Short Cruise Report
M76/3b-Guineco Leg 2

17.07.-24.08.08 Walvisbay – Walvisbay (Namibia)

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Main objectives

The main objectives of the cruise leg M76/3b "GUINECO" were the comparative biological, geological and biogeochemical analyses of fluid and gas seepage at cold seep ecosystems of the West African continental margin. This includes the detailed mapping of gas and fluid venting as well as gas hydrates and their associated ecosystems. The remotely operating vehicle QUEST4000 of MARUM was the main working tool of this leg. Measurements of different physical, chemical and geological processes were combined with intensive observation and sampling of seep communities, from micro- to megafauna. The program was developed in the framework of the cooperation between the MARUM (Bremen) and the French research institute IFREMER (Brest). The main research questions of GUINECO leg b were

- How does fluid and gas venting as well as diffusive seepage of gas influence biogeochemical processes at seeps?
- How high is the net flux of fluids and gases and other chemical compounds at different types of cold seeps?
- Which geochemical, geomicrobiological and sedimentological parameters control mineralization processes at gas and fluid vents?
- How is the biodiversity of different size classes of cold seep organisms coupled to geological and geochemical processes?

Cruise itinary

The second leg of the expedition GUINECO started 11:00 am on Thursday, 17 July with leaving the port of Walvisbay. We had to steam 1100 nautical miles to our main target area, the giant pockmarks and diapirs off Congo, Angola and Gabon. The previous leg M76/3a had provided us with bathymetry maps of different target areas as well as the positions for giant gas flares marking the escape of free gas from sites as deep as 3100m. We aimed at exploring several of these sites with the ROV QUEST, to learn more about the geological, geochemical and biological consequences of such vigorous gas escape.

Unfortunately, on the second day of our departure, in the early hours of the 18 July, we were informed of a tragic loss in the family of one member of the ship's crew and it was decided immediately to disembark him at the nearest harbor, namely Walvisbay. We left Walvisbay again in the morning of the 19 July. Due to excellent weather conditions, the ship reached our first target, the Diapir Area off Angola, in the morning of the 23 July. Here we carried out the first exploratory dive of this area (QUEST4000 dive 207), to obtain seafloor images of the source of the gas escape mapped by Parasound on the previous leg at 2800 m water depth. By using a combination of acoustic wayfinding with the forward looking sonar of the ROV and regular checks of characteristic features on the seafloor, we were able to track at least one of the sources

of free gas emission at this diapir site. Following the sonar image of gas bubbles, we landed on a giant bed of chemosynthetic mytilid bivalves (Photo 1). Unfortunately the dive lasted only a few hours, because a major oil leak was discovered that forced us to recover QUEST.

Fig 1: Sampling gas bubbles from a mussel bed (DIAPIR site; All Photo sources: MARUM)

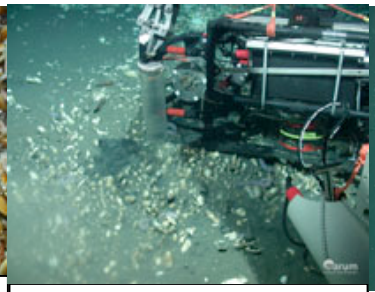


Fig 2: Pushcore sampling in front of the benthic chamber on a field of living vesicomyids.

