Petrology and U-Pb SHRIMP zircon chronology of migmatite from Tangtse Shear Zone, eastern Ladakh Himalaya, India: Evidences of melting of granitoid protoliths and formation of leucogranite-granulite

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Tangtse Shear Zone (TSZ) separates the Pengong Metamorphic Complex (PMC) to the northeast from the Ladakh batholith to the southwest (Reichardt et al. 2010 and references therein). The TSZ is an integral part of Karakoram Shear Zone that lies in the central part of Karakoram fault of trans-tensional nature having dextral strike slip (N55°W). This is marked by the presence of slickenside showing dextral strike slip movement of mylonitized calc-alkaline granite gneiss ubiquitous near Tangtse village. Farther away from this, a mylonitic zone grades into intense network of leucogranite to pegmatitic granites hosting mesocratic to melanocratic amphibolite and granulite lithotypes together referred herewith as Tangtse Migmatite Complex (TMC).

Detailed field association, petrographic features and U-Pb SHRIMP zircon chronology of some representative lithounits constituting the TMC have been investigated in order to infer the nature of protolith, residue and timing of leucogranite melt generation. To achieve the objectives we have chosen carefully an outcrop for detailed investigation which has variegated colour indices representing almost all major components of migmatite complex. Leucogranite veins, sometimes becoming pegmatite in nature, provide concordant to discordant relationships with mesocratic to melanocratic, foliated to stromatic metamorphosed host rocks. Insitu syn-deformational melting signature producing melt stream parallel to the foliation plane are also preserved. We report herewith melanosome granulite from Tangtse region consisting of cpx-scapolite-pl±qtz±ep±ttn assemblage typically representing granulose texture. Anhedral plagioclase is included in clinopyroxene whereas quartz inclusion is found inside the epidote. Mesosome, corresponding to amphibolite facies, bears hbl (±cpx)-bt-pl-qtz assemblage with predominating hornblende. Hornblende is rimmed by chlorite and in the core of amphibole and biotite lie pyroxene, Leucosome, representing typical leucogranite melt, exhibits hypidiomorphic texture having bt-Kf-qtz assemblage and occasional plagioclase residue with inclusions of quartz blebs as partial melts. Close to the studied outcrop calc-alkaline porphyritic granodiorite of Ladakh range is exposed, which most likely served as fertile crust for partial melting at deeper and shallow levels for the TMC. Experimental studies have indicated that melting of metabasic and intermediate rocks will form 15 to 50 vol% melt at $T \leq$ 900°C, and production of such large quantity of melt will cause buffering of metamorphic temperature, which means metamorphic temperature will rarely exceed 850-900°C. Such a thermal event will generate S- and I-type granitoid liquids leaving behind granulitic residue composed of mineral assemblages depending on the composition of the involved protolith (Vielzeuf et al. 1990). Brown (2010) suggested that increase of melt volume increases the melt connectivity and generates dynamic rheological environment, and melt may escape from the source in batches during several melt-loss events. These mechanisms evidently support the occurrences of melt dykes forming cross-cutting network ubiquitous in Tangtse region overall forming the TMC.

Zircons were separated from discordant leucogranite vein, and were subjected to U-Pb SHRIMP analysis. Back Scattered Electron (BSE) and Cathodo-luminescence (CL) images suggest euhedral and zoned nature of zircons, which frequently have anhedral, rounded but zoned inherited cores derived from igneous source regions. Oscillatory zones can also be recognized, which are sometimes truncated by new growth zones. Such morphological features and observed Th/U ratios indicate magmatic origin of zircons. Most of the zircons have yielded concordant to nearly-concordant U-Pb isotopic ages. Out of twenty

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seven analyzed spots of zircons, inherited cores (N=15) have yielded older weighted mean $^{206}Pb/^{238}U$ age of 72.1±1.9 Ma (MSWD=2.0) which corresponds to the age of granitoid protolith of Ladakh range. On the other hand, rims (N=06) of the zircons have provided younger weighted mean $^{206}Pb/^{238}U$ age of 18.24±0.29 Ma (MSWD=3.0), which suggest the primary crystallization age of zircons in leucogranite melt. Old zircons inherited from heterogeneous granodiorite-diorite protoliths, ranging in $^{206}Pb/^{238}U$ ages between 58.3 and 73.6 Ma, commonly have higher content of U (555-5076 ppm) and Th (269-3419 ppm) than the younger rims of zircons (U=592-2340 ppm, Th=79-574 ppm) crystallized in leucogranite magma. The obtained age of 18.24±0.29 Ma for leucogranite vein is consistent with the earlier suggested age of 18.0±0.4 Ma from leucogranite of Tangtse pluton (Reichardt et al. 2010). Based on available field, petrographic and chronological evidences it is suggested that Ladakh granitoid protoliths have undergone partial melting event at shallow to deeper levels during collisional events producing vast amount of leucogranite melt leaving behind granulite residue.

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