REPORT

MOVE WORKSHOP

24-27 November 2014

Centre Ifremer de Bretagne

Marjolaine Matabos, Jozée Sarrazin, PM Sarradin
Mathilde Cannat, Kim Juniper, Steve Mihaly

Internal Report REM/EEP/LEP 15.1
### Index

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>3</td>
</tr>
<tr>
<td>Program</td>
<td>4</td>
</tr>
<tr>
<td>Participants</td>
<td>6</td>
</tr>
<tr>
<td>Outcomes of the workshop</td>
<td>7</td>
</tr>
<tr>
<td>General remarks/ strategy</td>
<td>7</td>
</tr>
<tr>
<td>Scientific focus: towards a better understanding of hydrothermal systems</td>
<td>7</td>
</tr>
<tr>
<td>Considerations related to cruises</td>
<td>7</td>
</tr>
<tr>
<td>Limitations</td>
<td>8</td>
</tr>
<tr>
<td>Funding opportunities</td>
<td>8</td>
</tr>
<tr>
<td>Optimizing infrastructure and sampling strategy</td>
<td>8</td>
</tr>
<tr>
<td>Calendar and Working groups</td>
<td>9</td>
</tr>
<tr>
<td>Abstracts</td>
<td>10</td>
</tr>
</tbody>
</table>
Objectives

Innovations in ocean technologies has allowed the development of a new generation of ocean observing systems. The EMSO-Açores (EMSO-ESONET) and NEPTUNE (Ocean Networks Canada) observatories, located on the Mid-Atlantic and the Juan de Fuca ridges, respectively, are the first deep-sea platforms with a link to land to be deployed at hydrothermal vents. Both observatories have been operating since 2010 and have acquired large volumes of different types of data (scalar, acoustic, optical) for a wide range of disciplines.

The next big challenge is to integrate these data to reach a comprehensive understanding of hydrothermal ecosystem dynamics and functioning. This international workshop brought together researchers from various disciplines to share results and engage future collaborations.

Specific objectives were:

- Presentations and up-dates for the two observatories
- Develop ideas for multidisciplinary data integration: within a vent field and between vent fields
- Foster future collaborations, student exchanges, cruise participation
- Identify common funding opportunities
Program

Monday, 24 – MoMAR

13:00  Introductions, welcome and objectives - M. Matabos, J. Sarrazin
13:15  MoMAR update - M. Cannat, J. Blandin, PM Sarradin
   - Objectives
   - Infrastructure
   - Assessment and valorisation
   - ANR Lucky Scales
14:30  FixO3 European project and EU funding opportunities (H2020) - JF Rolin, PM Sarradin
15:00  Coffee
15:15  ANR Lucky Scales kick-off meeting: infrastructure improvement, new experiments, prioritisation and future planning

Tuesday, 25

8:30  Coffee
9:00  Workshop introduction and objectives
9:15  MoMAR – M. Cannat
9:30  ONC/Endeavour – K. Juniper

THEME: PHYSICS AND GEOPHYSICS (Cannat M., Mihaly S.)
9:50  Mihaly S. - Oceanic circulation at the Endeavour segment of the Juan de Fuca Ridge
10:10 Crawford et al. - The source of deep ocean infragravity waves in the North Atlantic Ocean
10:30 Xu et al. - Multidisciplinary observations of an episode of hydrothermal response to earthquakes
10:50  Coffee
11:10 Bemis et al. - Discerning the balance of entrainment and partitioning: insights from time series measurements at Grotto and entrainment models
11:30  Discussions: How to facilitate data integration at different variation scales? Define sampling strategies: data acquisition rate, instrument location and related site studies and experiments? What are the limitations and how to overcome them? Towards the comparison of 2 hydrothermal ridge systems, what do we need?
12:30  LUNCH

THEME: GEOPHYSICS, HYDROTHERMAL CIRCULATION AND CHEMISTRY (Chavagnac V., Heesemann M.)
13:50  Barreyre et al. - Temperature variation records at diffuse and focused outflow in Lucky Strike hydrothermal field (EMSO-Azores): characterization of long-term outflow dynamics
14:10 Fontaine et al. - Constraints on the dynamics and architecture of hydrothermal flow beneath the Lucky Strike vent field from geophysical/geological observations and numerical modeling
14:30  Chavagnac et al. - Update on the spatial and temporal variability of hydrothermal fluid chemical composition at the Lucky Strike vent field since the 1990’s. What shall we do next?
14:50  Leleu et al. - Fluid chemistry of the Capelinhos vent site. A key to understand Lucky Strike hydrothermal vent field (37°N, MAR)
15:10  Coffee
15:30  Pernet-Coudier et al. - *Tackling the dissolved/particulate distribution of metals at hydrothermal vents: are we measuring the right thing?*

15:50  **Discussions**

Villinger et al.: *Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transform-type plate boundaries: The FLOWS project (EU-CAST ES1301)*

17:30  End of day 2

---

**Wednesday, 26**

**THEME:** MICROBIOLOGY AND ECOLOGY (Rommevaux-Jestin C., Lee R.)

9:00  Rommevaux-Jestin et al. - *Microbial response to high temperature hydrothermal fluid forcing: AISICS vent (Lucky Strike, 37°N, MAR) and prokaryote community as example*

9:20  Henri et al. - *Microorganisms/basaltic glass interactions: results from an in situ experimental approach at Lucky Strike hydrothermal vent*

9:40  Matabos/Sarrazin et al. - *Temporal variations of a deep-sea hydrothermal mussel assemblage monitored by the EMSO-Açores MoMAR observatory: community dynamics and species behaviour*

10:00  Lelievre et al. - *Temporal study of macrofauna communities associated with a Siboglinidae assemblage using the NEPTUNE-Canada observatory*

10:20  Coffee

10:40  Lee et al. - *Temporal and spatial variation in temperature experienced by macrofauna at Main Endeavour vent field*

11:00  **Discussions**

12:20  LUNCH

13:30  Chairmen gather to summarize discussions: open groups

14:00  Wrap-up of two days discussions by chair persons

14:30  Carbonnière A. (Ifremer): *EU-Canada and Canada-Ifremer cooperation frameworks: policy updates and funding opportunities*

15:00  **Discussions**

- Build a vent observatories workgroup and an international framework Interoperability and standardisation for comparison between the 2 ridge systems (infrastructure, sampling, experiments)
- Mineral resources: how can observatories contribute to impact assessment?
- Outreach and citizen science: how to involve the public?

17:30  End of day 3

---

**Thursday, 27 – ONC**

9:00  NEPTUNE Endeavour update – K. Juniper and/or others?

