European Science Foundation
Standing Committee for Life, Environmental and Earth Sciences (LESC)

ESF LESC EXPLORATORY WORKSHOP:

Long-term monitoring of deep ocean hydrothermal ecosystems

Barcelona, Spain, 15-17 October 2003

Convened by:
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Contents

1. Executive summary

The ESF Exploratory Workshop on « Long term monitoring of deep ocean hydrothermal systems » was held at the Centre Mediterrani d'Investigacions Marines (CMIMA) in Barcelona, from the 15th to the 17th of October 2003. The CMIMA and the Unitat de Tecnologia Marina (UTM) of this same institute provided the facilities for this meeting, which was attended by more than 20 participants (see list of attendees in Annex 1), including both scientists and engineers involved in deep-sea intervention tools and instrumentation. The meeting was structured in two parts, with one day of both solicited and proposed updates and communications on status on national efforts, facilities and future developments, and a second part of open discussions.

Hydrothermal systems along mid-ocean ridges are the expression of the transfer of heat from deep levels in the crust towards the ocean, due to the separation of tectonic plates along these boundaries. These systems are **active**, and are controlled by numerous processes, including supply of magma from the mantle, volcanism at the seafloor, tectonics and earthquakes, chemical composition of the crust that hosts them, and the reactions associated with the interaction between the water and the rock. The hydrothermalism provides the heat and the chemical energy to sustain peculiar chemiosynthetic ecosystems in the deep-sea ocean. The study of ridges in general and hydrothermal systems in particular has evolved from exploratory descriptive approaches, to a functional approach based on **multidisciplinary experiments** involving repeated interventions and seafloor instrumentation to obtain **critical time-series measurements** that can provide information on the feedback between all the active processes and parameters that are associated with hydrothermalism. The rate at which mid-ocean ridges spreads varies from <1 cm/yr to >90 cm/yr. As this variation in spreading rate, among other factors, determines the amount of magma supplied to the crust, the structure of the crust, and the nature and rate at which processes occur is substantially different between fast-spreading ridges (e.g., East Pacific Rise) and slow-spreading ridges such as the Mid-Atlantic Ridge. It is therefore necessary to study and monitor deep-sea hydrothermal systems during long periods at both fast- and slow-spreading ridges.

The international scientific community, with an important European participation and thrust, has laid the scientific justification and basis to establish seafloor observatories at

deep-sea hydrothermal sites along the Mid-Atlantic Ridge. During the I **Mo**nitoring the **M**id **A**tlantic **R**idge (**MoMAR)** workshop (Lisbon, 1998), a section of the Mid-Atlantic Ridge south of the Azores was selected as the preferred site for such integrated studies. This workshop motivated several projects that allowed the characterization of the area in general, and of the hydrothermal vents of **Menez Gwen**, **Lucky Strike**, **Rainbow** and, more recently, **Saldanha and Menez Hom**. In 2002 two Expressions of Intention (EoI) for an Integrated Project and a Network of Excellence were presented for consideration to the EU's 6th Framework Program. The II MOMAR Workshop (Horta, Azores, June 2002) provided an implementation plan for integrated studies and long-term observations in the MoMAR area, with additional exploratory studies in the region. A specific list of critical experiments and the most adequate order for implementation were established[1]. Following this Workshop, the European scientific community coordinated several proposals, and a technology development project (**EXOCET/D**) and a research training and mobility network (**MOMARNET**) are being negotiated (11/03) with the EU. MoMAR is also one of the 9 sites considered by the European network of ocean observatories (**ESONET**) under consideration, with plans to choose 2 or 3 pilot sites in 3/04, for inplementation shortly after.

National and international programs have been established for the study of other sections of the Mid-Atlantic Ridge and their hydrothermal sites, including the South Atlantic (where a German national research plan will expand from 2004 to 2006) and Jan Mayen, among other sites along the Mid-Atlantic Ridge. While long-term monitoring studies in the MoMAR area can be implemented at the present time, this region can be also considered as an interesting site for future observatory-type experiments that can be expanded to other areas in the future, providing a broader scope to MoMAR. The MAR near the Azores is ideally located, as it is at a short transit from the nearest harbor for easy deployment, retrieval and other interventions associated with long-term observations. This portion of the MAR has also been the focus of a great number of cruises in the past few years, and therefore the geological-geophysical background of this

[1] Santos, R. S., J. Escartin, A. Colaço & A. Adamczewska (Eds.) 2002. Towards planning of seafloor observatory programs for the MAR region (Proceedings of the II MoMAR Workshop). Arquipélago- Life and Marine Sciences. Supplement 3: xi + 64pp.

region is therefore well constrained, as are the general characteristics of the known hydrothermal vents, and the broad diversity of the associated ecosystems.

The ESF Exploratory Workshop comes at a critical time, as the implementation of observatory-type experiments are beyond the reach of individual countries, and require planning over a long period of time. At this point the scientific community needs to coordinate their efforts both within Europe and internationally, share their technological means and human capital, and develop the projects and acquisition of technology that will be required to implement long-term observations. Presentations during the ESF Workshop demonstrate that, in parallel with the development of the scientific and implementation programs for MoMAR and other areas of the Mid-Atlantic Ridge, Europe has also acquired during the last 4-5 years an impressive fleet of ROVs and AUVs, in addition to research vessels. These systems provide the means for extensive deep sea intervention that will be required to install instrumentation, its servicing, and the recovery of data, samples and instruments during the monitoring of deep-sea sites. As these integrated projects must transcend national programs, it is also necessary to coordinate the development of technologies and instrumentation so as to allow transfer and compatibility of equipment among countries, facilitate the intervention of instrumentation on the seafloor independently of the platform used, and obtain the flexibility to exchange instrumentation and data.

The first and main conclusion of the ESF Exploratory Workshop is the need to coordinate efforts of European scientists and programs involved in studies at deep-sea hydrothermal vents involving long-term observations. A possible way of coordination of these efforts is the possibility of coordinating an EUROCORES program (see letter of intent in Annex), or establish a European-wide network. This EUROCORES project will be open to the study and monitoring of deep-sea hydrothermal sites along the Mid-Atlantic Ridge. The target length of the program is 5 years. There is a need to obtain long-term time-series (5-10 years) of all the measurable parameters to properly characterize the variability and feedback among active processes. While biological processes may show daily and seasonal (yearly) variability, other processes, such as seismicity or magmatism, show variability but at time scales that are not yet well constrained (1 year – decadal, or larger ?). It is thus necessary to acquire a baseline of

observations of sufficient length (5 years). It is foreseen that the Mid-Atlantic Ridge will be the focus of immediate pilot observatory-type studies at the MoMAR site, as it is one of the best characterized areas in the Atlantic, and the choice of this site is backed by a wide consensus of the scientific community. The coming effort in characterizing the southern Mid-Atlantic Ridge (south of Ascension Island) will also allow phasing of this type of studies to other areas of the Mid-Atlantic Ridge in the future.

