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Sodic amphibole zoning as an indicator of post-magmatic fluid interaction: unraveling the magma chamber processes and role of fenitization in the Lichi volcanics, Eastern Himalaya

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The Eastern Himalaya features hotspot-associated magmatism, which is inferred to be a consequence of dynamic movement of the Indian plate over the Kerguelen mantle plume. This mantle plume activity in the Eastern Himalaya produced the Abor and Lichi volcanic suite of rocks, which are analogous to the Rajmahal-Sylhet-Shillong-Mikir flood basalts of Northeast India, as well as the Comei-Bunbury magmatic province extending across southwest Australia and southeast Tibet. This investigation centers on the Lichi volcanics, an alkaline rock suite incorporating basalts, trachyandesites, and trachytes occurring in association with the Gondwana sediments. Optical and mineral chemical analyses on the studied trachytes and trachyandesites reveal the presence of amphiboles, albeit in different volumetric proportions. Notably, the amphiboles in the trachyandesites feature two compositionally distinct groups: sodic-calcic and sodic. The sodic-calcic amphiboles present in the trachyandesites are mostly richterite and winchite, where richterites, compared to winchite are present as relatively larger grains throughout the rock. Interestingly, the sodic group comprising of riebeckite and arfvedsonite, are present as rims that envelop the sodic-calcic amphiboles.

Emphasizing on petrographic observations, we infer the following mineral crystallization sequences: (1) richterite and winchite in the magmatic stage, and (2) arfvedsonite and riebeckite in the post-magmatic stage. Whole rock geochemical data of basalts, trachyandesites and trachytes indicate that the latter two rocks evolved from basaltic magma by fractional crystallization. Supposedly, extreme fractionation of the parent alkaline magma eventually shifted the melt composition towards the carbonate-silicate immiscibility regime. In alkaline complexes, hydrothermal alteration is driven by alkali metasomatism or fenitization. Introduction of Na, Ca and volatiles (primarily CO_2) by fenitizing fluids is exemplified by the replacement of sodic-calcic amphiboles by sodic amphiboles and occurrence of calcite in the trachyandesites. We have attempted to lay an insight on the magma chamber processes that led to the occurrence of sodic amphibole zoning, pointing towards the role of post-magmatic fluids and a probable scenario of carbonatite magmatism in the region.