

# Cold seepage: a window to the deep petroleum system

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Cold seepage sites are widespread and highly dynamic environments, and their physical and chemical characteristics have been described and correlated with the fluid sources, the fluid flow intensities, the tectonic setting and the properties of the hosting sediments. Cold seeps support petroleum exploration since the first oil discoveries and continue to show their usefulness nowadays. In this seminar will be presented two case studies, from Italy and Turkmenistan, that highlight how the study of mud volcanoes could provide information on the deep fluid sources and aid in future exploration strategies.

In the first half of the 20<sup>th</sup> century the petroleum exploitation in the Northern Apennines foothills and the near Po Plain (Italy) was focused on the numerous areas of hydrocarbons spontaneous seepages, by means of simple collecting techniques and hand drilled shallow wells. After the 1950 the exploration increased with the discovery of a wide number of hydrocarbon fields that produced biogenic and thermogenic gases. The hydrocarbons occurring in the reservoirs have been traditionally interpreted as generated in a coincident source/reservoir system. However, new analyses on hydrocarbons emitted by the various mud volcanoes evidenced the occurrence of a common source rock deeper than the reservoir units, which experienced different generation and migration steps along all the margin depending on burial conditions and deformation time. With the progressive increase of the economic return in in-chain hydrocarbon prospectivity, this extended source rock could also represent a high rewarding exploration target.

The understanding of sediment remobilisation associated with the migration of fluids is helpful to define the evolution of sedimentary basins. Sandstone intrusions may represent an important asset in hydrocarbon-rich basins, being able to significantly modify pre-existing migration pathways and to form exploitable traps. The mud volcano and sandstone intrusions complex occurring in the Boyadag anticline, Western Turkmenistan, is the only well-documented example of co-existing mud volcanism and sand injection. This unique case study is a site of primary importance to understand the spatial and genetic relations among the two phenomena and to define the geological conditions responsible for sand fluidisation in such a geological setting.



*Nirano mud volcanoes, Northern Apennines, Italy*