ESO NEWS
The Newsletter of the European Sea Observatory Network
Volume 2 Issue 1

ASSEM technology pág. 1
Teledyne Benthos pág. 5
ESONET Demo Missions pág. 7

ASSEM Technology

History

ASSEM concept was developed in the framework of an EC FP5 specific research and technological development program "Energy, Environment and Sustainable Development" (contract EVK3-CT2001-00051, ASSEM project) by a consortium led by IFREMER. ASSEM was designed as a light (less than 250 kg) and deep (4000 m water depth rated) platform. The first prototype was produced at IFREMER Brest Center in January 2004 and its objective was to monitor a set of geotechnical, geodesic and chemical parameters distributed on a specific seabed area in order to better understand the slope instability phenomena and to assess and possibly anticipate the associated risks (Blandin et al., 2003). Two test sites were selected to proof the basic concepts, one in Norway and the other in the Gulf of Corinth. The success of these operations fostered its use in a set of new targets, particular in the framework of ESONET Demonstration Missions.

Scope

ASSEM developed a new concept of sea bed observatory dedicated to long term monitoring of seabed parameters concerning an area of some km2, based on a cost-effective and light platform where sensors could be installed in a standardized way and able to share a common data and communication infrastructure. Deploy and recovery of ASSEM was thought to be made using available ROV or submersible facilities.
The design of ASSEM, described below, was made as modular as possible, with standard connecting and easy installation interfaces allowing to adapt the system to the site of interest, add new sensors and replace components for maintenance. In this sense, ASSEM is understood as an array of nodes, that can be deployed almost independently, and that interact in such a way that they can cooperate in a large monitoring multi-parameter monitoring operation.
A two-way communication link between sensors and between them and the shore is built on either an acoustic network, or wired links, to allow a large diversity of connection devices, either local (e.g. ROV) or remote. Local storage of all the raw data in each node with local analysis resources able to generate alarms is also a key element, adding reliability and redundancy on the information fluxes, critical for warning systems.

Electronic Design

ASSEM is designed as an array, composed of several nodes. Each node includes an electronic unit, named COSTOF (for COmmunication and STOrage Front-end), through which all sensors available (pore pressure, methane, geodesy, tiltmeter, CTD, turbidity, currents, …) can communicate. The architecture is organized around an internal CAN/CANopen bus hosting sensors, communication and data storage resources on a common transmission backbone. All the modules connected to the bus include the same "kernel" card and a specific extension card. Each "kernel" card includes a Atmega129L processor, a 2 Mb flash memory, a real time clock and 2 RS232 links.
The software resources needed to enable a monitoring node to act as a network node (routing algorithms throughout the network, network configuration management, data transmission protocol and other network layers) are implemented in every COSTOF unit. Warnings can be generated for example if a critical parameter, or a group of parameters, comes above a preset threshold for a given time length.
This distributed architecture allows to configure a Monitoring Node very easily and to add new functions without modifying the existing ones.

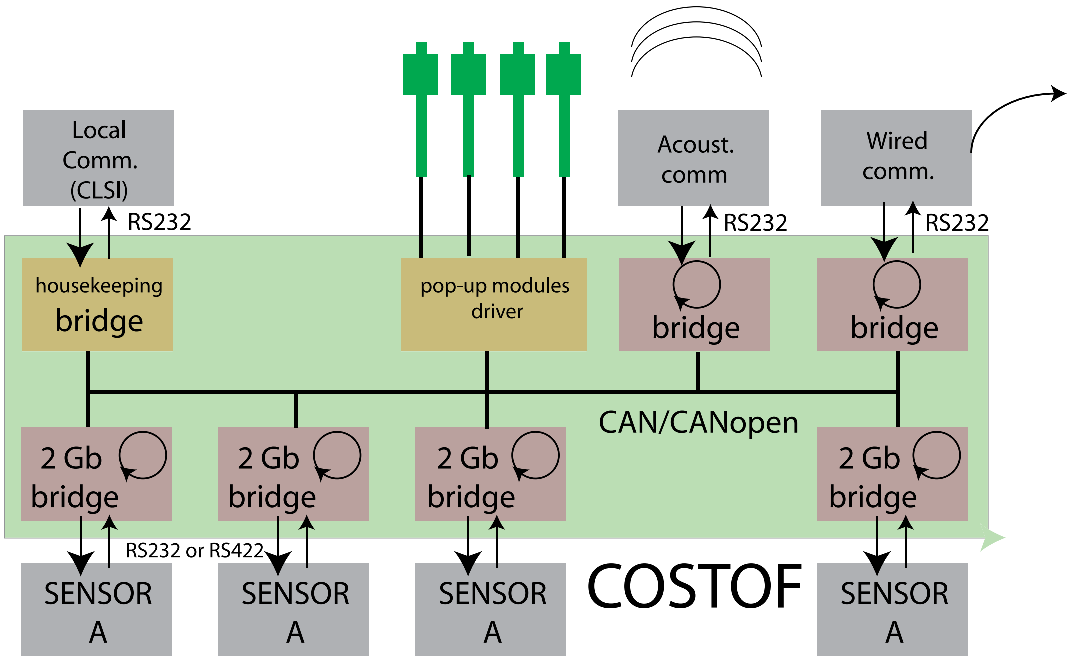
Cable deployment of ORION 4 in the ASSEM Gulf of Corinth network

