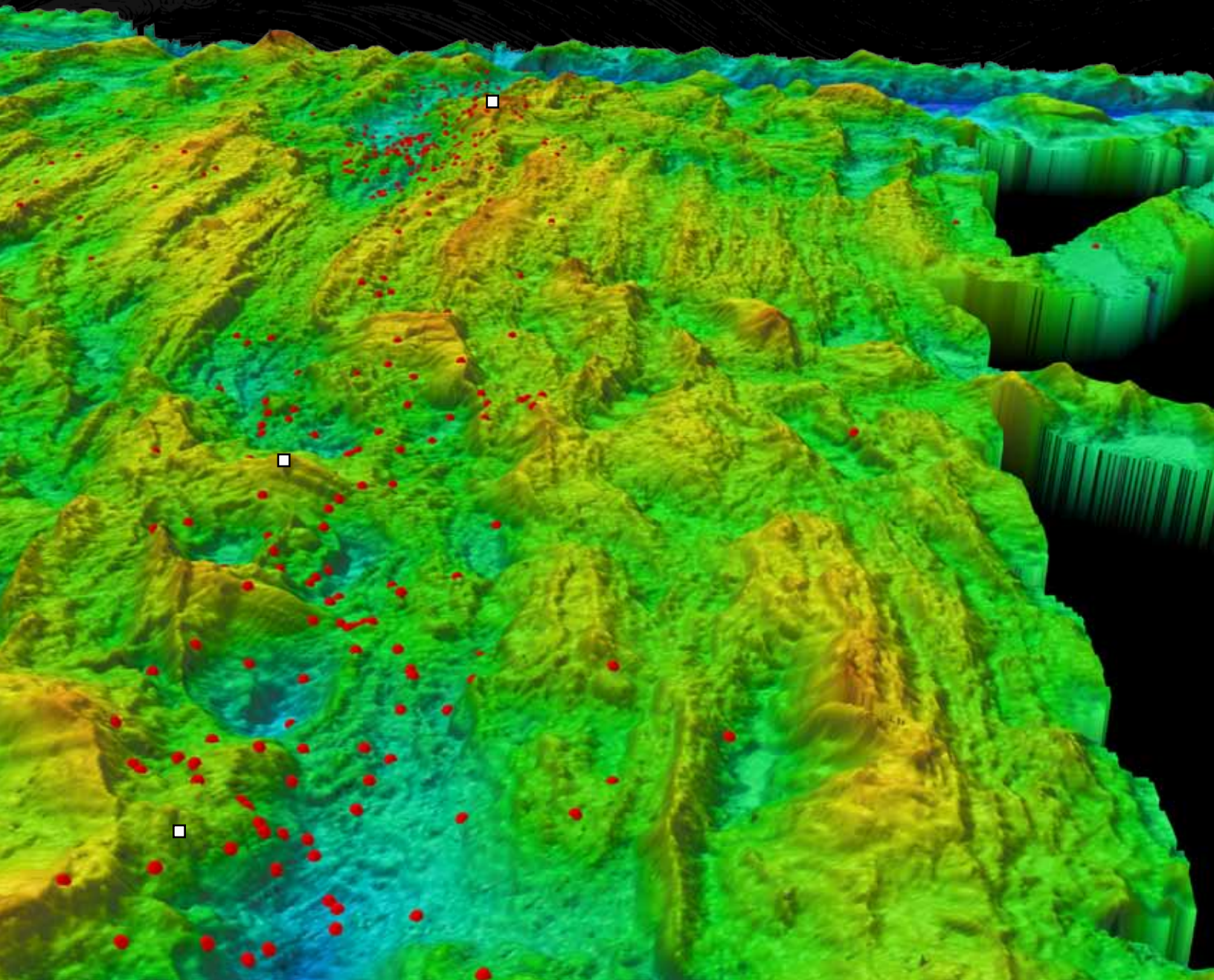


INTERRIDGE NEWS

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Contents

From the Office	1
Letter from the Chairs	1
Coordinator Update	2
InterRidge to sign Letter of Agreement with UNEP/GRID-Arendal	3
Education and Outreach Update	4
InterRidge Fellows	6
International Research	9
Mid-Atlantic Ridge	9
Seismic velocity variation within the footwall of an oceanic core complex - Atlantis Massif, Mid-Atlantic Ridge, 30°N (<i>Henig et al.</i>)	9
New data about hydrothermal fields on the Mid-Atlantic Ridge between 11° - 14°N: 32 nd Cruise of R/V <i>Professor Logatchev</i> (<i>Beltenev et al.</i>)	13
First record of <i>Pachycara thermophilum</i> (Pisces, Zoarcidae) from Ashadze Hydrothermal Vent Field (Mid-Atlantic Ridge, 13°N) (<i>Biscoito et al.</i>)	18
Detailed investigation of hydrothermal site Rainbow, Mid-Atlantic Ridge, 36°13'N: Cruise MoMARDream (<i>Dyment et al.</i>)	22
OSPAR to protect the Alps of the undersea: Progress and drawbacks on the Charlie-Gibbs Marine Protected Area (<i>Lutter</i>)	25
National News	28
Bulgaria	28
NEPTUNE Canada	28
China	29
France	30
Germany	31
India	32
Japan	32
Korea	34
Portugal	34
Russia	35
SOPAC (Pacific Islands Applied Geoscience Commission)	37
Switzerland	38
UK	40
USA	40
Working Group Updates	42
Deep Earth Sampling	42
Hydrothermal Energy and Ocean Carbon Cycles	43
Long-Range Ridge Exploration	44
Mantle Imaging	44
Monitoring and Observatories	45
Seafloor Mineralization	46
Vent Ecology	47
Workshops and Conferences	48
Workshop on Deep-Sea Mining of Seafloor Massive Sulfides	48
KOPRI's 16 th International Symposium on Polar Sciences	49
4 th International Symposium on Chemosynthesis-Based Ecosystems	51
Melting, Magma, Fluids and Life Workshop	52
Online Resources and Publications	54
Upcoming Events	56
Upcoming Cruises	58
InterRidge National Correspondents	60
InterRidge Steering Committee	61

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Detailed investigation of hydrothermal site Rainbow, Mid-Atlantic Ridge, 36°13'N: Cruise MoMARDream