- Endeavour status and plans (2015 cruise), uptake on LEF (Leading Edge Fund)
- Cruise proposal 2016-2018/SOI proposal? (due right after the workshop)
- Future collaboration: common students, data integration, how?
- Infrastructure improvement
- Funding opportunities

12:30 – 13:45 LUNCH

<table>
<thead>
<tr>
<th>Last name</th>
<th>First name</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARON</td>
<td>Michael</td>
<td>ISEN, Brest</td>
</tr>
<tr>
<td>BARREYRE</td>
<td>Thibaut</td>
<td>Woods Hole Oceanographic Centre, MA, USA</td>
</tr>
<tr>
<td>BATES</td>
<td>Amanda</td>
<td>National Oceanographic Centre, UK</td>
</tr>
<tr>
<td>BEMIS</td>
<td>Karen</td>
<td>Rutgers University, NJ</td>
</tr>
<tr>
<td>BLANDIN</td>
<td>Jérome</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>BORREMANS</td>
<td>Catherine</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>BOULTART</td>
<td>Cédric</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>CANNAT</td>
<td>Mathilde</td>
<td>IPGP, CNRS, Paris, France</td>
</tr>
<tr>
<td>CARBONNIERE</td>
<td>Aurélien</td>
<td>Ifremer, Issy-Les-Moulineaux, France</td>
</tr>
<tr>
<td>CASTILLO</td>
<td>Alain</td>
<td>GET, CNRS, France</td>
</tr>
<tr>
<td>CATHALOT</td>
<td>Cécile</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>CHAVAGNAC</td>
<td>Valérie</td>
<td>GET, CNRS, France</td>
</tr>
<tr>
<td>COTTE</td>
<td>Laura</td>
<td>IUEM, Brest, France</td>
</tr>
<tr>
<td>CRAWFORD</td>
<td>Wayne</td>
<td>IPGP, Paris, France</td>
</tr>
<tr>
<td>DELEO</td>
<td>Fabio</td>
<td>ONC, University of Victoria, BC, Canada</td>
</tr>
<tr>
<td>FONTAINE</td>
<td>Fabrice</td>
<td>IPGP, Paris, France</td>
</tr>
<tr>
<td>GODFROY</td>
<td>Anne</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>HEESEMANN</td>
<td>Martin</td>
<td>ONC, University of Victoria, BC, Canada</td>
</tr>
<tr>
<td>HENRI</td>
<td>Pauline</td>
<td>IPGP, Paris, France</td>
</tr>
<tr>
<td>HUSSON</td>
<td>Bérangère</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>JUNIPER</td>
<td>Kim</td>
<td>ONC, University of Victoria, BC, Canada</td>
</tr>
<tr>
<td>KONN</td>
<td>Cécile</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>LAES</td>
<td>Agathe</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>LANTERI</td>
<td>Nadine</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>LEE</td>
<td>Ray</td>
<td>Washington State University, WA, USA</td>
</tr>
<tr>
<td>LEGRAND</td>
<td>Julien</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>LELEU</td>
<td>Thomas</td>
<td>GET, CNRS, France</td>
</tr>
<tr>
<td>LELEVRE</td>
<td>Yann</td>
<td>Université de Montréal, QC, Canada</td>
</tr>
<tr>
<td>MAIGNIEN</td>
<td>Lois</td>
<td>IUEM, Brest, France</td>
</tr>
<tr>
<td>MATABOS</td>
<td>Marjolaine</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>MIHALY</td>
<td>Steve</td>
<td>ONC, University of Victoria, BC, Canada</td>
</tr>
<tr>
<td>PERNET-COUDRIER</td>
<td>Benoit</td>
<td>IUEM, Brest, France</td>
</tr>
<tr>
<td>PLUM</td>
<td>Christophe</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>ROLIN</td>
<td>Jean-François</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>ROMMEVAUX-JESTIN</td>
<td>Céline</td>
<td>IPGP, Paris, France</td>
</tr>
<tr>
<td>ROUSSEL</td>
<td>Erwan</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>SARRADIN</td>
<td>Pierre-Marie</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>SARRAZIN</td>
<td>Jozée</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>TOUROLLE</td>
<td>Julie</td>
<td>Ifremer, Brest, France</td>
</tr>
<tr>
<td>VILLINGER</td>
<td>Heiner</td>
<td>University of Bremen, Germany</td>
</tr>
<tr>
<td>XU</td>
<td>Guangyu</td>
<td>Rutgers University, NJ, USA</td>
</tr>
</tbody>
</table>
Outcomes of the workshop

For the first time researchers working at the EMSO-Açores and ONC-Endeavour observatories gathered to share ideas, methodologies and data processing methods. The three thematic sessions and subsequent discussions showed that the two somewhat separate research communities share the same scientific questions and limitations in data acquisition and processing.

General remarks/ strategy

Although cables are convenient for high-bandwidth and power hungry data acquisition (eg visual and acoustic), they are prohibitively expensive to maintain especially in volatile areas, and constrain observations to single points connected by cable. Combining cabled infrastructure with autonomous instruments, AUVs, gliders and re-locatable moorings greatly increases the observational footprint of installations seafloor and water column observatories. Such an expanded observing capacity is particularly valuable in deep-sea hydrothermal habitats where environmental conditions can be highly variable over short distances.

The importance of continuing sites studies and exploration (i.e. discovery of Capelinhos at Lucky Strike vent field) to complement the focused observatory approach was also underlined. More exploration efforts can also provide us with information on habitat heterogeneity, biodiversity in inactive areas and connections with other ecosystems (corals, seamounts...).

Scientific focus: towards a better understanding of hydrothermal systems

The 4 following points were identified as thematic priorities, or knowledge gaps

- Develop studies of physical oceanography to better understand temporal variability of habitat conditions at different scales (regional to very local), going down to small scale turbulence (eg Temperature mapping)
- Link seismic activity, porosity/permeability, modeling, heat flux and fluid chemistry to better constrain hydrothermal circulation
- Map sites and locations at different scales, including 3D reconstruction and image analysis : there is a necessity to collaborate with exterior lab (eg R. Garcia at Girone and/or T Kwasnitschka) and to develop new approaches such as crowdsourcing,
- Microbiology : adopt standardized protocols to facilitate comparisons of habitat controls on microbial diversity and microbial community function.

Considerations related to cruises

- Mooring anchor recovery: yearly maintenance cruises on the same areas have led to the accumulation of weights used to moor the instruments. This research debris is of particular concern in the two MPAs where the Endeavour and EMSO-Açores observatories are located! Alternative methods limiting the use of disposable weights, as well as methods for their recovery should be developed.
- ONC systematically adds value to the transits by submersibles (water column profiles and video survey), and is currently preparing to package these as data products for analysis of faunal distribution. This should be conducted during the EMSO-Açores maintenance cruises.
Limitations
- Lack of human resources (need to open more positions at institutions’ level) and funding
- Image processing: still labour intensive and not enough resources to process entire datasets
- Limited information on crustal porosity and permeability limits our ability to understand hydrothermal circulation: what tools can be used to measure it? How to model it?

