ENHANCEMENTS OF SEAFLOOR OBSERVATORIES AND APPLICATIONS FOR NATURAL HAZARD ASSESSMENT AND ENVIRONMENTAL MONITORING

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The final target of the MONSOON project (MONitoraggio SOttOmariNo for environmental and energetic purposes) is to build up a prototype of a new generation of seafloor observatory for which specific technological developments in terms of power consumption reduction, new data logger and new sensors have been planned. The project is carried out in the main frame of the wide range of scientific and technological activities developed by EMSO Research Infrastructure (European Multidisciplinary Seafloor and water-column Observatory, www.emso-eu.org).

The new seafloor observatory is planned to operate either in stand-alone and real-time modes. The latter is possible with the connection to a surface buoy able to 1) provide (via modem) an internet connection to the sea-floor system and 2) communicate with the sea-floor observatory. The observatory is planned to be deployed down to a water depth of 2000m, even in an extreme marine environment, with the presence of hydrothermal vents.

All the newly developed components of the observatory have been planned and laboratory-tested. In cooperation with the University of Malta a special activity is carried out to find out technical solutions for the detection of body and surface seismic waves and for the integration of specific seismic sensors into the multidisciplinary seafloor observatory. The purpose of that activity is the integration of a seismic sensor (either a short period or a broad band seismometer) in the same data acquisition system that manages the whole observatory in order to make the observatory able to be used in studies and monitoring activities in the georisks field. After a successful laboratory testing activity, experiments in a selected, real environment are planned.

The choosen test site is located at the Aeolian islands where the management of natural risks (seismic and volcanic) required a special attention in the period 2002-2003 when a low-energy submarine explosion occurred at shallow depths off the coasts of Panarea island (Caracausi et al., 2005). The degassing activity induced by the explosion was followed by a huge landslide and a tsunami wave originated at the nearby island of Stromboli. A few weeks later a large eruption started from the flank of Stromboli. The sudden unrest of submarine volcanic activity that occurred off the island of Panarea (November 2002) opened a "crater" of 20 by 10 meters wide and 7 meters deep. That event dramatically changed the geochemical features and the degassing rate of the submarine hydrothermal vents of the area and pushed the scientists to develop new methods to monitor the sea-floor venting activity. During the unrest period, the huge degassing activity increased the CO2 flow rate by some orders of magnitude. Apart from the former venting areas, degassing occurred from many new fractures opened at the seafloor along a N40°E trend and from the crater.

Besides the periodical sampling activity (gases and hot waters collection by diving activity, Figure 1), a continuous monitoring had been carried out by a small sea-floor observatory developed to provide data from a sensors to measure the temperature of vented thermal waters, the pressure of the water column and the noise of the vented gases. The changes observed in the temperature besides the data of the acoustic probe (hydrophone), working in a frequency range of 0.5-3 kHz, gave useful information for a tight link between the submarine volcanic activity of Panarea Island and the crater explosions of the volcanic island of Stromboli. (Heincke et al., 2009)

Figure 1: Fluids sampling activity during the 2002-2004 unrest of the submarine volcanic activity at Panarea island.

