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2D thermo-mechanical-chemical coupled numerical models of interactions between a cooling magma chamber and a visco-elastic host rock

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A recent focus of studies in geodynamic modeling and magmatic petrology is to understand the coupled behavior between deformation and magmatic processes. Here, we present a 2D numerical model of an upper crustal magma (or mush) chamber in a visco-elastic host rock, with coupled thermal, mechanical and chemical processes, accounting for thermodynamically consistent material parameters. The magma chamber is isolated from deeper sources of magma (at least periodically) and it is cooling, and thus shrinking. We quantify the changes of pressure and stress around a cooling magma chamber and a warming host rock, using a compressible visco-elastic formulation, considering both simplified idealized and more complex and realistic geometries of the magma chamber.

We present solutions based on a self-consistent system of the conservation equations for coupled thermo-mechanical-chemical processes, under the assumptions of slow (negligible inertial forces), visco-elastic deformation and constant chemical bulk composition. The thermodynamic melting/crystallization model is based on a pelitic melting model calculated with Perple_X, assuming a granitic composition and is incorporated as a look-up table. We will discuss the numerical implementation, show the results of systematic numerical simulations, and illustrate the effect of volume changes due to temperature changes (including the possibility melting and crystallization) on stress and pressure evolution in magmatic systems.