

Transition from effusive to explosive activity during lava dome eruption: the example of the 2010 eruption of Merapi volcano (Java, Indonesia)

Mélissa J Drignon, Laurent Arbaret, Alain Burgisser, Jean-Christophe Komorowski, Caroline Martel, Radit Yaputra

► To cite this version:

Mélissa J Drignon, Laurent Arbaret, Alain Burgisser, Jean-Christophe Komorowski, Caroline Martel, et al.. Transition from effusive to explosive activity during lava dome eruption: the example of the 2010 eruption of Merapi volcano (Java, Indonesia). American Geophysical Union, Fall Meeting 2014, Dec 2014, San Francisco, United States. pp.abstract #V51B-4759. insu-01386845

HAL Id: insu-01386845 https://insu.hal.science/insu-01386845

Submitted on 24 Oct 2016

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Transition from effusive to explosive activity during lava dome eruption: the example of the 2010 eruption of Merapi volcano (Java, Indonesia)

Mélissa J Drignon^{1*}, Laurent Arbaret¹, Alain Burgisser¹, Jean-Christophe Komorowski³, Caroline Martel¹, Radit Yaputra⁴

1 Institut des Sciences de la Terre d'Orléans (ISTO), CNRS, Université d'Orléans, BRGM, Orléans, France 2 ISTerre, Université de Savoie – CNRS, Chambéry, France

3 Institut de Physique du Globe de Paris, Sorbonne Paris Cité, Université Paris Diderot, Paris, France 4 Pusat Vulkanologi dan Mitigasi Bencana Geologi, CVGHM, Yogyjakarta, Indonesia

*Current Address: College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR, USA



Merapi volcano (Java, Indonesia) is one of the most dangerous volcanoes on Earth. It is known to produce lava domes that collapse in deadly pyroclastic flows because of gravity or auto-explosivity. Even though this volcano is mostly effusive, explosive eruptions occur in its history, most recently in 2010. Two major explosive events occurred that year, the first one on October 26, and the second one on November 05. They produced explosive co-lumns that quickly collapsed in pumice-rich pyroclastic flows that ran up to 15.5 km from the summit. The 2010 eruption was very well observed, making this event a good candidate for investigating the effusive-explosive transition with a full suite of geochemical and geophysical data. The pumice of these two events was analyzed and the data used in a two-step computer model in order to investigate the pre-explosive conditions. The explosive-effusive transition often occurs at arc volcanoes. The parameters driving this transition (overpressure, eruptive volume, . . .) are known but the relative importance of each parameter remains unclear. This study demonstrates the primacy of overpressure in determining the eruptive mode of the volcano, with volume and other parameters contributing only to the magnitude rather than the character of the event.



1. Analytical Study

We imaged the pumice of the two explosive events using the SEM at the University of Orléans. The aim was then to be able to trace the plagioclase microlites manually, and the oxides and bubbles automatically in order to obtain the glass proportion. At the same time, we obtained the bulk water content of the pumice using an Elemental Analyzer. We then combined these results to obtain the water content of the glass.

3. Results





Geophysical 6861.0 Distance Rk4 🗢 data Speed-6860.5 Deplacement rate on the South flank of Merapi ā o mana American 5 - 6858.5 (Surono et al., 2012) —3 km 200 m elevation loss **—** AME 10F **—** Cryptodome with solid crust microlites phenocrysts isolated bubbles **ME 10** outgassing 🔪 magma mixing **⊢**-6 mafic injection emptying **Reservoir depth:** *Costa et al. (2013)* _____

October 26th 2010, stage 2

39.55 (14.34) Sub-Plinian 21.55 (2.26) 38.95 (4.18) activity 118.22 (18.11) 3.97 (0.75)

4. Preliminary Source Depths

Temperature magma -chbr(°C)	950
ρ_{magma} (kg,m- ³)	2455
Pressure _{magma - chbr} (MPa)	300
X _{H2O max} (%wt)	7,38

The first part of the model uses our textural analyses to obtain the initial pressures and porosities of our samples.

Then, the second part of the determines the initial depths of the samples based on these parameters.

Before the explosive event of October 26, a cryptodome was growing in the south flank of the volcano. The pressure induced by this growth and the plug sealing the conduit generated a large overpressure (5-20 MPa assuming elastic conduit walls) that led to the explosion. The explosion sampled the conduit to 11 km depth. The pyroclastic flow associated with this event was pumice-rich and ran up to 7 km from the summit.

On November 5, after several events, the system was probably semi-open to degassing. The explosion sampled the conduit to a much shallower depth (up to 3 km) than on October 26. The pyroclastic flow associated ran up to 15.5 km from the summit.

It is interesting to consider why there were no stable eruptive columns for either event. The eruptive volumes were fairly small (6-10x10⁶ m³). Small eruptive volumes can't feed a stable eruptive column, so this led to an early collapse.

Eruptive volume is a key parameter for the creation of a stable eruptive column, but does not influence the explosive-effusive transition. The overpressure on the other hand has a major role. With a system closed to gas, it is possible to induce a large overpressure leading to an explosive eruption even at volcanoes that normally have effusive activity, such as Merapi.

email address: melissa.i.drignon@gmail.com

5. Possible Eruptive Sequence

