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Mantle-derived fluids in the oil and gas fields around the Lusi mud eruption, NE Java, Indonesia

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Lusi is an ongoing mud eruption in NE Java, Indonesia, that started in May 2006. This active sediment-hosted hydrothermal system is located in a hydrocarbon-rich back-arc sedimentary basin, only 10 km away from the nearest Holocene volcano. Three oil and gas fields are located in the immediate vicinity of Lusi (3-5 km to the west, south-west and north-east). The hydrocarbon (HC) accumulations are confined to shallow volcanoclastic Pleistocene reservoirs at 400-700 meter depth, and the current production is focused on gas, whereas oil was produced earlier. Sampling of these HC fields was conducted in 2017 within the framework of the ERC Lusi Lab project.

Gases were analyzed by gas chromatography and isotope ratio mass spectrometry. The results show that the gas is methane dominated, with higher methane homologues present as well, where the carbon and hydrogen isotope values of the methane indicate a thermogenic origin. Elevated helium isotope ratios ($^3He/^4He$) are similar to values from fumaroles of the Welirang volcano, 25 km to the south-west from the study area, suggesting a mantle source of the helium. Moreover, similar $^3He/^4He$ values were measured in the CO_2-dominated gas venting from Lusi and from CH_4-dominated satellite seeps, demonstrating a lack of correlation between gas speciation and helium isotope ratios. The data highlight that both the HC reservoirs and the Lusi system contain a geochemical signal derived from a deep-seated volcanic system, where helium likely migrated along faults together with CO_2.