

# MODERN MODELS OF MUD VOLCANISM.

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Many hypothesis have been developed regarding the origin of mud volcanoes. These have ranged from the earliest models of Abikh which were dependant on processes associated with magmatism to more recent hypothesis which have invoked an association between mud volcano development and sedimentary diapirism (Brown 1990).

Throughout most hypotheses is the common theme that the processes responsible for the development of mud volcanoes are linked with the generation of hydrocarbons, and in Azerbaijan in particular, with the development of oil and gas fields.

The role of gas in mud volcano hypothesis has always been important, from the early arguments which relied on mantle gas, to more recent suggestions that methane is actually generated by source rocks in the sedimentary sequence and the gas then acts as the principal driving mechanism for mud volcano development.

Perhaps the most detailed consideration of the mechanisms of mud volcano formation has been given by Ivanov and Guliev (1986,1988) who have recently argued that from geological and geochemical factors they could associate mud volcanism exclusively with processes originating from within the sedimentary succession. They noted that mud volcanoes occurred in association with high rates of sediment accumulation (8-22km of Tertiary sediment), and that mud volcanoes are associated with methane generation, they add that "one of the most important geotectonic conditions for the initiation and development of mud volcanism is the dislocation and folding of the sedimentary succession".

These authors argue that thick sequences of rapidly deposited sediment cause a state of mechanical or compaction disequilibrium to develop in which the rapidly accumulating sediment pile is unable to expel its pore fluids at a high enough rate. As a consequence, the pore fluid eventually bears part of the sediment load resulting in a massive increase in pore pressure gradient through such zones.

While it is acknowledged by most exploration geologists that excess pore pressures may be transmitted through porous beds into shallower horizons where seals may be breached, this mechanism alone is not considered adequate to justify the release of vast volumes of water, mud and hydrocarbon gases which are associated with mud volcano eruptions.

The relationship between mud volcanism and the generation of hydrocarbons, particularly methane, is considered to be a critical factor in mud volcano formation. Hedberg (1980) emphasises the link between overpressure and methane solubility in his classic review of methane generation and petroleum migration, and this connection is believed to be critical to the understanding of mud volcanos development.

Methane (and other hydrocarbon gases) are generated at depth and at relatively high

temperatures from both oil-prone and gas-prone source rocks. As the methane is generated it exceeds a critical saturation in the organic network of the source rock and is free to migrate. Methane may be lost during migration or it may eventually be trapped as a gas field, but equally important the gas may be dissolved in pore waters relatively near to the active source. Ivanov and Guliev (1986, 1988) claim that at the relatively high temperatures and pressures at depth the methane saturation in the pore waters may be high and may eventually reach a critical saturation "beyond the threshold of supercritical methane saturation". At this point, methane will separate into a free gas phase, and this phase transition "causes an impulse of excess pressure leading to the separation of methane micro-bubbles which become nuclei for the separation and growth of excess methane.

This system will still be mechanically stable if the sediment load is balanced by the excess pore pressure. Pore pressure "models" shown how the pore pressure development with depth may actually exceed the constraining pressure at the location of a mud volcano root. These locations will, they claim, be areas or potential seats of mud volcano roots.

Once the constraining pressure has been exceeded there will be a movement of fluid away from the zone of maximum pressure development and during this migration of fluid there is a tendency for the growth and expansion of gas bubbles as pressure and temperature decrease. Where suitable conduits are present the gas will expand and become mobile and as channels infill with gas (and the relative saturation of gas increases the permeability to gas) providing conditions for high speed gas flow.

At high flow rates the gas and sediment develops into a pseudo-liquid state and as flow increases the mass reaches the "so-called hover velocity" where mass transport begins. Have. The mass of fluid moves as a quasi uniform viscous mass through the sediment pile in a piston like manner until expelled from the surface as a "catastrophic eruption". Essentially these authors rely on the presence and liberation of methane during migration, but use the flow of free gas as a main driving mechanism for mud volcano eruptions. He refers to eruptions in Azerbaijan to support this observation.

It is concluded from this study that the incorporation of hydrocarbon gas, in particular methane in association with high fluid pressures caused by compaction disequilibrium is the main driving mechanism in mud volcano formation in Azerbaijan. The presence of methane causes a significant reduction in sediment density leading to the buoyant rise of mud diapirs which upon passing through lower temperature and pressure regimes suffer a major expansion of free gas causing an acceleration of the rate of migration to the surface. Reason of phase transition are various- over saturation of waters with gases, temperature change, pressure reduction etc. One of the real factors of phase transition is the waves of negative pressure. Negative pressure is one of the metastable states at which the liquid extension take place till the definite limit without the continuum break. In laboratory trials with observance of high degree of purity of liquid-vessel system there was success to achieve high values of negative pressure (to 40 MPa). These results had not acquired a proper value and appropriate application in natural sciences. One of the main reasons is that real liquid systems in nature are multicomponent, heterogeneous ("dirty"). On the base utilization of define kinetic and hydraulic factors there was success to get experimentally for the first time the negative pressure wave in real liquids such as oil, water, various solutions, etc. There had been determined that when rapid enough opening of hydraulic system, previously being under high pressure, a sharp decrease of temperature and pressure in system take place due to sudden change of shift tension.