FLUID EMISSIONS AND MUD VOLCANOES IN THE UPLIFTING NORTHERN APENNINES: LEAKAGE THROUGH DEEP ROOTED NORMAL FAULTS IN A COMPRESSIVE SCENARIO

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Abstract

In the Northern Apennines, spontaneous seepages are aligned in two belts, stretching the main divide and the foothills. Studied seepages, belonging to foothills belt, display two main patterns of fluid migration up to the surface. Geochemical and isotopic characters of saline waters and gas allowed distinguishing various depth of sources and reservoirs and to relate the leakage to deep-rooted normal faults or to up dip carrier beds which supply permeable shallow layers. The dominance of normal faults as migration pathway indicates the presence of an extensional state of stress in the uplifting Northern Apennine belt.

Keywords: mud volcano, geochemistry, normal fault, uplift.

Spontaneous fluid emissions and associated mud volcanoes occur in the Northern Apennines approximately along two belts striking near parallel to the main divide and to the foothills respectively (1). Along the foothill belt, we have studied some of these emissions belonging to different surface geological setting of the Northern Apennines. The study was addressed to mud volcanoes and seeps located in two geological setting, 1) topping the upper tectonic nappe of the chain (2) (the Ligurian unit), and 2) leaking through the foredeep units, where the Ligurian unit is absent. The study has been carried out by sampling, over a time spanning some months, the various components of fluid including saline waters and gas and by analysing their geochemical and isotopic characters. The definition of these characters integrated with data deriving from seismic profiles and the surface geology allows defining mechanisms of fluid leakage to the surface.

In particular, we would stress the importance of geochemical analysis on water emissions which allows reconstructing the migration through different carrier beds and steps in the migration pathway.

Geochemical and isotopic studies provided indication about the depth of gas sources. It resulted up to 6000 m in case of thermogenic gas migrating through deep-rooted normal fault and from below the Ligurian nappe, and typically biogenic when Neogene units can be identified as the main productive sedimentary body. This information is essential to confirm geological reconstruction also because testifies the presence of deep sources and permeable horizons down to 6-7 km under the surface.

The mud volcanoes of the studied region are caused by normal faults draining down to the lower tectonic foredeep unit, whereas, in the case of absent Ligurian, seepages are associated to shallow permeable carrier beds sealed by mudstones.

In the Northern Apennines, commonly interpreted as active compressive chain, the foothills records diffuse extensional features (3, 4), which are very effective pathways for the observed seepages. The presence of an extensional state of stress in the uplifting belt documents permutation of the stress axes in the late Quaternary, whereas, as a whole, the Adriatic plate still records a compressive state of stress.

References

1 - Borgia G.C., Elmi C. and Martelli G.,1986. Hydrocarbons in the Tuscan-Emilian Apennines: origin and characters of mineralization. *Mem. Soc. Geol. It.,* 31: 255-266.

2 - Capozzi R., and Picotti V., 2002. Fluid migration and origin of a mud volcano in the Northern
Apennines (Italy): the role of deeply rooted normal faults. *Terra Nova,* 14: 363-370.

3 - Bertotti G., Capozzi R., and Picotti V., 1997. Extension controls Quaternary tectonics, geomorphology and sedimentation of the N-Apennines foothills and adjacent Po Plain (Italy). *Tectonophysics*, 282: 291-301.

4 - Antonellini M., and Mollema P., 2002. Cataclastic faults in the Loiano Sandstones; Northern Apennines, Italy. *Boll. Soc. Geol. It.,* 121: 163-178.