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High temperature in-situ study of radiative properties of basaltic dry magmas

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Temperature is a key parameter controlling the evolution of lava flows. The hazardous behavior of eruptions prevents direct measurements of hot magmatic bodies. Hence, the temperature of magma is mostly retrieved by using non-contact methods (ground-based or satellite-based thermal cameras) based on measuring the infrared (IR) emission flux (E) of the body [1]. These well-established techniques are however subjected to important errors, ±100 °C, related to surrounding environment [2], large temperature gradients of cooling lavas [3], constant changes in composition and texture and especially an apparent lack of radiative emission properties during the lava emplacement. Despite that reducing the uncertainties of environmental and thermal gradients when measuring E is ultimately challenging, our study aimed to minimizing the uncertainty in one of the critical hitherto poorly known oversimplified parameters [3,4,5] namely spectral emissivity. Therefore, we performed optical measurements at relevant magmatic temperatures (up to 1200 °C) of representative basaltic dry magmas (MORB, alkaline, calc-alkaline). Emissivity has been systematically determined over a wide spectral (400-15000 cm^{-1}) and thermal range (from room up to 1200 °C) using a non-contact in situ IR emissivity apparatus [6]. SEM, EMPA and Raman spectroscopy techniques were also used in order to characterize and understand the complex radiative behavior of these natural magmatic compositions. Emissivity varies accordingly with temperature and wavenumber but our results also show that small changes in bulk-rock composition produce drastic changes in emissivity at given T, with iron content and its oxidation state being the main agents controlling this parameter. Appropriate emissivity values will then help to refine current field or (space) satellite IR monitoring data (i.e. Holuhraun 2014-2015, Iceland; [3]) and to implement the thermo-rheological models of lava flows [7] as to support hazard assessment and risk mitigation.

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