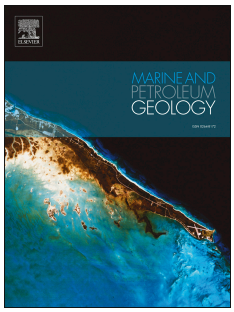
Accepted Manuscript



Modelling fluid flow in clastic eruptions: Application to the Lusi mud eruption

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PII: S0264-8172(17)30308-2

DOI: 10.1016/j.marpetgeo.2017.08.011

Reference: JMPG 3028

To appear in: *Marine and Petroleum Geology*

Received Date: 3 February 2017

Revised Date: 3 August 2017

Accepted Date: 9 August 2017

Please cite this article as: Collignon, M., Schmid, D.W., Galerne, C., Lupi, M., Mazzini, A., Modelling fluid flow in clastic eruptions: Application to the Lusi mud eruption, *Marine and Petroleum Geology* (2017), doi: 10.1016/j.marpetgeo.2017.08.011.

Modelling fluid flow in clastic eruptions: application to the Lusi mud eruption.

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Abstract.

Clastic eruptions involve the rapid ascension of sedimentary clasts together with fluids, gas and/or liquid phases that may further deform and brecciate the host rocks. These fluids transport the resulting mixture, called mud breccia, to the surface. Such eruptions are often associated with geological structures such as mud volcanoes, hydrothermal vent complexes and, more generally, piercement structures. They involve various processes, acting over a wide range of scales, which makes them a complex and challenging multi-phase system to model. Although piercement structures have been widely studied and discussed, only a few attempts have been made to model the dynamics of such clastic eruptions. The ongoing Lusi mud eruption, in the East Java back-arc basin, which began in May 2006, is a spectacular large scale clastic eruption. The Lusi eruptive behaviour has been extensively studied over the past decade and thus represents a unique opportunity to better understand ongoing clastic eruptions and thus fossil clastic systems. We use both analytical formulations and numerical models to investigate simple relationships between the mud breccia properties (density, viscosity, gas and clast content) and the volumetric flow rate. Our results show that the conduit radius of such piercement systems cannot exceed a few metres at depth, and that clasts, if not densely packed, will not affect the flow rate when they are smaller than a fifth of the conduit size. Using published data for the annual gas fluxes at Lusi, we infer a maximal depth at which exsolution starts. This occurs between 1800 m and 3200 m depth for methane and between 750 m and 1000 m for carbon dioxide. Based on annual gas fluxes, we estimate that the conduit radius should be no larger than 1.5 m to match the maximal mud discharge, recorded at Lusi.