

Origin of hydrocarbon gas venting on the recently discovered Mtwara mud volcano (Tanzania) in the western Indian Ocean

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The venting of hydrocarbon gas from submarine mud volcanoes (MV), often accompanied by the occurrence of benthic “cold vent” communities, is a well-known feature at tectonically active continental margins. However, mud volcanism and related hydrocarbon release at passive continental margins, where tectonic stress is induced e.g. by transform-faults is less known. The identification and quantification of hydrocarbon emanations into the water column and atmosphere is of particular importance with regard to their role as greenhouse gases and their influence on the global climate system.

The Mtwara MV was discovered at the Tanzanian margin during a scientific cruise of the German RV SONNE in August 2024. The Mtwara MV extends about 750 m in width and 80 m in height above the sea floor. Its summit is situated at a water depth of approximately 850 m and is characterised by a dense occurrence of chemosymbiotic bivalves (*Bathymodiolus* sp.) associated white bacterial mats. The latter served as an initial indication for the presence of hydrocarbon gas venting. Hydroacoustic investigation of the mound area using multibeam echosounder systems (MBES) and sub-bottom profiler (PARASOUND) revealed the presence of large gas (bubble) flares with several tens to a few hundred meters in height, emerging from the top of the mound. In order to characterise the composition and origin of the gas seepage, several water samples were taken close to the flares. The analysis of the dissolved gases revealed an elevated concentration of hydrocarbons (methane-propane) within the water samples in comparison to ambient water masses. Methane concentrations of up to ~100 ppm were determined with corresponding carbon isotopic composition ($\delta^{13}\text{C}$) between -30‰ to -40‰. The gas concentration ratios ($\text{C1}/(\text{C2}+\text{C3})$) range between 30 and 150. Both, the $\delta^{13}\text{C}$ of the methane and the $\text{C1}/(\text{C2}+\text{C3})$ ratio indicate a thermogenic origin of the gases. Hydrocarbons formed by thermal maturation of organic matter probably sourced from Lower Cretaceous to Jurassic source rocks and overlying reservoirs. Active mud volcanism and hydrocarbon-rich fluid migration is possibly linked to the nearby active Seagap Fault system. We hereby provide the first public report of a MV in the western Indian Ocean.