A second action taken by the Workshop is the set up of an ad-hoc committee that will coordinate and transmit information regarding MOMAR-related activities, formed by C. Devey, J. Escartín, A. Pascoal, R. S. Santos, P. Tyler and. One of the main tasks will be to ensure a coordination scheme among the different programs related with deep-sea observatories, at the European level (EXOCET/D, ESONET, ASSEM, ORION, MOMARNET, European Union, ESF…) international level (ION, InterRidge, IODP), and with the different national programs (USA-Ridge2K, Japan, national programs of European countries). This effort is necessary to facilitate communication and participation in different meetings of relevance to MoMAR as a community rather than as individual scientists. Plans for national meetings related to MoMAR are in place for France (24-25 Nov. 2003), Spain (27 Nov. 2003) and Portugal (during November of 2003). *France will set up a MOMAR steering committee formed by CNRS and IFREMER to coordinate national efforts. Spain will put forward a proposal requesting funding for MOMAR related work* (11/03). Finally, there is an important effort of outreach to be done towards general education, communication of cruise experience and results to the general public, preparation of educational material, communication with institutional representatives, etc. This effort needs to be carried out both prior to and within an EUROCORES project.

Table 1 : Upcoming events relevant to MoMAR & MARidge

Date	*Location*	*Topic*
13/12/03	San Francisco, USA	ION Meeting
4-7/1/04	San Juan de Puerto Rico	ORION – NSF Ocean Observatories Initiative
18-19/3/04	London, UK	ESONET Meeting
28/1-2/2/04	Providence, RI	Ridge 2K Meeting

Table 2 : European underwater vehicles and platforms in operation or near completion

Country	*Type - Name*	*Status*	*Organisation*	*MAX. deployment depth*
France	***AUV***			
	ALISTAR300	Prototype	ECA	300 m
	ALIVE	Prototype	IFREMER	1000 m
	AUV1	Development	IFREMER	3000 m
	ROV			
	VICTOR6000	Operational	IFREMER	6000 m
	Manned submersibles - HOV			
	NAUTILE	Operational	IFREMER	6000 m
Great Britain	***AUV***			
	AUTOSUB	Operational	SOC	2500 m
	ROV			
	ISIS	Development	SOC	6500 m
Denmark	***AUV***			
	MARIDAN 600	Operational	MARIDAN	1500 m
Norway	***AUV***			
	HUGIN1000	Operational	SIMRAD/NUI	1000 m
	HUGIN3000	Operational	SIMRAD/C&C	3000 m
	ROV			
	ARGUS	Operational	U. Bergen	2000 m
Germany	***AUV***			
	DEEPC	Development	STN-Atlas	4000 m
	BLUEFIN			
	ODYSEE	Development	AWI	3000 m
	MOVE	Development	MARUM/NIOZ	6000 m
	ROV			
	QUEST	Operational	MARUM	4000 m
	CHEROKEE	Operational	MARUM	1000 m
	Manned submersibles - HOV			
	JAGO	Operational	MPI	400 m
Portugal	***AUV***			
	INFANTE	Prototype	ISR/IST	600 m
	MAYA	Development	ISR/IST	1000 m
	ROV			
	DREAM	Development	ISR/IST-Fac.Sc.U.Lisb.	1000 m
Italy	***ROV***			
	ROMEO	Prototype	IAN-CNRS	500 m
EU	***Benthic stations:*** LANDER systems for stationary and long-term observations are in operational use in different European countries: Denmark, France, Great Britain, Germany, Sweden, The Netherlands. Devices mostly are of modular design and include micro-profilers, respiration chambers, acoustic tools, time laps cameras, etc. All of these systems are rated to full ocean depth			

Abbreviations:

AUV: Autonomous Underwater Vehicle
AWI: Alfred Wegener Institute for Polar and Ocean Research
HOV: Human operated Vehicle
IAN/CNRS: Robotics Group of the CNR-ISSIA Genoa Branch
IFREMER: French Research Institute for Exploitation of the Sea
ISR/IST: Institute Systems and Robotics/Instituto Superior Tecnico
MARUM: Centre of Marine Environmental Sciences
MPI: Max Planck Institute for Behaviour Physiology
NIOZ: Netherlands Institute for Sea Research
ROV: Remotely Operated Vehicle
SOC : Southampton Oceanography Centre
IFREMER: French Research Institute for Exploitation of the Se

2. Final Programme

The ESF Workshop took place between the 15th and the 17th of October. In addition to the presentations and discussion session listed below, an Icebreaker was organized the 14th of October at 18 :30 in the cafeteria of the CMIMA. A Workshop dinner was held on the 16th of October at the Restaurant « Los Caracoles », on the 16th of October.

15 October 2003
Main conference Room, CMIMA
9 :00 – 10 :30
Introduction and opening

Opening – J. Escartin
Welcome and presentation of CMIMA – D. Blasco, Director
ESF-LESC overview – Adam Schultz
Presentation of the Marine Technology Unit (CMIMA) – J. J. Dañobeitia
10 :30-11 :00 Coffee Break
1st floor meeting room
11 :00-13 :00
I- Updates, progress reports and presentations

International projects
ESONET, the European Seafloor observatory network – R. Person
EXOCET/D : Extreme ecosystem studies in the deep Ocean :
Technological Developments – P.-M. Sarradin
ION and DOES – A. Schultz
The MOMARNET project – J. Escartín

13 :30-15 :00 Lunch Break
15 :00-16 :30
AUVs and ROVs
UK remotely operated vehicle *ISIS* – P. Tyler
French ROV, AUVs and manned submersible – V. Rigaud
Quest 5 ROV technology and application for marine sciences
at the University of Bremen - G. Meinecke
Marine Science and Technology laboratory : AUV developments – A. Pascoal

National updates
From mantle to ocean, DFG Program – C. Devey

16 :30-17 :00 Coffee Break
17 :00-19 :00
Multidisciplinary studies on the hydrothermal fields of the MOMAR area,
Azores Sea, Mid-Atlantic Ridge – F. Barriga

Update on the Azores : LabHorta and MoMAR related efforts – R. S. Santos
SUBMAR : Subsurface Biosphere, Hydrothermal and magmatic activity
Along the Arctic ridges (2999-2003) – R. Pedersen
Ridge 2K – D. Blackman

16 October 2003

9 :00 – 10 :30
What can Spain do in MOMAR ? An update – E. Gràcia
II – Discussion sessions
Open discussion
- Way forward – ESF tools
- MOMAR and additional hydrothermal sites along the MAR
- Scope of coordinated efforts under the ESF umbrella

10 :30-11 :00 Coffee Break
11 :00-13 :00
- Cables and observatories
- ESF ad-hoc action group
- Communication and outreach

13 :30-15 :00 Lunch Break
15 :00-16 :30 Discussion groups :
A) Technology : standards, developments and dedicated instrumentation
B) Science : Deep-sea hydrothermal work and EUROCORES
16 :30-17 :00 Coffee Break
17 :00-18 :30
continued

17 Octobre 2003

9 :00 – 10 :30
- Summary of prior discussions
- Scope of EURECO : sites, extent, integration in a science program
- Tasks of ad-hoc comittee

Conclusion of discussion session
10 :30-11 :00 Coffee Break
11 :00-14 :00
Compilation of materials and texts from participants
Writing of report and letter of intent draft
Conclusion of the ESF Exploratory Workshop

3. Reports and updates

This section is a summary of the reports and communications provided by different participants and guests to the ESF Workshop. The presentations corresponding to most of these reports can be accessed through the MoMAR web pages : http://www.ipgp.jussieu.fr/rech/lgm/MOMAR

Welcome and introduction to the host institution (CMIMA):
D. Blasco

Introduction to the Unitat de Tecnologia Marina (UTM-CSIC, CMIMA):
J. J. Dañobeitia

The Unitat de Tecnologia Marina (UTM), which is part of the Spanish Research Council CSIC, is within the CMIMA, and is the organization in charge of operating, maintaining and developing the oceanography-related facilities of the Spanish scientific community. These include :

- R/V Hespérides, a haul-strengthened vessel that provides support to Antarctic operations, and is also available for scientific cruises elsewhere. This vessel is operated by the Spanish Navy (Ministry of Defence), and managed by the UTM-CSIC (Ministry of Science and Technology)

- R/V Garcia del Cid, a more than 20 yr old research vessel for regional oceanographic investigations

- Juan Carlos I, Spanish Antarctic Base in Livingston Island (South Shetland Archipielago) where glaciological and environmental research is being carried out during Antarctic summer, and a year-round meteorological and geophysical observatory.

