Geophysical Research Abstracts
Vol. 21, EGU2019-18752-1, 2019
EGU General Assembly 2019

Geological 3D model of the Lusi mud edifice based on gravity data, East Java, Indonesia

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The Lusi sediment-hosted hydrothermal system located near Sidoarjo in Central Java, Indonesia has erupted continuously since 2006. The continuous eruption and subsidence created a 7 km2 mud edifice that extends on the surface. The present study aims to investigate the geometry of the subsurface structures below the active Lusi vent using a detailed gravimetric model to build a 3D visualization. For the Bouguer anomaly map, the reference density of 2670 kg/m3 was determined through the Nettleton method and statistical correlation methods. The obtained residual Bouguer anomaly map allowed the identification of two subsidence zones interpreted as pull-apart structural depressions framed by master faults. The 2D inversions of the strong gravimetric decreases located over Lusi vent sites indicate that the bottom of the funnel shaped mud edifice extends from the surface to a depth of ca. 319 ± 11 m. A first 3D modelisation of the area was constructed with GRAV3D to highlight the main geological features. This model relies on density contrasts of the structures, available information on the basin geometry, and the interpreted residual Bouguer anomaly map that was obtained through geostatiscal interpolation methods. Then, using Geomodeller, the 3D model output was improved by incorporating faults, subsidence depth, more precise lithologies, density variations, and all constrained by the residual gravimetric map. Forward and inverse 3D algorithms were calculated and validated by demonstrating good correlations between models and observed data. The final output is a full 3D model of the Lusi mud edifice, with the pull-apart structural depressions and their relationship to the faults. These results provide important constraints on the Lusi subsurface for possible future exploitation of geothermal resources from this system.