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Solid Earth Discussions

Interactive comment on "Rheological control on the dynamics of explosive activity in the 2000 summit eruption of Mt. Etna" *by* D. Giordano et al.

O. Melnik (Referee)

melnik@imec.msu.ru

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The paper presents an interesting investigation of the relation between crystallinity of Etna's magmas and the style of activity – fire fountain vs. Strombolian. Observed relationships are statistically significant and must be seriously considered in interpretation of eruptive activity.

Authors utilize latest rheological models for non-Newtonian crystal reach magmas. The model takes into account changes in melt viscosity and relative viscosity due to the presence of crystals. This approach is valid for relatively bubbly poor magmas corresponding to extrusive dome forming eruption but doubtful for magmas with up to 65 vol % of bubbles.

For results interpretation a steady-state multiphase code Conduit4 is used. The applicability of the code to basaltic eruptions to my opinion still remains doubtful.

1. The code assumes relative gas motion only in a form of bubble rise. This is a good assumption for low viscosity, crystal-poor magmas. In crystal-reach magmas this mechanism is not efficient and gas escapes due filtration through the magma or into surrounding rocks.

2. Important feature of basaltic eruptions is bubble coalescence that is not accounted in the model.

3. The model ignores crystal growth inside the conduit assuming that crystal content is constant along the whole conduit. This might be applicable for the fire-fountain style of eruption but not for the Strombolian where intensive crystal growth occurs only at the upper part of the conduit with a formation of the crystal-reach plug.

4. The model assumes a parabolic velocity profile in order to calculate conduit resistance. This approximation is not valid for the case of non-Newtonian liquid where the profile must be a more plug-like.

5. None of the simulations show fragmentation of the magma. This is due to the fact that a strain-rate fragmentation criterion is used as a fragmentation condition. It is justified for silica-reach magmas but can be violated at low viscosity range.

6. The presence of simultaneous lava flows during fire-fountain phase requires efficient gas separation from the magma at some depth. This is outside the capabilities of the code.

7. The model is steady state. Its application to Strombolian activity is not justified.

8. The main driving force for explosive activity is the gas phase. Its balance due to exsolution and escape determines the explosivity of the eruption. Very little attention is paid in the discussion to this balance.

As a conclusion: the paper presents very interesting correlation between textures of eruptive products and the style of explosive activity but its interpretation is rather doubtful based on the current numerical model.

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