EGU2020-8372
https://doi.org/10.5194/egusphere-egu2020-8372
EGU General Assembly 2020

Thermal history and emplacement mechanisms of Theo's Flow lava: a proxy for Martian lava flows

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Terrestrial analogues are often investigated to get insights into the geological processes occurring on other planetary bodies. The pyroxenitic layer of the 120m-thick magmatic pile Theo's Flow (Archean Abitibi greenstone belt Ontario, Canada), due to its petrological similarities, has always been regarded as the terrestrial analogue for Martian nakhlites (e.g. Lentz et al. 2011). However, its origin and cooling history and, as a consequence those of nakhlites, have always been a matter of vigorous debate. Did this lava flow originate from a single magmatic event similar to those supposed to occur on Mars or do the different units derive from multiple eruptions?

To answer this question, we calculated the closure temperature and the cooling history for six augite crystals of Theo's Flow lava sampled at four different stratigraphic depths. These results were then coupled with (i) the low viscosity data by Vetere et al. (2019) on the same composition and (ii) the results from the finite difference method in order to test the possible emplacement mechanisms for Theo's Flow.

The combination of geothermometric constraints on augite single crystals and numerical simulations in the framework of a multi-methodological approach, allowed us to demonstrate that Theo's Flow has been formed by multiple magma emplacements that occurred at different times (Murri et al. 2019). Moreover, this discovery also supports the idea that the enormous lava flows with similar compositions observed on Mars could be the result of a process where low viscosity lavas are emplaced during multiple eruptions. This has profound implications for understanding the multiscale mechanisms of lava flow emplacement on Earth and other Terrestrial bodies.

M.M. and M.A. have been funded by the IMPACt project (R164WEJAHH) and by the ERC-StG TRUE DEPTHS under the European Union's Horizon 2020 Research and Innovation Programme (n. 714936) to M. Alvaro. M.C.D. has been funded by the IMPACt project (R164WEJAHH) to M. Alvaro.

D.P. has been funded by the ERC Consolidator Grant ERC-2013-COG (n. 612776) for the CHRONOS project to D. Perugini. The Alexander von Humboldt foundation senior research grant to F.V. is acknowledged. M.A. is also supported by the Ministero dell'Istruzione dell'Università e della Ricerca (MIUR)Progetti di Ricerca di Interesse Nazionale (PRIN)Bando PRIN 2017 - Prot. 2017ZE49E7_005.

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