Funding opportunities
Some of the opportunities identified:
- Interreg Atlantic Area – Transnational Cooperation Programme, Launching event: Autumn 2015, Relevant thematic priorities: Priority Axis 4: Enhancing biodiversity and the natural and cultural asset; Specific objective: 4.1 Improving the protection of biodiversity and enhancing ecosystem services. Action PM Sarradin
- GDRI: International research group on observatories in vents- Action PMS to examine the feasibility and funding scheme.
- NSERC: ship time to do science at Endeavour- Action SKJ
- FLOWS: COST project to encourage, foster and establish networks of effective use of ship time and scientific facilities. Can also fund participation in cruises.
- Visiting scientists and mobility grants to promote data integration

Running projects in France and Canada
- EMSO Açores Pls : M Cannat, PM Sarradin, J Blandin (A. Colaço and M. Miranda in Portugal)
- ANR Lucky scales : Magma chamber to micro-habitats: dynamics of deep sea hydrothermal ecosystems PI Mathilde Cannat
- LEF funding Endeavour: ‘Biogeochemical monitoring of mid-ocean ridge axis processes using the NEPTUNE Canada cabled observatory’ L. Coogan

Optimizing infrastructure and sampling strategy
A first step identified for methodology standardisation is related to image analyses, mapping and 3D reconstruction. Indeed, each observatory is already equipped with a version of Tempo/Tempo-mini and R. Lee thermistor’s arrays, providing an ideal basis for comparison. 3D reconstruction and mapping will contribute to site characterizations.

In addition, imagery analysis is one of the main barrier considering the time and resources needed to process the full archive. There is thus an urgent need to collaborate with computer vision labs/researchers and develop crowdsourcing projects to help in video/image data analyses.
Calendar and Working groups

In order to maintain discussions going beyond the workshop, participants agreed with the need to set up working groups that would regularly meet through visio-conference for updates (a frequency of once every 2 months was suggested). The objectives of those groups are data exchange and storage, surveying, processing and protocol standardisation. Three groups were suggested:

**Group 1: Tide and current characterization and their link with the fauna**

Coordinator: S. Mihaly


The focus of this group is to develop procedures to readily identify the various tidal and oceanographic signals (tidal currents and pressure, small scale turbulence and fluxes, low frequency mean flows) in available data on fluid chemistry, flux and faunal community dynamics, and to discuss solutions to acquire additional and better data. The group will share signal analyses methods and integrate data across the disciplines (physics, chemistry and ecology).

**Group 2: Image analyses and crowdsourcing**

Coordinator: M. Matabos

Members (not exhaustive): M. Aron, K. Bemis, F. De Leo, R. García¹, R. Lee, Y. Lelièvre, E. Mittlestaedt²

Through a collaboration between ecologists and computer scientists, this group will focus on automated methods for image analyses as well as the development of a crowdsourcing program to help in processing large video archives.

**Group 3: Microbiology**

Coordinator: C. Rommevaux-Jestin

Members (not exhaustive): C. Cathalot, V. Chavagnac, A. Godfroy, K. Juniper, L. Maignien

This group will focus on fluid geochemistry and microbiology patterns and activity.

Another initiative will be to gather a group of researchers to work on the 3D reconstruction of our focus sites and camera field of views. A meeting will be called including T. Kwasnitshka from Geomar, R. García in Girone, M. Aron from l’ISEN and other interested scientists. This could become a fourth working group.

**Another joint workshop should be organised two years from now.** Victoria was proposed as the next location. The date was agreed on December 2016, prior to the AGU meeting in San Fransisco, where M. Cannat suggested to propose a sessions on tidal signals at hydrothermal vents. Invitation of the OOI team?

---

¹ Not contacted yet

² Not contacted yet
Abstracts

ORAL PRESENTATIONS

Temperature variation records at diffuse and focused outflow in Lucky Strike hydrothermal field (EMSO-Azores): characterization of long-term outflow dynamics

Barreyre Thibaut¹, Cannat Mathilde², Escartin Javier², Sohn Robert

¹Woods Hole Oceanographic Institution, MA, US
²Institut de Physique du Globe de Paris - CNRS UMR 7154, Paris, France

Hydrothermal activity along mid-ocean ridges accounts for a large proportion of the Earth’s heat loss, but the space-time variation of both heat and chemical fluxes of venting at individual sites remains largely unconstrained. As part of the MOMAR experiment to monitor hydrothermal activity, we used an ROV to deploy autonomous temperatures sensors at black smoker chimneys, cracks, and diffuse flow areas throughout the Lucky Strike hydrothermal field (Mid-Atlantic Ridge, ~37°17'N) between summer 2009 and summer 2012. We deployed a set of high- and low-temperature thermal probes (<350°C and <125°C respectively) sampling at intervals that varied from <1 min to 24 min. Microseismicity and bottom pressure was also recorded with an ocean bottom seismometer network and a pressure gauge. We place particular emphasis on temporal variability at semi-diurnal tidal periods, and use poroelastic theory to constrain hydrologic parameters of the sub-surface circulation system. We identify two main types of temporal variability in the temperature records: (1) episodic variability with rapid temperature changes of ~5-150°C over time periods of few hours to several days, and (2) systematic variability at tidal periods with amplitudes ranging from a few tens of a degree to a few degrees, depending largely on mean outflow temperature. The episodic variability is stochastic (i.e., typically not correlated between mutitple probes among vents at the scale of the site), and does not appear to be correlated with local nor regional seismicity. The episodic events are observed primarily in diffuse flow records. The lack of spatial and temporal correlation of these events among probes, even at distances of <5 m within the same mound, suggests that they represent episodes of seawater mixing within the shallowmost crust underlying individual vents, or within the hydrothermal edifice itself. Most temperature records display systematic tide-related variability, with the strongest signal at the principal semidiurnal tidal periods (M2, S2, N2 and K2). Cross-spectral multi-taper methods applied to the temperature and bottom pressure records reveal robust phase relationships, particularly for the high-temperature, black-smoker records, as predicted by poroelastic theory (Jupp and Schultz, Wang and Davis, Crone and Wilcock). These results demonstrate the tidal pressures diffusely propagate through the porous matrix hosting sub-surface flow, which results in phase lags between the surface pressure and the fluid discharge temperature. We use this observation to constrain the poroelastic skin depth, bulk permeability, and vertical Darcy flow velocity of the sub-surface regime at the Lucky Strike field.
Discerning the balance of entrainment and partitioning: insights from time series measurements at Grotto and entrainment models

Bemis Karen¹, Xu Guangyu¹, Jackson Darrell², Ivakin Anatoliy²

¹Rutgers University, NJ, US
²Applied Physics Lab, University of Washington, Seattle, WA, US