- Oceanographic instrumentation for geosciences (swath bathymetry, high-res and multichannel seismic systems, ocean bottom seismometers, heat flow probes, gravity cores and dredges). Physical and biological oceanography (CTDs, current meters, plankton nets, biological ecosounders, etc.)

The UTM insures around 300 days of sea time per year both in the Garcia del Cid and the Hespérides. In addition, a new vessel 70 m long will be available in the near future to complement and renew the existing oceanographic fleet.

In addition to the technical vocation and service-oriented activities of the UTM-CSIC, the UTM is also committed to carry out scientific projects and develop technology through existing collaborations with engineers at the Technical University of Catalonia (UPC); other collaborations are actively being seeked at this time. UTM-CSIC Scientists are actively involved in international projects such as IODP (e.g., Gas Hydrates Leg 204), InterMARGINS, EuroMARGINS, ESONET, and are interested to get actively involved in observatory-related initiatives such as MoMAR.

Introduction to the Workshop goals, organization, and planning:
J. Escartín

Introduction to LESC/ESF:
A. Schultz

ESF provides several ways of action to coordinate scientific efforts, including the organization and support of Exploratory Workshops (this meeting). EUROCORES is an ESF mechanism that has been successful in the past to bring in the funding agencies of several countries (minimum of 4) around a detailed scientific programme. The lead-time to the implementation of this type of projects is approximately 3 years. As an Exploratory Workshop, LESC/ESF expects that specific and concrete decisions are put forward by and to the community and eventually presenting specific proposals to LESC/ESF (e.g., EUROCORES PROGRAM).

ESONET: R.
Person

ESONET proposes a network of sea floor observatories around the European Ocean Margin from the Arctic Ocean to the Black Sea for strategic long term monitoring as part of a GMES with capability in geophysics, geotechnics, chemistry, biochemistry, oceanography, biology and fisheries. Long-term data collection and alarm capability in the event of hazards (e.g. earthquakes, landslides, pollution, …) will be considered. ESONET will be developed from networks in key areas where there is industrial sea floor infrastructure, scientific/conservation significance (e.g. coral mounds) or sites suitable

for technology trials (e.g. deep water close to land). An Atlas of European Margin assets and hazards, model products from existing observatories and a list of potential participants will be produced as a basis for forward planning.

Two workshops on future observatory design and data management aspects took place in Brest in July 2003. As a result, working groups are preparing a technical report (taking in account results from GEOSTAR/ORION and ASSEM) and IFREMER is writing a preliminary draft of ESONET Data Management guidelines. ASSEM nodes can provide a standard infrastructure to a dedicated instrumentation deployed by ROV for monitoring of a site. They are compatible with GEOSTAR.

These reports will be presented in London 18th and 19th march 2003 during OI 2004. The MoMAR coordinator to present the project to ESONET during the OI meeting is M. Miranda (Portugal).

EXOCET/D Extreme Ecosystems in the deep ocean - Technological Development: P.-M. Sarradin

EXOCET STREP FP6 project is now in negotiation stage with EC (call identifier FP6-2002-GLOBAL-1 proposal no. 505342 "Extreme Ecosystems in the deep ocean - Technological Development"), and is coordinated by P.-M. Sarradin (IFREMER). It focuses on the technological development of specific instrumentation to allow the study of ecosystems in the deep ocean. There are a total of 7 work packages with 13 partners from France, Germany, Portugal and the UK, including 3 private companies (SMEs). This project includes a limited amount of ship time (10 days) for instrument deployment and tests at the seafloor, which could be coordinated with other MOMAR-related projects during its implementation phase. A final funding decision will be known before the end of 2003.

The objective of this project is to develop, implement and test specific technologies designed to explore, describe and quantify biodiversity in deep-sea and other fragmented habitats, to identify links between community structures and the variations of environmental factors in micro-habitats. Inboard experimental devices ("in situ simulated conditions") will complement the approach enabling experiments on species and faunal assemblage functioning. The targeted ecosystems are characterized by a patchy faunal

distribution, strong environmental constraints and tight relationships are developed between the organisms and their environment. They are related to:

- the emission of reduced fluids (hydrothermal vents, cold-seeps),
- peculiar topographic structures (seamounts, deep corals, off-shore structures),
- massive organic input (sunken woods, vertebrates carcasses)
- unpredictable events (pollution, submarine eruptions).

The concept of the EXOCET/D project emerged from the need of a specific integrated instrumentation suited to underwater vehicles or used for long term monitoring related to "sea bed observatories", including MoMAR and MARidge.

The working fields that will be addressed are:

- video imagery, image scaling and measurements, automatic image analyses, acoustic imagery, mosaics, local 3D reconstruction with stereo;
- in situ analysis of habitat chemical and physical components;
- quantitative sampling of macro- and microorganisms, in vivo experiments;
- 4D integration of multidisciplinary data acquired during the project;
- implementation of instrumentation on available European deep-submersibles;

sub systems validation and scientific validation during demonstration actions.

MOMARNET Research and Training Network, 6th FP: J. Escartín

The Research and Training Network (RTN) proposal, coordinated by M. Cannat (IPGP, France), is intended to train a group of young researchers in the broad range of disciplines that are needed to carry on deep seafloor environmental observatory work. Specific projects aim at advancing and implementing the MOMAR observatory project. A total of 14 groups from 7 European partners (France, Portugal, UK, Italy, Belgium, Spain, Germany), and with links with the US institutions, are coordinated around 7 specific sub-programs. These sub-programs involve both analysis and synthesis of existing data necessary for the implementation of MoMAR, and the development of new

tools and modeling techniques necessary to further MoMAR. This RTN was favorably reviewed and pending for final decision

Note: After the workshop, in November 2003, the MOMARNET RTN was selected for negotiation with M. Cannat. Final decision on the level of funding will be available in December 2003 or early 2004.

ION – International Ocean Network: A. Schultz

The ION (https://www.deos.org/ion) started as an association of seismologists to promote an Ocean Seismic Network, but its charter was modified in 2000 (Mt. Fuji Meeting) to include all ocean sciences ; the organization is actively seeking the participation of biologists and oceanographers. ION is now in charge of coordinating and adopting international standards for observatory operations, and will be a Union Committee of IUGG. An ION meeting will take place in San Francisco next 13 Dec. 2003, and an Ocean Observatories Initiative (OOI) will take place in San Juan de Puerto Rico next 4-7 January 2003 (ORION Meeting).

1) Regional cabled observatories : NEPTUNE has received 60M$ from Canada, and an additional 218M$ President's Budget Request for FY2006. Additional funds will be required for instrumentation, up to 300M$. Future cabled observatories are considered, including MOMAR, Lau Basin, and Arctic Gakkel Ridge…
2) Global, buoy based observatories, powered by buoys (first prototype paid by Keck Foundation).
3) Coastal observatories (LEO).

