Zircon U-Pb-Lu-Hf isotopes of granitoids and enclaves from Ladakh Batholith, Trans-Himalaya, India: Implication on timing and source of magmatism and India-Asia collision

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Felsic magmatic pulses in the north of Indus-Tsangpo Suture Zone (ITSZ) of northwest Indian Himalaya, referred herein Ladakh granitoids, and associated mafic to hybrid microgranular enclaves and syn-plutonic dykes constitute the bulk of the Ladakh Batholith (Kumar, 2010a), which is an integral part of the Trans-Himalayan gigantic batholiths stretched from Namche Barwa in the east to the Nanga Parbat in the west (see the inset map of Fig.1). The Ladakh granitoids and associated enclaves (microgranular enclaves and xenoliths) have been subjected to zircon U-Pb-Lu-Hf isotopic investigations in order to constrain timing and source of magmatism and its implication on the prcise timing of India-Asia collision.

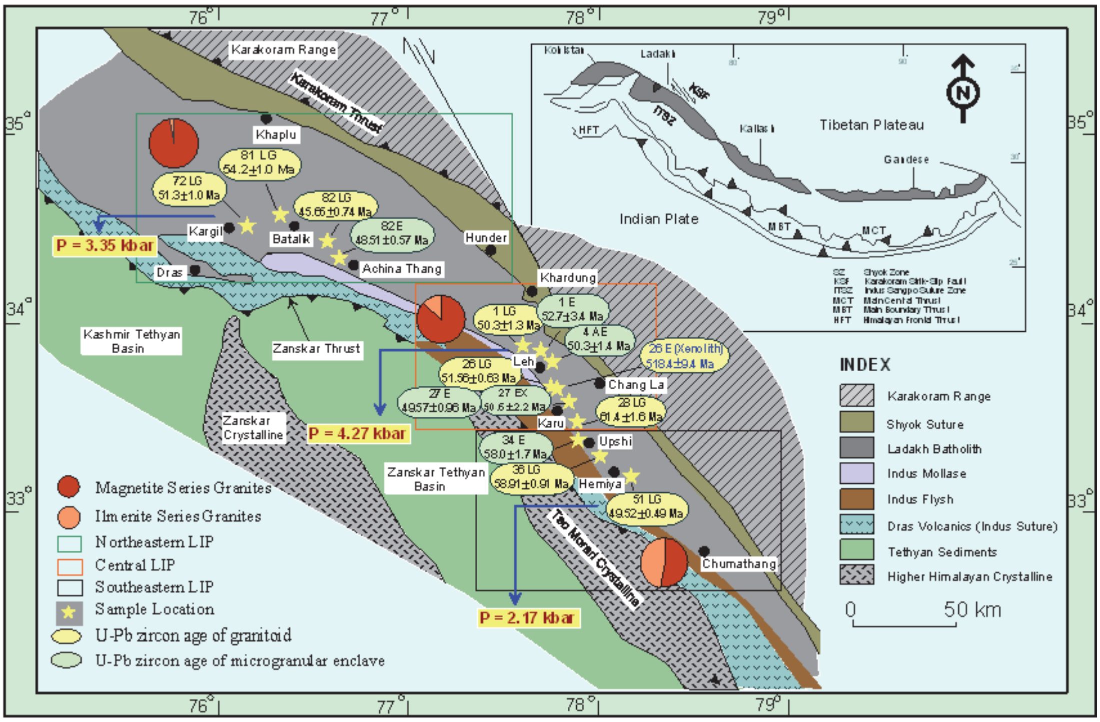

Fig. 1: *Geological structure of Himalaya showing location of Ladakh Batholith in the north of Indus-Tsangpo Suture Zone (ITSZ). Main Central Thrust (MCT) and Main Boundary Thrust (MBT) are also shown (after Gansser, 1977) (Inset map). Geological map of the Ladakh Batholith and associated litho-groups (Sharma and Choubey, 1983; Thakur, 1987). Locations of various places, pressures (P) of magma emplacement, U-Pb zircon ages of granitoids, microgranular enclaves and xenolith are shown on the map. Relative abundance of magnetite series (oxidized type) and ilmenite series (reduced type) granitoids in western, central and eastern parts of the Ladakh Batholith, northwest Indian Himalaya is also shown as wheel diagrams (Kumar, 2008)*

The Ladakh granitoids are calc-alkaline, largely metaluminous (I-type) to a few peralumous type, magnetite to ilmenite series granitoids whereas morcogranular enlclaves are highly metaluminous and magnetite series granitoids (Kumar, 2008, 2010b). Al-in-hornblende geobarometers (P= 3.35 kbar in the west, P=2.99 kbar in the central, and P=2.17 kbar in eastern parts of batholith) suggest differential unroofing of Ladakh granitoid magma chambers (Fig. 1). Fifteen samples (8 Ladakh granitoids and 6 microgranular enclaves including one xenolith) were treated for insitu zircon U-Pb-Lu-Hf isotopes. U-Pb zircon data suggests coeval nature of the Ladakh granitoids and respective enclave globules encloed therein in the Kargil-Batalik-Achinathang (ca 45, 51, 54 Ma, 48.5 Ma), Leh-Karu (ca 50, 61 Ma) and Upshi-Himiya (ca 50, 58 Ma). A magmatic xenolith hosted in the Ladakh granitoids near Karu region has yielded surprisingly an age of ca 518 Ma representing the Gondwana component whereas zircons from its host calc-alkaline granitoids yield a weighted mean age of ca 51 Ma. Most Lu-Hf isotopic data of zircons have shown positive $\varepsilon_{Hf}(t)$ values and young Hf model ages (200-980 Ma) comparable well to those observed for Gangadese Batholith (Ji et al. 2009), which strongly suggest involvement of juvenile magma sources in their genesis and mixing between felsic and mafic magmas. However, one sample of Ladakh granitoid (50 Ma) in the eastern part of the batholith exhibits heterogeneous zircon Hf isotopic ratios and negative εHf(t) values suggesting contribution of ancient continental crust, probably northermost parts of the Indian lithoshpere, in their evolution. This view is further supported by a xenolith (ca 518 Ma) hosted in a Ladakh granitoid (51 Ma), which provides heterogeneous zircon Hf model ages (1685-1740 Ma) and high negative εHf(t) values pointing to the involvement of Columbia Supercontinent related magmatic component in the evolution of eastern part of Ladakh granitoids that must have happened after the collision. The obtrained ages of ca 50-51 Ma may thus mark the onset of the India-Asia collision. The Ladakh Batholith is a product of multistage magma mixing of multiple pulses of mantle- and crustal-derived magmas concomitant fractional differentiation, mingling and diffusion mechanism.

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