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Hydrothermal site Rainbow, located on the Mid-Atlantic Ridge (MAR) at 36°13'N, is one of the first hydrothermal sites discovered on an ultramafic basement (Fouquet et al., 1997). The sulfide mineralization exhibits high concentrations of copper, zinc, gold, nickel and cobalt (Marques et al., 2006), and the hydrothermal fluid is remarkably abundant in natural hydrogen, methane, and iron (Charlou et al., 2002). Indeed, at Rainbow, iron plays an essential role in producing the strong magnetic anomalies discovered in 2001 (Dymant et al., 2005), and a symbiosis with bacteria based on iron oxidation is proposed for the shrimp *Rimicaris exoculata* (Zbinden et al., 2004).

In Aug. - Sept. 2008, cruise MoMARDream (MoMAR'08, Leg 2) of R/V *L'Atalante* with ROV *Victor* revisited site Rainbow to achieve: (1) a multidisciplinary, multi-scale study of the hydrothermal processes on an ultramafic basement, with a special focus on the role of iron; and (2) a systematic mapping and inventory of the site to (a) provide a reference state for future repeated observations and/or a permanent observatory in the framework of the MoMAR project (<http://www.momar.org>), and (b) help to define possible drilling sites to support a revised IODP proposal. To fulfill these objectives, ROV *Victor* was used in both the "survey" and "sampling" modes. During maintenance periods, we carried out 15 dredges which add to the already important sample collection from the Rainbow Massif.

ROV *Victor* in "survey" mode realized a full bathymetric and magnetic coverage of site Rainbow and its vicinity at an altitude ~50 m above the seafloor on a 4000 x 2500 m box, with profile interval of ~120 m. In addition, higher resolution bathymetric and magnetic surveys as well as complete vertical photographic coverage were achieved at an altitude ~10 m above the seafloor, with ~10 m profile interval, on three boxes: a 500 x 500 m box over site Rainbow, and two boxes, respectively 300 x 300 m and 100 x 100 m, east of site Rainbow, on the crest of the Rainbow Massif. Temperature and nephelometry data were also acquired on parts of these surveys.