Cables are available as they are being decommissioned. For example, cable TAT-10, that links New Jersey with Germany and Denmark and crosses the MAR at 42°N, could be used for MoMAR. Immediate action is required by the community, as these cables become unusable shortly after decommission. The European observatory community is not organized enough to act at this point, as this would require to set-up a structure that could manage the system and assume its operation (liability, repairs, etc). These opportunities have existed in the past (e.g., TAT-8 and TAT-9), and may not be available in the near future.

UK Remote Operated Vehicle *Isis*: P. Tyler

UK has acquired the ROV *Isis*, from Woods Hole Oceanographic Institution, a similar ROV to *Jason*. Since the end of the BRIDGE Program, funding on ridge-related topics has been erratic at best, although a community is still interested on hydrothermal vent studies and in monitoring, which was already involved in the AMORES and VENTOX programmes. *Isis* will be operated by SOC, and is conceived as a modular tool to allow shipment in containers throughout the world. Its operation depth is 1200-5000 m, with a payload of ~100 kg. The first test dives took place in March 2003, in the Bahamas, with successful operation down to 5000 m. The total cost of the *Isis* purchase is ~5MEUR, not including operation costs.

IFREMER subsea intervention systems (IFREMER /France): J.-L. Michel and V. Rigaud

The Ifremer conducts technological innovations for the evolutions of the operational submersible Nautile and ROV Victor 6000. Thus in the five years to come new equipment are under development related to positioning, optical imaging and measurements.

In particular the Victor 6000 will be fitted with a new optional module dedicated to acoustical and optical mapping. Attention will also be paid : upon Victor 6000 mobility allowing its interoperability on several DP ships, and, on the mutualisation of its equipment + exploitation tools with the Nautile and the coming AUVs.

A new autonomous vehicle "AUV 1" is equally under construction for a delivery in 2004 and, within five years, it will be fitted progressively with several scientific survey payloads. This modular AUV is appropriate for coastal research vessel deployments but is also able to dive till 3000 meters depth.

This set of evolving vehicles are, by themselves, powerful **mobile observatories** for the monitoring of processes coherent with there spatial and time domains of use. A practical way to extend their time domain is there capacity to precisely install

autonomous instrumentation. These “mobile observatories” are complementary to other acoustic and seismic tools used at larger scale.

These subsea intervention systems are also appropriate platforms for tasks dedicated to fixed observatories. The main tasks of detailed survey, installation and maintenance are thus practiced on the ANTARES neutrino long term observatory developed by the CNRS off Toulon. In particular the procedures and interfaces for subsea installation and maintenance are fully integrated since the early phases of the design of this ANTARES long-term observatory.

QUEST5 ROV Technology, U. Bremen: G. Meinecke & V. Ratmeyer

The MARUM Quest-5 is a commercial ROV that can operate to 4000 m. It was purchased at a cost of 2.2 MEUR with all equipment. It has a single type of cable and connector to facilitate maintenance, and a ring thrust system with no axis to facilitate maintenance. It is operated in a free-fly mode, with no depressor weight. Different scientific payloads can be installed in the toolskid. It is outfitted with a 7-operation arm and a 5-operation arm. Navigation is done with POSIDONIA USBL, and navigation will be logged with WHOI DVLNAV. Image and data logging will be done with GIS ADELIE and video tools from IFREMER. First test were carried out in the MoMAR area (Menez Gwen and Lucky Strike). Two cruises to the MAR in the South Atlantic are planned for 2005, in addition to a carbonate-mound cruise in the north Atlantic. Program for 2005 and beyond is to be determined, but more than 10 proposals have been submitted. Operating costs are estimated by U. of Bremen at 5 kEUR per day with insurance included, otherwise 3 kEUR per day to be added to ship costs.

From mantle to Ocean : DFG Program (Germany): C. Devey (InterRidge Chair from 2004)

The German funding agency has set-up a 6 year programme, presently funded at the level of 1.3 M Eur per year for the years 2003 through 2008, to study the 15°N area, including the Logachev hydrothermal site, and the southern MAR, with a focus on the ridge near Ascension Island (4-11°S). These studied involve all disciplines (structure,

volcanology, hydrothermalism, etc) and has as a major aim to obtain time-series of active processes. Work will be initiated in the Logachev area (15°N) in January-February 2004, with a monitoring component in 2005. Exploratory and characterization studies of the MAR between 4° and 11°S will begin in Nov/Dec 2004, to collect all necessary data to identify study areas, and prepare for long time-series observations. A total of 7 cruises are scheduled between Jan.'04 and 2006, with more than 30 proposals received to date. Germany is therefore not likely to get strongly involved in the MoMAR area for actual study, although is keenly interested to participate in and support the observatory developments which will be started there (German scientist are involved both in the EXOCET/D and the MOMARNET EU Proposals being negotiated).

Marine Science and Technology laboratory (IST, Lisbon) : Technologies for ocean exploration: A. Pascoal

The main goals of IST, through its Institute for Systems and Robotics, are to pursue research and development efforts in marine technology and to explore fruitful collaboration links between engineers and marine scientists. This is being done in cooperation with CREMINER (Faculty of Sciences, Univ. Lisbon) and the Department of Oceanography and Fisheries of the Univ. Azores. IST is keen on bringing to the core of MOMAR-related initiatives its expertise in the: i) design and development of marine robots (DELFIM and CARAVELA autonomous surface crafts, INFANTE and MAYA autonomous underwater vehicles, and DREAM ROV), ii) development of computer network-based data acquisition and data management systems, iii) study and implementation of advanced algorithms for marine vehicle navigation and control, iv) development of vision / acoustic systems for environment reconstruction and classification, and v) operation of autonomous platforms at sea.

CREMINER – Multidisciplinary studies on the MoMAR hydrothermal fields: F. Barriga

1. *Time-series studies at Menez Gwen and exploration of the Mid-Atlantic Ridge from Menez Gwen northwards*. This is based on the Maya AUV and Dream ROV currently being developed by ISR and partners (including Creminer in the case of Dream).

Availing ourselves with the favorable access to oceanographic vessels in Portugal and geographical proximity, we can efficiently cover a large stretch of the MAR.

2. Real-time volcanic monitoring. The Serreta eruption (Terceira Island, Azores, Portugal) in 1998-1999 showed that the Azores offer some of the best opportunities for real time monitoring. The concept can be extended to shallow segments of the MAR nearby, greatly improving the chances of success. Seismic monitoring can accompany this effort and greatly extend the scope of the seismic network in the Azores region.

3. Sub-seafloor hydrothermal deposition. It can arguably be shown that the largest accumulations of submarine massive sulphides in the geological record (e.g. those of the Iberian Pyrite Belt of Portugal and Spain) result largely from deposition under a cover rock, just below the coeval seafloor. The same is being found in many locations of the present oceans, including several along the MAR (TAG, Rainbow, Lucky Strike). Rainbow and Lucky Strike are considered targets for IODP drilling.

4. Serpentinite-hosted hydrothermal activity. The MAR in general and the MOMAR area south of the Azores contain hydrothermal fields associated with ultramafic rocks in two different situations: high temperature, acid fluids (Rainbow and Logatchev sites) and low temperature, alkaline fluids (Saldanha and Lost City sites). Additionally, at Saldanha a sediment cover throttles discharge and there are several analogies with methane cold seeps. There are excellent opportunities for multidisplinary deep biosphere studies.

5. We are very interested in public outreach / dissemination of results by a variety of means, including the production of documentary videos and multi-media presentations.