New ocean observatories (like NEPTUNE and MoMAR) have enabled the simultaneous measurement of long (or at least longer) time series on a variety of instruments in both focused and diffuse discharge sites. The advent of new technology (including COVIS (Cabled Observatory Vent Imaging Sonar) and the development of large-scale photo mosaics) is enabling realistic remote sensing of discharge sites, particularly the areal extent of diffuse discharge. Yet temperature and flow rates, especially for diffuse discharge, are still spot measurements requiring extrapolation to estimate edifice or vent field scale partitioning and fluxes. How can we move forward to accurately measure or reliably extrapolate such essential quantities as diffuse flow temperature and flow rates? COVIS (Cabled Observatory Vent Imaging Sonar) is enabled by the NEPTUNE observatory to measure time series at the sulfide edifice Grotto in the Main Endeavour Field on the Juan de Fuca Ridge of (a) volume flux, heat flux and bending in buoyant plumes and (b) area, and potentially discharge intensity, of diffuse flow. Tidal modulation is very pronounced throughout the Grotto system: from black smoker vent temperatures (BARS data from ONC archives; M. Lilley, PI) to buoyant plume properties (COVIS imaging and Doppler data) to diffuse flow area (COVIS diffuse data) and temperature (RAS data from ONC archives; D. Butterfield, PI; TEMPO-MINI data from ONC archives; J. Sarrazin, PI). An investigation of the spatial and temporal variability of these disparate data (and others on the NEPTUNE observatory) is used to development novel approaches to extrapolation of short-term spot measurements. The temporal behavior of hydrothermal discharge has important implications for ecosystems.
Update on the spatial and temporal variability of hydrothermal fluid chemical composition at the Lucky Strike vent field since the 1990’s. What shall we do next?

Chavagnac Valérie¹, Leleu Thomas¹,², Barreyre Thibaut³, Boulart Cédric⁴, Castillo Alain¹, Menjot Ludovic¹, Cannat Mathilde⁵, Escartin Javier⁵, and the MOMARSAT scientific parties

¹OMP, GET - CNRS UMR5563, Toulouse, France
²Université Paul Sabatier, Toulouse, France
³Woods Hole Oceanographic Institution, Woods Hole, USA
⁴Ifremer, Lab. Géochimie Métallogénie, GM, Plouzané, France
⁵IPGP - CNRS UMR 7154, Paris, France

The Lucky Strike hydrothermal field has been discovered in 1993 during the FAZAR cruise. Active hydrothermal vents are situated around a central lava lake with the exception of 2068/Y3 vent that stands within. High temperature hydrothermal fluids have been sampled several times in the 1990’s. The results indicated that the distinct chemical end-members (i.e. variable chlorinities, low H₂S and metal contents, ...) argue for a significant geographic control of the venting system and phase separation at depth. Since the installation in 2010 of the deep-sea observatory at the Lucky Strike vent field, hot hydrothermal fluids have been collected yearly at different discharge areas distributed over the Lucky Strike site to assess the variability of fluid and gas chemical compositions at spatial and temporal scales, providing a framework of the conditions of seawater-rock interactions. Overall, measured temperatures are higher for the western vents (up to 340ºC at South Crystal), lower for northern sites (Sintra, Y3) but stable in the South/South-East vents than previously recorded (Von Damm et al., 1998; Charlou et al., 2000). However, strong and rapid temperature changes of 5 to 150ºC may occur over a time period of a few hours to several days (see abstract Barreyre et al.). With the discovery of the Capelinhos site in 2013, the fluid chemical compositions indicate now four different end-member fluids: 1) Eiffel Tower, Montségur, Aisics, Cimendeff; 2) White Castle, Isabel, Cyprès; 3) Y3, Nuno, Crystal, South Crystal, Sintra, and 4) Capelinhos. Among these end-members, Capelinhos exhibits the lowest chlorinity, which makes this site crucial in terms of understanding fluid circulation within the Lucky Strike vent field (see abstract Leleu et al.). In terms of gases, we notice that Eiffel Tower shows either high CH₄ concentration (10 mmol/l) or high CO₂ concentrations (30 mmol/l). CH₄ is generated by water-rock interaction by Fischer-Tropsch catalysis of CO₂ reduction. The CO₂ concentrations have been extremely high in 2010, up to 120 mmol/l, impacting strongly the archaeal community (see abstract Rommevaux-Jestin et al.). Fluid chemical composition is strongly affected by phase separation at depth as well as the geographic control of fluid plumbing system but this has changed since the early 1990’s.
The source of deep ocean infragravity waves in the North Atlantic Ocean

Crawford Wayne¹, Ballu Valérie², Bertin Xavier² and Karpychev Mikhail²

¹Institut de Physique du Globe de Paris, France
²University of La Rochelle, France

Infragravity waves are long-period (25-250 second) ocean surface gravity waves generated at shorelines through wave-wave interactions or oscillation of the breaking point. Most of the infragravity wave energy is trapped near coastlines, but a small percentage escapes into the open oceans. We correlate measurements of infragravity waves in the deep North Atlantic Ocean with source parameters across the Atlantic and Southern oceans to find the dominant sources of deep ocean infragravity wave energy. The data are from a 5-year deployment of absolute pressure gauges west of the Acores islands (37°N, 35°W) as well as shorter datasets from seafloor tsunami gauges (DART buoys). Two sources are identified: one off of the west coast of southern Europe and northern Africa (25-40°N) in northern winter and the other off the west coast of equatorial Africa (the Gulf of Guinea) in southern hemisphere winter. Neither of these sites has strong source parameters, nor a favorable travel path to the measurement sites, indicating that the sites’ morphology dominates the creation of deep ocean infragravity waves.
Constraints on the dynamics and architecture of hydrothermal flow beneath the Lucky Strike vent field from geophysical/geological observations and numerical modeling

Fontaine Fabrice, Cannat Mathilde, Escartin Javier, Crawford Wayne

Institut de Physique du Globe de Paris - CNRS UMR 7154, Paris, France

The processes and efficiency of hydrothermal heat extraction along the axis of mid-ocean ridges are controlled by lithospheric thermal and permeability structures. Hydrothermal circulation models based on the structure of fast and intermediate spreading ridges and hydrothermal circulation models predict that hydrothermal cell organization and vent site distribution are primarily controlled by the thermodynamics of high-temperature mid-ocean ridge hydrothermal fluids. Using recent constraints on shallow structure at the slow-spreading Lucky Strike segment along the Mid-Atlantic Ridge, we present a physical model of hydrothermal cooling that incorporates the specificities of a magma-rich slow-spreading environment. Using three-dimensional numerical models, we show that, in contrast to the aforementioned models, the subsurface flow at Lucky Strike is primarily controlled by across-axis permeability variations due to the presence of an axial fractured graben. Models with across-axis permeability gradients produce along-axis oriented hydrothermal cells and an alternating pattern of heat extraction highs and lows that match the distribution of micro-seismic clusters recorded at the Lucky Strike axial volcano. The flow is also influenced by temperature gradients at the base of the permeable hydrothermal domain. Although our models are based on the structure and seismicity of the Lucky Strike segment, across axis permeability gradients are also likely to occur at faster spreading ridges and these results may also have important implications for the cooling of young crust at fast and intermediate spreading centers.
Microorganisms/basaltic glass interactions: results from an in situ experimental approach at Lucky Strike hydrothermal vent.

