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Toward accurate magma temperature determination: in situ direct emissivity measurements of phonolite Teide and Erebus volcanos

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The temperature of magma is an important parameter to understand the activity of volcanos in consideration of minimize the volcano hazard. Recently, real time thermal remote sensing (such as camera IR or different instruments install on satellite) is largely used for the temperature measurements. This technology is based on measuring the infrared (IR) emitted flux of the body. However, these techniques have large uncertainties of $\pm$ 100°C [1]. Our study is aimed at gaining new information on the radiative heat transfer of rocks, in order to improve the accuracy of magmatic temperature determination through laboratory optic measurements.
Samples from two phonolite volcanos (Erebus and Teide) have been selected for the measurements, their chemistry composition are very similar (except the percentage of FeO*, 3 wt% for Teide sample and 5 wt% for Erebus sample). We used high potential IR emissivity apparatus [2] allowing a direct non-contact in situ IR emittance measurements as a function of high temperature and in a wide spectral range. The Erebus and Teide samples were measured from room temperature up to 2000K with a CO_2 laser, both on heating and cooling; spectra were collected from 400 to 8000 cm-1.
Our results reveal that thermal emissivity of magmatic rock is affected by changes in composition and thermal history. The Teide sample has no significant evolution of emissivity during heating. However, the Erebus sample shows an important emissivity changes (level of 50% difference between high and low emissivity) with the temperature, pointing clearly that the emissivity is not a constant value and it can be very variable during heating and cooling.
Two cooling rates are applied on the sample during the test, fast cooling refers to volcanic bomb, and slow cooling is associate to lava flow. Erebus sample shows different emissivity with different rate of cooling.
The emissivity measurements show also the important role of the iron on the spectral response of the phonolite composition. Starting from 5 % the iron-based clusters are formed and change drastically radiative properties of the sample.
Finally, our results allowed to discuss the accuracy of Erebus lava lack temperature presented in literature.

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