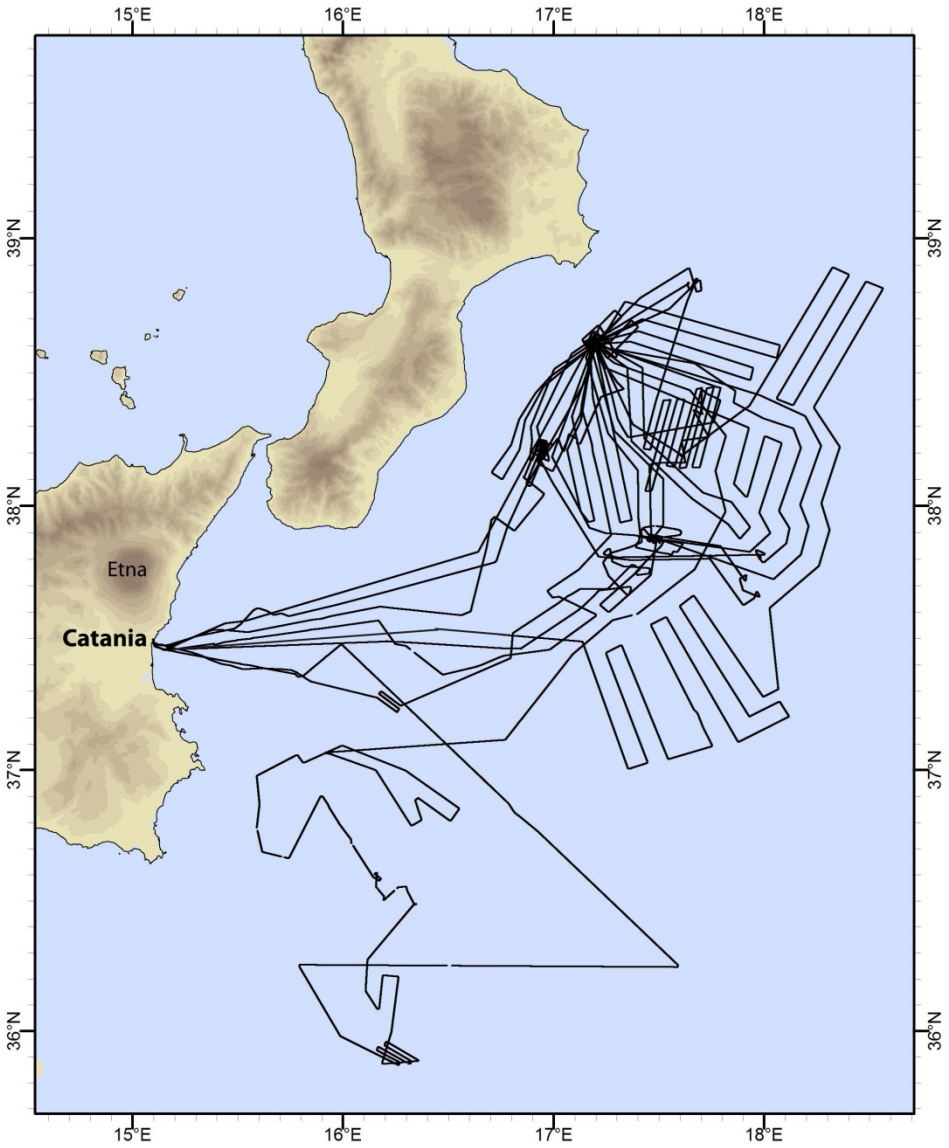
Prof. Dr. Gerhard Bohrmann
MARUM – Center for Marine Environmental Sciences
Klagenfurter Str.
28359 Bremen – GERMANY
Tel. +49 421-218-65050
Email: gbohrmann@marum.de

Zentrum für Marine Umweltwissenschaften

Short Cruise Report
R/V METEOR – M112
Catania – Catania – Catania
November 06 – December 15, 2014
Chief Scientist: Gerhard Bohrmann
Captain: Rainer Hammacher



Objectives

Mud volcanoes are geological structures that morphologically and dynamically remember magmatic volcanoes. Beside the morphology the erupting fine-grained sediments like mud, containing very often clasts from deeper strata are further characteristics of mud volcanism. Mud volcanoes are are highly dynamic systems and are responsible for greenhouse gas emissions which may influence global climate regimes and several attempts to estimate their contribution have been made. Beside gases mud volcanoes are also important interfaces for the transfer of water and other dissolved elements including hydrocarbons and oil. Mud volcanoes have been found in various geological settings on passive and active margins, but are mostly known from collision zones on earth like along the southern rim of the Eurasian plate. Specifically in the Eastern Mediterranean sea approximately more than 500 mud volcanoes are known from several regions like the Mediterranean Ridge, the Anaximander Mountains and Florence Rise, the Nile deep-sea fan area and the Calabrian arc. Within the framework of several European projects scientists from Italy and other countries collected over the last 10 years numerous multibeam echosounder data from the inner and outer Calabrian arc. By combining multibeam bathymetry and backscatter imagery, integrated with sub-bottom profiles and locally proven from geological sampling a total of 54 mud volcanoes have been identified in a sector of 35,600 km^2 (Ceramicola et al. 2014). Detailed sampling and seafloor investigations have been performed from only two mud volcanoes the Madonna dello Ionio and Pythagoras Mud volcano (Praeg et al. 2009).