Henri Pauline¹, Rommevaux-Jestin Céline¹, Godfroy Anne², Lesongeur Françoise², Ménez Bénédicte¹

¹Institut de Physique du Globe de Paris - CNRS UMR 7154, Paris, France

²Ifremer, LM2E EEP – CNRS UMR 6197, Plouzané, France

Basalt could provide energy sources for microbial growth, which in turn contribute to their alteration. To explore the colonization of basaltic glass and the basalt weathering by microorganisms in hydrothermal context, a long term in situ experiment has been conducted at the Lucky Strike filed in the framework of the MoMAR and EMSO- Açores observatory. Microbial incubators containing synthetic MORB glasses (enriched either in oxidized or reduced iron) and abiotic controls have been deployed and recovered in the vicinity of chimney or diffusers at different sites of the Lucky Strike hydrothermal field (West Lava Lake, Cypress, Eiffel Tower). Other locations like the edge of the axial valley (East Volcano) and a sedimentary abyssal plain were also selected to have a panel of different hydrothermal fluid influences. The duration of the in situ incubation varies from only few weeks to more than two years. We will present here the results of the multi-sites comparison both in terms of bacterial communities (assessed by pyrosequencing of the 16S RNAr) and related alteration (characterized by electronic, fluorescence and Raman microscopy/spectroscopy). We evidence a close association between the different alteration phases at the basalt surface, and the presence of microbial cells and/or biofilms, in favor of a biological origin. Moreover, the nature of these alteration products and the associated microbial diversity strongly varies according to the level of hydrothermal fluid influence.
Temporal and spatial variation in temperature experienced by macrofauna at Main Endeavour vent field

Lee Ray¹, Robert Katleen.², Matabos Marjolaine³, Bates Amanda E.², Juniper S. Kim⁴

¹School of biological sciences, Washington State University
²School of Ocean and Earth Science, National Oceanography Centre, Southampton, UK
³Institut Carnot Ifremer EDROME, Centre de Bretagne, REM/EEP, Laboratoire Environnement Profond, Plouzané, France
⁴Ocean Networks Canada, University of Victoria, Victoria, British Columbia, CANADA

Spatial and temporal temperature variations were mapped in a diffuse flow community at Grotto vent in the Main Endeavour vent field on the Juan de Fuca Ridge. This site is a focus area of the Ocean Networks Canada cabled observatory. An autonomous temperature logger array was used to collect hourly data over 8-12 month periods from 2010 to 2014. The conspicuous organisms were predominantly Ridgeia tubeworms, gastropods (primarily Lepetodrilus fucensis), and polychaetes (scaleworms and Paralvinella palmiformis). Two dimensional spatial gradients in temperature were generally stable over the deployment period. The average temperature recorded over the entire array revealed a distinct tidal cycle of increasing and decreasing temperature. We postulate that this may be due to changes in bottom current or changes in vent flow. A distinct transient temperature increase that lasted over a period of days was observed in April 2011. Previously we have shown that the distributions and behavior of Juan de Fuca Ridge invertebrates may be partially constrained by environmental temperature and temperature tolerance. During the deployment, the temperatures observed were generally similar to the thermal preferences for some species, and well below lethal temperatures for all species. Average temperatures of the four arrays ranged from 4.1 to 11.0 °C during the deployment. These results indicate that on hourly to monthly timescales the temperature conditions in this tubeworm community were fairly moderate and stable. The generality of these findings and the influence on organisms and community dynamics is an area for further investigation. Simultaneous temperature and digital image data are currently being collected at Grotto, and a similar array is planned for the MoMAR observatory.
The Lucky Strike hydrothermal field has been discovered in 1993 during the FARA (French American Ridge Atlantic) cruise. Vents are situated around a central lava lake with the exception of 2068/Y3 vent that stands within. Active vents have been sampled several times since then in 1993, 1994, 1996, 1997, 2008 and every year routinely since 2009 with the EMSO-Azores program and the MoMARsat observatory. A new vent has been discovered during the MoMARsat 13 cruise exploration session with the ROV Victor 6000 at about 1.5 km to the East of the lava lake which makes it the most distant active vent site from the volcano. This vent, named Capelinhos, is composed of several ten meters high chimneys with both focused and diffused flow. Maximum fluid temperature was measured at 324 °C in 2013 and 318°C in 2014 at the same chimney. Subsequently hydrothermal fluids have been sampled with gas-tight titanium syringe. On shore chemical analysis reveal intense phase separation process with vapor chlorinity end member as low as 270 mmol/l making Capelinhos the most Cl-depleted vent of Lucky Strike hydrothermal field. Based on Pester (2011) Fe/Mn geothermometer, reaction zone temperature is calculated at about 398°C for Capelinhos fluids (Fe/Mn=3.96) agreeing with phase separation and implying that conductive cooling has occurred before reaching the seafloor at 318°C. Low Fe and Mn value for the other site (Fe/Mn vary from 1 to 2.4) may then reflect a more altered nature of the rock surrounding the volcano (Von Damm et al. 1998) and/or loss of both elements by conductive cooling in a more fractured area. Recent studies based on Si and Cl geothermobarometer (Fontaine et al, 2009, Pester et al, 2012) gives P and T condition of phase separation along with quartz equilibrium to be at 430-475 °C and 410 to 480 bar.
Temporal study of macrofauna communities associated with a Siboglinidae assemblage using the NEPTUNE-Canada observatory

Lelièvre Yann¹,², Matabos Marjolaine¹, Legendre Pierre³, Sarrazin Jozée¹

¹Ifremer, LEP/EEP/REM, Plouzané, France
²Département de Sciences Biologiques, Université de Montréal, Montréal, QC, Canada

One of the NEPTUNE Canada observatory’s site located on the Endeavour segment of the Juan de Fuca Ridge hosts various measurement geophysical tools, seismic, hydrothermal flow and an ecological module called TEMPO-mini. Deployed on the Grotto hydrothermal edifice, at 2186 m depth, the module acquires real-time and continuous imagery along with temperature and oxygen data. The camera module is focused on a Ridgeia piscesae (Siboglinidae) tubeworms nearby a hydrothermal diffusion area. 365 days of imagery were analysed on a daily frequency. The establishment of a protocol and a variety of statistical analyses allowed the study of the macrofauna community temporal dynamics (Buccinidae, Zoarcidae, Poly noidae, Pycnogonidae and Lepetodrilidae) on annual time scale. Video analysis allowed a better understanding of the biotic interactions between species but also between individuals of the same species. Significant changes in density were observed along the time axis. Various hypotheses have been put forward to explain this. Direct observations of sulphide slides were recorded and their frequencies noted.

This first "long term" approach has helped to enhance the potential of observatories in understanding of the ecology of hydrothermal vents.
Oceanic Circulation at the Endeavour Segment of the Juan de Fuca Ridge.

Mihaly Steve

*Ocean Networks Canada, University of Victoria, BC, Canada*

Since 1986, scientists from the Institute of Ocean Sciences and the University of Washington have been intermittently measuring currents at the Endeavour Segment. Starting with lowered ADCPs, then moving on to moorings of current meters and ADCPs and now (or soon) cabled current/meters and ADCPs, the circulation within the axial valley, on the flanks and above the ridge in the water column this talk attempts to synthesize what we “think” we know of the circulation of the region.
Tackling the dissolved/particulate distribution of metals at hydrothermal vents: are we measuring the right thing?

