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Geochemistry of 1800 Ma Ramgarh granitoids of Kumaun Lesser Himalaya – An example of Palaeoproterozoic arc magmatism in Columbia supercontinent

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Ramgarh Thrust (RT) is largely considered to be a major structural feature along the entire stretch of the Lesser Himalayan Duplex known by different names in different sectors. In the type locality of RT in Kumaon Lesser Himalayan Sequence (LHS), the hanging wall is characterized by mylonitic granitoids of lower greenschist facies. Rb-Sr and U-Pb ages for these granitoids have yielded consistent ages of around 1800 Ma making these the oldest in Kumaon LHS.

The Ramgarh granitoids are pervasively foliated, mylonitized, sheared, and appear as gneisses with minute augen shaped porphyroclasts of feldspar and quartz grains. Petrographic studies reveal that quartz and feldspars are present as coarser porphyroclasts in a fine grained matrix of muscovite, biotite and recrystallized quartz grains. Deformation features such as deformation lamellae in quartz grains, kinking of plagioclase lamellae and C-S fabric are common in these rocks. Geochemically, these granitoids fall in granodioritic composition in TAS classification (Middlemost [1]) and are strongly peraluminous (A/CNK=1.61-3.09). These rocks are SiO_2 rich and their content ranges from 63-67 wt%. K_2O content in all but one sample is more than Na_2O; such higher K_2O than Na_2O is a characteristic change in granitoids from Archaean to Proterozoic (Hussain et al. [2]). Al_2O_3 content in these granitoids is also high and ranges from 13.46-16.47%. On primitive mantle normalized multi-element spidergram (Sun and McDonough [3]), these granitoids show relative depletion of Ba, Nb, Sr, Y, P, Ti and enrichment of Rb, Th and U. Negative HFSE and relative higher LILE point towards a crustal source for these rocks while Sr depletion may indicate plagioclase fractionation. Chondrite normalized (Boynton [4]) curves of rare earth elements (REE) show relative enrichment of LREE than HREE with pronounced negative Eu anomalies. Negative Eu anomalies (Eu/Eu^*=0.28-0.66) in these granitoids may suggest removal of plagioclase feldspar by fractionation in early magma chamber. ΣREE in these rocks range from 223.04-355.13 ppm whereas $(La/Yb)_N$ ranges from 5.86-15.28, the latter indicates low to moderate fractionation. Geochemically, these rocks are calc-alkaline in nature and plot in calc-alkaline field of AFM diagram (Irvine and Baragar [5]). In tectonic discrimination diagrams of Rb vs. Y+Nb and Nb vs, Y (Pearce et al. [6]), these rocks plot consistently in the field of volcanic arc granitoids. Results of such plots along with low values of Mg#, Ni, Cr, Sr and high SiO_2 point to a melting of older supracrustals and a lack of melt-mantle interaction in the generation of these granitoids.

1800 Ma granitoids are sometimes considered to represent basement for younger LHS rocks (Valdiya [7]). These basement rocks are supposed to be northward extension of granitic cratons of peninsular India, especially Bundelkhand Granite Massif (BGM). However, Ramgarh granitoids may not represent reworked older granitoids of Bundelkhand Granite Massif as granitoids of the latter are richer in Mg#, Ni, Cr, Sr and poorer in SiO_2 which suggest melt-mantle interaction during generation of BGM granitoid magmas (Hussain et al. [2]). On the other hand, Ramgarh granitoids are possibly the result of

arc magmatism in the realm of Columbia supercontinent as evidences of such widespread magmatic activities are recorded from different sectors of LHS (Kohn et al. [8]).

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