The main goal of our expedition was to investigate active mud volcanoes which are characterized by recent mud flows, and emissions of fluids and gases, which we can image by hydro-acoustic recording of the water columns. Of particular interest was the presence of methane hydrates, which form within sediments of the mud volcanoes under certain conditions of pressure and temperature, and may play a sealing role during eruptions. At the same time, methane hydrates are a concentrated source of methane that is used by chemosynthetic organisms living at and below the seabed.

The working program varied between the two legs: During the first two weeks (Leg 1) we planned to use the hull-mounted multibeam EM122 and the PARASOUND system to explore which of the mud volcanoes have gas emission sites. Those gas flares are ideal indicators for mud low activities and are also very good indicators for active seafloor seepage. MARUM AUV SEAL 5000 was used to map single structure of mud volcanoes mostly during night time. During day time used the MARUM ROV QUEST 4000 which is also the main program during Leg 2. Another focus during the three weeks of Leg 2 was coring distinct mud flows in order to investigate the minimum age of the mud flows revealed from the pelagic sediments overlying the mud flow breccia. Furthermore deployments of the dynamic autoclave piston corer (DAPC) were planned to quantify the gas and gas hydrate saturation in sediments of mud volcanoes. Heat flow measurements and water column work were planned to complete the work program. The following scientific questions were addressed during the cruise:

- How different are the mud volcanoes in their construction?
- Are there relative fresh mud flows which can be identified and how are the shallow gas hydrates associated to those recent flows?
- Are the hydrates in older or younger sediments?
- Are there differences in hydrate concentrations for different lithologies e.g. pure mud, or mud breccias?
- Which conditions control the escape of fluids (liquid, gas) and mud and how does this shape the appearance of the seeps?
- How much methane is escaping as gas bubbles from the sea floor to the water column?
- What is the advective fluid flow and what is the source of the fluids?
- How much gas and gas hydrates exist in the sediments?
- Which organisms live at the seeps and how are they distributed?

Cruise Narrative

On Thursday, 6 November 2014, at 9 a.m. local time R/V METEOR left berth No. 12 of road Sporgente Central in the port of Catania, heading for research work on the Calabrian Arc. Before sailing, R/V METEOR had spent time at dock in Catania while the scientists and research tools of cruises M111 and M112 were exchanged. New research tools on board for M112 are the deep-sea remotely operated vehicle ROV MARUM QUEST 4000 and the autonomous underwater vehicle AUV SEAL 5000, as well as a number of geologic sampling devices. In total seven 20' containers from Bremen had to be stored on deck – partly in double layers - and the entire contents of a 40' container were distributed to the labs by the vessel's boatswain and seamen.

The scientists from Germany, Italy, Switzerland, Austria, Netherlands, France and Brazil embarked between 3 – 5 November and used the time to do necessary deck work together with the vessel's crew, as well as to set up the labs. We faced quite stormy weather, and were surprised by some heavy blasts while still in the port and upon sailing. Consequently the first days at sea, Thursday and Friday (6 and 7 Nov), were quite bumpy, and despite medical precautions resulted in some seasick persons. In particular, the first two nights were characterized by wind speeds on Beaufort-Scale of up to 7-8, peaking up to 9. Nonetheless, we were able to undertake the planned measurements using our hull-mounted hydro-acoustic systems, following the acquisition on Thursday, 6 November of a first underwater sound profile in water depths of up to 1,500 m using the SVP-Sonde.

Until Saturday night (8 November), under improving weather conditions, further potential locations were surveying using the hull-mounted Parasound and Multibeam systems, including the „Madonna dello Ionio" which shows a complex structure comprising several individual mud volcanoes. During the night from Saturday to Sunday we sailed back to Catania where, off the entrance to the port, we could gather a very important spare part for the ROV, which had not been delivered before our official time of departure last Thursday. This was also an opportunity to bring on board the luggage of our French colleague, which had been lost during her flight to Catania. On Sunday, 9 November R/V METEOR sailed back to Venere mud volcanoes under ideal weather conditions and a bright blue sky,. After a preliminary mapping of our target area at the foot of Venere Mud Volcano, on 9 November we deployed ROV QUEST 4000 for the first time during the cruise on Monday 10 November, in the darkness of night until sunrise at 06:00 a.m.

