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Exploring the in situ high temperature emissivity of 2014–2015 Bardarbunga magmas

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Abstract: Temperature is a key parameter controlling the rheology of lava flows. Unfortunately, the hazardous behavior of eruptions prevents direct measurements of hot magmatic bodies. Hence, the temperature of magma is mostly retrieved by using remote sensing methods (ground-based or satellite-based detectors) build on measuring the infrared (IR) radiance of the body [1]. These well-established techniques are however subjected to important errors related to, among others, the poor knowledge of the spectral emissivity (ϵ), which is one of the most critical parameters in IR radiance measurement [2, 3]. In this study, we performed in situ optical measurements at relevant magmatic temperatures of basaltic magma from the 2014–2015 Holuhraun eruption (Bardarbunga volcano, Iceland). Spectral emissivity has been systematically determined over a wide spectral range ($400\text{--}15000\text{ cm}^{-1}$) covering TIR, MIR and SWIR regions, from room temperature up to 1473 K using a non-contact in situ IR emissivity apparatus [4]. SEM, EMPA, Raman spectroscopy, DSC, XRD and TEM techniques helped characterize and understand the complex radiative behavior of this natural magmatic composition. The results show not only that spectral emissivity varies accordingly with temperature and wavenumber but also that small changes in bulk rock composition or texture produce drastic changes in emissivity at given temperature, with iron content and its oxidation state being the main agents controlling this parameter. Appropriate emissivity values can then be used to refine current radiative data from IR remote sensing and to implement the thermo-rheological models of lava flows [5] as to support hazard assessment and risk mitigation.

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