

# Tectonic control on the formation of mud volcanoes: an analogy

Hayrettin Koral

Istanbul University, Department of Geological Engineering 34320 Avcılar-Istanbul/Turkiye  
[hkoral@istanbul.edu.tr](mailto:hkoral@istanbul.edu.tr)

Mud volcanoes and gas seeps are abundant in the Black Sea and the Caspian Sea region. The term mud volcano refers to cones created by excreted liquids and gases, and they resemble small volcanic cones. The largest structures reach to order of kilometers in diameter and a few hundred meters in height. Hydrocarbon gases are often erupted, methane being the most common and carbon dioxide and nitrogen being least frequent emitted gasses. Ejected materials often are slurry of fine solids suspended in liquids which include water and hydrocarbon fluids. Mud volcanoes are often associated with hydrocarbon occurrences in the tectonic or orogenic belts.

Excess pore-fluid pressures originating from several mechanisms have been considered as triggers for mud volcanoes. These mechanisms include seismicity induced liquefaction, tectonic stresses, deposition-related processes and the influx of an overpressured fluid from deep within the basin into shallow depths.

The Black Sea basin was formed in the late Mesozoic as a back-arc basin above the northward subducting Tethyan oceanic lithosphere. It comprises western and eastern sub-basins separated by the NW-SE trending mid-Black Sea ridge and is surrounded by the Caucasian fold-thrust Belt (Fig.1). The western basin is floored by an oceanic crust overlain by thick sediment units probably of Cretaceous and younger age. The eastern basin has a thinned continental or oceanic crust overlain by sediments less than 10 km thick. The whole basin lies in a compressional tectonic setting and undergoes active shortening.

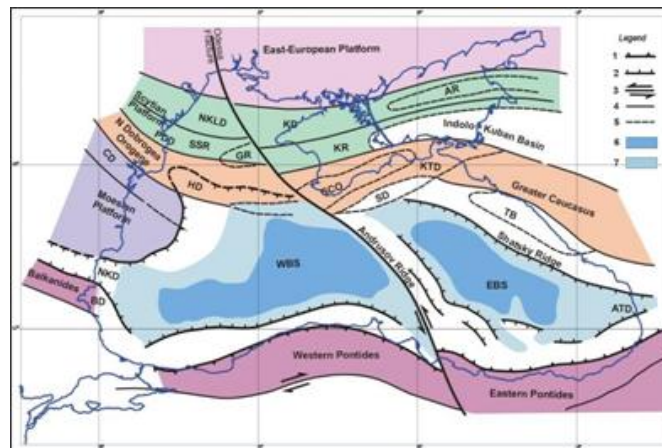


Fig. 1. Tectonic sketch of the Black Sea Region (after Dinu et al., 2005; Görür., 1988).

Sand volcanoes are reasonable analogues for mud volcanoes and form synchronous with earthquakes. They indicate fluidizations of unconsolidated alluvial/colluvial deposits during a seismic event (Fig. 2). A sand volcano is a cone of sand formed by the ejection of sand onto a surface from a central point. The process is often associated with earthquake liquefaction and the ejection of fluidized sand in water saturated sediments during an earthquake. The sand expelled builds up a cone; a crater is commonly seen at the summit. The cone can range in size from centimeters to meters in diameter. The cones are found lying often along a linear trend and this suggests a fracture/fault control during their formation. The seismic waves cause an increase in the pore-fluid pressure in the deposits, and fractures/faults provide pathways to release the excess of pressure.

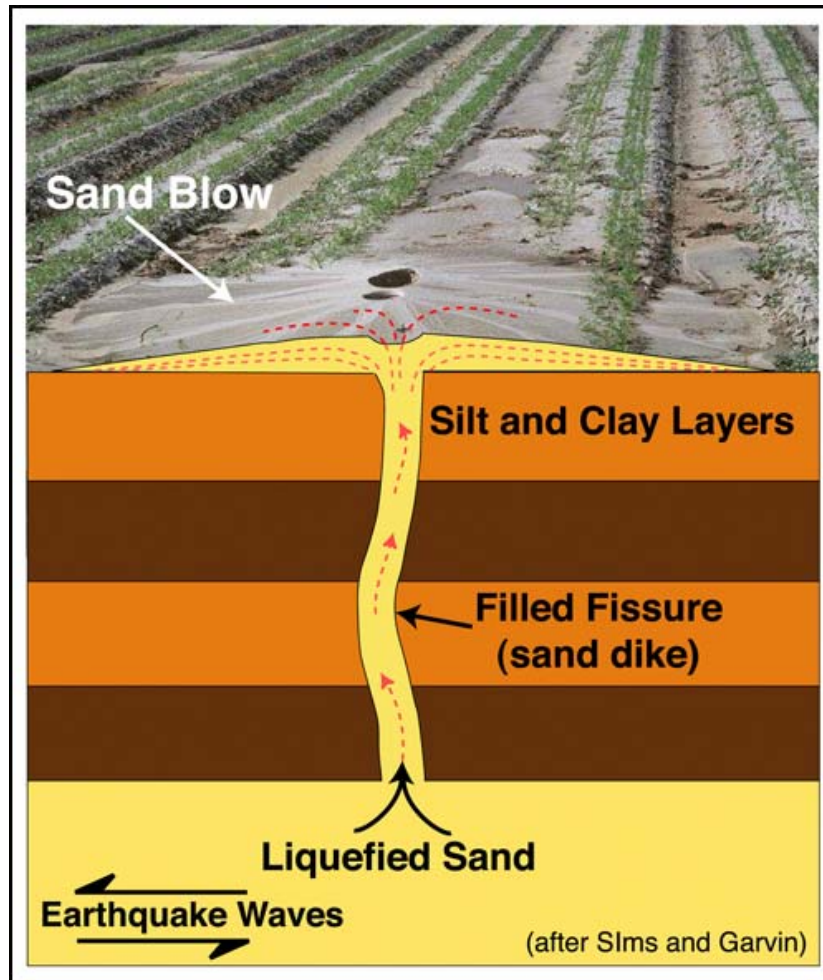


Fig. 2. Formation mechanism for a sand volcano.

Geological history of the Black Sea basin reflects a complex interplay between large scale rifting, uplift of the orogenic flanks and large-scale post-rift subsidence. As a result of a long and complex tectonic history, many major and auxiliary faults formed. Analogy between sand volcanoes of earthquakes and mud volcanoes suggests that events such as seismicity, mud volcanism, mud diapirism be related with activity on major faults in the basin, other faults in the sedimentary cover and also relevant tectonic processes in the region. Lying in an active orogenic zone, these faults produce small and medium-size earthquakes, directly affecting formation and positions of mud volcanoes and gas seeps.

#### References:

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