ROV *Victor* in "sampling" mode devoted a full dive and part

of another dive to the geological exploration of areas located south and north of the site, as possible signs for other active or fossil hydrothermal fields had been observed on the magnetic data. No active site was found, although evidence for fossil low-temperature hydrothermal activity was widespread. Sulfide and serpentinite samples were collected for mineralogical and magnetic property analyses. Seven dives were devoted to chemical and biological experiments, including the collection of shrimps, mussels (Figure 1), and a broken chimney fragment, and the deposition and recovery of biological colonization modules. Measurement of chemical parameters and collection of diffused fluid samples were carried out at a number of points around Thermitière, on the most active part of the site, for a detailed study of the bio-geochemical interactions. Samples of pure hot fluids were also collected for inorganic and organic geochemical analyses. Such samples have been collected during most of the cruises visiting the site since its discovery for geochemical data compilation and time-series study.

The large harvest of data and samples obtained during the cruise is currently being analyzed. An excerpt of the bathymet-

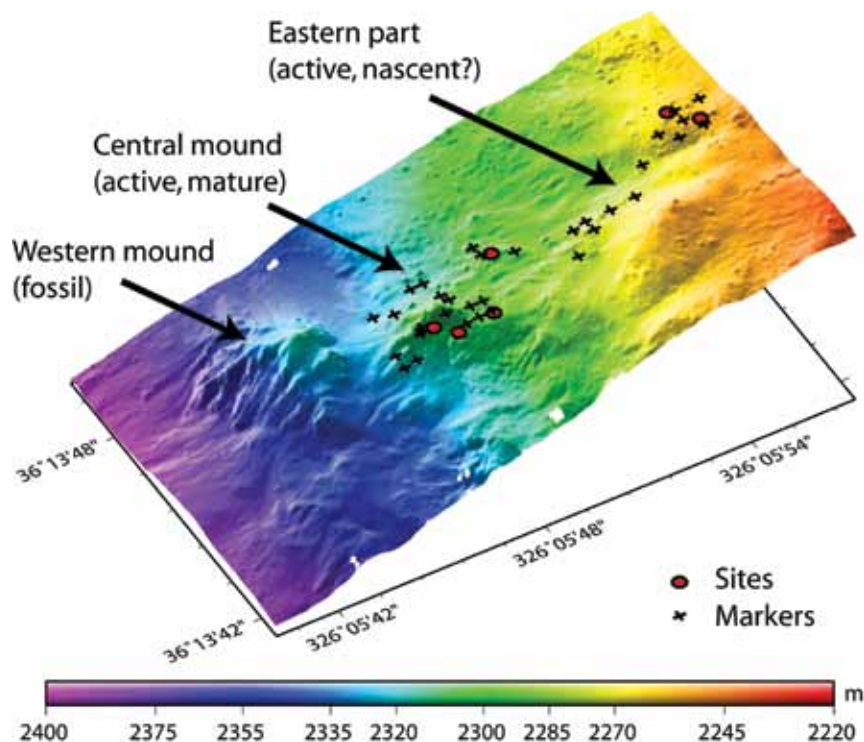


Figure 1: ROV *Victor* collects mussels at Rainbow – a difficult task requiring highly specialized devices!

¹IPGP, France; ²CNRS, France; ³IFREMER, France; ⁴UPMC, France; ⁵Univ. Brest, France; ⁶ENS Paris, France; ⁷UM2, France; ⁸Univ. Stockholm, Sweden; ⁹IGN, France; ¹⁰Univ. Azores, Portugal; ¹¹Univ. Lille, France; ¹²Ecole Navale, France; ¹³MNHN, France; ¹⁴CERAP, France

Figure 2: (upper, right) 3D view of the multibeam bathymetry collected by ROV *Victor* at altitude ~50 m (processed by R. Thibaud and P. Gente). Crosses and red circles show the relocated markers and some hydrothermal sites.