During the following ROV dive (ROV-338) we were able to make use the high-resolution micro-bathymetry map acquired during the first dive using the AUV SEAL 500 (AUV-62). In particular, the AUV map showed an area of about 100 x 100 m with high seafloor backscatter intensities, characteristic of fluid and/or gas emissions. On Thursday 13 November we received news saying that, unfortunately, we will not obtain the research permit for the Turkish Anaximander Mountains, where we had originally planned to do our work during METEOR cruise M112. Despite the strong efforts during the past weeks of the German Federal Foreign Office (AA), the German Embassy in Ankara, the Control Station German Research Vessels in Hamburg and many others, trying to obtain the research permit for our work in Turkish waters, this could not be achieved. After long discussions among the scientific team we were sure that we will be able to successfully continue our expedition using the available equipment on the Calabrian Arc until 15 December.

Following last week's decision to refocus the expedition M112 on the Calabrian Arc in Italy, we developed several new ideas for planning the scientific program over the coming days. First priority was given to deployment of the AUV, as the autonomous underwater vehicle and its crew were only available until our stopover in Catania on 20-21 November. Several AUV dives were therefore planned, and professionally and perfectly undertaken by the AUV-team, but some problems were experienced with the recording of data by the new multi-beam system on the vehicle. A severe intervention into the electronic part of the pressure chamber and a change of hard disks finally

brought a workaround, so that – after a short processing – on 17 November we could admire a fantastically detailed micro-bathymetry map of Venere mud volcano.

On Monday 17 November, we performed a 10-hour dive with the ROV QUEST 4000 (ROV-339) in the area of the most prominent gas emission (Flare 1). The 340th dive of the ROV QUEST was performed on Tuesday 18 November, at the foot of the southern flank of Venere mud volcano, where acoustic data indicate a relatively weak gas emission (Flare 2). Through sampling and targeted observation we documented a heterogeneous seep area similar to that north of the mud volcano, also including thick carbonate crusts and occurrences of tube worms. The final AUV dive (AUV-66) of this cruise was performed during the night, in the area of the central caldera of Cetus mud volcano. Its mapped micro-bathymetry was astonishing because of the high details. On Wednesday 19 Nov, after acquiring two gravity cores and a water column profile measurement at Cetus mud volcano, we headed for Catania and arrived punctually in the port under best possible weather conditions on Thursday 20 November.

The two days in harbor were used for an exchange of expedition equipment, scientists and crew members, and divided our cruise into two legs. After leaving the port of Catania last Saturday 22 November we focused on mapping the seafloor in the southern part of our working area using the hull-mounted multi-beam sonar. In addition to looking for new mud volcanoes, we simultaneously prospected for gas emission sites on the seafloor. The first station work of Leg 2 occurred on Tuesday, 25 November, and included a sediment core, and a CTD-deployment in the 3,100 m deep basin on. The rest of that day and through the night we conducted mapping on several crooked profile lines north of Venere Mud Volcano. During the following day, 26 November, we performed a dive at the northern Flare 1, which is the same location where we had observed the strongest gas emissions at the seafloor the previous week.

During our acoustic surveys, we found up to five gas emission locations at Venere Mud Volcano, which were chronologically named Flare 1 to 5 according to their discovery date. The ROV QUEST dive (Dive ROV- 341) on Wednesday morning, 26 November, started with a surprise. At the seafloor in 1,570 m water depth, we could not see any gas bubbles at the emission location that always showed strongest gas emission the Parasound records. Such a change in gas bubble activity after only a few days revealed the high variability of the active gas emissions, both in time and space. From now on we focused on studying the variability patterns of these 5 flares in more detail by crossing the locations almost daily and checking them with PARASOUND several times in a 1.5-hours transit.
During the night to 27 November, we steamed for Catania in order to obtain a late parcel from the USA and some luggage lost during the flight from Germany. Back in the northern work area off Calabria we successfully conducted ROV Dive 342 at the western summit of Venere Mud Volcano on 28 November. The following Saturday, 29 November, became a day of gravity coring, which we continuously deployed at six different locations within the mud volcano area. The selection of the stations was supported by the backscatter map. On Sunday, 30 November, we had an early CTD-station for studying the methane plume in the water column. Afterwards we conducted the extremely fascinating ROV dive 343 at Flares 4 and 5, at the southern edge of the mud volcano structure.

RV METEOR's fifth week of the 112nd expedition was dominated by dives using the MARUM remotely operated vehicle QUEST 4000m. We conducted dives almost daily, during which the scientific payload that included push cores, a temperature probe, gas bubble samplers, bubble catcher, nets and a shovel was routinely utilized on the seafloor, representing the main program of this cruise. On Monday, Wednesday, and Thursday we performed dives at Venere mud volcano, which was well-known to us from the AUV-map, while on Friday, 05 December, and Saturday, 06 December, dives ROV-347 and 348 were conducted at Cetus and Nikolaus mud volcanoes.