Pernet-Coudrier Benoît¹, Cotte Laura¹, Waeles Matthieu¹, Cathalot Cécile², Sarradin Pierre-Marie², Riso Ricardo¹

¹ Université de Bretagne Occidentale, IUEM, Lemar UMR CNRS 6539, Place Copernic, F-29280 Plouzané, France
² Département Etudes des Ecosystèmes Profonds, Ifremer centre de Brest, BP70, F-29280 Plouzané, France

Recent studies have shown that hydrothermal sources could contribute significantly to the export of metals to the open ocean (Tagliabue, Nat. Geosci. 3(4): 252-256; Hawkes, Earth Planet. Sci. Lett., 375, 280–290). However, sampling in hydrothermal vents is still difficult and a rigorous methodology, similar to the one used for surface waters, is difficult to implement particularly regarding the filtration of the samples and the tracer of the hydrothermal fluid-seawater mixing. The objectives of this work were 1) to evaluate the impact of the filtration (in situ vs. on board vs. in the laboratory) on the phase distribution (dissolved/particulate) of trace elements like iron, manganese, zinc, etc. and 2) to study the distribution of these elements along a mixing gradient between hydrothermal fluids and seawater. Hydrothermal fluid samples were collected during the MoMARSAT 2012 and Biobaz 2013 cruises on the Mid-Atlantic Ridge. Dissolved and particulate elements were analyzed by ICP-AES and ICP-MS-HR. Results show that on board filtration and later filtration in the laboratory generate precipitation of metals such as Mn, Fe and Zn up to 8%, 81% and 95% respectively. Hence, filtration after freezing is definitely not recommended. In situ filtration appears necessary to evaluate properly the chemical and physical speciation of metals. Despite total concentration of metals behave roughly conservative along the mixing gradient, our data show significant exchanges between dissolved and particulate phases. Depending on the considered metal, precipitation or oxidative redissolution was highlighted at the very short time scale of the mixing. Total Mn, however, is not conservative, especially within the oxic-anoxic transition zone, where macrofaunal assemblages are. The observed Mn loss could result from chemical precipitation and/or bacterial oxidation processes. We conclude that total Mn cannot be used as a tracer of the hydrothermal fluid in the most diluted zone of the gradient. This feature may have relevant implications in the computation of hydrothermal metal export to the deep ocean.
Microbial response to high temperature hydrothermal fluid forcing: AISICS vent (Lucky Strike, 37°N, MAR) and prokaryote community as example

Rommevaux-Jestin Céline¹, Degboe Jefferson², Leleu Thomas³, Chavagnac Valérie³, Boulart Cédric⁵, Castillo Alain², Lesongeur Françoise³, Godfroy Anne³

1. IPGP - CNRS UMR 7154, Paris, France
2. GET - CNRS UMR5563, Université de Toulouse, Toulouse, France
3. Ifremer, LM2E EEP – CNRS UMR 6197, Plouzané, France
4. Université de Sherbrooke, Sherbrooke, Canada
5. Ifremer, Lab. Géochimie Métallogénie, GM, Plouzané, France

At ridge axes, where energy-rich hydrothermal fluids and nutrients are abundant, chemotrophic microorganisms colonize oceanic basalts and contribute, in addition to seawater and hydrothermal fluids interactions, to rock weathering through redox reactions. To study the chemical forcing of hydrothermal fluids on microbial colonization and their impact on the oceanic crust alteration processes, an integrated study at AISICS hydrothermal chimney was performed since 2009, as part of EMSO-Açores observatory. To do so, we carried out high temperature and diffuse fluids sampling and analyses, chimney sampling for microbial study and microbial colonizing modules for prokaryotic composition and rock alteration study. The evolution of prokaryotic composition through time is interpreted taking into account the chemical variations of fluids and gazes observed. These environmental parameters influence the prokaryotic composition, particularly the archaeal community, as well as the substrate composition and/or the mixing between high hydrothermal fluids and surrounding deep-sea seawater.
Temporal variations of a deep-sea hydrothermal mussel assemblage monitored by the EMSO-Açores MoMAR observatory: community dynamics and species behaviour

Sarrazin Jozée¹, Matabos Marjolaine¹, Cuvelier Daphné¹, Brouard Johan¹, Legendre Pierre², Shillito Bruce³, Barthélémy Dominique⁴, Ravaux Juliette³, Zbinden Magali³, Peton Loic¹, Sarradin Pierre-Marie¹

¹Ifremer, LEP/EEP/REM, Plouzané, France
²Département de Sciences Biologiques, Université de Montréal, Montréal, QC, Canada
³MNHN, UMR CNRS 7208, BOREA, Paris, France
⁴Océanopolis, Brest, France

Although several ecological studies assessed the spatial distribution of hydrothermal vent assemblages in relation to environmental conditions, little data exist on the temporal variation of the vent community fauna and the corresponding abiotic factors. Video time-series proved to be an adequate tool to study small scale assemblage dynamics including biological interactions and species behaviour. Since its first deployment in 2006, TEMPO-mini provided high-resolution video and environmental data allowing for the assessment of small-scale community dynamics and species behaviour in relation with variations in abiotic factors. Video sequences were recorded between twice and four times a day, oxygen and temperature measurements every hour and iron concentration every 12 hours. Results from daily observations showed that the vent mussel assemblage was quite stable over 48 days, reflecting the relative stability of environmental conditions during this period. B. azoricus mussels appeared to thrive in areas of very limited hydrothermal fluid input in habitats that are, as in other deep-sea ecosystems, significantly influenced by ocean tidal signals. Variation in species abundance was observed but, with the exception of Mirocaris fortunata shrimp, no links could be established with measured environmental variables.

For behavioural characterization of two key species: the shrimp Mirocaris fortunata (Martin & Christiansen, 1995) and the crab Segonzacia mesatlantica (Williams, 1988), we combined in situ observation with ex situ approaches. Observations of individuals maintained for the first time under controlled conditions in atmospheric pressure (classic tank) and pressurized (AbyssBox) aquaria allowed to better characterize and describe the different types of behaviour and interactions observed in nature. M. fortunata's swarming behaviour resulted in the occurrence of numerous intraspecific interactions mainly involving antenna/antennule contacts and fleeing behaviours when in contact or close to individuals of S. mesatlantica.

Longer time series are currently being acquired by different experiments deployed on the EMSO-Açores MoMAR observatory (2010–2013 and still recording). They should further improve our knowledge of the dynamics of hydrothermal systems and their associated faunal communities.

