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On the nature and episodicity of fluid expulsion in mud volcanoes

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Fluid migration and expulsion are widespread phenomena along ocean margins, and their cyclicity has long been recognized. Features on the surface and subsurface include fresh water fuelled horizons, pipes and chimneys, pockmarks, polygonal faults, mud volcanoes and diatremes, to name just a few. While some of them cannot studied easily, mud volcanoes and their extrusive products are often preserved in onshore and offshore settings for considerable periods of time.

Recent advances in mud volcano research include deep marine drilling (ODP Leg 160 in the Mediterranean Sea), in situ and laboratory experiments on the physical properties of fluid-bearing sediment, measurements and estimates of gas and water expulsion rates onshore and offshore (e.g. Sicily, Azerbaijan, Eastern Mediterranean, NW Atlantic near Norway and Gibraltar), and balances of global methane emission from mud volcanic activity by various workers. ODP drilling in particular has shed light on the episodic nature of mud eruptive activity and explained the “Christmas-tree” geometries often seen in seismic reflection profiles satisfactory for the first time. Given that individual mud flows were penetrated and dated, clues were obtained about periods of quiescence interrupted by (in part violent) eruptions. Very recent work on active mud volcanoes near the Caspian Sea, Azerbaijan, supports earlier models concerning cyclic eruptions and trigger mechanisms for fluid seepage and emission of hydrocarbon gas. Excess pore pressure increase, either by mineral dehydration reactions or hydrocarbon formation in deeply buried claystones and shales, appears to precede eruptive periods. Locally, tectonic loading and earthquake activity represent an extra hazard that drive fluid-fuelled systems into eruptive activity, as is attested from historical records and, very recently, by in situ long-term observations.