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Genesis of emulsion texture due to magma mixing: a case study from Chotanagpur Granite Gneiss Complex of Eastern India

Bibhuti Gogoi (1,2), Ashima Saikia (1), and Mansoor Ahmad (3)

(1) Department of Geology, Delhi University, New Delhi 110007, India (bibhuti.gogoi.baruah@gmail.com), (2) Department of Geology, Cotton College State University, Guwahati 781001, Assam, India, (3) Rajabazar, Patna 800020, India

The emulsion texture is a rare magma mixing feature in which rounded bodies of one magmatic phase remain dispersed in the other coherent phase (Freundt and Schmincke, 1992). This type of special texture in hybrid rocks can significantly contribute toward understanding the mechanisms facilitating magma mixing and magma chamber dynamics involving two disparate magmas as the exact processes by which mixing occurs still remain unclear. Recent developments in microfluidics have greatly helped us to understand the complex processes governing magma mixing occurring at micro-level. Presented work uses some of the results obtained from microfluidic experiments with a view to understand the formation mechanism of emulsions preserved in the hybrid rocks of the Ghansura Rhyolite Dome (GRD) of Proterozoic Chotanagpur Granite Gneiss Complex (CGGC), Eastern India.

The GRD has preserved hybrid rocks displaying emulsion texture that formed due to the interaction of a phenocryst-rich basaltic magma and host rhyolite magma. The emulsions are more or less spherical in shape and dominantly composed of amphibole having biotite rinds set in a matrix of biotite, plagioclase, K-feldspar and quartz. Amphibole compositions were determined from the core of the emulsions to the rim with a view to check for cationic substitutions. The amphibole constituting the emulsions is actinolite in composition, and commonly shows tschermakite (Ts) and pargasite (Prg) substitutions.

From petrographical and mineral-chemical analyses we infer that when mafic magma, containing phenocrysts of augite, came in contact with felsic magma, diffusion of cations like H^{+}, $Al^{3+}$and others occurred from the felsic to the mafic system. These cations reacted with the clinopyroxene phenocrysts in the mafic magma to form amphibole (actinolite) crystals. The formation of amphibole crystals in the mafic system greatly increased the viscosity of the system allowing the amphibole crystals to venture into the adjacent felsic magma as veins. As these veins traversed in the felsic medium they underwent sinuous perturbations as a result of the competition between the viscous torque, due to difference in drag on each side of the veins, and the dynamic viscous bending resistance (Cubaud and Mason, 2009). Further downstream, the undulations amplified and swirls started to develop on the sinuous veins by accumulating the high viscosity mafic phase into central bulbs and depleting the regions in between them forming tails. Gradually the tails thinned out and blended into the surrounding felsic melt forming discrete viscous emulsions/swirls. After separation, the amphibole constituting the emulsions started interacting with the surrounding felsic magma forming biotite at the periphery of the emulsions. Eventually, biotite is eroded away and new rinds simultaneously form on freshly eroded surfaces of emulsions facilitating the mixing process (Farner et al., 2014).

Cubaud T and Mason TG (2009) New J. Phys. 11, 075029.

Farner et al. (2014) Earth and Planetary Science Letters 393, 49-59.

Freundt A and Schmincke HU (1992) Contrib Mineral Petrol 112, 1-19.