Coeval extrusion and lateral flow of the Greater Himalaya: New insights from structural and geochronological data in southern Tibet

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Orogen-parallel structures have been recognized in the Greater Himalayan Crystalline Complex (GHC). However, because the top-to-the-north and top-to-the-south shear fabrics are predominant in the north-dipping Main Central thrust (MCT) below and the South Tibet detachment (STD) above across the entire GHC, the tectonic significance of the orogen-parallel deformation in exhumation of the GHC was often ignored. Based on new field structural data, kinematic and geochronological analyses along the line of Pulan-Nyalam-Yadong in the GHC, we determined the east-west lateral flow between the GHC basement and its sedimentary covers. The lattice preferred orientations (LPO) of quartz and sillimanite from mylonite and mylonitic gneiss were measured using the electron backscatter diffraction (EBSD) technique. The kinematic fabrics in the wide shear zone and asymmetric LPOs of quartz and sillimanite indicate a consistent top-to-the-east shear sense in the eastern GHC, both top-to-the-east and top-to-the-west shear sense in the central GHC, and a top-to-the-west shear in the western GHC. The characteristic fabrics of quartz and sillimanite indicate the lateral flow occurred in the middle crust. However, the stretching lineation turns to north-south trending when close to the MCT and STD. Therefore the GHC is characterized by an extruded recumbent-shaped structure, which developed the top-to-the-north fabric and normal metamorphism sequence near the STD, and top-to-the-south fabric and inverse metamorphism sequence near the MCT. SHRIMP dating on zircon indicates that the orogen-parallel deformation initiated at 28-26 Ma in the eastern GHC, and 22-16 Ma in the western GHC. In addition, 40Ar/39Ar dating on biotite and muscovite yields 14-11 Ma for the eastern GHC. Our dating results are consistent with the activation age of the MCT (23-20 Ma) and STD (20-16 Ma), implying coeval orogen-parallel and orogen-perpendicular deformation during extrusion of the GHC. We propose a new channel flow model to interpret the architecture and extrusion of the GHC, in which the coeval east-west extension and north-south shortening occurred under pure shear during the India-Asia collision. The relatively fast strain rate in the middle of the channel resulted in the lateral flow of material in the GHC, and ductile detachment between the crystalline basement and the sedimentary cover in the middle crust.