Microgranular enclaves in Neoproterozoic South Khasi Granitoids of Meghalaya plateau, Northeast India: Evidences of magma mixing, mingling and undercooling processes at mid-crustal level

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Neoproterozoic(690 Ma) felsic magmatism in the south Khasi region of northeast Indian Precambrian shield, referred to as south Khasi granitoids (SKG), contains coutry-rock xenoliths and microgranular enclaves (ME). The ME are mesocratic to melanocratic, fine to medium-grained granular, hypidiomorphic and porphyritic in nature. The shape of the ME is rounded to elongate, and size ranges from few cms to 1.5 meter across having sharp, occasionally crenulate and diffuse contacts. The mineral assemblages (Pl-Hbl-Bt-Kf-Qtz-Mag) of the ME and SKG are the same but differ in proportions and grain size. The presence of acicular apatite, fine grains of mafic-felsic minerals, resorbed xenocrysts and ocellar quartz in ME strongly oppose the restite and cognate origins rather suggest magma mixed origin of ME. Al-in-hornblende estimates the solidification of SKG pluton at about 4 kbars, which suggests that the magma mixing and mingling occurred below the mid-crustal level. Compositions of plagioclase (An_{15}-An_{40}), amphibole ($Mg/Mg+Fe^t$ = 0.27-0.50) and biotite ($Mg/Mg+Fe^t$ = 0.37-0.54) in ME are slightly distinct or similar to plagioclase (An_{19}-An_{38}), amphibole ($Mg/Mg+Fe^t$ = 0.24-0.47) and biotite ($Mg/Mg+Fe^t$ = 0.36-0.56) of fhost SKG, which appear equilibrated during mafic-felsic magma interaction and ME mingling into SKG prior to complete solidification at mid-crustal (~ 4 kbar) level. Biotite compositions from ME and SKG demonstrate $Fe \rightleftharpoons Mg$ substitution as commonly observed in biotites of subduction-related, calc-alkaline I-type (metaluminous), oxidizing felsic melt. Most geochemical features of ME and SKG show affinity with high K_2O, I-type shoshonitic to H-type granitoids. Near-linear variations of major oxides (MgO, $Fe_2O_3^t$, P_2O_5, TiO_2, MnO and CaO) and some trace elements (Pb, Ni, Y, and Ga) against SiO_2, largely suggest the origin of ME by mixing of mafic and felsic magmas in various proportions. However, identical trace and rare earth elements patterns of ME and respective host SKG have been attributed to chemical equilibration through diffusion mechanism during mafic-felsic magma mixing and ME-SKG syn-crystallization. The ME in SKG represent mingled, undercooled, heterogeneous hybrid magma formed by mixing of crystal-charged mafic (enclave) and felsic (SKG) magmas, which simultaneously experienced differential degrees of chemical exchanges with the surrounding felsic host in an open (oxidizing) magma system.