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Towards MagmaFoam, a computational tool to simulate magmatic systems

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Numerical models have been widely used to predict and better understand generation, ascent and eruption of magma. The recent extraordinary progress in computer performances and improvements in numerical modeling allow us to simulate multiphase-multicomponent systems in mechanical and thermodynamic disequilibrium. Nonetheless, the growing complexity of the simulations requires more sophisticated constitutive models which are difficult to be validated with experiments. In most cases, simple constitutive equations and freely adjustable parameters are used to tackle with the complexity of real systems. Free tuning of parameters allows satisfactory fit of experimental data, but may significantly reduce the reliability of models at the natural scale. For instance, the calibration of free parameters expressing phenomena at the liquid-gas interface (e.g., phase change) with analogue experiments is useless if the properties controlling the kinetics are not scaled.
Here we present MagmaFoam, a model based on the open source library OpenFOAM that resolves the fluid dynamics of melt-gas systems. The model includes thermo-mechanical non equilibrium phase coupling and phase change, state of the art multiple volatile solubility models and constitutive equations with real thermodynamic and transport properties. Benchmark simulations and comparison with experimental data provide means to explore and discuss the constitutive models to be used in MagmaFoam in order to account for the physical processes that affect the dynamics of natural magmas.