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Determination of thermal/dynamic characteristics of lava flow from surface thermal measurements

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Rapid development of ground based thermal cameras, drones and satellite data allows getting repeated thermal images of the surface of the lava flow. Available instrumentation allows getting a large amount of data during a single lava flow eruption. These data require development of appropriate quantitative techniques to link subsurface dynamics with observations. We present a new approach to assimilation of thermal measurements at lava's surface to the bottom of the lava flow to determine lava's thermal and dynamic characteristics. Mathematically this problem is reduced to solving an inverse boundary problem. Namely, using known conditions at one part of the model boundary we determine the missing condition at the remaining part of the boundary. Using an adjoint method we develop a numerical approach to the mathematical problem based on the determination of the missing boundary condition and lava flow characteristics. Numerical results show that in the case of smooth input data lava temperature and velocity can be determined with a high accuracy. A noise imposed on the smooth input data results in a less accurate solution, but still acceptable below some noise level. The proposed approach to assimilate measured data brings an opportunity to estimate thermal budget of the lava flow.