

## **The Role of Public Safety Divers in Supporting Scientific Diving: Examples from Italy**

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### **Abstract**

Scientific diving activities are usually carried out by research institutions and universities that use their own teams. Sometimes, a diving environment requires extra support from specifically skilled divers who are routinely employed by emergency services such as the Fire Department. This support is mostly logistical and technical in nature; the divers join the scientific team for specific operations. One remarkable example of this type of operation is a multi-year exploration of a flooded sinkhole in Italy (Pozzo del Merro) for which teams from the Italian Fire Department joined teams of scientific divers to provide specific equipment support (ROVs) and safety and logistical assistance for the diving operations. Scuba divers of the Fire Brigade also actively collaborated in underwater sampling of volcanic, and potentially toxic, fluids during a submarine gas blowout near one of the Aeolian Islands. Finally, cave-trained Fire Department divers managed to successfully retrieve a geological specimen from a submarine cave along the shore in Tuscany. In all of these situations, a positive synergy developed between the scientific divers and the supporting teams with a reciprocal exchange of knowledge and experience.

Keywords: cave diving, Fire Department, geology, sinkhole, volcanic fluids

### **Introduction**

Scientific diving is usually conducted by teams of divers from universities and institutions who dive as part of their research activity. Sometimes the typology of the dive demands skills, equipment, experience and training above those commonly available to scientific divers. In such situations, the support of specialized diving professionals is needed in order to complete the planned tasks with a good degree of safety and efficiency.

Public safety divers may have the necessary characteristics to act as a support team for scientific diving in many situations. The advantage of using their professional skills is also enhanced by the fact that such support activity often falls within the institutional goals of the public safety agency involved, and therefore permission is usually granted and it is cost effective to use these divers.

In Italy, the main role of the National Fire Brigade Scuba Teams is search and rescue, but they are also involved in supporting environmental and archaeological research activities. The divers have experience in operating in very unforgiving environments including caves and polluted waters. The teams have mechanical aids available, such as tethered cameras and ROVs, which can be deployed in situations that are not safe for divers or to reach depths beyond those that can be safely reached by divers. Here, some case studies of such successful collaborations in Italy are outlined including lessons learned and potential future developments.

### ***Exploration and study of the flooded sinkhole “Pozzo del Merro”***

“Pozzo del Merro” is a deep water-flooded sinkhole in Italy that was explored and studied by scientific divers in the late 1990s and early 2000s (Caramanna, 2005). The submerged section of the cavity is a sub-vertical karst shaft that is 396 meters deep. Due to this extreme depth, ROVs supported divers in the exploration. The National Italian Fire Brigade deployed three different ROVs (Mercury, Hyball 300 and Prometheus) during consecutive exploration efforts. One ROV carried a multi-parametric probe that was used to monitor the main chemical and physical parameters of the water column. This was very complex logistically and required the firemen to design and build a floating platform (Figure 1) and trolley to carry the equipment back and forth from the sinkhole’s surface opening to the water surface about 70 meters below ground. A helicopter was used to take aerial pictures of the sinkhole. During the ROV survey, an opening along the main shaft walls at about 160 m in depth was identified, which is likely a connection to a nearby cave.



Figure 3. The ROV control floating platform at the surface of the "Pozzo del Merro"

### ***Geological specimen recovery in the submerged marine cave of Argentarola Island***

Argentarola Island lies close to the shore of southern Tuscany and hosts a cave that underwent phases of flooding and emersion during the last 215 ka. For this reason, a stalagmite was recovered to obtain records of the variations of the sea level in the form of alternate levels of calcite and serpulid worm overgrowth layers (Antonioli et al., 2004). Despite the relatively shallow water (about 20 m/66 ft) the cave is a challenging environment due to the presence of thick deposits of silt on the bottom that can be easily stirred reducing the visibility to zero. Another issue is the dimensions (1.5 m/5 ft length) and weight of the stalagmite that was to be carried outside the cave. The firemen realized a cableway, which was necessary to move the stalagmite in a controlled manner so to avoid damage to the

specimen and/or the cave. The operation was carried out in almost zero visibility by specifically trained divers who were used to working in restricted environments and in extremely low visibility.

#### ***Underwater geological survey and sampling of submarine volcanic vents in the island of Panarea***

In 2002, an area offshore the island of Panarea (Aeolian Islands) was affected by a submarine eruption of geothermal fluids of volcanic origin (Caramanna et al., 2011). The Italian National Institute of Geophysics and Volcanology (INGV) started survey and monitoring activity to assess the origin of such emissions and their potential hazard for the local population. The Italian Fire Brigade scuba divers joined the scientific divers in supporting the submarine sampling operations. The presence of potentially toxic gases (CO<sub>2</sub>, H<sub>2</sub>S) required the use of enhanced personal protection in the form of dry suits and full-face masks. The Fire Brigade also provided a motorboat that was used as a diving platform; this helped reduce the costs of fieldwork operations. Moreover, the specific skills of the firemen in diving in polluted waters were a key factor in developing sound and reliable diving procedures aimed at the highest safety levels for the divers.

#### **Lessons Learned and Potential Future Developments**

The collaboration between scientific and public safety divers allowed targets to be reached that otherwise may not have been possible. The water safety experience of the Italian Fire Brigade Scuba Diving Team was extremely useful in developing safe diving plans and in managing complex operations. The advantage was also reciprocal, as the Firemen were exposed to challenging scenarios that were more realistic than a simulation, thus providing valuable experience for continuous training, which is a mandatory part of their institutional activity.

Even though the ROVs used by the Fire Department are not intended for scientific applications, since they are part of search and recovery equipment, their deployment was invaluable in supporting the exploration of depths well below the safety and technical limits of the divers. The ROV pilots and technicians demonstrated ability in using and reconfiguring the machines to fit the scientific needs.

Building on this successful experience, the development of an even closer collaboration between research institutions and public safety teams in the field of scientific diving operations is desirable, leading to high-quality research activities and effective exchange of knowledge and experience with mutual benefit and cost-saving. This was partially already achieved in the “Pozzo del Merro” study where as follow-up of the first phase of research the Firemen allowed to continue the collaboration for two following phases which involved two different universities.

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## Literature Cited

Antonioli F., E. Bard, E-K. Potter, S. Silenzi, and S. Improta. 2004. 215-ka history of sea-level oscillations from marine and continental layers in Argentarola Cave speleothems (Italy). *Global and Planetary Change*, 43: 57-78.

Caramanna G. 2005. Scientific diving and ROV techniques applied to the geomorphological and hydrogeological study of the world's deepest flooded karst sinkhole (Pozzo del Merro, Latium, Italy). In: Godfrey J.M and S.E. Shumway, eds. *Proceedings of the American Academy of Underwater Sciences*. Groton, CT.: AAUS.

Caramanna G., N. Voltattorni N., and M. Maroto-Valer. 2011. Is Panarea Island a valid and cost-effective natural laboratory for the development of detection and monitoring techniques for submarine CO<sub>2</sub> seepage?" *Greenhouse Gases: Science and Technology* 1: 200–210.