Update on the Azores/MAR (Portugal) activities related to MoMAR: R. S. Santos

Mention was made to the position paper presented at 1st MoMAR workshop held in Lisbon in 1998 (Appendix C of the report) proposing the creation of a land based laboratory in Horta, and the development of a system of retrievable deep-sea cages, to study hydrothermal vent organisms all year round. The facilities, known as LabHorta, where implemented under the scope of the EC-VENTOX (coordinated by D. Dixon) and Regional funding. LabHorta has been operating for three years now. It involved international research on bio-chemistry, eco-toxicology, behavior and physiology, genetics, etc. Several students participated in research activities ; these activities were

developed under the scope of the EU-VENTOX project and the FCT-PDCTM-SEAHMA project, and include in 2001 and 2003: 168 days of work at LabHorta in 2001, involving 19 scientists in experiments, 5 mussel cages recovered after several-month long deployments, 5 recovery trips by R/V Arquipélago, 3 technicians and 4 students dedicated to run experiments, 150 additional days in 2003, with 12 scientists involved, deployment and recovery of 4 cages on 2 recovery trips by R/V Arquipélago, and 4 technicians and 3 students managing the experiments.

The results of the II MoMAR and the Vent Management workshops held in Horta in 2002 were presented (the proceedings of these two workshops were distributed to the participants), and the result of the MoMAR EoI under the FP6 was critically analyzed. Research cruises at the Azores MAR were mentioned: the Quest/Meteor and the Russian MIR, both in 2003. Other projects, e.g. OASIS and MAR-ECO, were referred. Reference was made to the report of the ESFRI ad-doc group for Marine Research infrastructures. The mandate of the Strategic Commission for the Oceans, recently created in Portugal was explained. Portugal is creating a new policy and a strategic program for the Oceans which were selected as a priority area.

SUBMAR: Subsurface biosphere, hydrothermal, magmatic activity at Arctic Ridges: R. Pedersen

Interest in Norway has focused on the Northern-most portions of the Mid-Atlantic Ridge and on the Arctic ridges. This SUBMAR program started in 1999 and finishes in 2003, and has focused both in active and inactive hydrothermal sites along the Kobayensi and Jan Mayen areas. A BIOCRUST proposal, that will have an important in-situ program of geo-microbiological experiments (i.e., closely related to observatory studies) is presented for the years 2004 through 2007. It is planned that the project will involve a messanger system through a buoy with IRIDIUM telecommunication to transfer data over a modem. Norway is also trying to upgrade the Abyss ROV to 5000 m within the MARECO program. This ROV is owned by the company, but on loan to the Norwegian scientific community.

RIDGE 2000- Current Status and Expectations for Future Atlantic Efforts: D. Blackman, representing R2K Steering Committee

The U.S. RIDGE 2000 (R2K) program is currently coordinating projects in Time Critical Studies, at three Integrated Studies Sites (ISS), and in Education and Outreach. The Endeavor segment on the Juan de Fuca ridge and the EPR 8-11°N ISS are fairly advanced in terms of site characterization. Initial monitoring experiments are underway and new, continuously recording systems will be deployed in 2004 for multi-year periods. The Eastern Lau Spreading Center is expected to transition from a reconnaissance phase into site characterization, following a series of cruises scheduled for 2004. The suite of studies funded at each site is clearly multidisciplinary. There will be a community workshop November 7-8, 2003, in Boulder, Colorado, to determine how to prioritize efforts over the next few years to maximize chances for success (results that allow true linkage between processes of different spatial and temporal scales, both inorganic and organic) for at least one ISS.

There has always been significant interest within the R2K community in operating an ISS at a slow spreading center. There were more Mid-Atlantic Ridge responses submitted to the call for ISS than for any other spreading center when R2K began in 2001. Effort to obtain consensus on where a MAR ISS should be located are ongoing and this will be a main focus of a workshop in Providence, Rhode Island, Feb 29-Mar 2, 2004. European colleagues that are working on the MAR are encouraged to participate in this discussion so that the many opportunities for collaboration can be developed. The time frame for an R2K MAR ISS is not certain at this time but it is envisioned that it could ramp up after the current ISS work (2004-2006/7) tapers off at the initial sites.

Update on Spanish activities related to the ESF/LESC Workshop: E. Gràcia, R. Garcia, P. Ridao, S. S. Panahi and J. J. Dañobeitia

Efforts on ridge-related research in Spain have been limited during the last few years in the frame of the National Research Programme. For instance, the guidelines of the Spanish "*Programa Nacional de Investigación, Desarrollo e Innovación Tecnológica*" (I+D+I, 2000-2003) in Marine Geosciences (involving ship time) include: a) Development of Integrated Geology and Geophysical surveys and studies of the shelf,

continental margins and neighboring basins; b) Integrated Evaluation of Geological Hazards (volcanic, seismic and submarine landslides).

Within this program, several research projects have been funded to be carried out in the research vessel BIO Hesperides. They are focused on the study of active processes (seismogenic faults, mud-volcanoes, sedimentary processes) around the Iberian Peninsula margins and Antarctic Peninsula area. However, there are still some chances of obtaining funding for MOMAR-related topics through the following subjects:

- Technological aspects (instrumentation, unmanned underwater vehicle development, etc.)
- Biodiversity and Extreme Ecosystems (Deep Ecology, Microbiology, etc.)

Spain in InterRidge

From 1990 to 1996 Spain was a full member of InterRidge. During that period several cruises were funded for RIDGE studies: Galapagos Ridge, Gulf of California, ridge-hotspot interactions, back-arc basins, etc. Following this research line, several PhD thesis were also carried out. Since 1996, Spain has become a corresponding member of InterRidge, reducing the involvement of Spanish funding and researchers in this topic.

Spanish Involvement in MOMAR

The following groups have been involved in the workshop:

- Unitat de Tecnologia Marina-CSIC, CMIMA Barcelona (Hosting Group)
- Computer Vision and Robotics Group, University of Girona (Girona)
- Grupo SARTI Centro Tecnológico de Vilanova i la Geltrú (Barcelona)

As one of the main outcomes of this workshop, a national meeting is planned to be organized by the end of November in CMIMA (Barcelona). This meeting will be open to all research and technology community willing to join MOMAR, and is planned to be the starting point to identify common interests and main objectives among the assistants. The selection of potential sites and ridge-related cruises linked to the transits of the RV Hesperides on its way to the Spanish Antarctic Bases (e.g. Equatorial and South Atlantic, Scotia Sea and Bransfield Basin) will be also discussed.

Regarding potential funding issues, we should take into account that Spain is highly involved in the ESF Eurocores-Euromargins program with several projects being funded

for the next three years. In our opinion MOMAR initiatives in Spain may be funded in the future if a critical mass of researchers applies for projects under a common ESF Eurocores umbrella.

4. Summaries of specific discussions

4.1 – EUROCORES

The group reached a decision to coordinate all European efforts on long-term observations of hydrothermal systems along the slow-spreading Mid-Atlantic Ridge. One possible mechanism for such cooperation is the organization of an EUROCORES programme to be submitted to LESC/ESF; a preliminary letter of intent (see attached document) will be distributed to the international community as a basis for comment and discussion among the scientists of the different national programs. A final coordinated proposal will be put forward to ESF/LESC by April 2004, after feedback of the different countries that may be included is taken into account.