ROV QUEST Dive 344 on Monday, 01 December, guided us to quite fresh looking mud flows coming down from the summit of Venere mud volcano. Under optical control of ROV-video cameras we picked the freshest looking one and followed it upslope to the summit. Although there was no visible movement of the flow, we could see from its fractures, furrows and other fabrics that it must have been flowing lately. This was confirmed by the temperature lance measurements, which recorded 22°C in 50 cm depth at the emission location, corresponding to an increase of 8°C from bottom water temperature. This very high heat flow is caused by the ascent of mud within the conduit of the mud volcano from greater depth, and certainly made the ROV-based sampling of sediments and bottom water direct from the chimney very exciting. After that dive, and during a further processing of the sediments, we found that the pore water of the mud has a drastically reduced salinity, which reach values of 10 ‰. Such fluids are quite rare in the Mediterranean because of the omnipresent Messinian salts. Furthermore the gas composition of the mud clearly showed a thermogenic source. This finding was surprising to us because the gas composition of Flares 1-5 in the surrounding regions of the mud volcano revealed of a mixture of biogenic and thermogenic sources. We could successfully sample and quantify the gas in the sediments by means of our autoclave piston corer, because this device encases the sediment with its pore water and gas content in an autoclave under the *in situ*-pressure, and therefore the sample comes to the surface without any loss of gas. The quantification under atmospheric pressure documented a more than threefold volume of gas to sediment, and explained why the mud deposits in the cores have a bubble-like appearance throughout.

In contrast to Venere mud volcano Cetus and Nikolaus MVs show only little evidence of any current activity. In the central caldera of Cetus MV, we measured a slight increased heat flow, however, a bottom water sample collected near the seafloor in the volcanic cone of Nikolaus MV showed a clear increase in methane concentration. Both facts are very typical for mud volcanoes; however, the low values indicate a calmer phase in mud volcanism currently. Nikolaus mud volcano was discovered just two days ago, during a night geophysical survey and we named it Nikolaus because the ROV-dive at this newly discovered mud volcano was conducted on St. Nicolas' day, 6 December. Besides all the diving activities also numerous gravity cores from single mud flows had been taken, as well as CTD-stations with sampling of water column in order to follow more in detail the near-bottom methane spreading and the methane plume formation of seeps.

We performed a last dive on this cruise with ROV QUEST 4000m – it was dive number 350 since the ROV was installed in 2003. ROV QUEST dived at gas emission site Flare 2 which was already visited during the first leg of the cruise. Our multiple surveys of the 5 flare locations clearly shows that the seep activities around Venere mud volcano are highly variable and we can hardly describe this variability by rules. Nevertheless the gas seepage is connected with the activity the mud volcano. After exploration of more than ~50 mud volcanoes at the Calabrian Arc, Venere mud volcano seems to be the only active one right now in the surveyed part of the Calabrian accretionary wedge.

Monday, Tuesday and Thursday of the last week were characterized by gravity core sampling at Venere and Cetus mud volcanoes, and sediment cores had been taken from different mud flows. Cetus mud volcano showed a further highlight as we could precisely determine the chimney of the mud volcano after temperature measurements during ROV dive 347 and sample it with a so-called plastic bag gravity corer. A pore water analysis of the mud breccia core showed that like in Venere mud volcano the salinity of seawater concentration of 38.2 ‰ is decreasing by increasing depth and reaches a constant salinity value of 10 ‰ in a depth of 50 cm. By means of that curve we can clearly prove the freshwater signal from the underground but also – by the curve progression – we can model the time of the latest mud volcano eruption via the rate of diffusion of the overlying seawater.

On Friday, 12 December, last station work of this cruise was performed by sampling some mud flows of Satori mud volcano and since Friday night some mapping with Parasound and Multibeam in the deeper part of the Calabrian accretionary wedge was performed. We continued with this program

until Sunday night, 14 December, and on Monday morning, 15 December, we arrived in Catania port as planned. Despite the short-term change of the research area the cruise M112 ends as a very successful cruise of METEOR.

Acknowledgements

The research permission from the Italian Foreign ministry was performed on a very fast track. We are thankful to all authorities who helped to reach this permission, like the German embassy in Rome, the foreign ministry in Berlin and the Control Station German Research Vessels in Hamburg. The cruise was coordinated and carried out by MARUM Center for Marine Environmental Sciences at the University of Bremen. The research program is part of the DFG Research Center and Cluster of Excellence "The Ocean in the Earth System" in Research Area "Geosphere Biosphere Interactions", project GB3 "Contribution of Cold Seeps to Geological Processes, Carbon Fluxes, and Ecosystem Diversity". The cruise was financed by MARUM the German Research Foundation (DFG) within GB3 and by an incentive fund proposal "Anaximander Mud volcanoes". The shipping operator Reederei Briese Schiffahrts GmbH & Co KG provided technical support on the vessel. We would like to specially acknowledge the master of the vessel Rainer Hammacher, and his crew for their continued contribution to a pleasant and professional atmosphere aboard R/V METEOR.

