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Short Cruise Report

R/V METEOR – M128

Ponta Delgada – Ponta Delgada

2. July 2016 – 27. July 2016

Chief Scientist: Christoph Beier

Captain: Jan F. Schubert

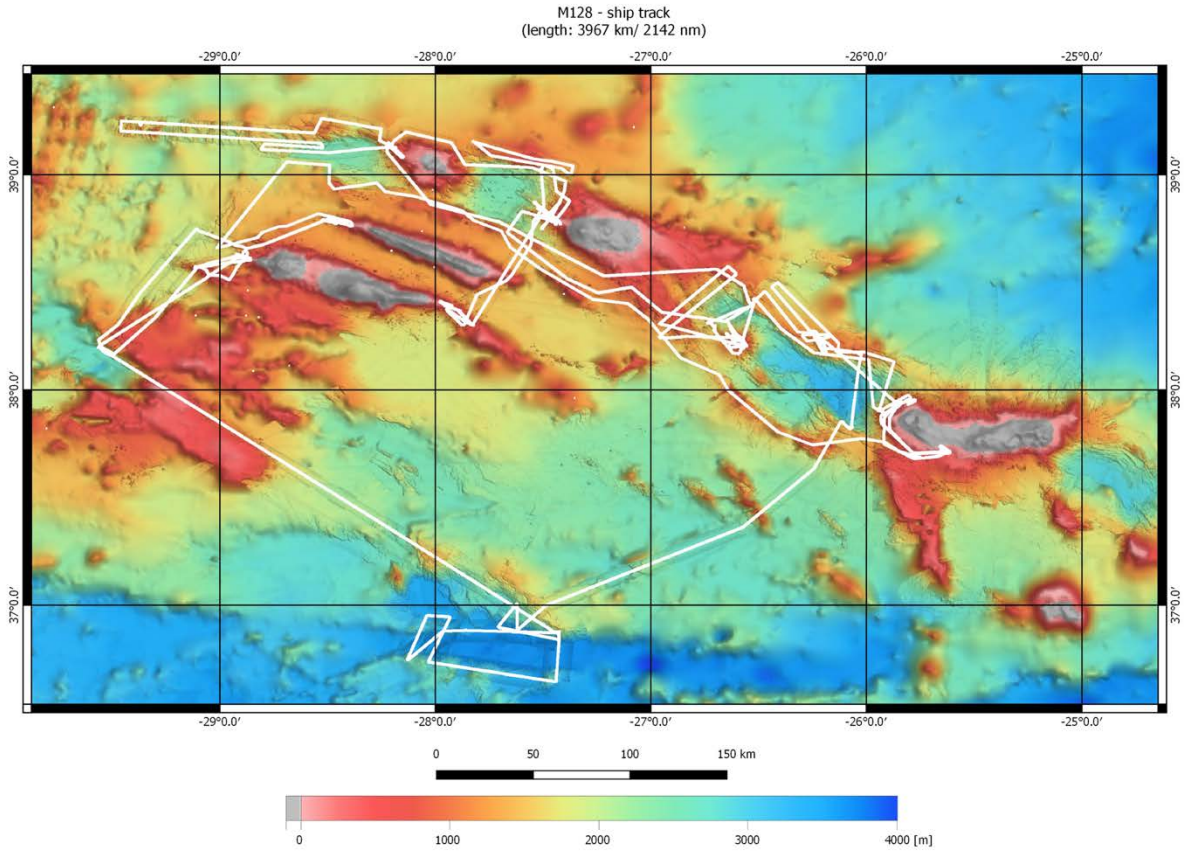

Fig. 1: Overview map of ship track of cruise M128 Azores Plateau.

Objectives

The research program of M128 had the main objective of sampling and mapping both the oldest and youngest volcanic edifices of the Azores that were identified but not sampled during previous cruises (Pos232, Pos286, M79/2, M113). The rock sampling targeted numerous young, historically to recently volcanically active structures (João de Castro seamount, Serreta, Capelinhos, Sete Cidades) but also aimed at the older volcanic sequences that were sampled in the basins north of João de Castro, between Terceira and Graciosa, west of São Miguel, along the East Azores Fracture Zone and at Princesa Alice bank to better constrain the initial formation, timing and evolution of the Azores Plateau. The combination of detailed bathymetric maps and petrological samples allows us for the first time to better constrain the evolution of volcanic rift systems in this tectonically and magmatically active region. During and after the cruise we aimed to test the following hypotheses with our working program:

- Relatively incompatible element depleted tholeiitic lavas form the lower part of the Azores Plateau and reflect enhanced melting either in a plume head or when the Azores plume occurred beneath the Mid-Atlantic Ridge.
- The lavas from the deep part of the entire Azores Plateau have about similar ages (~10 Ma?) reflecting one event of voluminous flood basalt volcanism.
- Compositional changes occur within the flood basalts reflecting variations in melting and fractional crystallization processes.
- The young eruption events occurred along dikes connected to larger volcanic structures and produced pillow lavas reflecting relatively low lava eruption rates.