Discussions regarding the geographical scope of the proposal concluded that this effort cannot be exclusive of MoMAR, but that MoMAR has to be the central and pilot site. Germany has a strong interest and vigorous scientific program in the Equatorial North and South, while Norway and a wide community of scientists are interested in the Arctic and the northernmost portions of the Mid-Atlantic Ridge.

4.2 Ad hoc coordination group and links to other programs

To steer and coordinate the drafting of the EUROCORES letter a group was designated : J. Escartin (to see after the CNRS-IFREMER Meeting in November), C. Devey, P. Tyler, R. S. Santos and A. Pascoal. A. Pascoal was included after discussions dealing with technological issues, and on the realization that important developments are coming up in the near future (standards, technology transfer, other observatories elsewhere…). This working group is intended to serve as a liaison with other efforts nationally and internationally, and with the scientific community of the respective countries. If ESF recommends and supports the EUROCORES MARidge programme, this group will also serve as a liaison with ESF. It is also expected that the InterRidge Working Group will include this group among its members. As part of this coordination effort, the group will insure that appropriate representation attends the different meetings, or that actions are coordinated with existing people attending them:

ESONET (Meeting March 2004, London) : M. Miranda, R. Person, M. Cannat, ?

EXOCET/D : P.-M. Sarradin

MOMARNET : M. Cannat & J. Escartin

ION (Meeting December 2003, San Francisco): R. Person, C. Devey

Ridge 2K (Meeting March 2004, Providence): J. Escartín

ORION (Meeting January 2004, Puerto Rico): M. Cannat, J. Sarrazin.

4.3 Structuring of deep sea work and MARidge time-line

There has been a real expansion of deep-sea intervention capabilities, with the development and acquisition of numerous AUVs and ROVs, in addition to existed manned submersibles (see Table 2). These efforts have been carried out without much coordination, and based on national or inter-institution programs rather than in the context of Europe-wide or international programs. This has led to a lack of standardization of instrumentation and systems, redundancy of capabilities, and gaps in the required systems. Implementation of observatory work also requires acquisition of dedicated instrumentation for deployment at the seafloor. Projects such as EXOCET/D, in addition to existing technology, provide in the present time or in a short period of time the means to acquire time-series data that are crucial for observatory studies. Acquiring such instrumentations parks, assuring their deployment and management, and maximizing the platforms that can operate or intervene on them (AUVs, ROVs) is the next step for implementation of observatory-type studies in MoMAR and elsewhere along the MAR.

It is anticipated that three stages are required for the development of deep sea floor observatories:

1) Exploration
2) Characterization
3) Implementation

MoMAR sites have completed phases 1 and 2, and are ready to be implemented (3). Additional sites of interest within MARidge such as the MAR South of Ascension Island

are in phase 1, with a funded program to complete phase 2 in the next few years. This phase-in of sites is required if a proper characterization of the MAR is to be achieved in the long run.

The length of the programme will be ~5 years, to insure that the initial site (MoMAR) is fully implemented, and instrumentations and procedures fully tested. Both the EU-funded EXOCET/D and MOMARNET projects will be the base of this work S. of the Azores. Long-term observations will be implemented with dedicated seafloor instruments and repeated missions to the study site to obtain data, service instruments, and lay out new experiments. Real time data transmission requires either a cable or a dedicated buoy, and may be contemplated at a later stage of seafloor observatory implementation.

4.4 Public outreach

A much needed but underdeveloped aspect of deep sea research is the communication and dissemination of information to the education system in particular and society in general, in addition of the promotion of observatory programs to the larger scientific community. It is recognized that the development of education materials, leaflets and other documentation of easy access by students of all levels and the public in general is required. Other actions that were discussed was the integration of professors in scientific programs to directly link with students and schools, and using events such as the future release of IMAX movies on hydrothermal systems to bring some public attention to research and technology on deep-sea hydrothermal vents. F. Barriga offered to further look into funding mechanisms for this aspects within the EU ; such activities will be an important component of any future proposition to ESF/LESC (see Annex). The need of individual initiatives is much needed here.

4.5 Technology transfer and coordination

The implementation of seafloor observatories is an important focus of interest internationally, and numerous efforts exist in Europe (e.g., MoMAR, ESONET) and elsewhere (NEPTUNE, ORION, ION, etc). It is therefore necessary to avoid unnecessary investments to develop technologies that exist or are on the works, to facilitate exchange of instruments and information across observatories, and to maximize the number of platforms that can operate and manipulate instrumentation at all sites. The ad-hoc group will ensure that required links with organizations, observatories and other programs are in

place, and that information is passed to the community. Much of the existing information can be centralized on a web-base, so as to facilitate the contact with individuals responsible for technological development.

4.6 National programs

During November 2003 a series of town meetings will take place at national level in France, Portugal and Spain. France will discuss the implication of the scientific community on the MoMAR program, with the objective of coordinating efforts (including cruises) geared towards the implementation of observatory-type studies ; several cruises have already been approved to perform work on this area. Portugal will meet in November to discuss specific actions related to MOMAR. Spain will have a town meeting with the intention of developing a community interested in deep-sea observatories and experiments, that will be implicated in MoMAR and MARidge in the future. The ESF Workshop provided a good opportunity to bring together this community and promote observatory-type studies in Spain.

ANNEX 1 – Final list of participants

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ANNEX 2 – Letter of intent for an EUROCORES program – draft

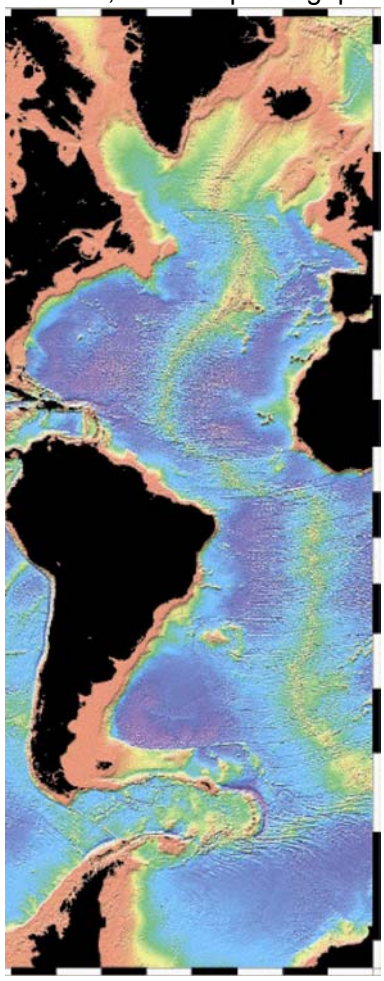
Attached we provide the first draft of a letter of intent coordinated by C. Devey, J. Escartín, A. Pascoal, R. Santos and P. Tyler. This first draft will be circulated through the European scientific community for information, comments and discussions. We intend to formally submit the final letter for an EUROCORES program before the end of April 2004.

MARidge

A suggestion for a EUROCORES Programme on international long-term monitoring of the Mid-Atlantic Ridge

Coordinated by C.W. Devey, J. Escartin, A. Pascoal, R.S. Santos and P.Tyler[2]

The mosaic of tectonic plates that makes up the Earth´s surface is in constant motion. Where two plates separate from one another, the incipient gap is constantly filled by material rising tectonically and volcanically from below. The result is an active 60,000 km long global system of almost wholly submarine mountains that are volcanically and tectonically active – the mid-ocean ridges. One such ridge, the Mid-Atlantic Ridge (which is the western boundary of the European plate) runs the entire length of the Atlantic, from the high Arctic Ocean in the North to near Bouvet Island in the South (Figure 1).



