# Very fast magma dynamics at Mt. Etna revealed by clinopyroxene growth rates

M. MASOTTA[1], A. PONTESILLI[2], P. ARMIENTI[1], S. MOLLO[3,4], M. NAZZARI[4], P. SCARLATO[4]

[1]Dipartimento di Scienze della Terra, Università di Pisa (Italy), matteo.masotta@unipi.it
[2]Department of Geology, University of Otago (New Zealand)
[3]Dipartimento di Scienze della Terra, Sapienza - Università di Roma (Italy)
[4]Istituto Nazionale di Geofisica e Vulcanologia (Italy)

We present new high-pressure crystallization experiments carried out on one of the most primitive trachybasalt from Mt. Etna, at temperatures ranging from 1000 to 1250 °C and pressure ranging from 300 to 800 MPa. Experiments were designed to investigate the effect of undercooling ($\Delta T = T_{liquidus} - T_{crystallization}$) on hydrous and anhydrous crystallization kinetics and to place constraints on magma dynamics. Undercooling experiments were conducted by heating the charge at the temperature of 1300 °C, cooling down to the final target temperature at a constant rate (80 °C/minute) and holding the temperature for 24 hours. Clinopyroxene and titanomagnetite are the dominant mineral phases. Plagioclase crystallizes under anhydrous conditions, amphibole forms in hydrous experiments at 800 MPa, and olivine saturate the melt only at 300 MPa. Clinopyroxene growth rates are maximum at very low degrees of undercooling ($\Delta T < 20$ °C), producing exceptionally large euhedral crystals (>500 µm). In contrast, at moderate to high degrees of undercooling ($\Delta T > 20$ °C), skeletal crystal shapes prevail. Growth rates measured in undercooling experiments are orders of magnitude higher than those from equilibrium isothermal experiments (performed heating the charge to the target temperature and holding the temperature for 24 hours), where smaller (<50 µm) euhedral crystals occurs clustered in patches. Chemical sector zoning of clinopyroxene is observed at high degrees of undercooling ($\Delta T > 50$ °C), accounting for a very fast (few minutes) growth of skeletal crystals followed by a slower (few hours) filling and coarsening of crystal mantle and rim. Undercooling experiments closely reproduce the liquid line of descent of magmas at Mt. Etna and set constrains on magma evolution and dynamics, indicating early crystallization of clinopyroxene ± amphibole at 800-400 MPa, followed by late crystallization of plagioclase and olivine at pressure below 400 MPa. The low water content (<2 wt.%) and the extremely fast growth rates imposed by the undercooling remark the "open system" conduit evolution and the extremely fast dynamics of magmas erupted at Mt. Etna.