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Modelling the 1982 and 2000 channelised lava flows at Mt Cameroon Volcano using FLOWGO thermo-rheological model

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Like many other effusive volcanoes, Mount Cameroon is a volcano for which only limited information exist on the properties and emplacement dynamics of recent lava flows. Limited accessibility of remote eruption sites together with the lack of monitoring equipment make it difficult to carry out on-site rheologic measurements during eruptions. This study is based on field documentation of the morphometry of historical lava flows at Mt Cameroon, e.g. channel geometry (width and depth), levee and background slope, in order to derive the lava yield strength, velocity and effusion rate. Lava density and viscosity were calculated from compositional data and using laboratory methods. This first phase enabled us to constrain quantitatively the rheological and dynamic characteristics of lava flow effusion for the 1982 and 2000 Mt Cameroon eruptions. These parameters served as input to calibrate the FLOWGO thermo-rheological model. This 1D physical model is aimed at modelling the down-flow evolution of the temperature, geometry and rheology of channel-contained cooling limited lava flows. To account for the uncertainty in the input rheological and geometrical data, three end-member scenarios were used to bracket the potential range in lava channel initial dimension, initial lava temperature and phenocryst content. For each of these scenarios, two crustal growth models were used one assuming a strong insulation due to lava flow surface crusting, the other a much lower rate of lava surface crusting. A total of 12 simulations were made per flow and the results were compared against the channel geometry, microlite content and yield strength and viscosity estimates at different distance from the vent derived from field and laboratory analyses. Best-fit models where obtained for both the 1982 and 2000 lava flows using a low rate of surface crusting, a high initial temperature and a low phenocryst content. Model-predicted lengths were within 95% of the actual lengths. Both modelled viscosity (10^2 – 10^4 Pa s) and yield strength (10^3 – 10^4 Pa) increased down flow consistently with morphometry-based estimates. Modelled mean effusion rates for the 1982 (52 - 64 m^3 s^{-1}) and 2000 (10 m^3 s^{-1}) flows closely matched field calculations (30-70 and 17.5 m^3s^{-1} respectively). Heat loss due to radiation (Q_{rad};10^5 – 10^7 Wm^{-1}) was the dominant heat loss process. FLOWGO model was however unable to reproduce the near-vent increase in microlite content, probably related to lava temperature decrease caused by rapid flow degassing after extrusion. Sensitivity analyses using the 1982 lava flow showed that flow length is greatly sensitive to input channel dimension and initial volume fraction of phenocrysts. The volume fraction of phenocrysts was observed to have an effect on velocity, flow length and effusion rate producing shorter flows as the percentage of phenocrysts increased. The calibration of the FLOWGO model is a first step towards a lava flow hazard assessment at Mt Cameroon.