Cruise participants

Name	Discipline	Affiliation	Leg
Alvarez, Ruben	Pore water	MARUM	2
Biller, Tiago	Multibeam/Parasound	MARUM	2
Bohrmann, Gerhard	Chief Scientist	GeoB	1 & 2
Buchheister, Stefanie	Pore water and gases	GeoB	1 & 2
Büttner, Hauke	ROV	MARUM	1 & 2
Canoni, Oliviero	Observer	OGS	2
Dehning, Klaus	DAPC, gravity cores	MARUM	2
Ferreira, Christian	Multibeam/Parasound	MARUM	1 & 2
Geprägs, Patrizia	OA-ICOS	MARUM	1 & 2
Heinken, Siebo	Web log	NG	1
Hüttich, Daniel	ROV	MARUM	1
Johansen, Caroline	ROV mapping	MARUM	1
Klar, Steffen	ROV	MARUM	1 & 2
Klüber, Sven	ROV tools	MARUM	1 & 2
Leymann, Tom	ROV	MARUM	1 & 2
Mai, Hoang Anh	ROV	MARUM	1 & 2
Marcon, Yann	Mosaicking/ROV	AWI	1
Mary, Flore	Sediments	OGS	1
Meinecke, Gerrit	AUV	MARUM	1
Menapace, Walter	T-lance	MARUM	2
Nowald, Nicolas	ROV	MARUM	1
Pape, Thomas	DAPC	MARUM	2
Präg, Daniel	Observer	OGS	1 & 2
Rehage, Ralf	ROV	MARUM	2
Renken, Jens	AUV	MARUM	1
Reuter, Christian	ROV	MARUM	1 & 2
Römer, Miriam	Flares/data handling	MARUM	1 & 2
Sahling, Heiko	ROV dives	GeoB	1
Sans i Coll, Cristina	T-lance, observatory	GeoB	2
Schade, Tobias	DAPC, gravity cores	MARUM	2
Seiter, Christian	ROV	MARUM	2
Spalek, Phillipp	Photography	NG	1

Spieseke, Ulli	AUV	MARUM	1
Tamborrino, Leonardo	Sediment cores	DCGS	2
Torres, Marta	Pore water	OSU	2
von Wahl, Till	AUV	MARUM	1
Wiebe, Monika	Multibeam/Parasound	MARUM	1 & 2
Wintersteller, Paul	Multibeam/Parasound	MARUM	1 & 2
Zarrouk, Marcel	ROV	MARUM	1 & 2

MARUM Center for Marine and Environmental Sciences, DFG Research Center and Cluster of Excellence, University of Bremen, Postfach 330440, 28334 Bremen, **Germany**

GeoB Department of Geosciences, University of Bremen, Klagenfurter Str., 28359 Bremen, **Germany**

OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale - OGS Borgo Grotta Gigante 42/c, 34010 Sgonico, Trieste**, Italy**

NG National Geographic Deutschland, G +J/RBA GmbH & Co KG; Am Baumwall 11; D-20459 Hamburg, **Germany**

OSU Oregon State University, Corvallis OR, **USA**

DCGS Department of Chemical and Geological Sciences of the University of Modena and Reggio Emilia, Modena**, Italy**

AWI Alfred-Wegener Institut, Helmholtz Zentrum für Meeres- und Polarforschung, Bremerhaven, **Germany**

