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Role of assimilation and mixing in the evolution of Paleoproterozoic magmatic rocks of outer Kumaun Lesser Himalaya, India: Evidence from the field, petrography, zircon U-Pb chronology and Lu-Hf-O isotopes

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The Lesser Himalayan belt is an integral part of the Paleoproterozoic northernmost Indian Block (NIB), which is composed of granite, granite gneiss, meta-mafics, and massive pink and grey quartzites. They are also exposed in the outer Kumaun Lesser Himalaya. A peculiar highly chloritized lithological unit occurs in and around Laugar close proximity to these lithounits and appears similar to the fine to porphyritic mafic volcanics, which contain pronounced xenocrysts of feldspars and quartz embedded in a fine-grained matrix. In the published records, the same lithological unit is termed as *porphyroid* or *keratophyre* and remains elusive in terms of its nomenclature and stratigraphic position. Does the so-called *porphyroid* or *keratophyre* represent assimilation and mixing? This paper addresses this question based on field relation, petrographic features, and zircon U-Pb-Lu-Hf-O isotopic investigations.

The field and petrographic observation suggest that volcanic rocks exposed in the outer Kumaun Lesser Himalaya are a composite suite of mafic volcanics, intermediate trachyte porphyry (porphyroid or *keratophyre)*, and ignimbrites, which may be genetically related. They show mixing, assimilation and devolatilization-related petrographic features. The chronological records of assimilated zircons (1.81 Ga) in the trachyte porphyry are identical to the primary zircon ages (1.88-1.85 Ga) of Amritpur granites, which underline the assimilation and mixing process. This is consistent with the field and petrographic evidence. The assimilation leads to profuse devolatilization forming the barren silicic and pegmatite veins which are evident in the field. Chondritic to sub-chondritic zircon εHf^{t} values of the Amritpur granite (-0.5 to -4.9) and trachyte porphyry (+2.9 to -3.2) with T_{DM} (2.6 to 2.3 Ga), zircon inheritance (2.2, 2.3 and 2.4 Ga), and higher zircon $\partial^{18}O$ ‰ values (8.51 ± 0.50) also support our hypothesis. The isotopic results also narrate a long crustal evolutionary history of NIB. It is suggested that 1.9 to 1.8 Ga bimodal magmatism is produced by the reworking of older crustal components, accompanied by mantle input. The development of successive marginal rift basins allows the penecontemporaneous deposition of continent-derived and mafic volcanogenic sediments. Assimilation and mixing played a dominant role in 1.8-1.9 Ga bimodal magmatism and crustal evolution of NIB.