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Pulsating and quasi-hydrothermal mud volcanism at LUSI, Indonesia

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Piercement structures, such as mud volcanoes, are common in many sedimentary basins. Studies on mud volcanoes aim to get a better understanding of the mechanism driving the formation of such features and the factors controlling their activity. Nevertheless such studies are normally conducted on structures with an eruption history. This means that the high permeability cylindrical conduit zones are commonly re-used for fluid migration during the eruptions and the dormant periods (i.e. during the time intervals between eruptions).

We present data collected during fieldwork in September 2006 at LUSI eruption site in Eastern Java. These data are integrated with a database acquired before and during the drilling of a neighbouring exploration well. LUSI gives the unique opportunity to observe the formation and evolution of a mud volcano erupting from day one.

Eruption of boiling mud and gas started on May 29^{th} flooding a large area close to the Sidoarjo village in Northeast Java. Thousands of people have been evacuated due to the mud flood from the newly formed LUSI structure. Here we present the eruption history of LUSI and new geological and geochemical data unravelling the blast mechanisms. Since the initial burst, the flow rate increased from 5000 to 120000 m^3/d during the first eleven weeks. The eruption rate started to pulsate between almost zero to 120 m^3/d during the period 14 Augusts-10 September. After an earthquake occurring the 10^{th} of September the flow suddenly increased dramatically reaching several hundred thousands of m^3/d in January 2006. The erupted sediment, water and gas are at boiling temperature (100˚C). Together with the mud, a cloud of aqueous vapour and other gases is emitted. The gases are dominated by CH_4 and CO_2, with minor amounts of heavier hydrocarbon gases and H_2S. Waters collected close to the crater revealed salinity comparable to sea water, with Na and Cl as major elements. Data from a nearby bore hole shows that the dominant lithologies down to $\sim$9000 ft are claystone and sandstone. A marked overpressure is recorded in the borehole, and temperature gradient reveal T= 100˚C reached at $\sim$5000 ft. We suggest a mechanism where the eruptions started following a 6.3 M earthquake the 27 May due to fracturing and accompanied depressurization of $>$100˚C pore fluids. This resulted in the formation of a quasi-hydrothermal system with a geyser-like surface expression. The significant amount of CO_2 erupted is accordingly explained by a solubility reduction during pressure drop at high temperatures. Geochemical and petrography analyses provide converging results indicating that mud, water and gas at are mainly rising from clayey units located considerable depth.