Mechanical Design

The same modularity concept is applied to the mechanical design. The usual deployment and maintenance procedures imply the use of a submersible or a ROV, but free fall launching is possible if needed. The design includes some innovations:

- A low cost underwater connection system is used to replace in-situ power packs, to install or to replace sensors and to establish cabled links between nodes, if needed;
- A contact-less serial interface (CLSI) allows to test the node before launching and during maintenance operations;
- The acoustic array, with bell-shape protection is mounted at the top of a flexible mast to have protection against trawlers.

Lithium cells are used as power source. Two voltages, 12 V and 24 V, are available on the ASSEM platform with a capacity up to 16 kWh. Power packs are replaceable by ROV or submersible. Protection devices against trawling are used and the acoustic transmitter is installed on a special flexible arm.



Basic Design of the ASSEM nodes

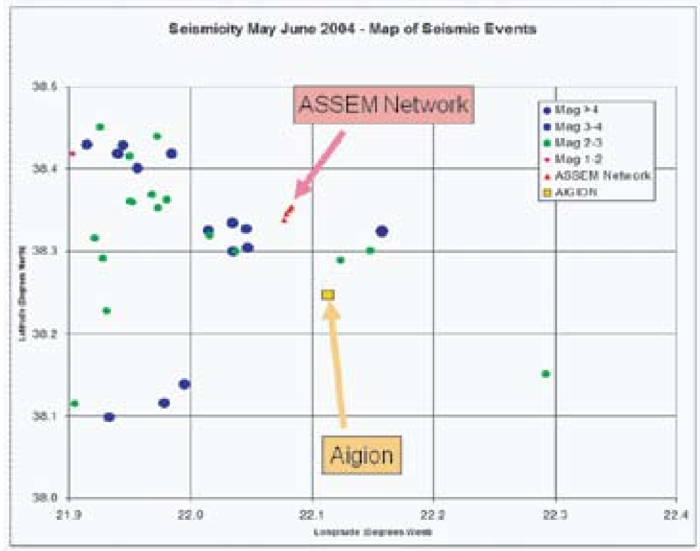
Geodetic base to be deployed with the help of a submersible

Sensors

A lot of sensors can be installed on an ASSEM node. The configuration is chosen depending of the scientific objectives. Usually, temperature sensors are implemented on all nodes. At least, one node from a network is equipped with a CTD probe and another one (or the same) with a current meter. Turbidity sensor, current profiler, static and dynamic water pressure are also options available. Pore pressure is an important parameter for the modifications of the soil before and during any geohazard event. It is possible to measure pore pressure at several levels, in bore holes down to 200m and in tubes of CPT probes inserted in the sediment layer down to 30m.
The natural occurrence and emission of gas on the sea floor (methane seeps) are increasingly recognized as an important marine process for its environmental and geohazard implications. A methane sensor from CAPSUM was adapted for long term deployment.
In tectonically active areas, ground deformation sensors are claimed but geodesy is still in its infancy in deep water. Different sensors have been developed and tested: a long range taut wire distancemeter (NGI) for measurement of distances up to 200m with accuracy of a few millimeters, an acoustic distancemeter (IPGP) and a tiltmeter.

