# Two-stage Petrogenetic Evolution of the Miocene Higher Himalayan Leucogranite from Migmatites

P.K. Mukherjee[1], A.K. Jain[2], Saptarishi Ghosh[3], Preety Singh[4]

[1] Wadia Institute of Himalayan Geology, 33 GMS Road, Dehradun,India, mukherjee_pk@wihg.res.in
[2] CSIR-Central Building Research Institute, Roorkee, India
[3] Department of Earth Sciences,Indian Institute of Technology, Roorkee, India
[4] Department of Geology & Geophysics, Indian Institute of Technology, Kharagpur, India

The metamorphic core of the Higher Himalayan Crystalline (HHC) is characterized by extensive migmatites with varying degree of in situ melting and leucogranite dykes. The Miocene leucogranite magmatism in the HHC is generally linked to these migmatites. In this study, various components of migmatites from two contrasting protoliths, i.e. an orthogneissic migmatite from Bhutan and paragneissic migmatite from Dhauliganga section in Garhwal (western Himalaya) have been investigated to understand the petrogenesis of derivation of leucogranite magmatism from the HHC migmatites. In Bhutan, migmatite is developed on the western flank of the Kuri Chu half-window, a few kilometres up the section of the HHC, while the Dhauliganga section in Garhwal exposes the migmatite in the upper parts of the HHC near the South Tibetan Detachment System (STDS).

The leucosomes are characteristically enriched in Sr but depleted in Rb compared to the mesosome protolith while opposite is true in case of melanosome residue. Compatible behavior of Sr and incompatible of behavior Rb suggest Kf in the residue in preference to plagioclase which diminished into melt. Though the protolith has ubiquitous negative anomaly but a significant positive Eu anomaly is observed in leucosome with melanosome illustrating enhanced Eu negative anomaly compared to the protolith. These features together with the major elemental composition of leucosome suggest preferential plagioclase melting in preference to K-feldspar. These characteristics are observed in both, orthogneissic migmatites as well as in paragneissic migmatites alike.

Consistent with the textural and petrographical observation following fluid saturated melting reaction can be suggested for the para-gneissic migmatite:

Ms + Pl + Qtz = Melt + Kfs + Sil + Bt

However, in case of orthogneisses, melting reaction may be related to ternary eutectic melting or melting starting from eutectic and the residual solid composition moves on K-feldspar-quartz join through consumption plagioclase into melt phase.

Trace elemental modelling using batch melting model suggest very high degree of partial melting (>70%) for both type of protoliths. This is also consistent with (i) relative proportions of melanosome (restite) and leucosome (melt) observed in field as well as macro-scale specimens, and (ii) proximity of major and trace elemental abundances of the leucosome and mesosome or protolith gneiss with melanosome fraction plot far away in the tie-line (Figure 1).

However, temperature estimates of melting are within a range of about 650 - 750$^0$C. At this moderate temperature range, such high degree of melting is possible only in presence of plentiful fluids. It is therefore inferred that the fluid requirement was met externally possibly from the dehydration of metasedimentary rocks.

The leucosome composition is markedly differing from the compositions of leucogranite plutons in the HHC. However, the leucogranite compositions show a linear trend emanating from the field of leucosome compositions (Figure 2). This would mean that the leucogranite magma was derived from the pristine

Cite as: Mukherjee, P.K., et al., 2014, Two-stage Petrogenetic Evolution of the Miocene Higher Himalayan Leucogranite from Migmatites, in Montomoli C., et al., eds., proceedings for the 29th Himalaya-Karakoram-Tibet Workshop, Lucca, Italy.

melt (leucosome) through AFC processes. And this trend being parallel to plagioclase fractionation, it is possible that plagioclase fractionation (~30-40%) would be required to derive most of the leucogranite plutons in the HHC (fig.2). It is also important to note that leucosome compositions with lower degree of melting of paragneiss probably did not yield leucogranite magma through segregation and migration.

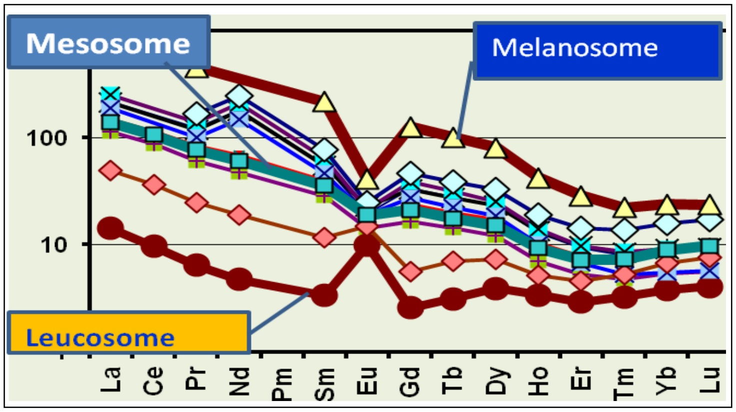


**Figure 1.** Normalized REE pattern of three components of paragneissic migmatite. Leucosome is strongly depleted in REE with a prominent positive Eu anomaly while melanosome is equally enriched with a negative anomaly; producing a mirror image across the mesosome protolith composition. Other plots are migmatites with variable amounts of mixture of these three components.

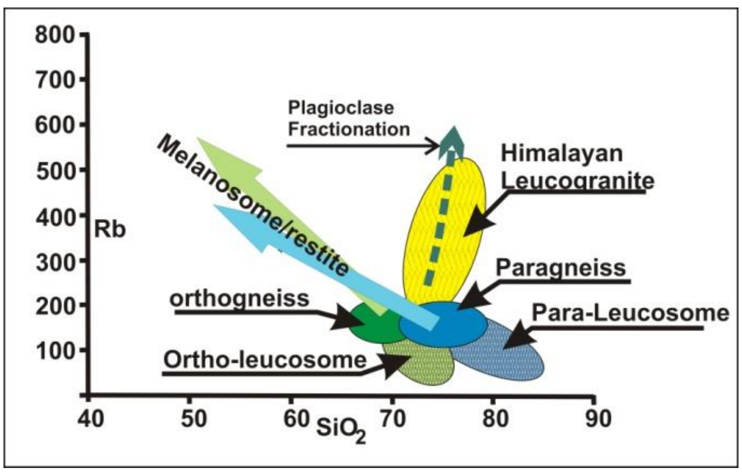


**Figure 2.** Representative compositional plot of migmatite showing mutual relationships of mesosome protolith, leucosome melt and melanosome residue for both ortho- and paragneissic source migmatites. The average of various HHC leucogranites plot along a trend parallel to a plagioclase fractionation line suggesting derivation of leucogranite through fractionation of calcic-plagioclase during ascent of the accumulated melt. The HHC leucogranite average compositions are taken from various sources.

The above results lead us to conclude that both types of migmatites derived from ortho- and para-gneisses are equally potential source for leucogranite melt generation. High degree of melting involved externally-sourced plentiful fluid flux from dehydration of subducting metasediments of northward moving Indian plate. Partial melting was promoted by external fluid flux and not by dehydration of biotite as it occurs as dominant residual phase. Plagioclase played a dominant role both as melting phase as well as fractionating phase that fashioned a two-stage development of the Miocene Himalayan leucogranite magmatism in the upper parts of the HHC.