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Hydrocarbon gas efflux from an active deep-water mud volcano constrained by seismic velocity profiles

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Mud volcanoes are considered to be one of the largest geological sources emitting hydrocarbon gases into the atmosphere. Numerous studies have revealed their origins and compositions from offshore mud volcanoes. The gas is composed dominantly by methane and is of mixed biogenic and thermogenic origin. Methane emissions from each mud volcano have high temporal variability of their intensities as found at cold seeps. A recent long-term observation in a submarine mud volcano sheds light on that larger volume of methane gas than expected is escaped from deep-water mud volcanoes. However, estimates on the gas volume fraction inside submarine mud volcanoes have been challenging because of difficulties of in-situ measurements without secure deep-drilling. Herein we provide a new scheme to link gas concentration and seismic velocity in gas-charged fluidized mud conduits of a submarine mud volcano. This model enables to estimate the methane concentration in the mud conduits of the offshore mud volcano using the seismic velocity profile derived from reflection and/or refraction seismic data. The scheme is universally applicable using the seismic data and provides useful and robust estimations of gas concentration in the conduits of offshore mud volcanoes. These estimations can be forwarded to assess stationary methane fluxes from deep-water mud volcanoes. Moreover, addressing these problems helps an assessment of potential methane concentration inside the mud volcanoes, which contributes to unpuzzle roles of offshore mud volcanism on subsurface carbon cycling as well as an urgent issue into the Missing methane. The application to an active mud volcano in the Kumano mud field of the Nankai unveils that the methane fraction in its conduits reaches a higher value than expected.

Keywords: Submarine mud volcanoes, methane gas fraction, seismic velocity