Acoustic Network

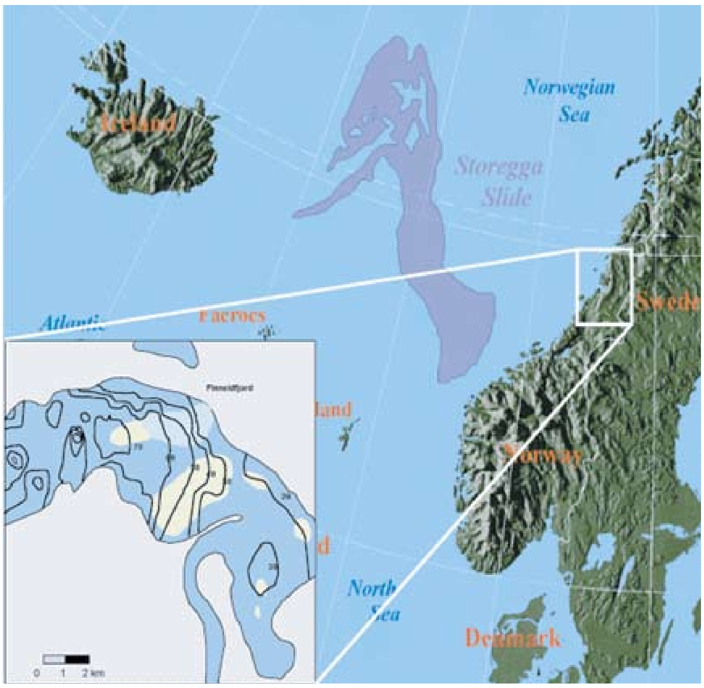
ASSEM uses an acoustic network based on the MATS 200/R acoustic modem from ORCA instrumentation. This digital modem based on micro-controller and DSP cards, is capable of data transmission under adverse channel conditions. Original network protocols, with autonomous handshaking and adaptive bit rate, adaptive modulation and adaptive routing were implemented.
Patented modems perform noise analysis and impulse response measurement of the channel.



Map of Seismic Events

Pilot Experiments

Two pilot projects were designed to test the efficiency of ASSEM concept. Both deal with geo-hazards but in different geological contexts. The complexity of the monitoring strategy needed to recover relevant information on the seafloor was important to test the distributed approach, and the heterogeneity of sensors needed.