Figure 3: (lower, right) Hydrothermal chimney at Rainbow, in the vicinity of site Magali. Note the broken chimney on the right and marker Flores 09 in the background (see Table 1 on next page for location).



ric map acquired at ~50 m altitude shows the overall structure of the site, made of three parts (Figure 2). The western mound, now hydrothermally inactive, displays an accumulation of iron sulfide and represents a fossil, partly dismantled, hydrothermal site. The central mound exhibits chimney groups and strong hydrothermal and biological activity – it is considered as a mature hydrothermal site. The eastern part of the site is made of isolated active chimneys, without any large mound, and may represent a nascent hydrothermal site. The systematic survey allowed us to revisit and relocate many markers set up during previous cruises (Figure 3). Table 1 on the next page gives the relocated position of known markers at Rainbow.

For a summary of the previous cruise MoMARDream-Naut, please refer to the article by Gaill et al. in the 2007 InterRidge News.

Acknowledgements

We thank Captain Houmard, the crew of R/V *L'Atalante*, and the operating team of ROV *Victor*, for their excellent work and a memorable expedition.

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Table 1: Relocated sites and markers at site Rainbow (prepared by J. Renard).

SITES	Latitude (Decimal °)	Longitude (Decimal °)	Latitude	Longitude	Depth (m) ¹
Jean-Luc	36.229100	-33.903367	36 ° 13 ' 44.76 " N	33 ° 54 ' 12.12 " W	2307
Caroline	36.229489	-33.901141	36 ° 13 ' 46.16 " N	33 ° 54 ' 4.11 " W	2249
Thermitiere	36.229482	-33.902832	36 ° 13 ' 46.14 " N	33 ° 54 ' 10.20 " W	2297
Magali	36.229217	-33.903483	36 ° 13 ' 45.18 " N	33 ° 54 ' 12.54 " W	2309
Hisako	36.229100	-33.903083	36 ° 13 ' 44.76 " N	33 ° 54 ' 11.10 " W	2302
Thin Chimney	36.229700	-33.901258	36 ° 13 ' 46.92 " N	33 ° 54 ' 4.53 " W	2260

