Numerical simulation of magma chamber degassing

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When magma is introduced into the upper crust, volatiles, such as water vapor, carbon dioxide and sulfur dioxide, exsolve and rise to the surface through permeable host rocks. Volatile carry salts and trace elements such as metals and quartz, which can be deposited on the rock skeleton as pressure and temperature decrease. If the thermodynamic conditions allow the deposition of metals, for example, copper, then ore deposits can be formed.

In [1], the degassing of the magma chamber was studied by means of of non-isothermal multiphase filtration model of a binary mixture of salt and water (NaCl–H2O). For numerical modelling the MUFITS code [2] was used. It is shown that when the pressure drops, magmatic supercritical fluid separates into a liquid and a vapor phase. As a result, the liquid phase is enriched with salt, and at depths of 1-2 km, its supersaturation occurs, leading to salt precipitation. An impermeable salt crust separates brine from meteoric water leading to formation of highly concentrated brine lens.

The influence of a quartz precipitation on the brine lens formation was studied. With prolonged deposition, quartz can occupy a significant part of the pore volume, reducing the permeability of the rock. A numerical model of the flow resulting from the degassing of a magma chamber was developed for accounting of the transport and precipitation of the quartz. It is shown that the precipitation of quartz blocks the flow of magmatic gases to the surface, leading to large fluid overpressures. We introduced the model of dynamic permeability that accounts for fracturing of the rocks when fluid overpressure exceeds some critical value.

It is demonstrated that the process of lens formation occurs periodically: the time intervals associated with clogging of pores with quartz alternate with the periods of development of fractures. The resulting brine lens is smaller than in the case of no-quartz precipitation model.

[1] Afanasyev, Melnik (2017) *Fluid Dynamics* **3**, 88–95. [2] Afanasyev (2017) *Energy Procedia* **125**, 596-603.