List of Stations

					Time (UTC)		Begin / on seafloor		
Date 2014	St. No.	Instrument	GeoB St. No.	Location	Begin	End	Latitude N	Longitude E	Water depth (m)
06.11.	1214-1	SVP-1	19201-1	Italy	13:36	14:35	37°29.315	16°12.446	2224
09.11.	1215-1	ROV-337	19202-1	Venere MV (Flare 1)	19:32	06:04	38°37.085	17°11.606	1560
09.11.	1215-1	TS	19202-2		22:13	23:14	38°37.084	17°11.593	1567
10.11.	1216-1	AUV-62	19203-1	Venere MV	07:55	17:35	38°36.920	17°10.190	1555
10.11.	1217-1	CTD-1	19204-1	Venere MV	19:12	20:22	38°37.104	17°11.643	1554
10.11.	1218-1	GC-1	19205-1	Venere MV (Flare 1)	20:44	22:10	38°37.102	17°11.619	1556
10.11.	1218-2	GC-2	19205-2	Venere MV (Flare 1)	22:55	00:15	38°37.103	17°11.620	1556
11.11.	1219-1	GC-3	19206-1	Venere MV	00:42	01:49	38°36.605	17°11.235	1506
12.11.	1220-1	CTD-2	19207-1	Venere MV (Flare 1)	17:25	19:12	38°37.156	17°11.603	1565
12.11.	1221-1	MIC-1	19208-1	Venere MV (Flare 1)	20:00	21:12	38°37.104	17°11.619	1560
12.11.	1222-1	MIC-2	19209-1	Venere MV (West)	21:27	22:35	38°36.607	17°11.229	1508
13.11.	1223-1	CTD-3	19210-1	Venere MV (Flare 1)	05:01	06:38	38°37.165	17°11.600	1566
13.11.	1224-1	ROV-338	19211-1	Venere MV (Flare 1)	07:15	18:42	38°37.088	17°11.636	1556
13.11.	1224-1	Mosaik	19211-1		12:43	16:27	38°37.093	17°11.630	1565
13.11	1225-1	GC-4	19212-1	Venere MV (Flare 1)	19:32	20:38	38°37.106	17°11.623	1561
13.11.	1226-1	GC-5	19213-1	Venere MV (in High-BS)	21:10	22:15	38°37.075	17°11.641	1567
14.11.	1227-1	CDT-4	19214-1	Venere MV (Flare 1)	05:01	06:05	38°37.109	17°11.622	1560
14.11.	1228-1	AUV-63	19215-1	Venere MV	07:28	18:01	38°36.930	17°10.207	1560
14.11.	1229-1	CDT-5	19216-1	Venere MV (Flare 1)	18:30	20:46	38°37.037	17°11.729	1547
15.11.	1230-1	SVP-2	19217-1	On transit to Cetus MV	17:02	17:28	37°43.570	17°53.115	2699
16.11.	1232-1	AUV-64	19219-1	Venere MV	15:10	00:38	38°37.086	17°09.877	1659
17.11.	1233-1	CTD-6	19220-1	Venere MV (Flare 2)	04:29	06:05	38°36.066	17°12.570	1587
17.11.	1234-1	ROV-339	19221-1	Venere MV (Flare 1)	07:00	17:31	38°37.083	17°11.606	1561
17.11.	1235-1	AUV-65	19222-1	Venere MV	18:25	07:11	38°36.652	17°13.279	1588