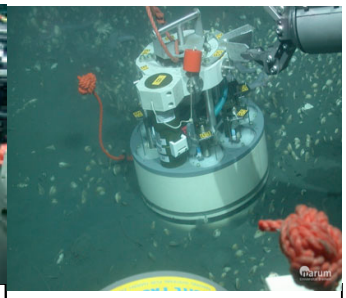


Fig 3: Respiration measurements with the benthic chamber CALMAR

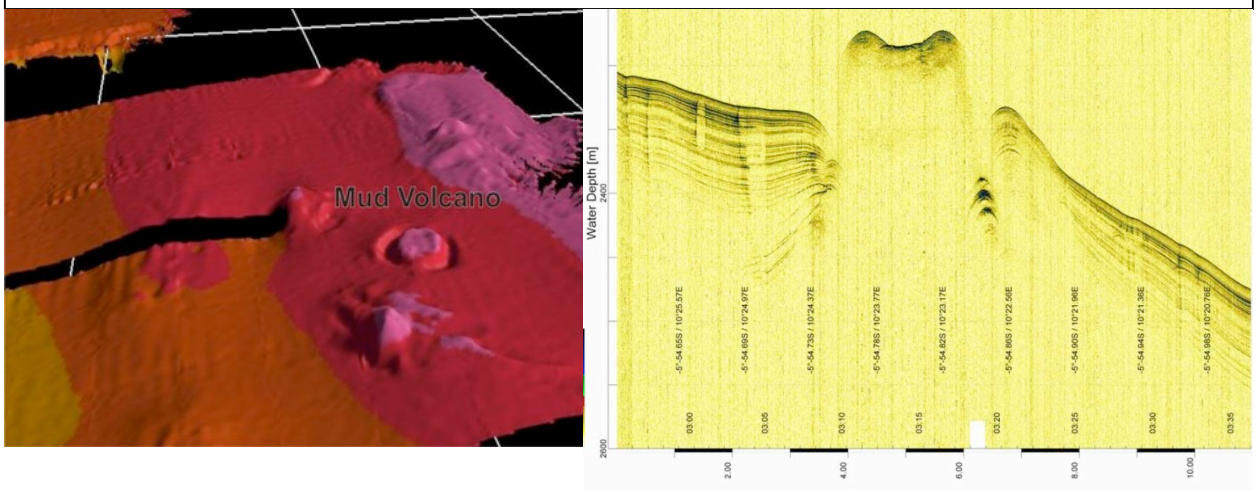
We continued to the giant pockmark REGAB off Congo and carried out four short dives between the 24 and the 28 July due to continuous problems with oil leakage. The dives 208, 209, 211 and 212 provided us with net and pushcore samples from bacterial mats and clam fields (Photo 2), as well as with a first in situ microsensor and respiration chamber measurement. In alternation with dives and during repair times we carried out Parasound and Multibeam transects as well as gravity coring, for the geophysical and geological characterization of the area (see station list). The coring aimed at retrieving carbonates and hydrates for a characterization of the gas system and associated processes of the REGAB pockmark. The dives focused first on habitats dominated by a species of vesicomyid bivalves, which dwell the sediments for sulfide to nourish the thiotrophic symbionts hosted in their gills. These vesicomyid clams are often found at cold seeps and in association with hydrate bearing sediments. At REGAB the healthy clams form typical assemblages in the reduced sediments close to the central area of the pockmark. We also came across large fields of dead bivalve shells witnessing previous areas of gas emission, which went extinct. After having measured the respiration of the clams and their associated community, we sampled the patches with blade and push cores for biogeochemical and biological analyses.

The problem with the oil leakage improved from dive to dive, however, we also encountered a major problem with the cable of the ROV. After dive 212, the cable came up strongly distorted and needed cutting and refitting work. We continued with dive 214 and 215 on the 30 and 31 July to finish the work at the first habitat site. Targets for the Parasound and Multibeam mapping were three previously unknown mud volcanoes between the REGAB and the DIAPIR site (Figure 4). We carried out videoguided Multicorer Transects to detect potential gas seepage activity, but neither the visual inspection nor the coring on some central sites gave evidence for recent seepage. However, large fractions of the mud volcanoes were covered with carbonate cements indicating probably strong ancient seepage activities. Interesting, a gas flare was mapped on one of the MVs, showing that very locally parts of the MVs maybe active.

The fourth week was dedicated to exploration and measurements on the eastern part of the REGAB pockmark. In 2000, dives of IFREMER's BIOZAIRE expedition found that the eastern part of the pockmark was characterized by a flat and sedimentary seafloor, covered by large mussel beds associated with gassy sediments. The first overview of this area 8 years later (Dive 217, 218 on 3 and 4 August) indicated considerable changes over time. The extension of the

mussel beds was strongly reduced and they seem to be replaced by assemblages of vesicomyid clams, potentially indicating a decrease in the gas flux. Still the benthic activity associated with the small mussel patches was very high, and indicated strong gas emissions.

Picture 4: Between REGAB and DIAPIR: a mud volcano field. Left: the bathymetry of 2 cone-shaped and one pie-shaped mud volcano. Right: the subsurface structure of the pie-shaped mud volcano, which is about 1.5 km in diameter and extends 100m above the seafloor.