Location of Finneifjord Experiment

Finneidfjord

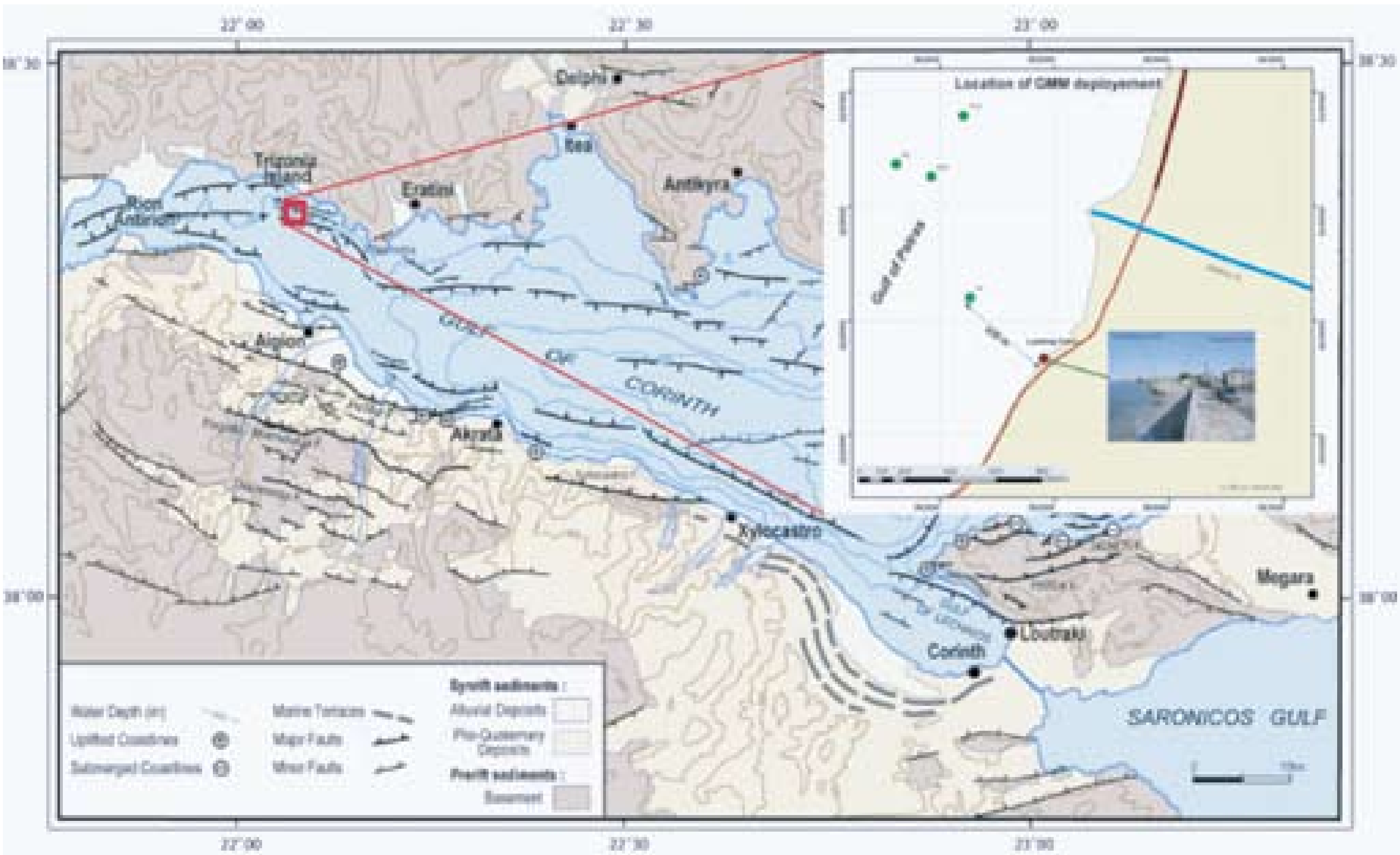
The first pilot experiment using ASSEM technonolgy was conducted at a site with a risk of slope instability, in Finneidfjord. The experiment was active during 4 month, using 2 monitoring nodes, and sensors for pore pressure methane, temperature and tiltmeter.

Gulf of Corinth

The second experiment took place in the Gulf of Corinth. The shelf (with its pockmarks), the slope and the margin of the basin off the coast of a faulted area were selected for the deployment of the ASSEM array of sensors.
It is the most active extensional basin in Europe, with more than 1 cm/year of deformation across the Gulf and high rates of margin uplift. Together with physical oceanographic measurements, both horizontal and vertical deformation devices were installed. Horizontal deformation estimates were based on acoustic traveltime measurements and vertical deformation estimates on pressure measurements. The monitoring operation took place during 7 months with a seabed network of 5 nodes including one designed in the FP5 ORION project. It ensured real time access to gas, geodesy and seismic data.

Conclusions

ASSEM presents a new concept of real time sea floor observatories dedicated to deliver warning information and collect data with low sampling rate. It can be operated alone or linked to other observatory system, such as GEOSTAR/ORION system. Its concept can be applied to other long term studies in a wide variety of applications such as biological ones or in emergency to environment moni toring of dangerous wrecked ship.
The automated alert function on ASSEM pilot experiment in the Gulf of Corinth issued a warning message that was initiated and transmitted within 1 mn 54 s to the server at IPGP in Paris. The International Coordination Meeting for the Development of a Tsunami Warning and Mitigation System for the Indian Ocean within a global framework during their meeting at UNESCO Headquarters in Paris (3-8 March 2005) indicates that 15 mn is a basic data transmission period for "real-time". The objective is to reach 2 mn in dedicated warning networks.
Interoperability is a major concern of modern observatory design. During the pilot missions, ASSEM showed the capabilities to deploy in the same cruise on board HCMR research vessel AEGEO the equipments of IPGP, Tecnomare/INGV, Ifremer, Sercel/IFREMER, and Capsum with HCMR crew. This point the success of the clustering between AS-



Location of ASSEM network in the Gulf of Corinth Pilot Project

SEM and ORION platforms and to the feasibility of interoperable underwater networks.
ASSEM showed the capabilities to deploy in the same cruise on board HCMR ship AEGEO the equipments of IPGP, Tecnomare/INGV, Ifremer, Sercel/IFREMER, and Capsum with HCMR crew.