18.11.	1236-1	CTD-7	19223-1	Venere MV (Flare 1)	07:50	10:00	38°37.083	17°11.633	1549
18.11.	1237-1	ROV-340	19224-1	Venere MV (Flare 2)	10:59	16:35	38°36.049	17°12.577	1593
18.11.	1238-1	AUV-66	19225-1	Cetus MV	21:34	08:01	37°52.589	17°28.922	2239
19.11.	1239-1	GC-6	19226-1	Cetus MV	08:32	10:00	37°52.837	17°30.375	2412
19.11	1240-1	GC-7	19227-1	Cetus MV	10:20	11:12	37°52.433	17°29.310	2322
22.11.	1241-1	SVP-3	19228-1	East of Catania	12:17	12:39	37°21.533	15°48.649	2420
25.11.	1242-1	CTD-8	19229-1	Basin, SE of Sicily	05:05	07:37	37°04.003	15°55.096	3111
25.11.	1242-2	GC-8	19229-2	Basin, SE of Sicily	08:02	10:00	37°04.006	15°55.096	3113
25.11.	1242-3	GC-9	19229-3	Basin, SE of Sicily	10:24	12:20	37°04.010	15°55.100	3112
26.11.	1243-1	ROV-341	19230-1	Venere MV (Flare 1)	07:02	16:49	38°37.088	17°11.604	1564
26.11.	1244-1	CTD-9	19231-1	Venere MV (Western summit)	17:48	19:17	38°36.430	17°11.282	1507
28.11.	1245-1	ROV-342	19232-1	Venere MV (Western summit)	08:48	16:43	38°36.478	17°11.179	1499
28.11.	1246-1	CTD-10	19233-1	Venere MV (Western summit)	18:25	21:10	38°36.447	17°11.313	1505
29.11.	1247-1	GC-10	19234-1	Venere MV (East)	07:12	08:22	38°36.663	17°11.973	1505
29.11.	1248-1	GC-11	19235-1	Venere MV (West)	08:52	09:57	38°36.457	17°11.037	1510
29.11.	1249-1	GC-12	19236-1	Venere MV (Flare 1)	10:29	11:39	38°37.094	17°11.605	1557
29.11.	1249-2	GC-13	19236-2	Venere MV (Flare 1)	11:57	13:10	38°37.095	17°11.606	1556
29.11.	1250-1	GC-14	19237-1	Venere MV (West)	13:49	15:01	38°35.930	17°11.828	1594
29.11.	1251-1	GC-15	19238-1	Venere MV (West)	15:40	16:50	38°36.757	17°11.378	1521
30.11.	1252-1	CTD-11	19239-1	Venere MV (Flare 5)	04:59	06:58	38°35.547	17°12.011	1604
30.11.	1253-1	ROV-343	19240-1	Venere MV (Flare 4+5)	07:46	19:18	38°35.425	17°11.967	1605
01.12.	1254-1	CTD-12	19241-1	Venere MV (Flare 5)	05:00	06:53	38°35.455	17°12.039	1598
01.12.	1255-1	ROV-344	19242-1	Venere MV (Western summit)	07:26	18:00	38°36.453	17°11.244	1500
02.12.	1256-1	DAPC-1	19243-1	Venere MV (Flare 1)	06:58	08:30	38°37.095	17°11.604	1556
02.12.	1256-2	DAPC-2	19243-2	Venere MV (Flare 1)	10:05	12:13	38°37.096	17°11.607	1556
02.12.	1257-1	GC-16	19244-1	Venere MV (East)	12:53	14:03	38°36.648	17°12.062	1518
02.12.	1258-1	GC-17	19245-1	Venere MV (Western summit)	14:34	15:35	38°36.455	17°11.223	1496
02.12.	1258-2	GC-18	19245-2	Venere MV (Western summit)	15:59	17:45	38°36.454	17°11.222	1495
02.12.	1259-1	GC-19	19246-1	Venere MV (West)	17:34	18:57	38°36.504	17°11.615	1528
03.12.	1260-1	CTD-13	19247-1	Venere MV (Canyon SE)	05:13	07:13	38°35.590	17°11.367	1602
03.12.	1261-1	HF-1	19248-1	Venere MV (Western summit)	11:11	11:22	38°36.445	17°11.229	1498
03.12.	1261-2	HF-2	19248-2	Venere MV (Western summit)	11:35	11:46	38°36.452	17°11.221	1500
03.12.	1261-3	HF-3	19248-3	Venere MV (Western summit)	11:57	12:08	38°36.452	17°11.223	1498
03.12.	1261-4	HF-4	19248-4	Venere MV (Western summit)	12:30	12:40	38°36.455	17°11.226	1495
03.12.	1261-5	HF-5	19248-5	Venere MV (Western summit)	12:51	13:02	38°36.456	17°11.227	1496
03.12.	1262-1	ROV-345	19249-1	Venere MV (Flare 4+5)	14:26	20:44	38°35.457	17°12.016	1605
04.12.	1263-1	CTD-14	19250-1	Venere MV (Western summit)	05:26	07:55	38°36.451	17°11.214	1495
04.12.	1264-1	DAPC-3	19251-1	Venere MV (Western summit)	08:06	09:59	38°36.452	17°11.224	1497
04.12.	1265-1	ROV-346	19252-1	Venere MV (Flare 4+5)	11:29	20:27	38°35.448	17°12.022	1605
05.12.	1266-1	ROV-347	19253-1	Cetus MV	09:10	19:16	37°53.121	17°27.751	2267
05.12.	1267-1	HF-6	19254-1	Cetus MV	20:35	20:43	37°52.959	17°28.450	2258
05.12.	1267-2	HF-7	19254-2	Cetus MV	21:22	21:30	37°52.806	17°28.513	2254
05.12.	1267-3	HF-8	19254-3	Cetus MV	21:55	22:03	37°52.754	17°28.631	2250
06.12.	1268-1	ROV-348	19255-1	Nicolas MV	10:13	20:07	37°49.003	17°58.231	2676
07.12.	1269-1	CTD-15	19256-1	Venere MV (Flare 2)	05:08	07:10	38°36.115	17°12.549	1589
07.12.	1270-1	DAPC-4	19257-1	Venere MV (Flare 1)	07:43	09:15	38°37.095	17°11.604	1561
07.12.	1271-1	ROV-349	19258-1	Venere MV (Western summit)	09:58	19:20	38°36.304	17°11.177	1523
07.12.	1272-1	HF-9	19259-1	Venere MV (West)	20:11	20:19	38°36.461	17°11.255	1494
07.12.	1272-2	HF-10	19259-2	Venere MV (West)	20:38	20:46	38°36.455	17°11.285	1499
07.12.	1272-3	HF-11	19259-3	Venere MV (West)	21:04	21:12	38°36.436	17°11.323	1505
07.12.	1272-4	HF-12	19259-4	Venere MV (West)	21:39	21:47	38°36.400	17°11.372	1515
07.12.	1272-5	HF-13	19259-5	Venere MV (West)	22:11	22:19	38°36.430	17°11.406	1519

