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Dynamics of pulsatory magma discharge at Fagradalsfjall volcano during Jul-Aug 2021: insights from observations, tremor locations and numerical models.

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Fagradalsfjall eruption showed a remarkable pulsatory magma discharge activity in Jul-Aug 2021, with a characteristic timescale of ~36 hours (with cycles varying from 17 to 76 hours) and a duration of lava outflow from the crater of 10 to 70 hours. Active lava discharge coincides with the presence of both shallow and deep volcanic tremors that stops abruptly as soon as the active phase of the cycle finishes. The initial phase of each eruption cycle is characterized by some shifts of the tremor source between a depth of ~ 5 km and a shallow level, active degassing, and appearance of fresh lava at the top of the crater. Deep tremor source might be continuously active.

We propose that the pulsatory activity is caused by the dynamics of magma flow in a feeding dike. The model assumes purely elastic wall-rocks rheology and Newtonian temperature-dependent magma viscosity. Elastic displacement of host rocks is calculated by means of the analytical solution for an elliptic cavity subject to fluid overpressure. We assume that surrounding rocks temperature is linearly increasing with depth and the heat transfer from the magma following Newton's law. The influx of the magma at the base of the dike is controlled by the dike overpressure. For reasonable values of governing parameters, the system shows pulsatory activity in accordance with the observed timescales. During low discharge rate magma viscosity in the upper part of the dike increases dramatically, magma flow stops, and the dike starts to inflate at depth storing large amounts of magma. As the pressure increases the flow of the fresh hot magma destroys the plug and discharge episode occurs. The dike deflates and the flow rate decreases leading to consequent cooling of the magma and blockage of the dike.

Parametric study reveals the influence of controlling parameters (magma influx rate, elastic modulus of rocks, heat exchange coefficient end others) on the period of discharge and the presence of pulsatory activity.

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Supplementary material file

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