Vast amounts of the Earth´s inner heat are liberated along these ridges. The heat drives vigorous seawater circulation through the ocean crust. This circulation provides the basis for chemosynthetic life both in the subsurface and at seafloor hydrothermal vents. These vents, and the deep-rooted circulation systems that feed them, constitute one of the most important link between the lithosphere, hydrosphere and biosphere on the planet. Numerous vent systems have been found along the Ridge in the North Atlantic; strong evidence for their presence has been found south of the equator.

Not all mid-ocean ridges create new seafloor at the same rate. The Mid-Atlantic Ridge is characterised by slow rates of plate separation, which, steadily increase from North (0.3 cm/year) to South (4 cm/year). These slow separation rates result in a much more complex pattern of magmatic and tectonic activity than

[2] On behalf of the participants at the ESF/LESC Exploratory Workshop "Long-term monitoring of deep-ocean hydrothermal ecosystems" (Barcelona, 15-17 October 2003) and the InterRidge Working Group "Monitoring and Observatories"

that found on faster separating ridges such as the East Pacific Rise (up to 15cm/year). As a result, the crustal make-up in the Atlantic is highly heterogeneous, a situation that is directly reflected in the diversity of hydrothermal systems produced. Furthermore, both the tectonic and magmatic processes, that deliver the heat for the hydrothermal systems and the fluid circulation itself, are not steady-state processes. Volcanic eruptions, earthquakes, sub- and supercritical boiling of the water and progressive mineral deposition and clogging of fluid pathways are but some of the processes which make hydrothermal activity highly dynamic. It is for all these reasons that these systems can only be truly understood through the acquisition of long-term, large-scale multi-disciplinary data sets at selected vent sites. This will involve the installation of dedicated seafloor observatories and the infrastructures necessary both to maintain and to retrieve their data, eventually in real-time. Such installations are beyond the scientific and financial resources of a single European nation. Europe as a whole is, however, ideally equipped both technically, intellectually and in terms of underwater and surface vehicles capable of installing and servicing the observatories, to play a leading role in this effort that is developing globally.

The present suggestion is the culmination of a 6-year intensive planning effort during which time our understanding of the Atlantic hydrothermal systems has improved in parallel with developments in underwater technology. Workshops in 1998 (Lisbon) and 2002 (Horta) lead to the developments of scientific and implementation plans, respectively, for monitoring a portion of the Mid-Atlantic Ridge southwest of the Azores (MoMAR). Programmes within Framework 6 of the European Commission (ESONET, MOMARNET, EXOCET/D) will permit extensive intellectual exchange between the numerous groups studying these systems. We are now in the position to begin work turning these plans into reality, initially at the MoMAR site, but progressively extending towards the Arctic and South Atlantic as these sites become more thoroughly studied through the activities of individual nations. The geological-geophysical background of MoMAR region is well constrained, as are the general characteristics of the known hydrothermal vents, and the broad diversity of the associated ecosystems. From an oceanographic and climatologically standpoint, the MAR near the Azores offers an opportunity for remote observation of basin scale ocean circulation and its effect on long-term climate changes. This is a unique system on our planet, as evidenced by the number of international expeditions, initiatives, and resolutions that target this areas and its surrounding regions for in-depth studies of underwater hydrothermalism and volcanism, mineral resources, extreme environment-type ecosystems with exceptional genetic resources, organisms with strong pharmaceutical potential, and the extent and characteristics of the deep biosphere to name but a few. This proposal to ESF for a EUROCORES programme under the title “MARidge” will contribute to bring this monitoring effort to fruition.

Placing long-term monitoring of marine hydrothermal systems on a European footing also has important societal, educational and economic implications. The increasing use of the oceans mean that it is important that Europe actively

develops its intellectual property rights in ocean technology. The potential for outreach and scientific education inherent in real-time data transmission to and from these fascinating, dynamic and exotic habitats is enormous. Finally, OSPAR recognizes hydrothermal vents as priority habitats. They are being proposed as some of the first deep-sea Marine Protected Areas, making it imperative that we increase our efforts on the understanding of the factors that generate and sustain them, as also as the life sustained by this environments.

The scientific case for monitoring the Mid-Atlantic Ridge

Mid-ocean ridges are highly dynamic magmatic, tectonic, hydrological and biological systems whose activity can vary intensely on time scales ranging from millions of years to seconds. In some cases (e.g. volcanic eruptions, excursions in vent fluid chemistry), the activity may be dominated by intense transient events whose occurrence cannot be predicted and whose investigation is only possible in a rapid-response mode. This is especially true at the slow-spreading Mid-Atlantic Ridge, whose activity is predicted to be highly time-dependent and episodic. Understanding the processes that operate on mid-ocean ridges will only be achieved when observations are available to allow the quantification of range of these temporal variations. On time scales of seconds to years such observations can only be made using long-term monitoring, with at least some component of real-time or near real-time data transfer, of selected sites. Variation on time-scales longer than those amenable to long-term observation can only be constrained by comparing areas that are at different stages of long-period tectono-magmatic cycles.

Long-term monitoring of selected sites requires simultaneous measurements, including:

- Seismic activity
- Volcanic activity
- Seafloor deformation
- Heat fluxes
- Vent fluid temperature and chemistry
- Fluxes of particles
- Distribution, physiology and behaviour of all life forms

Monitoring the parameters listed above is within the capabilities of existing technologies or planned developments.

Monitoring will need to be carried out at a variety of scales: Biological monitoring, for example, can be performed realistically only at the scale of a single vent; Hydrothermal monitoring at the scale of the several vents or the vent field; and geophysical observations can range from the vent field to the segment scale. This requires extensive preparatory work (e.g. reprocessing existing records, designing additional experiments to better characterise the area) to provide and

accurate context to these measurements, and to assure that monitoring is performed on adequate parameters and sites.

Sites

The variety of styles of plate accretion in the Atlantic, the differences in spreading rate from north to south, the interaction of the Ridge with hotspots along its length and questions of global diversity of vent fauna all mean that no one monitoring site can fully characterize processes at the MAR. The different time scales over which events take place means that each site could have different monitoring requirements. Sites identified for monitoring will pass through several stages of preparedness depending on our level of existing knowledge: Exploration, Characterisation and Implementation.

The MoMAR area, south of the Azores, comprising the Menez Gwen, Lucky Strike, Saldanha, Menez Hom and Rainbow vent fields, has been the subject of the most intense international activity in the last decade [e.g. MARFLUX (1993-1997), AMORES (1997-2000), VENTOX (2000-2003), Luckyflux (2003), and Portuguese FCT funded projects AMAR (1997-2000) and SEAHMA (2002-2004), in addition to planned cruises (SEISMOMAR, 2005?)]. Besides standard cruises a land based laboratory (LabHorta) was installed under the frame of the VENTOX project. This has enabled year-round supply of vent mussels, and other organisms, from Menez Gwen through the recovery of deep-sea retrievable cages with the R/V “Arquipélago” based in the Azores. Long-term monitoring at the MAR will be initiated at the MoMAR. The techniques, instruments and protocols established at MoMAR will be transferable to the other areas along the MAR or elsewhere. Such areas will require exploration and characterisation before the installation of monitoring equipment. From the Arctic to the South Atlantic, candidate areas include:

- Gakkel Ridge – The slowest spreading (and hence theoretically the coldest) ridge on Earth, which shows, paradoxically, very active hydrothermallism.
- Mohns Ridge – close to Jan Mayen, an area where extensive work on deep and extreme biosphere has been carried out.
- Grimsey Field – in shallow water (400m) and close to Iceland
- Logatchev – at 15°N, a focus areas for the German national programme
- South of Ascension Island – in terms of biodiversity, completely unexplored; this area of the MAR may act as a link or melting pot between fauna in the North Atlantic and those of the Indian and Pacific Oceans.

