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3D Deep Electrical Resistivity Tomography of the Lusi Eruption Site in East Java

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Lusi is the nickname of the largest sub-aerial erupting clastic system on Earth. This sediment-hosted geothermal system relentlessly erupts since May 2006 in the East Java back-arc sedimentary basin. This spectacular system features two main active craters (~100 m in diameter each) surrounded by thousands of satellite active seeps that extend over a region of 7km^2. Previous multidisciplinary studies revealed that Lusi is connected at depth with the neighboring Arjuno-Welirang volcanic complex through a system of faults (Watukosek Fault System) that extend from the volcano towards the north in the sedimentary basin. The migration of these mantle-derived fluids feeds the long-lasting activity of the eruption. Vigorous convection fuels the system and leads to geyser-like eruptive activity.

To investigate the morphology and the effect that pre-existing geological structures may have on the development of the shallow plumbing system of Lusi, we deployed a pool of 25 IRIS V-Fullwavers to conduct a 3D deep electrical resistivity tomography extending over 15 km^2 around the eruption site. The inverted data reveal the structure of the subsided area hosting the region where a mix of groundwater, mud breccia, hydrocarbons and boiling hydrothermal fluids are stored. We estimate that after 12 years of Lusi's inception, a collapse region of 0.6km^2 developed around the active vents. Combining the flow rate data with our geoelectrical data, we estimate a total budget of 0.47km^3 of mud breccia (i.e., including the erupted volume and that trapped in the collapse zone around the carter). Our investigation also points out the link between the well-developed Watukosek Fault System and the upwelling of the deep-sourced fluids that initiated, and still drive, the development of the new-born Lusi eruption. Lusi provides the unprecedented opportunity to study the development of the early phases of a piercement structure and its impact on society. Our study highlights how fully 3D geoelectrical methods may represent a key tool to investigate and possibly mitigate geohazards.