After further maintenance, QUEST dives 222 and 223 (08-09 August) allowed us to carry out a series of benthic flux measurements on the remaining mussel beds as well as the vesicomyid assemblages in the eastern area of the pockmarks, and we were able to deploy a series of carbonate colonization experiments as well as to collect more megafauna for the investigation of the diversity of chemosynthetic symbioses at REGAB. Also, we found areas of gas bubble escape where they were not expected – away from the center and not associated with carbonate formation or benthic assemblages.

Unfortunately, between 10-14 August, we had to stop the ROV operations because the ROV suffered a complete black out. This forced us to steam to a close by harbor (Luanda, Angola) to receive spare parts from Bremen by courier. We arrived in Luanda to pick up the needed parts in the afternoon of the 14 August and after further repairs were able to dive again at REGAB on the 15 August (dive 225). This dive allowed for retrieval of samples, in situ measurements and interesting video footage at another habitat with clam beds (bivalves of two families of Vesicomyidae) in the Southwestern part of the REGAB pockmark. This site was previously described as the largest clam field of the REGAB pockmark, during its first exploration by the ROV VICTOR in 2001. Faced another cable failure, we were able to carry out only one further dive (226) from the 18 to 19 August. The tasks included deployment of several profiling instruments, recovery of some experimental moorings, biological samples, water chemistry and “videomosaicking” to produce visual maps for quantitative estimates on the areal coverage of the benthic habitats. Finally, we also carried out some measurements in the central pockmark area. A peculiar feature of this habitat is the attachment of mytilid bivalves to the tubes, as well as the dense colonization by hydroid polyps. The dive ended at 5:15 am in the morning of the 19 August with the recovery of the ROV QUEST before starting a final, long parasound transect in the direction of Walvisbay (Namibia). The expedition M76/3b ended in Walvisbay port in the morning of the 24 August.

Stationlist of Meteor Leg M76/3b

Cruise	Station	Area	Gear	Gear-#	Operator	GeoB
M76/3b	300a	Transit	MB-PS	1	Caparachin	-
M76/3b	301	Diapir	PS	2	Caparachin	-
M76/3b	302	Diapir	ROVQ	207	Ratmeyer/Bri	13 1 2 2
M76/3b	303	Diapir	SP	1	Wilkop	-
M76/3b	304	Diapir	GC	1	Wilkop	-
M76/3b	305	Diapir	GC	2	Wilkop	13 1 2 3
M76/3b	305a	Transit	MB-PS	3	Caparachin	
M76/3b	306	Regab	SP	2	Asendorf	-
M76/3b	306a	Regab	PS	4	Caparachin	-
M76/3b	307	Regab	GC	3	Wilkop	-
M76/3b	308	Regab	GC	4	Wilkop	13 1 2 4
M76/3b	309	Regab	GC	5	Wilkop	13 1 2 5
M76/3b	310	Regab	ROVQ	208	Ratmeyer	13 1 2 6
M76/3b	311	Regab	MB-PS	5	Caparachin	-
M76/3b	312	Regab	ROVQ	209	Ratmeyer	13 1 2 7
M76/3b	313	Regab	MB-PS	6	Caparachin	-
M76/3b	314	Regab	GC	6	Wilkop	13 1 2 9-1
M76/3b	315	Regab	GC	7	Wilkop	-
M76/3b	316	Regab	GC	8	Wilkop	13 1 2 8
M76/3b	317	Regab	GC	9	Wilkop	13 1 2 9-2
M76/3b	318	Regab	GC	10	Wilkop	-
M76/3b	319	Regab	MB-PS	7	Caparachin	-
M76/3b	320	Regab	LIFT	1	Wilkop	-
M76/3b	321	Regab	ROVQ	210	Ratmeyer	-
M76/3b	322	Regab	GC	11	Wilkop	13 1 30
M76/3b	323	Regab	ROVQ	211	Ratmeyer	13 1 31
M76/3b	324	Regab	WOOD	1	Asendorf	-
M76/3b	325	Regab	ROVQ	212	Ratmeyer	-
M76/3b	326	Regab	MB-PS	8	Caparachin	-
M76/3b	327	Regab	WOOD	2	Asendorf	-
M76/3b	328	Regab	ROVQ	213	Ratmeyer	-
M76/3b	329	Regab	TV-MUC	1	Wilkop	13 1 32
M76/3b	330	Regab	MB-PS	9	Caparachin	-
M76/3b	331	Regab	TV-MUC	2	Wilkop	-
M76/3b	332	Regab	ROVQ	214	Ratmeyer	13 1 33
M76/3b	333	Regab	MB-PS	10	Caparachin	-
M76/3b	334	Regab	LIFT	2	Asendorf	-
M76/3b	335	Regab	ROVQ	215	Ratmeyer	-
M76/3b	336	Regab	MB-PS	11	Caparachin	-
M76/3b	337	Regab	TV-MUC	3	Wilkop	13 1 34
M76/3b	338	Regab	TV-MUC	4	Wilkop	13 1 35
M76/3b	338a	Regab	MB	12	Caparachin	
M76/3b	339	Regab	TV-MUC	5	Wilkop	-
M76/3b	340	Regab	ROVQ	216	Ratmeyer	-
M76/3b	341	Regab	TV-MUC	6	Wilkop	-
M76/3b	342	Regab	TV-MUC	7	Wilkop	-
M76/3b	343	Regab	MB-PS	13	Caparachin	-

