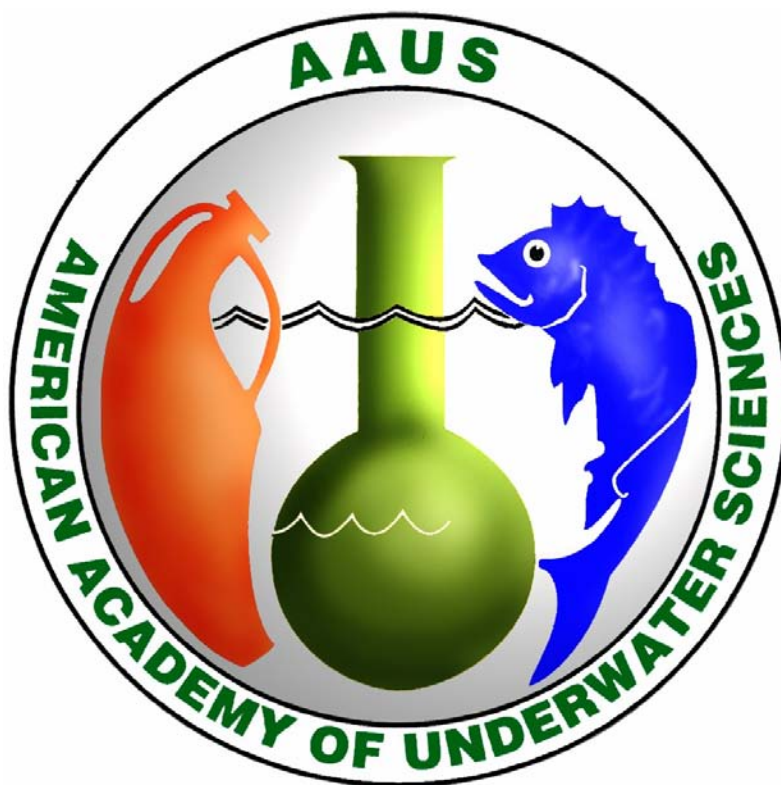


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Scientific Diving and ROV Techniques Applied to the Geomorphological and Hydrogeological Study of the World's Deepest Karst Sinkhole, (Pozzo del Merro – Latium – Italy)

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Extended Abstract

The “Pozzo del Merro” (Lat. 42° 02’ 14’’ N - Long 12° 40’ 52’’ E) is located in the “Macchia di Gattaceca” Natural Park, 130 meters above sea level on the Cornicolani Mounts near the village of Sant’Angelo Romano just 30 km east of Rome. This is a 452 meters deep karst sinkhole, 392 meters are water filled creating a challenging environment for the study of this natural phenomenon.

The Cornicolani Mounts represent the western boundary of the Latium Apennine. They are made predominantly by Lias limestone. These calcareous outcrops are close to the ancient Volcano Albano structure named the “Albani Hills”. The last volcanic activity here ended about 30.000 years ago.

In the area there are regional and local faults with main directrices NW-SE, NE-SW, N-S. These tectonic displacements favored a spread karst erosion creating imposing hypogean and epigeous structures, (Facenna et al, 1994; Mattei et al, 1986; Maxia, 1948).. The diameter of the sinkhole varies from 150 meters at the top of the dry section to 30 meters on the water surface of a small lake hosted in the sinkhole (Fig. 1). The lake is the link to a deep flooded karst shaft that reaches 392 meters of depth below the water surface (Fig. 2).

Direct study of the underwater morphology showed a sub vertical karst chimney with clear evidences of high chemical erosion. The limestone outcrops in the area: the Cornicolani Mounts, the Lucretili Mounts and the Tiburtini Mounts are recharging areas of the regional aquifer. The main flows are from north to south towards the Aniene River (Fig. 3). The aquifer feeds some high mineralized springs hosted in small sinkholes, the Acque Albule (White Waters) ponds, in a travertine plate close to the city of Tivoli (Fig. 4). The Merro’s water surface oscillations reflect changes in the level of the deep aquifer. This oscillation correlates with local rainfall but with a delay of some months due to the inertia of the regional aquifer response (Fig. 5).

Geochemical parameters (pH, TDS, temperature) have been collected by the use of a multi probe carried by an underwater robot (ROV) down to 95 meters (Fig. 6). The direct investigations were made by the author and some others volunteer cave divers with the collaboration of the National Fire Brigade Scuba Team (Fig.7). For deeper exploration some ROVs have been used. A ROV is an underwater device equipped with electric thrusters, a video camera, a compass and a depth meter. The control unit is on the surface and power is supplied to the robot trough a cable. The ROVs have no limits as to their diving time; the

only limit is the maximum operative depth. (Caramanna, 2001; Caramanna et al, 2001; Caramanna, 2002) (Fig. 8-9).