Impact of Fluid circulation in old oceanic Lithosphere on the seismicity of transform-type plate boundaries: The FLOWS project (EU-COST ES1301)
The recent occurrence of large earthquakes and discovery of deep fluid seepage calls for a revision of the postulated hydrogeological inactivity and low seismic activity of old oceanic transform-type plate boundaries. Both processes are intrinsically associated. The COST Action FLOWS (https://www.flows-cost.eu) seeks to merge the expertise of a large number of research groups and support the development of multidisciplinary knowledge on how seep fluid (bio)chemistry relates to seismicity. It aims to identify (bio)geochemical proxies for the detection of precursory seismic signals and to develop innovative physico-chemical sensors for deep-ocean seismogenic faults. At present, study areas include the Azores-Gibraltar Fracture Zone and the North Anatolian Fault which have generated some of the most devastating earthquakes in Europe.

FLOWs has established 3 major working groups focusing on i) Seismicity and fluid flow at Transform-Type Plate Boundaries (TTPBs): field data and modeling – WG1, ii) Deep lithospheric structure and mechanical behaviour of TTPBs – WG2 and iii) Fluids, minerals, and microbial processes at TTPBs – WG3. A fourth working group looks after the dissemination and integration of data.

In addition to the FLOWS management meetings FLOWS will organize training schools and workshops to encourage interdisciplinary research on a European level. FLOWS supports visits to institutes and laboratories based in FLOWS participating countries to: 1) foster collaborations, 2) learn innovative techniques, 3) acquire new datasets, and 4) use specific methods/instruments. These so-called Short-term Scientific Missions (STSM) visits are specifically aimed at early career scientists and are funded to a certain level.

The cross-disciplinary approach fostered by the FLOWS project offers first insights into relationships between tectonics and seismicity and the secondary processes that shape the geochemical compositions of fluids transported from buried sediments to the seafloor.
Multidisciplinary observations of an episode of hydrothermal response to earthquakes

Xu Guangyu\textsuperscript{1}, Bemis Karen G.\textsuperscript{1}, Jackson Darrell R.\textsuperscript{2}, Rona, Peter A\textsuperscript{1}

\textsuperscript{1}Institute of Marine and Coastal Sciences at Rutgers University, NJ, US

\textsuperscript{2}Applied Physics Lab at University of Washington

Seafloor hydrothermal systems feature intricate interconnections among oceanic, geological, hydrothermal, and biological processes. The advent of the NEPTUNE observatory at the Endeavour Segment, Juan de Fuca Ridge enables scientists to study these interconnections through multidisciplinary, continuous, real-time observations. The multidisciplinary observatory instruments deployed at the Grotto Mound, a major study site of the NEPTUNE observatory, makes it a perfect place to study the response of a seafloor hydrothermal system and its local ecosystem to natural perturbations caused by geological events. In this study, we report an episode of significant increases in the venting temperature and heat output of Grotto vents observed using the Benthic And Resistivity Sensor (BARS) and the Cabled Observatory Vent Imaging Sonar (COVIS). We explore the link between the changes in hydrothermal venting to local earthquakes using mathematical models. The result sheds light on the potential mechanisms underlying the influences of earthquakes on hydrothermal venting.
POSTERS

Precision of vertical seafloor deformation measurements at the summit of Lucky Strike Volcano (POSTER)

Ballu Valerie¹, Crawford Wayne², de Viron Olivier¹, Cannat Mathilde²

¹ University of La Rochelle, France
² Institut de Physique du Globe de Paris, France

Quantifying vertical deformation is a key to understanding Earth near-surface processes such as magmatic intrusions or hydrothermal pressure variations in volcanic contexts and tectonic subsidence/uplift associated with inter-plate coupling in subduction contexts. At sea, vertical deformation measurements are generally made using absolute pressure gauges, taking advantage of the insensitivity of the overlying water column to small seafloor movements. We present seafloor pressure data collected at more than 1700 m depth on the Mid-Atlantic Ridge, south of the Azores Islands, at the MoMAR (Monitoring of the Mid-Atlantic Ridge) seafloor observatory. We analyze data collected with Seabird SBE53 and Paroscientific pressure sensors at two sites since 2007 to characterize seafloor pressure variations and infer the amount of seafloor deformation that we could detect. The seafloor pressure varies periodically over a 5 to 10 cm-equivalent range - mainly due to oceanographic variations - plus sensor drift. We investigate means to lower the tectonic event detection threshold using 1) reference sensors away from the active zone; and 2) oceanographic models such as ECCO and MERCATOR. A differential vertical movement of 1 cm between two sites separated by a few km is detectable if it occurs over less than 10 days; the detection threshold decreases to about 0.2 cm for minute-scale time periods and increases for longer time periods due to instrumental drift.
Hydrothermal seismicity beneath the summit of Lucky Strike volcano

Crawford Wayne, Singh Satish, Cannat Mathilde, Escartin Javier, Daniel Romuald

Institut de Physique du Globe de Paris, France

We present two years (July 2007–July 2009) of earthquake locations from a local seismological network on the Lucky Strike volcano (Mid-Atlantic Ridge), whose summit hosts one of the most active and largest deep-sea hydrothermal fields known. Two clusters of small (M_Lo0.8) but continuous seismicity with well-defined lower depth limits extend north and south along-axis from the hydrothermal field. The lower limit of the northern cluster (79% of events) is a few hundred meters above the axial magma chamber (AMC) reflector, whereas the lower limit of the southern cluster (7% of events) is 600 m shallower. During a 3-month long event swarm in April–June 2009, the northern cluster's lower limit deepened by 50–100 m and two other event clusters were activated: one to the east of the hydrothermal vent fields (5% of events) and another beneath the fields (2% of events). We interpret the continuous background events in the northern and southern clusters as adjustments within a narrow weak axial region due to stress created by thermal contraction events at the bottom of the hydrothermal circulation zone or in the AMC. We interpret the swarm as an episode of hydrothermal penetration toward the AMC that may have been activated by a broader, AMC-level, contraction event. We propose that a narrow axial region of lower upper crustal porosity, combined with the sloped top of the AMC, generates along-axis hydrothermal circulation towards the vent fields. The hydrothermal circulation may in turn modify the AMC topography through enhanced cooling. The AMC reflector's complex topography suggests that the volcano is in a waning phase in which the AMC has already been significantly altered since the latest magma emplacement.
The Endeavour segment of the Juan de Fuca ridge is home to one of the deepest (2200 – 2400 m) collections of experiments in the NEPTUNE Observatory. This deep-sea mountain ridge is located approximately 300 km off the British Columbian coast along the spreading crustal boundary between the Juan de Fuca and Pacific tectonic plates. The Endeavour site presents an elaborate network of seafloor structures where active hydro-geothermal venting creates highly variable local temperatures throughout the system. Due to its dynamic characteristics, Endeavour offers a rare opportunity to study globally significant chemical, biological and geological processes unique to these otherworldly deep-sea environments.