Acknowledgements

ASSEM Consortium was formed by IFREMER (Yannick AOUSTIN, Jean-Yves COAIL, Jacky DUPONT, Gérard GUYADER, Yves LE GALL, Julien LEGRAND, Bernard LEILDE, Jean-Pierre LEVEQUE, Jean-François MASSET, Roland PERSON, Pascal PICHAVANT and Jean-Pierre SUDREAU), NGI (John H. LØVHOLT, Per SPARREVIK and James M. STROUT), IPGP (Jérôme AMMANN, Valérie BALLU, Alexandre NERCESSIAN and Olivier POT), INGV (Giuseppe ETIOPE and Giuditta MARINARO), CAPSUM (Michel MASSON), HCMR (Matina ALEXANDRI, Dionysis BALLAS, Kostas KATSAROS, Vasilis LYKOUSIS, Aggelos MALLIOS, Theodoros POTOPOULOS, Dimitris SAKELLARIOU, Vasilis STASSINOS, Spyros VOLO NAKIS, the Captains and the Crew from R/V AEGAEO), UPAT (Dimitris CHRISTODOULOU, George FERENTINOS and George PAPATHEODOROU), FUGRO as “THALES Geosolutions”(David CATHIE, Chris GOLIGHTLY and Steven SMOLDERS).

References

[1] EC FP5 in the specific research and technological development programme “Energy, Environment and Sustainable Development” (contract EVK3-CT2001-00051, ASSEM project).

[2] Blandin J, R. Person, J.M. Strout, P. Briole, G. Etiope, M. Masson, C.R. Golightly, V; Lykousis, G. Ferentinos (2002). ASSEM: Array of Sensors for long term Seabed Monitoring of geohazards. Proc. Underwater Technology, Tokyo, 16-19 April 2002, p.111

[3] Blandin J, R. Person, J.M. Strout, P. Briole, G. Etiope, M. Masson, C.R. Golightly, V; Lykousis, G. Ferentinos (2003): ASSEM: a new concept of observatory applied to long term SEabed Monitoring of geohazards, in Proceedings of OCEAN’2003, San Diego, 115.

[4] Blandin J., Rolin, J.F. An Array of Sensors for the Seabed Monitoring of Geohazards, a Versatile Solution for the Long -Term Real-Time Monitoring of Distributed Seabed Parameters. Sea Technology December 2005, Volume 46, No. 12.

[5] Person R, Aoustin Y, Blandin J, Marvaldi J and Rolin J-F. From bottom landers to observatory networks. ANNALS OF GEOPHYSICS, VOL. 49, N. 2/3, April/June 2006.

TELEDYNE BENTHOS

Real Time Acquisition of CTD data from a remotely deployed CTD

Customer: Florida Institute of Oceanography
Depth: Approximately 5 meters
Range: Up to 800 meters
Data Rate: 1,200 bits/sec data throughput with error correction convolutional coding
Host Sensor: Falmouth Scientific, Inc. NXIC Auto-500 CTD

The Problem:

The over active 2005 hurricane season damaged weather stations in the Florida Keys. These weather stations send real-time data to the National Oceanic and Atmospheric Administration’s National Data Buoy Center, NDBC, to be distributed to national weather providers. Some stations suffered severe damage and were completely destroyed. Others were damaged and scheduled to be rebuilt.
Sand Key just south-west of Key West, Florida was one station scheduled to be rebuilt but one problem was evident on the evaluation trip. The structure on which the CTD was mounted was so badly damaged that the Coast Guard removed it completely. This posed a problem for the Florida Institute of Oceanography, FIO, who was charged with the care of this station. The second problem was the station is located in an area with very low tides that could possibly cause the instrument to come out of the water when at low tide.
What was needed was a combination of equipment that would allow FIO to monitor the ocean environment using the Falmouth Scientific, Inc, FSI, CTD wirelessly from a distance at which the instrument could be located in water deep enough to sustain a reading at any tide.