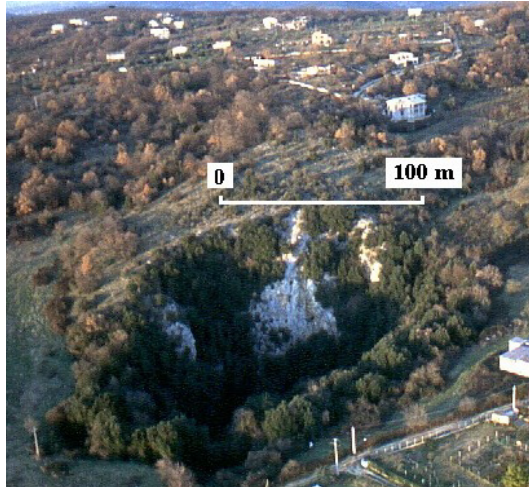


Figure 1 Air view of the "Pozzo del Merro"

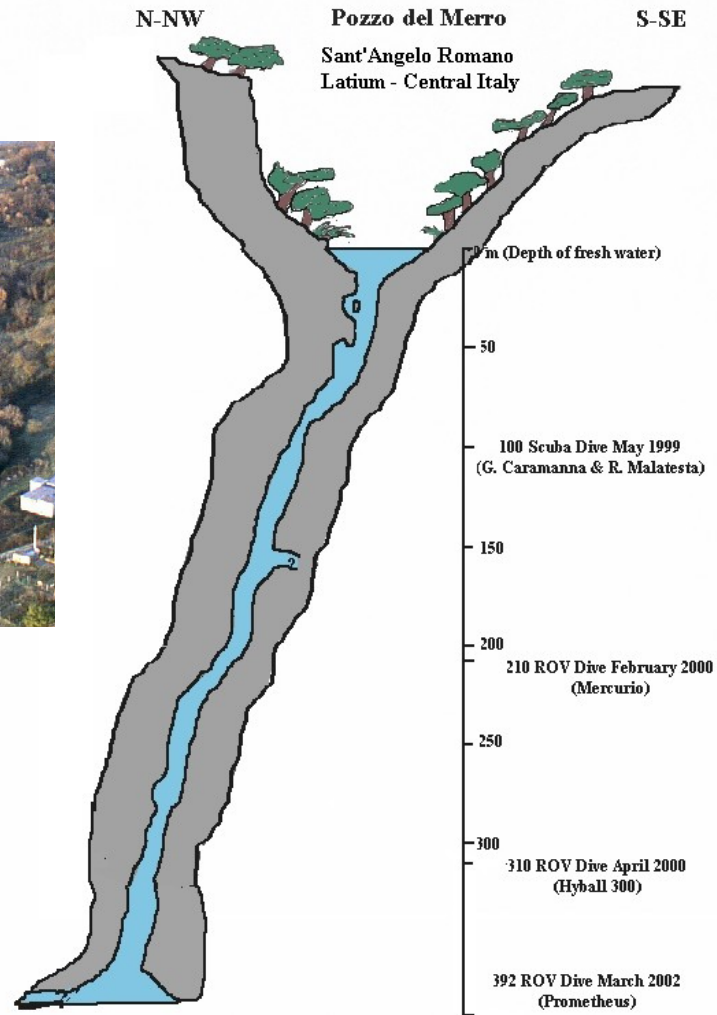


Figure 2 Vertical sketch of the "Pozzo del Merro"



(Facenna et alii, 1994. Mattei et alii, 1986. Maxia , 1948.).

