Geophysical Research Abstracts
Vol. 19, EGU2017-5491, 2017
EGU General Assembly 2017

Parametric investigation of a brine lens formation above degassing magma chamber

Andrey Afanasyev, Oleg Melnik, Ivan Utkin, and Yulia Tsvetkova
Institute of Mechanics, Moscow State University, Moscow, Russian Federation (afanasyev@imec.msu.ru)

Formation of porphyry-type ore deposits is associated with degassing of crustal magma chambers. Saline, metal-rich magmatic fluid penetrates into a shallow region saturated with cold meteoric water where the metals concentrate in brine lenses. The formation of the lenses and, thus, of the deposits occurs due to phase transitions [1]. The evaporation of H_2O results in enrichment of residual fluid in NaCl. At a depth of 1–2 km precipitation of solid halite blocks the pore space and facilitates formation of concentrated brine lenses.

In order to investigate lens formation, we developed an extension of our multiphase simulator MUFITS [2] for NaCl–H_2O mixture flows. We applied the code in a simple axisymmetric scenario with a high permeability zone in the central part of the domain surrounded by low permeable rocks. The high permeability zone simulates a volcanic conduit above a magma body. The degassing of magma is simulated with a point source of hot supercritical fluid that ascends rapidly up the conduit, undergoing phase transitions en route. Evaporation and rapid ascend of vapor results in increasing from bottom to top salinity of the fluid. As temperature and pressure decline closer to the surface, solid halite precipitates blocking the conduit. Convection of meteoric water in surrounding rocks favors compact location of the brine lens beneath the region of precipitation. Typical temperature in the lens is 450–550°C and overpressure above lithostatic is a few MPa.

We conducted a parametric analysis, investigating the influence of model parameters on accumulation of halite and metals. We found that a higher permeability in the conduit, a smaller permeability in the surrounding rocks and a higher salinity of magmatic fluid favor larger lenses. A smaller magmatic fluid temperature T, i.e. temperature in the chamber, results in a smaller lens that disappears abruptly at a threshold value $T_a \approx 650^\circ$C, and it does not form at $T < T_a$. This is because at $T < T_a$ the thermodynamic conditions at shallow depth do not favor halite precipitation that blocks the flow up the conduit. Finally, we conclude that at $T > T_a$ the lens parameters are most sensitive to the permeability of rocks surrounding the conduit, because the permeability influences a lot intensity of meteoric water convection that blocks spreading of brine at a depth of 1–2 km.

This work was supported by the Russian Science Foundation under grant RSF-16-17-10199.

References

[1] Weis, P. (2015) The dynamic interplay between saline fluid flow and rock permeability in magmatic-hydrothermal systems // Geofluids, 15, 350–371.

[2] Afanasyev, A. MUFITS Reservoir Simulation Software. www.mufits.imec.msu.ru.