

The Geothermal Systems along the Watukosek fault system (East Java, Indonesia): The Arjuno-Welirang Volcanic Complex and the Lusi Mud-Eruption

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The Java Island is characterized by an intense volcanic activity with more than 100 active volcanoes. Moreover, this island is also known by the presence of many mud volcanoes and hydrothermal springs. In particular, in the 2006 several sudden hot mud eruptions, with fluids around 100°C, occurred in the NE side of the island resulting in a prominent eruption named Lusi (contraction of Lumpur Sidoarjo) located along the major Watukosek strike-slip fault zone. The Watukosek fault system, strikes from the Arjuno-Welirang volcanic complex, intersects Lusi and extends towards the NE of the Java island. Conversely of the normal mud eruptions (cold fluids emitted in a short time period of few days), the Lusi eruption was characterized by a persistent effusive hot fluids emissions for a long-time period of, so far, nearly a decade. Moreover, the isotopic composition of emitted gases like Helium showed a clear magmatic origin. For this reasons we decided to investigate the near Arjuno-Welirang complex located on the same strike-slip fault.

Arjuno-Welirang is a twin strato-volcano system located in the East of Java along the Watukosek fault, at about 25 km SW respect to the Lusi volcano system. It features two main peaks: Arjuno (3339 masl) and Welirang (3156 masl). The last recorded eruptive activity took place in August 1950 from the flanks of Kawah Plupuh and in October 1950 from the NW part of the Gunung Welirang. This strato-volcano is characterized by a S-rich area, with high T-vent fumarole at least up to 220°C (and likely higher), located mainly in the Welirang crater. In addition, several hot springs vent from the flanks of the volcano, indicate the presence of a large hydrothermal system. During July 2015, in the framework of the Lusi Lab project (ERC grant n° 308126), we carried out a geochemical field campaign on the Arjuno-Welirang volcano hydrothermal system area, sampling water and dissolved gases from the thermal and cold springs located on the flanks of the volcano and from two high-T fumaroles located on the summit area of Welirang. Hydrothermal springs reveal temperatures up to 53°C and pH between 6.2 and 8.2. The hydrothermal springs show a volatile content (mainly CO₂ and He) that is several order of magnitude higher than the Air Saturated Waters values (ASW) indicating a strong gas/water interaction processes between waters of meteoric origin and deep volatiles of volcanic origin. The hydrothermal springs have dissolved helium isotopic values with clear magmatic signature (R/Ra around 7) that is remarkably close to the helium isotope values from the fumaroles (R/Ra= 7.30).

The isotopic composition of helium measured in the fluids emitted from the Lusi mud-volcano around 6.5R/Ra is very similar to the Welirang volcanic fluids indicating the presence of magmatic gases in the Lusi emitted fluids. While the isotopic composition of waters in the Welirang and Lusi fluids are markedly different suggesting a different origin and/or recharge areas for these two hydrothermal systems. These data support the hypothesis that the presence of volcanic gases could have triggered and conveyed the hot and persistent mud fluids emissions of Lusi volcano.