Geochemical surveys in the Lusi mud eruption

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The Lusi mud eruption started in May 2006 following to a 6.3 M earthquake striking the Java Island. In the framework of the Lusi Lab project (ERC grant n° 308126) we carried out geochemical surveys in the Sidoarjo district (Eastern Java Island, Indonesia) to investigate the gas bearing properties of the Watukosek fault system that crosses the Lusi mud eruption area. Soil gas (222Rn, CO₂, CH₄) concentration and flux measurements were performed 1) along two detailed profiles (∼1km long), trending almost W-E direction, and 2) inside the Lusi embankment (about 7 km²) built to contain the erupted mud.

Higher gas concentrations and fluxes were detected at the intersection with the Watukosek fault and the antithetic fault system. These zones characterized by the association of higher soil gas values constitute preferential migration pathways for fluids towards surface. The fractures release mainly CO₂ (with peaks up to 400 g/m²day) and display higher temperatures (up to 41°C). The main shear zones are populated by numerous seeps that expel mostly CH₄. Flux measurements in the seeping pools reveal that \( \varphi_{CO_2} \) is an order of magnitude higher than that measured in the fractures, and two orders of magnitude higher for \( \varphi_{CH_4} \).

An additional geochemical profile was completed perpendicularly to the Watukosek fault escarpment (W-E direction) at the foots of the Penangungang volcano. Results reveal CO₂ and CH₄ flux values significantly lower than those measured in the embankment, however an increase of radon and flux measurements is observed approaching the foots of the escarpment.

These measurements are complemented with a database of ∼350 CH₄ and CO₂ flux measurements and some soil gas concentrations (He, H₂, CO₂, CH₄ and C₂H₆) and their isotopic analyses (\( \delta^{13}C–CH_4 \), \( \delta D–CH_4 \) and \( \delta^{13}C–CO_2 \)). Results show that the whole area is characterized by diffused gas release through seeps, fractures, microfractures and soil degassing. The collected results shed light on the origin of the seeping gases.

Statistical analyses over the 7 km² area allowed us to estimate the full amount of gas currently released. Flux estimates from the crater zone suggest an order of magnitude higher than those measured from the surrounding region.