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Analogy of flow microstructure observed in magmatic dykes and viscous suspensions

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The general flow curve of a magmatic suspension depends strongly, among other physical factors, of the geometrical arrangements (flow microstructure) formed by the suspended crystal phase, which is created and modified by forces affecting the fluid system. In the particular case of magma dyke emplacement, viscous forces are predominant and induce the microstructural arrangement among the phenocrystals. Theoretically, shape, size and distribution of suspended particles in magmatic fluids can provide an approach to its overall rheology during shearing. To investigate the validity of this premise, we analyze the flow microstructure formed in magmatic dykes from a mafic swarm in southern Mexico, and compare the results with those formed in analogue suspensions. The Tuzantla-Tiquicheo-Nanchititla (TTN) swarm of dykes are intrusive andesitic and andesitic-basaltic bodies of dark green color or gray, with intergranular, intersertal, and seried glomeroporfidic texture characterized by a phenocrystal plagioclase phase, which in some cases constitutes glomeroporfids of big size (from 2 to 2.5 cm), with crystal overgrowth of the type subhedral and anhedral of hedenbergit, olivines, and opaques. Sizes of the longest axis in phenocrystals vary from 0.5 to 2.5 cm, which is a particular feature that facilitates the direct observation of microstructure in cuts of rock samples. Analogue suspensions in literature and in lab determinations show a rheological curve with an random microstructure starting at a Newtonian platform with low shear strain rates, followed by viscosity decrease with shear strain, and a microstructure characterized by alignment of particles. With higher strain rates, the suspension system may behave as shear thickening as it evolves to higher order degree. The characteristic flow microstructure for different rheological curves is then compared to direct observations in rock samples.