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Isotopic and ion analysis of erupting Lusi water for constraints on numerical models

Maïté Faubert (1), Reza Sohrabi (1), Guillaume Mauri (1), Adriano Mazzini (2), and Stephen Miller (1)

(1) CHYN-Centre for Hydrogeology and Geothermics, University of Neuchatel, Switzerland, (2) CEED – Centre for Earth Evolution and Dynamics, University of Oslo, Normay

The LUSI mud eruption, in the Sidoarjo district, East Java, Indonesia, has been continuously erupting great amounts of material for ten years. From a hydrogeological point of view, the hypothesis that this is a newly born deep hydrothermal system is supported by geochemistry, thermal properties, and its geyser-like behavior. The present work investigates the configuration of this hydrogeological system through hydro-chemical analysis of the erupting fluids, and to establish constraints on numerical model parameters.

We used two different radioactive isotope dating methods (δ14C and δ3H) to constrain travel time from inflow to outflow, and major ion analyses to determine water-type from LUSI. We also measured δ2H and δ18O to determine the source of the water. Additionally, it has been reported that significant amounts of Li is found in the erupting fluid.

Result of δ14C provides ages in the range of 16ka, and ion analyses show the water is of the Na-Cl type, typical for hydrothermal volcanic fluids. However, typical volcanic fluids have high K, and the low K that we measured in the LUSI erupting waters could result from K-consumption associated with smectite-illite metamorphism (e.g. dehydration) of the Upper Kalibeng formation. The quantity of Li reinforces the volcanic source hypothesis, while the stable isotope results show that the water feeding the erupting system is a combination of formation dehydration, magmatic origin, and mixed with some meteoric water.

We propose that the erupting water originates from deep strata, likely below the carbonate formation at a depth of > 4 km deep. The carbonate formation provides the necessary permeability to feed the substantial outflow observed at the surface. The Arjuno-Welirang volcanic complex, situated at $\sim$20 km from LUSI, offers the necessary hydraulic gradient to drive the eruption. These parameters provide constraints on numerical models that we are developing to understand LUSI's deep hydrodynamic, hydrothermal, system.