MARKERS	Latitude (Decimal °)	Longitude (Decimal °)	Latitude	Longitude	Depth (m) ¹	Cruise & Year	Valid. / Comp. ²
Flores 01 / F1	36.229165	-33.902219	36 ° 13 ' 44.99 " N	33 ° 54 ' 7.99 " W		Flores 1997	Comp.
Flores 02 / F2	36.229115	-33.902402	36 ° 13 ' 44.81 " N	33 ° 54 ' 8.65 " W		Flores 1997	Comp.
Flores 03 / F3	36.229132	-33.903126	36 ° 13 ' 44.88 " N	33 ° 54 ' 11.25 " W		Flores 1997	Comp.
Flores 04 / F4	36.229692	-33.901036	36 ° 13 ' 46.89 " N	33 ° 54 ' 3.73 " W		Flores 1997	Valid.
Flores 05 / F5	36.229537	-33.901553	36 ° 13 ' 46.33 " N	33 ° 54 ' 5.59 " W		Flores 1997	Comp.
Flores 06 / F6	36.229115	-33.903693	36 ° 13 ' 44.81 " N	33 ° 54 ' 13.29 " W		Flores 1997	Comp.
Flores 07 / F7	36.229199	-33.903610	36 ° 13 ' 45.12 " N	33 ° 54 ' 13.00 " W		Flores 1997	Comp.
Flores 08 / F8	36.229382	-33.902736	36 ° 13 ' 45.78 " N	33 ° 54 ' 9.85 " W		Flores 1997	Comp.
Flores 09 / F9	36.229154	-33.903825	36 ° 13 ' 44.95 " N	33 ° 54 ' 13.77 " W	2321	Flores 1997	Valid.
Flores 10 / F10	36.229548	-33.901255	36 ° 13 ' 46.37 " N	33 ° 54 ' 4.52 " W	2259	Flores 1997	Valid.
PP27	36.229566	-33.902856	36 ° 13 ' 46.44 " N	33 ° 54 ' 10.28 " W	2290	French before 2001	Valid.
PP37	36.229273	-33.902221	36 ° 13 ' 45.38 " N	33 ° 54 ' 8.00 " W	2281	French, before 2001	Valid.
Iris 3	36.229500	-33.903650	36 ° 13 ' 46.20 " N	33 ° 54 ' 13.14 " W		Iris 2001	Comp.
Iris 4	36.229584	-33.903384	36 ° 13 ' 46.50 " N	33 ° 54 ' 12.18 " W	2320	Iris 2001	Valid.
Iris 5	36.229400	-33.903267	36 ° 13 ' 45.84 " N	33 ° 54 ' 11.76 " W		Iris 2001	Comp.
Iris 6	36.229650	-33.903283	36 ° 13 ' 46.74 " N	33 ° 54 ' 11.82 " W		Iris 2001	Comp.
Iris 7	36.229283	-33.902283	36 ° 13 ' 45.42 " N	33 ° 54 ' 8.22 " W	2276	Iris 2001	Comp.
Iris 9	36.229281	-33.901842	36 ° 13 ' 45.41 " N	33 ° 54 ' 6.63 " W	2255	Iris 2001	Valid.
Iris 11	36.229217	-33.903650	36 ° 13 ' 45.18 " N	33 ° 54 ' 13.14 " W		Iris 2001	Comp.
Iris 13	36.229261	-33.903299	36 ° 13 ' 45.34 " N	33 ° 54 ' 11.88 " W	2292	Iris 2001	Valid.
EXO1	36.229508	-33.901083	36 ° 13 ' 46.23 " N	33 ° 54 ' 3.90 " W	2248	Exomar 2005	Valid.
EXO2	36.229485	-33.902878	36 ° 13 ' 46.15 " N	33 ° 54 ' 10.36 " W	2295	Exomar 2005	Valid.
EXO3	36.229245	-33.903577	36 ° 13 ' 45.28 " N	33 ° 54 ' 12.88 " W	2311	Exomar 2005	Comp.
JL	36.229125	-33.903249	36 ° 13 ' 44.85 " N	33 ° 54 ' 11.70 " W		Revelle 2008	Valid.
US B	36.229597	-33.901379	36 ° 13 ' 46.55 " N	33 ° 54 ' 4.96 " W	2265	Revelle MAR 2008	Valid.
US C	36.229183	-33.903350	36 ° 13 ' 45.06 " N	33 ° 54 ' 12.06 " W	2309	Revelle MAR 2008	Valid.
US E	36.229306	-33.901982	36 ° 13 ' 45.50 " N	33 ° 54 ' 7.14 " W	2271	Revelle MAR 2008	Valid.
X3	36.229153	-33.903171	36 ° 13 ' 44.95 " N	33 ° 54 ' 11.42 " W		Revelle MAR 2008	Valid.
X6	36.229126	-33.903343	36 ° 13 ' 44.85 " N	33 ° 54 ' 12.03 " W		Revelle MAR 2008	Valid.
X7	36.229207	-33.903126	36 ° 13 ' 45.15 " N	33 ° 54 ' 11.25 " W	2300	Revelle MAR 2008	Valid.
X11	36.229611	-33.901202	36 ° 13 ' 46.60 " N	33 ° 54 ' 4.33 " W	2258	Revelle MAR 2008	Valid.
TIC	36.220833	-33.894841	36 ° 13 ' 15.00 " N	33 ° 53 ' 41.43 " W	2081	MomarDream 2008	Valid.
TAC	36.229655	-33.901250	36 ° 13 ' 46.76 " N	33 ° 54 ' 4.50 " W	2258	MomarDream 2008	Valid.
Soliton	36.229259	-33.902182	36 ° 13 ' 45.33 " N	33 ° 54 ' 7.86 " W	2275	MomarDream 2008	Valid.
Russian marker	36.229617	-33.903733	36 ° 13 ' 46.62 " N	33 ° 54 ' 13.44 " W		??	Comp.
Cylinder	36.229107	-33.903759	36 ° 13 ' 44.79 " N	33 ° 54 ' 13.53 " W	2320	??	Valid.

¹ Depth is the reported depth from cruise.

² Valid means that the location has been validated during cruise MomarDream, Comp means that the location has been modified taking into account the average shift, determined for each previous cruises, between the original and relocated coordinates for all validated location.