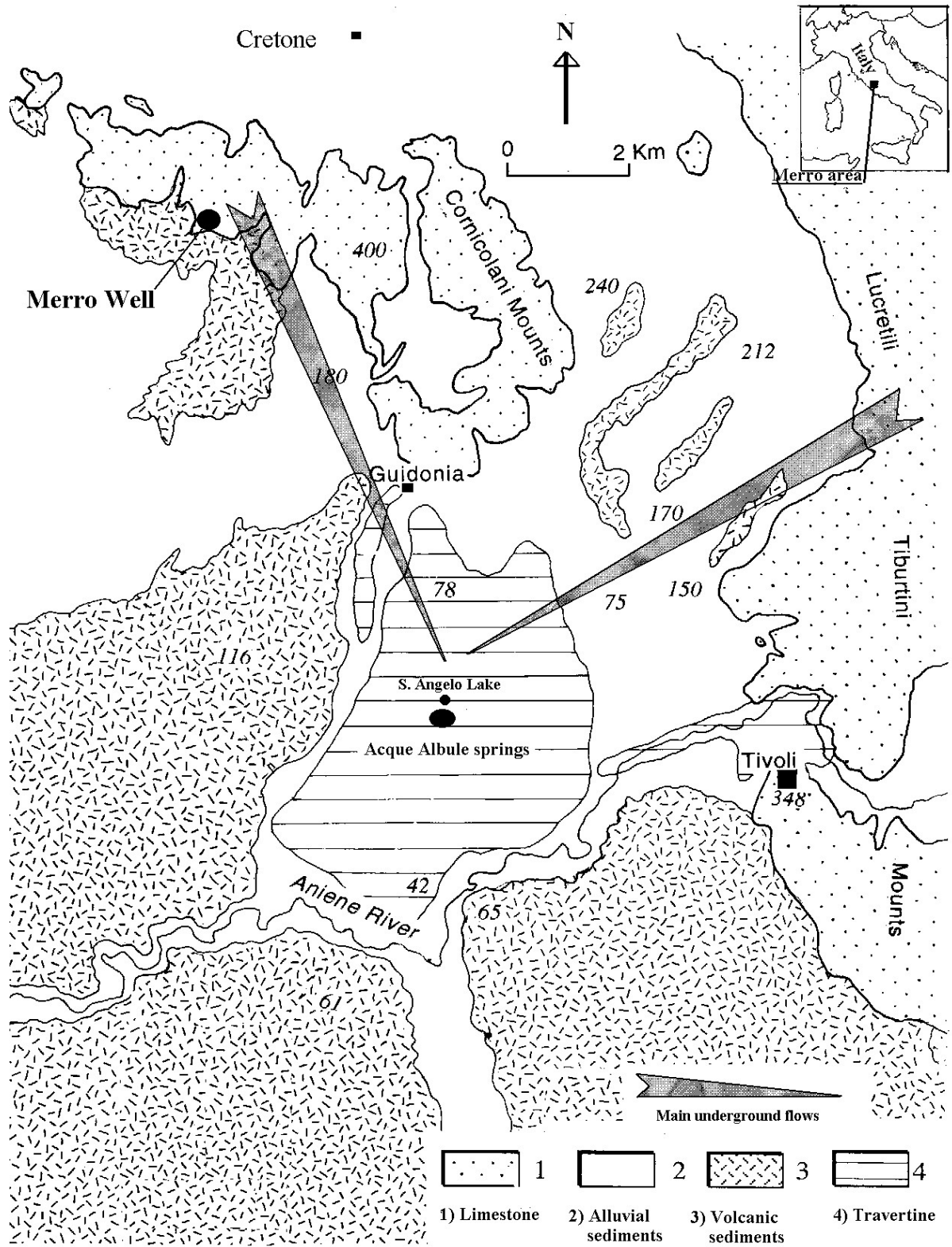


Figure 3 Simplified geological map of the Cornicolani Mounds area.

