

Examination of extrusion model of Himalayan metamorphic belt by study of exhumation process of metamorphic nappe

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A ductile extrusion model explains that metamorphic core of the Himalaya, called the Higher Himalayan Crystallines (HHC), was originated by ductile channel flow of partially melted mid-crust from beneath the Tibetan plateau. No definite evidence of the model has yet been documented that shows the melted mid-crust extruded to form the HHC though many numerical models were proposed and their simulation was performed.

We performed thermochronological study of the HHC nappe by means of zircon and apatite fission-track dating in order to examine the extrusion model on the basis of emplacement and cooling history of the HHC nappe, which extensively covers the Lesser Himalayan autochthon ranging in width of 80 to 120 km. As the results, we could have revealed the emplacement history of the nappe, which has strong constraints on the extrusion model: the HHC of more than 10 km thick extruded on the ground at 15-14 Ma, and advanced to the SSW with the rate of 3-4 cm/yr retaining hot condition more than 300 °C . The nappe finally terminated its movement at 11 Ma. Early Miocene foreland basin sediments on the top of the Lesser Himalayan autochthon have undergone weak metamorphism after covering of hot nappe at 11-10 Ma. Both metamorphic nappe and the underlying foreland basin sediments cooled down below 240 °C by 10 Ma and below 110 °C by 8 Ma. The metamorphic nappe laterally cooled down toward the NNE from its front at the rate of ca. 1cm/yr, and root zone area of the nappe reached 240 °C by 4 Ma and 110 °C by 1 Ma. One more constraint is that estimated P-T condition is consistent from the nappe front to the root zone: maximum temperature is around 750 °C and maximum pressure is 11-12kb.

Under these constraints, we examined the disposition of the HHC nappe before its extrusion, considering width of nappe as 80 km and inclination angle of metamorphic belt as 20 degree. After simple calculation of position of root zone of nappe under 12kb, it is concluded that root zone was located at 53 km to the north of the front of partially melted mid-crust of Tibet and seated 39 km in depth. It indicates that the HHC nappe must have been originated from partially melted mid-crust of Tibet.

Keywords: extrusion, nappe, fission-track dating, zircon, Himalayan metamorphic belt, Lesser Himalaya