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Sphene-centered ocellar texture as a petrological tool to unveil the mechanism facilitating magma mixing

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The sphene-centered ocellar texture is a unique magma mixing feature characterized by leucocratic ocelli of sphene enclosed in a biotite/hornblende-rich matrix (Hibbard, 1991). The ocelli usually consist of plagioclase, K-feldspar and quartz with sphene crystals at its centre. Although geochemical and isotopic data provide concrete evidence for the interaction between two compositionally distinct magmas, the exact processes by which mixing takes place is yet uncertain. So, textural analysis can be used to decipher the behaviour of two disparate magmas during mixing.

Presented work is being carried out on the sphene ocelli, occurring in hybrid rocks of the Nimchak Granite Pluton (NGP), to understand its formation while two compositionally different magmas come in contact and try to equilibrate. The NGP is ca. 1 km^{2}in extent which has been extensively intruded by number of mafic dykes exhibiting well preserved magma mixing and mingling structures and textures in the Bathani Volcano-Sedimentary Sequence (BVSS) located on the northern fringe of the Proterozoic Chotanagpur Granite Gneiss Complex (CGGC) of eastern Indian Shield.

From petrographic and mineral chemical studies we infer that when basaltic magma intruded the crystallizing granite magma chamber, initially the two compositionally different magmas existed as separate entities. The first interaction that took place between the two phases is diffusion of heat from the relatively hotter mafic magma to the colder felsic one followed by diffusion of elemental components like K and incompatible elements from the felsic to the mafic domain. Once thermal equilibrium was attained between the mafic and felsic melts, the rheological contrasts between the two phases were greatly reduced. This allowed the felsic magma to back-vein into the mafic magma. The influx of back-veined felsic melt into the mafic system disrupted the equilibrium conditions in the mafic domain wherein minerals like amphibole, plagioclase and biotite were crystallizing. This led to the incongruent melting of amphibole and biotite to form liquids of sphene composition. Meanwhile, plagioclase continued to grow in the mafic-turned-hybrid system with a different composition after the advent of felsic melt as indicated by compositional zoning in plagioclase crystals. The newly produced sphene-liquid, owing to its higher affinity for felsic phase than mafic, got incorporated into the back-veining felsic melt forming a distinct liquid of its own. The felsic melt also incorporated crystallizing plagioclase grains in it from the mafic matrix. The mixture of felsic melt, sphene-liquid and plagioclase crystals flowed through the biotite, amphibole and plagioclase dominated matrix towards the low pressure zones to occupy the spherical void spaces left behind by escaping of gases/volatiles forming the sphene ocelli.

Hibbard, M.J., 1991. Textural anatomy of twelve magma-mixed granitoid systems. In: Didier, J., Barbarin, B. (Eds.) Enclaves and granite petrology, 431-444.