We present the current state of the installation of geophysical instrumentation connected to the NEPTUNE observatory at the Endeavour site and plans for future expansion. Currently installed instruments include short-period seismometers to monitor local seismicity, high resolution bottom pressure recorders (BPRs) detecting tsunamis, and a Cabled Observatory Vent Imaging Sonar (COVIS) measuring volume flux and flow velocity of a vigorous deep-sea hydrothermal plume. Even though problems with cable lays in this very challenging environment precluded the installation of a local seismometer array that allows exact localization of local earthquakes so far, we were able to detect some local seismicity that coincided with changes in hydrothermal vent activity.
A first model to help assessing the potential impacts of sulphide mining on the functioning and dynamics of hydrothermal ecosystems

Husson Bérengère¹, Sarradin Pierre-Marie¹, Menesguen Alain² and Sarrazin Jozée¹

¹Laboratoire Environnement Profond, Unité Étude des Écosystèmes Profonds, Ifremer (Brest)
²Laboratoire DYNamique de l’Environnement C0tier, Benthos, Ifremer (Brest)

Modeling the world’s ecosystems is an increasingly used tool to estimate both human impacts and profits on natural (food webs) and anthropogenic (climate change) processes. It is also a mean to further assess the structure and function of ecosystems that are difficult to access. Indeed, because of the difficulties to operate studies, modelling is a new emerging approach to study the deep-sea (e.g., Soetaert and van Oevelen, 2009, Martins et al., 2008).

Hydrothermal vents have been discovered along the Mid-Atlantic Ridge (MAR) in 1985 (Rona et al., 1986). While the first observations were only possible thanks to submersibles, data are now acquired several times a day and sent to Brest every 6 hours through the EMSO-Acores MoMAR deep-sea observatory (Cannat et al. 2011). In function since 2010 on the Lucky Strike vent field, the observatory is composed of an autonomous system that records images (video camera) and measures physico-chemical conditions in the ecosystem (in situ chemical analyser, autonomous oxygen and temperature probes, Sarrazin et al. 2007). New data on spatial distribution, biotic interactions and temporal dynamics of the different vent species are thus available now (Cuvelier et al. 2009, 2011a,b, Sarrazin et al. 2014, Sarrazin et al. submitted, Matabos et al. submitted). Concurrently, stable isotope (De Busserolles et al., 2009) and fatty acid analyses (Colaço et al., 2002, Portail et al., in preparation) have brought new hypothesis on the trophic relationships linking the species found within these communities. During the MoMARSAT 2014 cruise, other data were sampled to study assemblages’ biomasses and Bathymodiolus azoricus growth rates.

The ecosystemic model will allow an evaluation of the potential impacts of natural variations in vent fluid supply to the hydrothermal communities. It will combine two models: a biogeochemical one, predicting the microbial production in the fluids along a dilution gradient (Cathalot et al. in preparation), and a physiological one, predicting the biomass of different Bathymodiolus azoricus faunal assemblages. It will constitute a first tool to support decision making in the management of hydrothermal vent ecosystems, which are increasingly valued for their mineral resources.
Copepod colonization of different substrata at hydrothermal vents

Plum Christoph^1, Pradillon Florence^1, Sarrazin Jozée^1

^1 Institut Carnot Ifremer EDROME, Centre de Bretagne, REM/EEP, Laboratoire Environnement Profond, France

Hydrothermal vents (HV) are physically highly disturbed environments. The rapid changes in physico-chemical conditions of vent fluids can result in temperature and pH gradients, shaping the diversity and community composition of the hydrothermal fauna. While mega- and macrofauna in HV have been intensively studied since their discovery, meiofaunal organisms, in spite of their ecological relevance, have only partly been included in HV ecological studies. This includes one of the most abundant taxa among the meiofauna, the copepods. The few existing studies on vent copepods indicate relatively low abundance and diversity compared to deep sea sediments. Additionally, HV copepods show a low connectivity with the surrounding environments and reveal a high endemism. Due to the limited information, our knowledge about colonization mechanisms and the interconnectivity of vent copepods is still scarce.

The objective of this study is to identify copepod diversity and understand their colonization processes in response to environmental factors such as fluid flow and the presence of different substrata at HV sites.

To address these questions, we deployed in situ experiments using organic (wood, bone) and inorganic (slates) substrata equipped with temperature probes along a gradient of hydrothermal activity, from active to inactive areas. The substrata were deployed in 2011 during the MoMARSAT cruise on the Mid-Atlantic Ridge and were recovered after two years in 2013. Temporal series of environmental data collected since 2010 with the multidisciplinary observatory MoMAR at Lucky Strike provided additional environmental data to interpret the results of the colonization experiment.

Preliminary results suggest the dominance of endemic Dirivultidae and specialized harpacticoid copepods which are restricted to chemosynthetic habitats. Based on the results on higher taxonomic levels, we expect significant differences in copepod community composition and diversity along the chemical gradient of the hydrothermal outflow and between different substrata. Results will be discussed in order to understand the potential influence of fluid flow on newly arriving copepods and potential preference in colonizing different organic and inorganic substrata.

The outcome of this study will increase our knowledge of copepod diversity, colonization processes and interconnectivity at hydrothermal vents, allowing a better understanding of ecological processes in these extreme environments.
A new microbial Connected In Situ Instrumented Colonizer System (CISICS) at Lucky Strike Observatory (EMSO Azores)

Rommevaux-Jestin Céline¹, Godfroy Anne ², Legrand Julien ³, Lesongeur Françoise ², Henri Pauline ¹, Guyader Gérard ³, Coail Jean-Yves ³, Leleu Thomas ⁴, Chavagnac Valérie ⁴

¹Institut de Physique du Globe de Paris - CNRS UMR 7154, Paris, France
²Ifremer, LM2E, EEP-CNRS UMR 6197, Plouzané, France
³Ifremer, I2M, RDT, Plouzané, France
⁴GET-CNRS UMR5563, Université de Toulouse, Toulouse, France

At ridge axes, where hydrothermal fluids and nutrients are abundant, chemotrophic microorganisms colonize oceanic basalts and contribute, in addition, to seawater and hydrothermal fluids interactions and rock weathering through redox reactions. To study the hydrothermal forcing on microbial colonization and their impact on the oceanic crust alteration processes, a new microbial Connected In Situ Instrumented Colonizer System (CISICS) was deployed for a year at AISICS hydrothermal chimney (N.O. PP?; MoMARSAT13 cruise (Aug.-Sept. 2013) and MoMARSAT14 cruise (Jul. 2014)). CISICS consists of: 1) 12 mini-colonizers, filled with basaltic glasses, stacked on two floors (i.e. 3 biotic, 3 abiotic per floor) in a perforated titanium cylindrical chamber, 2) two Micrel™ temperature sensors recording in-situ temperature every 5 min, and 3) a pumping and filtering (1µm, 0.45µm and Sterivex® 0.22µm) system collecting and storing fluids samples in 150ml sterile “blood”-like bags. CISICS is connected also to the SeaMoN East node via a 25m cable enabling via the Borel buoy, data transmission of temperature reading, and the possibility to trigger a sample from land if an event (i.e. temperature change) occurs. The first feedback and data after one-year deployment was presented and analysed here, with interesting results on microbial composition and chemical parameters of AISICS chimney and with perspectives for future improvements of CISICS instrument.