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Microstructural and geochemical studies of Mid-Miocene deformed leucogranite in the Gular Mandhata area: implications for the initiation age of the Gular Mandhata detachment fault

Lining Cheng and Xiaosong Yang

State Key Laboratory of Earthquake Dynamics, Institute of Geology, China Earthquake Administration, Beijing, China (chenglining@ies.ac.cn)

The key method to understand the shear age and slip rate of the fault is to analyze the temporal and spatial relationship between magmatism and faulting. In this study, we undertake a geochemical and microstructural investigation in the north of the Gular Mandhata detachment fault, Northwest Himalaya.

There are many deformed leucogranite dikes and sills emplaced along the footwall of the Gular Mandhata detachment fault. The most abundant lithology is tourmaline-garnet-bearing leucogranite. Our geochemical analysis show that these rocks are characterized by (1) high SiO_2 (73.86-75.06 wt.%), Al_2O_3(14.73-15.18 wt.%), K_2O (3.73-4.40 wt.%), and low level of CaO (<1 wt.%), TFeO (<1 wt.%), TiO_2(<0.1 wt.%); (2) relatively high Rb (201-331ppm), Rb/Sr (4-14) and low Sr (23-68ppm), Ba (13-150ppm); (3) weakly fractionated REE pattern ($[La/Yb]_N$=2-5) within strong negative Eu anomalies (Eu/Eu^* <0.2). This geochemical analysis indicates that the deformed leucogranite were derived from fluid-absent muscovite-dehydration melting of the metapelite, which is probably triggered by the E-W extension process of the Himalayan orogenic belt.

Besides, understanding whether leucogranite magmatism is prekinematic or synkinematic is crucial to deduce the fault's initiation age. A careful microstructural analysis in this study indicates that these deformed leucogranite undergone a solid-state deformation with temperature below the lower amphibolite facies. And, there are no evidences showing that deformation occurred in the magmatic or submagmatic state. Therefore, the main magmatic intrusion and crystallization occurred before the fault initiation. LA-ICP-MS zircon U-Pb dating indicates that the crystallization age of the deformed leucogranite is between ca.16Ma and 11Ma, similar to the E-W extension age of the Himalaya orogenic belt.

Consequently, based on the formation mechanism and microstructure feature of the deformation leucogranite, we propose that the U-Pb age of prekinematic deformed leucogranite defines the maximum age of initiation for ductile deformation on the Gurla Mandhata detachment fault. We also conclude that the initiatory age of transition from arc-normal shortening to arc-parallel extension is earlier than 16Ma in the Gular Mandhata area.