The Solution:

Teledyne Benthos, Inc Acoustic Telemetry Modem Series ATM-885 are designed to connect to an RS-232/RS-422 instrument and telemeter the data to a receiver with range capabilities of transmitting from 1 to 10,000 meters. The modem is capable in the omni-directional form of transmitting a 180° beam pattern which allows it to send and receive data in shallow water very well over both long and short distances. The data transmitted to a receiver which is capable of transmitting and receiving data for bidirectional half duplex communications.

Around Sand Key just south-west of Key West, Florida there are marker buoys that cordon off a protected reef area that is closed to fishing. These markers are moored to the sea floor with large weights which are located in approximately 5 meters of water. The buoys were selected as an installation site for the CTD and ATM-885 based modem based on local knowledge to avoid this area and because there were no physical blockages between the two modems.
Since flotation and release capability was required for this application the SMART Modem and Release Technology, SMART, pioneered by Teledyne Benthos was put to use. The SMART SM-75 was used because it provides an omni-directional transducer, internal battery, modem functionality, flotation in the form of a glass sphere and acoustically triggered burnwire release. This multifunction unit allows the mooring to be small, easy to deploy and inexpensive. The FSI CTD was mounted to the side of the SM-75 and a counter weight was installed to allow the SM-75 to float vertically in the water column.
The unit was set to output data every hour so that the weather station could send the data to NDBC for use by national weather providers. The data was being transmitted 800 meters horizontally.
The mooring package was at a depth of 3 to 5 meters and the receiver was at a depth of one to less then one meter at low tide. Mounted on the weather station was an ATM-885R PCB kit that uses a 25 meter cable to connect to an AT-408 omni-directional dunking transducer. Data was then sent to the NDBC payload and transmitted via satellite to shore.

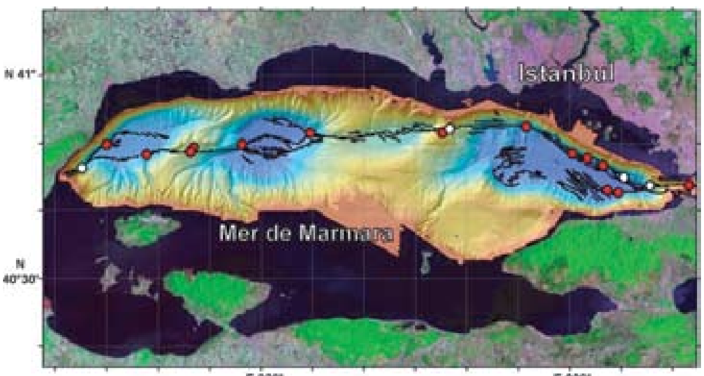
Our thanks to Jon Fajans, FIO and Jeff Bartkowski, FSI.

ESONET
Demonstration Missions

ESONET NoE, according to the DoW, supports pilot experiments at sea and site surveys that help to define the monitoring strategies and the most appropriate parameters to be measured in order to meet the scientific objectives. The pilot experiment are implemented in the Demonstration Missions (DMs). DMs are considered means to strengthen the integration process of the ESONET NoE scientific and technological community bringing at high level of excellence the technology at different development phases, implementing the standardisation and interoperability of the different platforms from the consortium. DMs are also aimed at acquiring relevant scientific time-series. They will be an input for integrated studies, common workshops and a raw material to demonstrate the integration of data management.
Four DM proposals were approved for funding in January 2008:

Marmara Sea

The goal of the present demonstration mission is to contribute to the establishment of optimized permanent seafloor observatory stations for earthquake monitoring in the Marmara Sea, as part of ESONET NoE.
The Marmara Sea (MS) offers the ideal location for seafloor seismogenic observations directed towards risk assessment, because of the following reasons:
1. The deformation rates (20 mm/y) are very high compared to any other marine sites in Europe, resulting in active submarine processes that are measurable on short time scales,
2. More than 15 millions people are under the threat of seismogenic hazard in the whole Marmara Region. Hence, the continuous seafloor monitoring would have societal impact.
3. Numerous fluid vents and related features have been discovered along the MS fault system. The MS is thus a unique area to test hypothesis on the relations between strike-slip deformation, seismic activity, fluid flow and gas expulsion within the active fault zone.



