Geophysical Research Abstracts
Vol. 21, EGU2019-15779, 2019
EGU General Assembly 2019

Ongoing hydrocarbon generation enhanced by magmatic and hydrothermal activity, implications of the Lusi eruption site, NE Java, Indonesia

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The largest volumes of hydrocarbons on Earth have been generated by organic-rich deposits that reach their maturity through burial during large time scales (typically over millions of years). This process of maturation can be accelerated by rapid geological events such as the intrusions of magma or hydrothermal fluids migration in organic-rich sedimentary packages. Few examples exist on Earth where this phenomenon can be actively observed.

Lusi (North-East Java, Indonesia) is the world largest active sediment-hosted hydrothermal system, bursting since 2006 oil and gas, along with boiling mud breccia, water, and rock clasts. The mud eruption is located within the East Java petroleum basin and surrounded by hydrocarbon production fields. Previous investigations revealed that the migration of magma and hydrothermal fluids from the neighbouring Arjuno-Welirang volcanic complex are responsible for the continuous activity of this eruption.

A set of organic geochemistry analyses (Rock Eval, GC and GC-MS-MS), organic petrography and palynological studies have been performed on rock clasts and oil erupted at Lusi, as well as oils from the neighbouring production fields. All the analysed oils share the same genetic source rock (i.e. the regional Middle Eocene – Lower Oligocene source rock Ngimbang Fm.), but different maturity can be distinguished (i.e. temperature and timing of the oil generation). Basin and geochemical analyses indicate that the reservoirs were filled by migrated hydrocarbons formed in the deeper depositional center located to the north-east of the study area (within < 15 km distance). The Lusi oil instead indicates a very low maturity. Converging data indicate that the Lusi oil is currently vented to the surface directly from the >3.8 km seated Ngimbang Fm. Here the intruding magmatic fluids are responsible for the elevated pressure and temperatures and are currently promoting the hydrocarbon generation within the organic-rich sediments. This study highlights that Lusi is an excellent example, where large scale ongoing hydrocarbon generation and migration processes can be investigated in detail.