This list is of course not exhaustive and reflects instead the distribution of previous and planned work.

The state of monitoring technology

The last decade has witnessed tremendous progress in the development of marine technologies, which can now provide scientists with adequate equipment and methodologies for ocean exploration. Developments in marine robotics,

sensors, computers and communications are fast-paced, and will undoubtedly revolutionize the way the oceans are studied.

In line with the above trend, the MARidge efforts will address the integration of marine platforms, sensors, and data acquisition / management systems to implement successful monitoring of the MAR. These entail gathering segment scale studies and performing site experiments on two time scales: i) 0 to 5 years at the beginning of the MARidge project, where the main emphasis will be the utilization of "classical methods" for ocean exploration, together with the use of advanced marine platforms that include ROVs, AUVs, and dedicated sea-floor instrumentation at one site (i.e. MoMAR), and ii) 5 to 10 years corresponding to a second step in data acquisition, with special emphasis on the full implementation of dedicated ocean observatories.

Phase 1 - 0 to 5 years

The first phase of the MARidge project will witness the development of both an initiation of implementation of observatories with existing technology, and an exploratory strategy combining repeated cruises (using surface ships or manned submersibles). Some of the required technology has already been used in vent fields (e.g. ocean-bottom seismometers, retrievable deep-sea cages), and needs minor developments for long-term deployments. At the same time, the MARidge participants will avail themselves of the potential that is being offered by the availability of new advanced underwater platforms to access hydrothermal vents. New vehicles in operation or soon to be deployed include ROVs (QUEST-Germany, ISIS-UK, AGLANTA-Norway, DREAM-Portugal, and VICTOR-France) and AUVs (e.g., AUVs to be operated by IFREMER, the INFANTE and MAYA AUVs from Portugal, or the AUTOSUB from the UK).

Comment: Need to be verified.

A key issue in the development of autonomous systems for marine data acquisition (to be addressed in the scope of the MARidge initiative) is centred on the standardisation of software and hardware, reducing the size and price of equipment, and increasing its reliability. Existing projects (ASSEM, ESONET, EXOCET/D) are already addressing the problem of standardization, and a common Workshop is planned for 2004 or 2005. Standardization goes far beyond a description of hardware and software, but includes the definition of operational procedures dealing with the use of deep-sea equipment globally. The operational procedures will have an impact on the design of the equipment themselves. At the same time, they will be instrumental in defining rules for interfacing, data acquisition, maintenance,calibration, data management structure, quality assurance protocol, data dissemination policy, long term safeguarding, explitation policy,.... The final goal is to make operations reliable and simplify the interchange of equipment among different communities, platforms, and other observatories. Links with the ION initiative will be pursued to ensure the integration of European standards.

An important need stressed at the I MoMAR workshop in 1998 is the lack of chemical and biological sensors for long-term deployment in hydrothermal fields. This will be partly addressed in the scope of the EUY-funded EXOCET/D project,

which plans to develop, among other, non-invasive techniques such as video imagery associated with scaling methods (e.g. lasers). The MARidge initiative will build on this effort and lead to a major European drive to develop improved long-term sensors. At present only a few sensors are available or have been yet adapted to environmental studies in hydrothermal fields, autonomous temperature probes being the only ones readily available for long term monitoring. Other sensors (pH, flow meters, methane probe) or in situ analysers are available for short term studies (cruises) and must be adapted to longer working periods.

Phase 2 - 5 to 10 years

The goal of the second phase of MARidge is the full implementation of a long-term, real-time observatory site in the MoMAR area together with the extension of these type of studies to other sites to build a larger-scale network. Links with other seafloor observatories at mid-ocean ridges (e.g., Ridge2K sites, US) and elsewhere that are now being implemented (e.g., ASSEM, GEOSTAR) will allow us to fully implement deep-seafloor observatories with the required energy supply, data acquisition systems, and data transmission.

This project will be closely linked to the InterRidge working group dealing with long term monitoring, and with international seafloor-observatory projects. This IR working group could ensure communication so that important issues such as technical specification for the interface and sensors are as standardised as possible.

Strategic importance for Europe

The present initiative is both an opportunity and a scientific and technological challenge for Europe.

The scientific challenge is created because regional scale, multidisciplinary observatory-type science has simply never been done in marine environments before, and definitely represents a new frontier for all the disciplines of marine science. The implications for industrial science could also be far-reaching: Natural products of marine microbes and deep-sea fauna can be identified and patented, and used by drug and food industries.

The technological challenge also stems from the fact that long-term monitoring is at the frontier of research. Although some of the required technology is readily available, new technology is continuously emerging, for in-situ sensors, data transmission, data management, autonomous underwater vehicles, marine robots, and energy supply systems. All these technologies are essential to the future of marine science. They also have many applications in other fields (space exploration, oil exploration in the deep seas, automated genomics, etc). Europe has been very active in the development of observatory-related technologies and solutions for the long-term multidisciplinary autonomous observation systems on

the seafloor, including FP4 and FP5 funded projects such as “GEOSTAR”, "ORION" and “ASSEM”. FP6 has funded EXOCET/D for development of deep-seafloor monitoring instruments, and MOMARNET, to establish a European network of research centres and scientists that will be the base for the implementation of monitoring at the MoMAR site.

Combining the scientific and technological expertise available in Europe to create one or more functioning long-term, real-time observatories will be the overarching goal of MARidge. We expect that MARidge will provide the following results:

- Development of technology and assuring availability of instrumentation for deep seafloor observations in all environments
- Coordination of European and other international deep-sea intervention tools (instruments, ROVs, AUVs, manned submersibles, etc)
- Links with medical, pharmaceutical and other industries to exploit discoveries associated with microbial and biological research at vent sites

The proposed research and development effort will bring together teams with complementary expertise in the fields of marine science and technology and provide scientists with advanced equipment and methodologies for ocean exploration and exploitation. As such, this program (or set of projects) will mobilize a community that is larger than the forces of any one country within Europe. It takes advantage of the great opportunities offered by the MAR region, builds upon many years of research led by European teams, and integrates the wide range of marine scientific and technological expertise that exists within Europe to a common propose and under a common umbrella.

Making MARidge science and technology accessible to the public – KIDS

Monitoring hydrothermal vents on the ocean floor provides important opportunities to involve the public in the exploration and understanding of our planet, in addition to bring this work and scientific results to the public domain outside the world of science. We will develop a KIDS (**K**nowledge **I**n the **D**eep **S**ea) sub-program that will be an integral part of MARidge, and will involve professional educators and communicators of science to provide a two-way link between the research scientists and the public. It is envisioned, for example, that KIDS might initiate programs to allow teachers, policy makers or others to participate either in research cruises to the vents being monitored or to be involved in the design, execution and interpretation of experiments and observations at the vents. The preparation of teaching packages, manuals for professors, didactic presentations, basic scientific questions and topics, and other useful educational material will be an important product of this effort geared towards education. Further dissemination of MARidge results to the general public will be achieved with distribution of imagery DVDs, CDs and other materials.