Nautile dives in Marmara Sea during MARNAUT:–Red : cold seeps found–White : no cold seeps

Lido

LIDO (Listening to the Deep Ocean environment) proposes to establish a first nucleus of a regional network of multidisciplinary seafloor observatories contributing to the coordination of high quality research in the ESONET NoE by allowing the long-term monitoring of Geohazards and Marine Ambient Noise in the Mediterranean Sea and the adjacent Atlantic waters. Specific activities are addressed to a long-term monitoring of earthquakes and tsunamis and the characterisation of ambient noise induced by marine mammals (Bioacoustics) and anthropogenic noise.

MoMAR-D

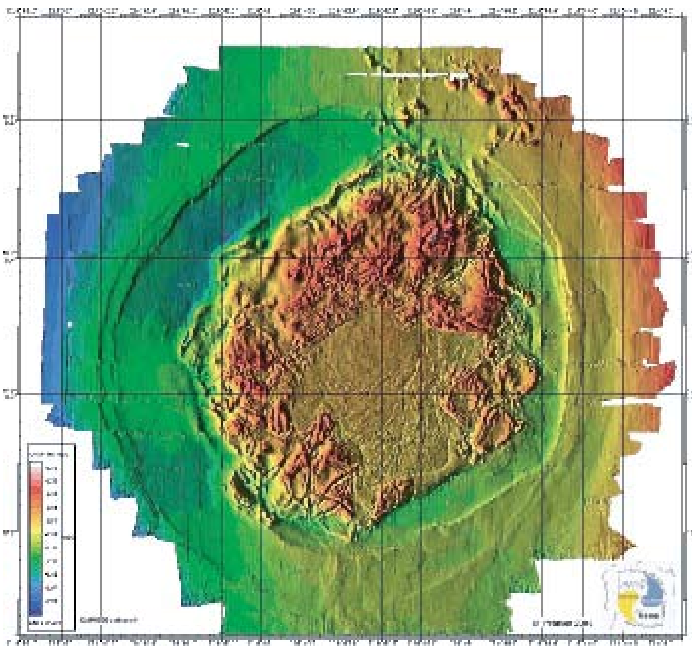
The MoMAR-D proposal will address all the tasks connected to the implementation of a seafloor observatory to study the temporal variability of active processes such as hydrothermalism, ecosystem dynamics, volcanism, seismicity and ground deformation, in order to constrain the dynamics of mid-ocean ridge hydrothermal ecosystems
•To deploy a multidisciplinary acoustically linked observing system, with satellite connection to shore, •To integrate the partners' observation means around an existing and proven, non cabled, long term sub sea monitoring infrastructure. •To demonstrate the overall management of this system during 1 month even if its operation will actually continue during 12 months.

MOMAR:
sampling on an hydrothermal vent

ESO NEWS

Loome DM

LOOME DM is a networking action for the long-term observation of a major site of methane emission from the deep European margin, the Håkon Mosby mud volcano (HMMV). The HMMV is a cold seep ecosystem located at a water depth of 1250 m on the SW Barents Sea slope off Norway, in an area with a history of seabed slides and tsunamis, and under exploitation for hydrocarbon resources and fisheries. The Barents Sea slope is a target area for sustainable management and monitoring of global change effects. A main goal of the project is the integration of existing technology to establish in a first phase an autonomous non-cabled observatory for seafloor seismics, temperature and pore pressure, chemical profiling, sonar detection of gas flares, methane measurements and hydrography of bottom water, together with the study of colonization patterns, community structure and biodiversity.



High resolution Hakon Mosby map

EsoNews is a publication from ESONET Network of Excellence
Executive Editor: J. M. Miranda • Managing Editor: Roland Person
Printed at REPRO2000
ESONET Office • IFREMER Centre de Brest, BP 70 29280 Plouzané, FRANCE • Tel: + 332 98 22 40 96 - Fax: + 332 98 22 46 50
email: esonet-coordinator@ifremer.fr - URL: http://www.esonet-emso.org
To receive the ESONEWS letter by Email, send an Email to sympa@ifremer.fr, with <SUBscribe esonews> in the subject, if you are not already registered