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Investigating the Watukosek fault system using combined geophysical methods around Lusi eruption site

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The Lusi mud eruption is located in the Sidoarjo area, Indonesia and is continuously erupting hot mud since its birth in May 2006. Lusi sits upon the Watukosek fault system that originates from the neighboring Arjuno-Welirang volcanic complex and develops in back-arc basin extending towards the NE of Java. After the 27-06-2006 M 6.3 earthquake this fault system was reactivated and hosted numerous hot mud eruptions in the Sidoarjo area. Until now, no targeted investigations have been conducted to understand the geometry of the faults system crossing the Lusi eruption site.

A comprehensive combined electrical resistivity and self-potential (SP) survey was performed in the 7 km² area inside the Lusi embankment that was built to contain the erupted mud and to prevent flooding of the surrounding roads and settlements. Additional profiles were also acquired outside the SW part of the embankment towards the Watukosek escarpment and on the west of Lusi. The goal of the geophysical survey is to map the near-surface occurrence of the Watukosek fault system, delineate its spatial pattern, and monitor its development.

In total nine lines of resistivity measurements using Wenner and Wenner-Schlumberger configuration and SP measurements using roll-along technique were completed. The resistivity data were inverted into 2-D resistivity images with a maximum penetration depth of almost 200 m. The profiles collected in the region inside the Lusi embankment consistently reveal the presence of a region of ~300 m in width (between 30-90 m depth) characterized by anomalous resistivities, which are lower than the values observed in the surrounding area. The profiles outside the embankment show consistent results. Here the contrast between anomalous low resistivity zones (perceived as the fault system) and the surrounding area with higher resistivity value is more pronounced. The profiles also shows that the distance between the main crater and the boundary of mud body observed on the subsurface reach ~1.3 km. The results of the SP data fit well with the resistivity profiles in the anomalous parts, which suggests that their origin is related to fluid flow in the subsurface.

The geometry and the orientation these defined zones are consistent with the direction of the Watukosek fault system that intersect the Lusi eruption site and continues towards the Madura straight where other piercements are located.