Three Dimensional Exhumation Process of the Greater Himalayan Complex above the Main Himalaya Thrust

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The Greater Himalayan Complex (GHC) is characterized by high-grade (up to granulite facies) metamorphic rocks exhumed from the middle to lower crust, widespread migmatites from extensive anatectic process and high-temperature ductile deformation, suggesting that the Himalayan orogen is a "hot" collisional orogen. For a long time, the southward exhumation of the GHC was assumed to occur between the Main Central Thrust (MCT) and the South Tibet Detachment (STD) at ~24–10 Ma. However, our previous studies in the GHC revealed the widespread presence of sub-horizontal ductile detachment with orogen-parallel stretching lineation in the upper part of the GHC, which can be traced from the Purang area in the western Himalaya to the eastern Namche Barwa Syntaxis. The U–Pb ages of metamorphic zircon rims and $^{40}Ar/^{39}Ar$ cooling ages of mica and hornblende indicate that the orogen-parallel extension in the GHC is asymmetric: initiated first in the central GHC and moved faster eastward (28–26 Ma in the Nyalam and Jilong areas), but migrated slower westward (22 Ma in the Purang area). The lateral flow along the orogen-parallel detachments continued to 13–11 Ma, coeval with the activation of the MCT and STD.

In this study we revealed a large-scale ductile thrust shear zone in the GHC in the Beni-Jamson cross-section, Central Nepal, which is characterized by high-temperature quartz fabric (>650 °C), syn-tectonic felsic veins and a top-to-the-south shear sense. This thrust shear zone began the high-temperature ductile deformation at 34 Ma in the top of the GHC, and progressively migrated to the south at 26 Ma in the lower part of the GHC, i.e., earlier than the activation of the STD and MCT. Combined with seismic profiles across the Himalaya, we interpret this thrust shear zone as the exposed Main Himalaya Thrust (MHT). Activation of the MHT probably triggered the emplacement of late Eocene leucogranites in the Lagugoi Ganri metamorphic domes of the Tethys Himalaya.

Therefore, we propose a 3-D exhumation process of the GHC as follows: (1) Initial activation of the MHT triggered the partial melting of a thickened crust at 45–36 Ma and resulted in a weak and hot GHC; (2) Top-to-the-south thrusting along the MHT formed a thick shear zone in the GHC in the Oligocene (34–26 Ma); (3) Initial orogen-parallel gravitational collapse occurred in the late Oligocene in central and eastern GHC (28–26 Ma); (4) Widespread orogen-parallel extension and southward extrusion of the GHC in the Early-Middle Miocene, accompanied with the activation of the STD and MCT (24–10 Ma) under upper-amphibolite to greenschist facies metamorphism conditions. Subsequently, the MHT was migrated southward and produced the Main Boundary Thrust and Main Front Thrust between 10 and 5 Ma.

The Luobusa ophiolite lies in the eastern part of the Indus-Zangbo suture zone, Tibet and contains the biggest chromitite deposit in China. In recent years, lots of ultrahigh pressure and highly reduced minerals were surprisingly discovered in the Luobusa mantle peridotite and chromitite. They indicate a deep mantle (> 300 km) origin contrary to previously SSZ origin thought (Yang et al., 2014). Here, we report our new discoveries of in-situ natural moissanite and chromium-rich included olivines in Luobusa. They also suggest a lower mantle or transition zone origin.

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Cite as: Xu, Z.Q., Cao, H., Cai, Z.H., Zeng, L.S., Rai, S.M., et al., 2014, Three Dimensional Exhumation Process of the Greater Himalayan Complex above the Main Himalaya Thrust, in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.