08.12.	1273-1	GC-20	19260-1	Venere MV (Flare 2)	06:00	07:10	38°35.802	17°11.579	1590
08.12.	1274-1	GC-21	19261-1	Venere MV (Mud flow 3)	07:31	08:41	38°35.876	17°11.714	1600
08.12.	1275-1	CTD-16-1	19262-1	Venere MV	10:09	11:38	38°37.340	17°10.154	1522
08.12.	1275-2	CTD-16-2	19262-2	Venere MV	12:12	13:29	38°36.966	17°10.522	1560
08.12.	1276-1	GC-22	19263-1	Venere MV	13:54	15:07	38°36.448	17°11.282	1500
08.12.	1277-1	GC-23	19264-1	Venere MV (Mud flow 4)	15:24	17:00	38°36.166	17°12.041	1590
08.12.	1278-1	CTD-17	19265-1	Venere MV (SW Canyon)	16:53	18:38	38°35.697	17°11.029	1597
09.12.	1279-1	DAPC-5	19266-1	Venere MV	04:46	06:53	38°36.449	17°11.283	1498
09.12.	1280-1	ROV-350	19267-1	Venere MV (Flare 2)	07:58	14:38	38°36.093	17°12.571	1593
09.12.	1281-1	DAPC-6	19268-1	Venere MV	15:00	17:07	38°36.450	17°11.282	1500
09.12.	1282-1	GC-24	19269-1	Venere MV (Mud flow 1)	17:44	19:05	38°36.105	17°11.915	1590
09.12.	1283-1	GC-25	19270-1	Venere MV (Mud flow 1)	19:21	20:46	38°36.176	17°11.129	1534
09.12.	1284-1	CTD-18	19271-1	Venere MV (South)	21:17	23:02	38°35.853	17°12.060	1594
09.12.	1285-1	CTD-19	19272-1	Venere MV (Southern flank)	23:44	00:52	38°36.081	17°11.682	1566
10.12.	1286-1	CTD-20	19273-1	Venere MV (Western summit)	01:22	03:12	38°36.426	17°11.260	1505
10.12.	1287-1	CTD-21	19274-1	Venere MV (Northern flank)	03:43	04:46	38°36.700	17°10.942	1532
10.12.	1288-1	CTD-22	-	Venere MV	05:12	05:17	38°35.470	17°12.650	1613
10.12.	1289-1	GC-26	19275-1	Venere MV (Flank)	07:05	08:18	38°36.022	17°11.865	1587
10.12.	1290-1	GC-27	19276-1	Venere MV	08:40	10:00	38°36.393	17°11.348	1516
10.12.	1291-1	GC-28	19277-1	Venere MV (Western flow)	10:32	11:43	38°36.167	17°10.873	1543
10.12.	1292-1	GC-29	19278-1	Venere MV (NW flow)	12:07	13:24	38°36.338	17°10.850	1535
10.12.	1293-1	GC-30	19279-1	Venere MV	14:12	15:20	38°34.784	17°12.881	1560
10.12.	1293-2	-	19279-2	Venere MV	16:00	16:10	38°34.790	17°12.880	1560
10.12.	1293-3	MIC-3	19279-3	Venere MV	16:24	17:50	38°34.783	17°12.883	1560
10.12.	1294-1	GC-31	19280-1	Venere MV	18:05	19:07	38°36.851	17°12.048	1513
10.12.	1295-1	CTD-23	19281-1	Venere MV (NW channel)	19:34	21:32	38°36.149	17°09.983	1555
11.12.	1296-1	GC-32	19282-1	Cetus MV	07:00	08:34	37°52.275	17°28.362	2287
11.12.	1297-1	GC-33	19283-1	Cetus MV	09:22	11:00	37°52.807	17°27.736	2216
11.12.	1298-1	GC-34	19284-1	Cetus MV	11:28	13:10	37°51.789	17°30.230	2432
11.12.	1299-1	GC-35	19285-1	Cetus MV	13:45	15:13	37°52.067	17°29.900	2378
11.12.	1300-1	GC-36	19286-1	Cetus MV	15:47	17:20	37°52.140	17°30.436	2438
12.12.	1301-1	DAPC-7	19287-1	Venere MV (West)	05:57	07:59	38°36.394	17°11.361	1516
12.12.	1302-1	CTD-24	19288-1	Venere MV (SE basin)	08:35	10:03	38°35.462	17°12.637	1622
12.12.	1303-1	GC-37	19289-1	Sartori MV	13:15	14:40	38°12.200	17°35.712	1960
12.12.	1304-1	GC-38	19290-1	Sartori MV	15:01	16:20	38°11.732	17°36.241	1958

AUV = Autonomous underwater vehicle: 5 dives
ROV = Remotely Operated Vehicle: 14 dives
GC = Gravity cores: 38 stations
DAPC = Dynamic autoclave piston corer: 7 deployments
CTD = 24 CTD/hydrocast stations
HF = Heat flow probe: 7 deployments
MIC = Minicorer: 3 stations
SVP = Sound velocity profiler: 2 stations
In total R/V METEOR sailed 4.489 nautical miles