

GLOBAL DISTRIBUTION OF MUD VOLCANOES AND THEIR SIGNIFICANCE AS AN INDICATOR OF ACTIVE PETROLEUM SYSTEMS, A SOURCE OF METHANE IN THE ATMOSPHERE AND OCEAN, AND A GEOHAZARD

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Mud volcanoes are documented in 44 onshore and 21 offshore areas, and there is indirect geological and geophysical evidence of offshore mud volcanoes in 25 areas. Approximately 1,100 mud volcanoes are documented onshore and in shallow water on continental shelves, and 1,000-100,000 mud volcanoes may exist on continental slopes and abyssal plains. These features are most common in areas of rapid sedimentation, lateral tectonic compression, and geologically recent magmatic activity. Approximately 80% of all mud volcanoes occur on convergent and transform continental margins. Mud volcanoes often occur at the surface and the seafloor as a result of migration of fluidized sediment along active faults due to overpressure, and may also form on top of seafloor/surface-piercing shale diapirs. The study of mud volcanoes is important for a variety of reasons. First, sediments and fluids expelled from these features provide useful information on the geology and petroleum potential of deep sedimentary basins. Mud volcanoes are often associated with large petroleum basins (e.g., Azerbaijan, the Gulf of Mexico) where they expel thermogenic hydrocarbons enriched in C₂₊ gases. Thus, mud volcanoes may indicate active petroleum systems. However, some mud volcanoes documented outside of large petroleum basins (e.g., Norwegian Sea, Copper River basin) expel mainly bacterial methane or CO₂ or N₂, occur in areas with thin sedimentary cover (e.g., ~2 km), and associate with areas of active magmatic activity. Thus, mud volcanoes may not indicate active petroleum systems. The expelled fluids should be carefully studied to evaluate the hydrocarbon potential of mud volcanic areas. Second, mud volcanoes are considered to be an important source of greenhouse gases. Approximately 6 Tg yr⁻¹ of gases (mainly methane and CO₂) may escape from mud volcanoes directly into the atmosphere. Mud volcanoes appear to be a minor source of methane in the atmosphere (~1% of the total source), but may contribute a significant amount of fossil (¹⁴C-depleted) methane (~9% of the current fossil methane source). In addition, ~27 Tg yr⁻¹ of gases may escape into the ocean on continental slopes suggesting that the total hydrocarbon seepage from deep-water areas (currently estimated at 18-50 Tg yr⁻¹) may be underestimated. Third, submarine mud volcanoes represent a potential geohazard for petroleum exploitation. Lastly, gas hydrate associated with deep-water mud volcanoes may be considered as a potential energy resource. However, many mud volcanoes are likely to provide only subeconomic gas hydrate resources because the volume of hydrate-bound gas in such accumulations may be insignificant.