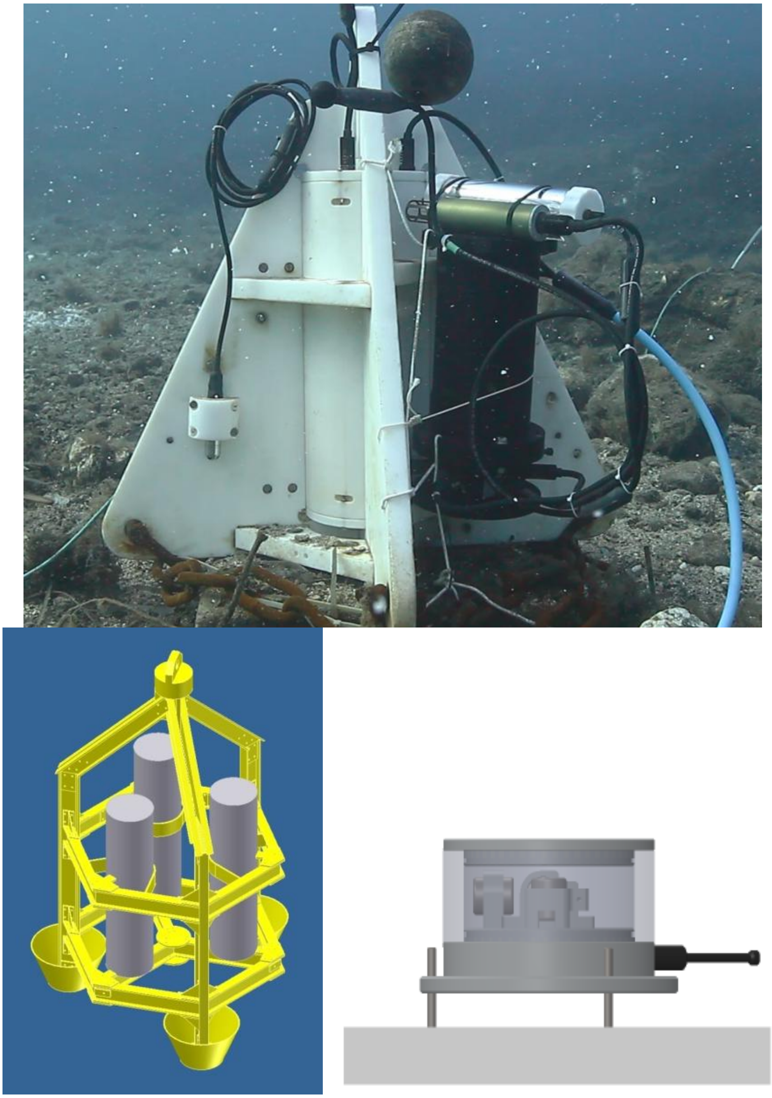

Figure 2:The sea-floor observatory deployed off the island Panarea at shallow depth. The picture shows two observatories contemporary working and connected to same cable. The black vessel contains the electronic devices that will feed the seafloor observatory developed in MONSOON project. There are three probes connected: the dissolved CO_2 (white probe, digital output), a hydrophone and the very sensitive temperature probe from Sea-Bird (bronze probe, analog output). The geophone will be connected to the same electronic cards. (bottom panel) Schematics of the sea-floor observatory and the geophone integrated in a vessel able to work at a depth of 2000m. The heavy platform is necessary to couple the geophone with the sea-floor. The geophone is equipped with an electronic compass and an system to check the tilt

As that approach allowed us: 1) to gain a deeper insight for the management of such an unrest of the submarine volcanic activity results and 2) to recognize that the observed changes in the fluids geochemistry were caused by a magmatic input showing that the nearby active volcanic system of Stromboli Island is somewhat involved in feeding magmatic fluids to Panarea, we decided to enhance the capabilities of the multidisciplinary observatory which is now able to measure either geochemical (e.g. dissolved CO_2 content in sea-water, dissolved oxygen, pH, dissolved CH_4) and geophysical parameters (hydrophones and geophones).

The test site is located in a shallow hydrothermal system off and after the end of the 2002-2004 volcanic crisis, it allows an easy access to an extreme submarine environment with temperatures up to 140°C, pH less than 3 and electrical conductivity higher of the normal sea-water. In that hostile environment we tested all the materials planned to be used to manufacture the different parts of the observatory (Figure 2), as well as all the sensors including those off-the-shelf and those planned within the MONSOON project: probes for acoustic signals, dissolved CO_2 data as well as a short period seismic sensor. Special attention will be paid to the correct coupling of the geophone with the seafloor using a heavy plate that avoids seismic frequencies cuts and losses. The coupling will be manually arranged. All the probes are connected to the observatory by submarine cables and connectors to a vessel hosting the electronics made of new low-power cards for data collection, electrical power management, sensor driving and control, network communication and data storage. The power is provided by high capacity Lithium-polymer batteries. The tests are carried out using a permanent INGV infrastructure made of a buoy cabled to a seafloor station operating at a depth of 23 metres two miles to the East of the Panarea island. This infrastructure allowed to perform the communication tests and to check the status of all the probes by near-real time communication.

The developed technologies greatly enhanced the capabilities of the seafloor observatory planned for environmental applications (target of MONSOON project) making possible to use the same observatory for natural hazards monitoring and assessment purposes (Figure 2). The activities support the EMSO scientific infrastructure, and make available new technologies for seafloor continuous monitoring of a wide range of scientific parameters including oceanographic, chemical, seismic and physical sensors.

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