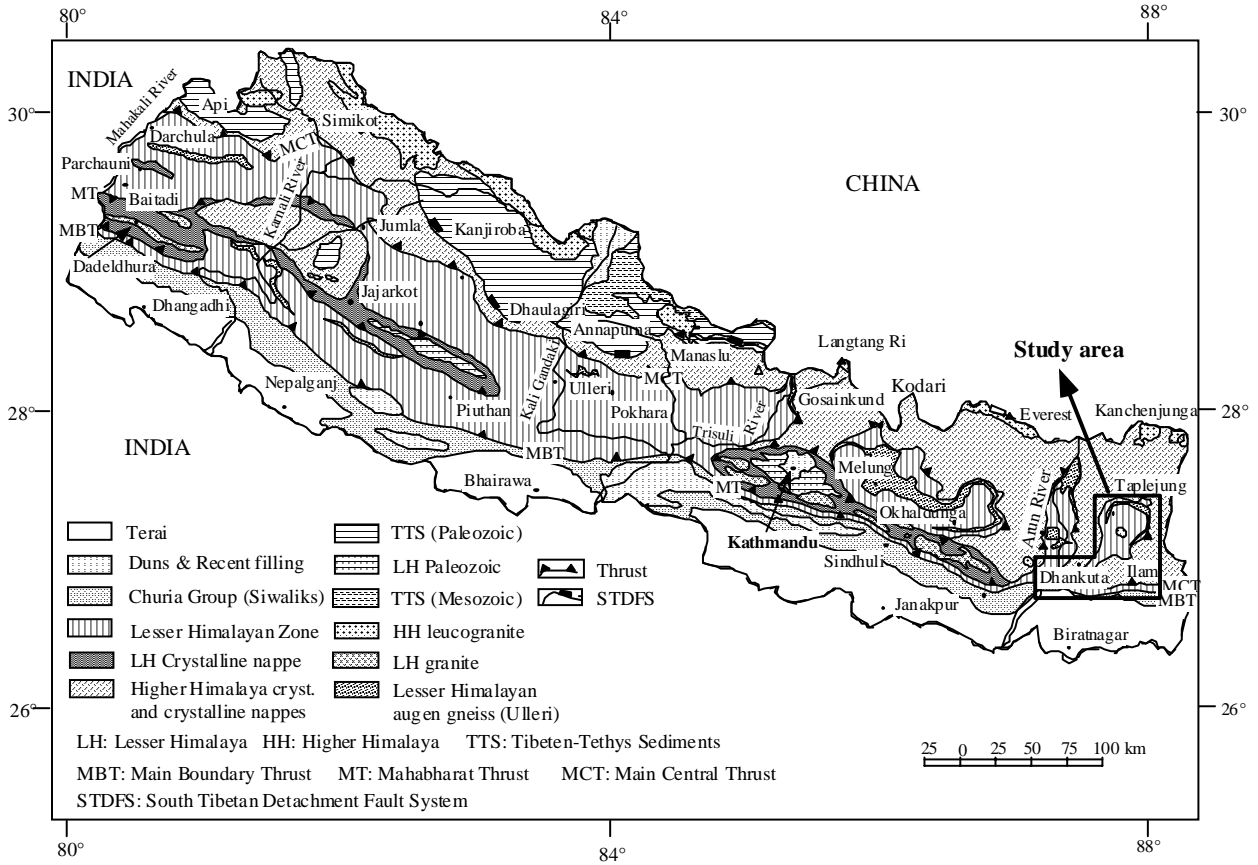


FIGURE 1. Geological outline map of the Nepal Himalaya after Upreti (1999)

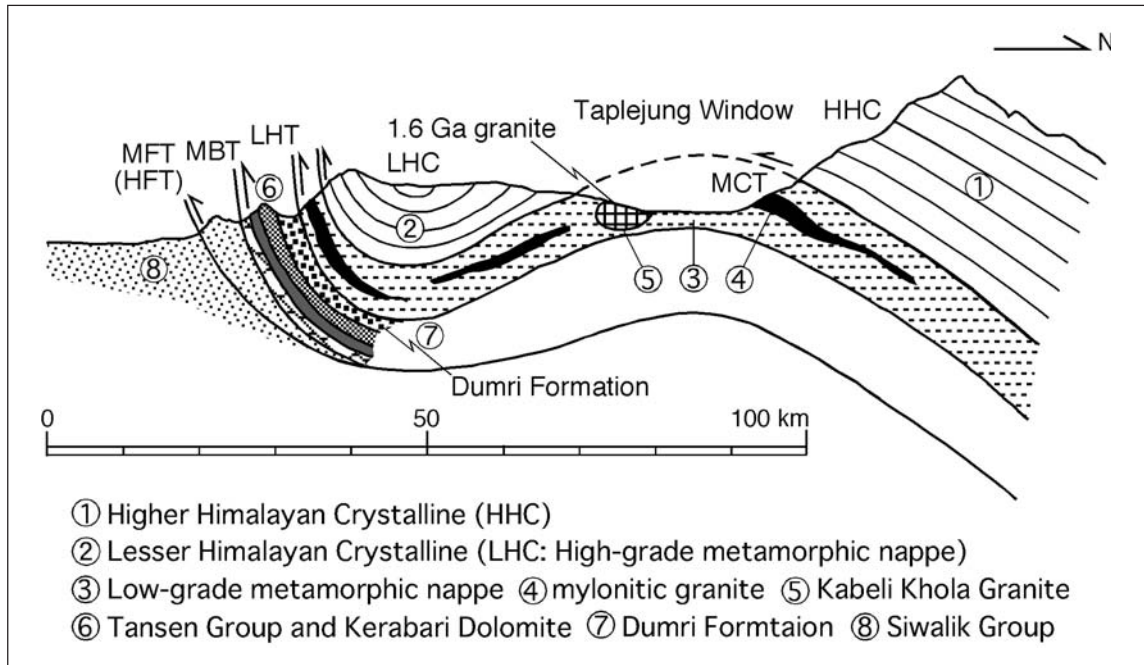


FIGURE 2. Schematic geological cross-section of far eastern Nepal, central Himalaya