Stationlist of Meteor Leg M76/3b							
Cruise	**Station**		**Area**	**Gear**	**Gear-#**	**Operator**	**GeoB**
M76/3b		344	Regab	ROVQ	217	Ratmeyer	13 1 36
M76/3b		345	Regab	MB-PS	14	Caparachin	-
M76/3b		346	Regab	LIFT	3	Asendorf	-
M76/3b		347	Regab	TV-MUC	8	Wilkop	13 1 37
M76/3b		348	Regab	ROVQ	218	Ratmeyer	-
M76/3b		349	Regab	MB-PS	15	Caparachin	-
M76/3b		350	Regab	ROVQ	219	Ratmeyer	-
M76/3b		351	Regab	MB-PS	16	Caparachin	-
M76/3b		352	Mudvulcano	TV-MUC	9	Wilkop	13 1 38
M76/3b		353	Mudvulcano	MB-PS	17	Caparachin	-
M76/3b		354	Mudvulcano	TV-MUC	10	Stiens	13 1 39
M76/3b	354a		Mudvulcano	MB	18	Caparachin	
M76/3b		355	Regab	ROVQ	220	Ratmeyer	13 1 40
M76/3b		356	Regab	MB-PS	19	Caparachin	-
M76/3b		357	Regab	LIFT	4	Asendorf	-
M76/3b		358	Regab	ROVQ	221	Ratmeyer	-
M76/3b		359	Regab	GC	12	Wilkop	13 1 41
M76/3b		360	Regab	GC	13	Wilkop	13 1 42
M76/3b		361	Regab	ROVQ	222	Ratmeyer	13 1 43
M76/3b		362	Regab	MB-PS	20	Caparachin	-
M76/3b		363	Regab	LIFT	5	Asendorf	-
M76/3b		364	Regab	ROVQ	223	Ratmeyer	13 1 44
M76/3b		365	Regab	MB-PS	21	Caparachin	-
M76/3b		366	Regab	MB-PS	22	Caparachin	-
M76/3b		367	Regab	GC	14	Wilkop	-
M76/3b		368	Regab	LIFT	6	Asendorf	-
M76/3b		369	Regab	ROVQ	224	Ratmeyer	-
M76/3b		370	Regab	GC	15	Wilkop	-
M76/3b		371	Regab	GC	16	Wilkop	-
M76/3b		372	Regab	MB-PS	23	Caparachin	-
M76/3b		373	Regab	GC	17	Wilkop	-
M76/3b		374	Regab	GC	18	Wilkop	-
M76/3b		375	Regab	TV-MUC	11	Asendorf	13 1 45
M76/3b		376	Regab	GC	19	Wilkop	-
M76/3b		377	Regab	GC	20	Wilkop	13 1 2 4-2
M76/3b	377a		Transit	MB-PS	24	Caparachin	
M76/3b		378	Regab	LIFT	7	Asendorf	-
M76/3b		379	Regab	ROVQ	225	Ratmeyer	13 1 46
M76/3b		380	Regab	GC	21	Wilkop	13 1 47
M76/3b		381	Regab	GC	22	Wilkop	13 1 48
M76/3b		382	Regab	MB-PS	25	Caparachin	-
M76/3b		383	Regab	MUC	12	Wilkop	13 1 49
M76/3b		384	Regab	LIFT	8	Asendorf	-
M76/3b		385	Regab	ROVQ	226	Ratmeyer	-
M76/3b		386	Transit	MB-PS	26	Caparachin	

Track of METEOR expedition M72/3b GUINECO, 17.07.-24.08.2008