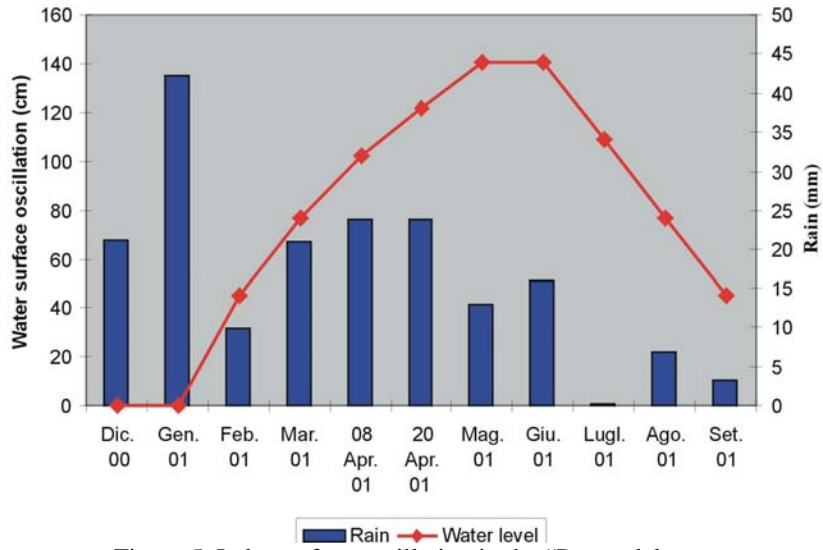


Figure 5 Lake surface oscillation in the "Pozzo del Merro" versus rainfall

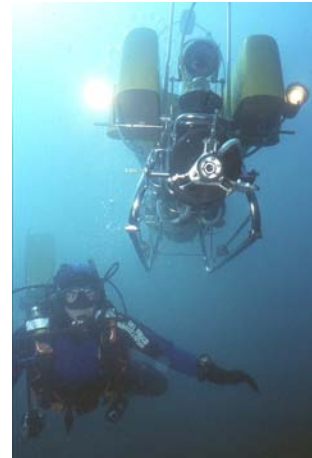


Figure 7 A scuba diver of the Fire Brigade and ROV "Mercury" (picture courtesy of Fire Brigade)

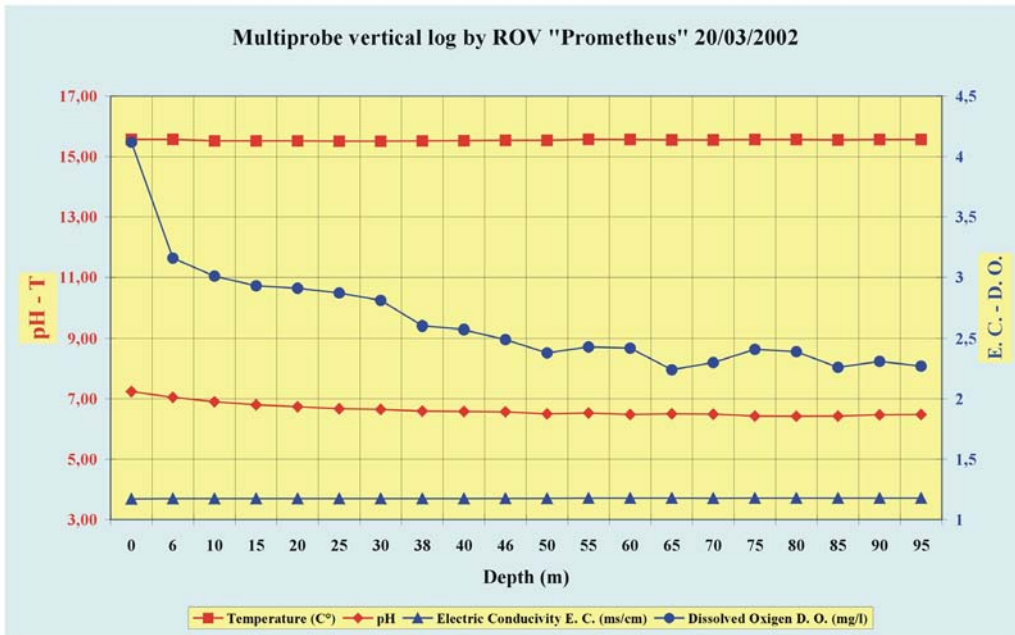


Figure 6 Vertical log made by a multiparametric probe carried by ROV "Prometheus"



Figure. 8 The author and ROV "Hyball 300"

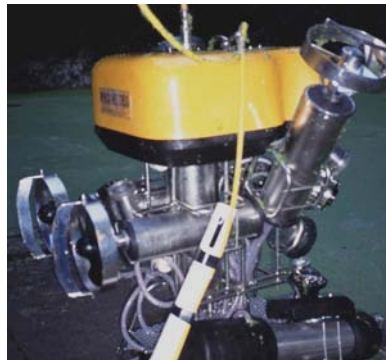


Figure. 9 The ROV "Prometheus" with the multiparametric probe

This study has shown a direct correlation between sinkhole development, faulting and geothermal fluids. In the studied area we have a regional karst water aquifer that in some locations shows the influence of geothermal and mineralized fluids. The dissolution of calcareous rocks is increased by the action of these aggressive fluids, mainly CO₂, rising through faults and cracks. This erosion is a “reverse type” because the main chemical action is not due to rain water dropping but to the rising of deep and highly mineralized fluids mixed with the regional karst water. Regarding the origin of the “Pozzo del Merro” the evidences indicate that this is a dissolution sinkhole in which the karst erosion has been increased by the presence of aggressive fluids rising through faults and tectonic displacements. The origin of these hydrothermal solutions is in all likelihood be the ancient “Volcano Albano” structure.

Scientific cave diving and ROV techniques for the study of flooded karst features are new tools that will certainly increase our knowledge of underwater environments. This study is just a small first step in a new style of research which allows the direct presence of scientists in places studied before only by remote probing.

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