- We aimed to test whether the high volatile content of the Azorean magmas affects the hydrothermal venting considerably, leading to very high CO_2 contents in the fluids. Unfortunately, we did not find any evidence for the occurrence of recent hydrothermal activity and previous interpretations of active degassing SE of the summit of João de Castro were apparently wrong.
- A description of deep-sea biological assemblages required further voucher specimens to be collected for taxonomy as many dominant species remain beyond simple visual recognition.
- High-resolution surveys conducted on the selected bathyal areas suggest that the occurrence of assemblages dominated by habitat-building species may be patchier than broad-scale models forecast. Such detailed information is currently in high demand for (i) marine spatial planning at regional scales as well as for (ii) the design of zonation schemes at marine protected area scales.
- The submarine rift zones along the Terceira axis are probably connected by dikes to the magma systems of the subaerial volcanoes and this connection can be tested using geochemistry and petrology. Using ROV Quest 4000 and TV-grab, and hydroacoustic surveys to map and study these sites in detail offers the possibility to determine the composition of lavas, their volume and the volcanic processes of their formation.
- If the Azores volcanism formed due to a mantle "wetspot" then the H_2O and CO_2 contents in the magmas should be high and we need to study melt inclusions in minerals and possibly glassy submarine lavas in fresh samples from Serreta, João de Castro and Capelinhos. We intend to study the volatile content in young submarine lavas in order to test the hypothesis of an Azores "wetspot". So far, sampling of glassy lavas by dredging has been difficult and fortuitous and only few samples suitable for determination of H_2O and CO_2 have been recovered. The ROV and TV grab samples yielded better results and numerous fresh glassy samples were recovered during M128.

In addition, a hydroacoustic survey and sampling profile targeted the area W of Graciosa aiming at the triple junction of the Eurasian, African and American Plates and the structural and geological evolution of the ultraslow spreading Terceira rift axis. The sampling was based on the multibeam surveys of M79/2, M113 and M128 and was preferentially done by Remotely Operated Vehicle (ROV Quest 4000) and TV grab to ensure consistent and accurate sampling as well as structural and geological control of the sampling. During the TV grab sampling we used Miniature Autonomous Plume Recorders (MAPR) devices provided by the Pacific Marine Environmental Laboratory of NOAA. These recorders of turbidity, E_H, pressure, and temperature were used to detect potential hydrothermal vents in the vicinity of the Azores. Unfortunately, we did not find any evidence for hydrothermal activity and could not confirm previous interpretations of large-scale submarine volcanic degassing at João de Castro Seamount.

Cruise Narrative

A delegation of scientists from the GeoZentrum Nordbayern of the Friedrich-Alexander-Universität Erlangen-Nürnberg and the entire ROV Marum QUEST team arrived on the 28th of June and started installing the ROV and the TV grab on RV Meteor on the 29th of June. The majority of the scientific party joined on the 30.06.2016 and the entire scientific party boarded the ship on Friday, the 1st of July 2016. During port stay the installations for the Remotely Operated Vehicle Quest (ROV QUEST), the TV grab (TVG) and the volcanic wax corer (VSR) were done and the labs were prepared for their operations.

Saturday the 2nd of July RV METEOR left Ponta Delgada harbour at 9 am and reached the open sea only a few minutes later with calm seas and little wind. The scientific program started at 9:25 am with hydroacoustic surveys along the southern coast and west of São Miguel followed by two successful TV grabs west of São Miguel. During the night of the 2nd to the 3rd of July the scientific program continued with a multibeam survey along the northern rift shoulder of the Hirondelle Basin between São Miguel and Terceira. During the morning RV METEOR headed south towards João de Castro seamount, a major scientific target that was sampled by TV grabs and ROV dives. From the 3rd to the morning of the 5th of July we performed numerous successful TV grabs, a hydroacoustic profile and an ROV dive in the vicinity of João de Castro.

During daytime of the 5th of July the ROV sampled the graben shoulder of the Terceira Rift north of João de Castro and recovered 13 stratigraphically controlled samples of the older lavas of the Azores Plateau. This stratigraphic profile was then continued on the 15th of July. During the night of the 5th of July to the morning of the 6th of July, we successfully carried out five TV grabs at João de Castro.

The morning of Wednesday the 6th of July was used to perform an ROV dive in the north of João de Castro and during the night to Thursday the 7th of July we carried out a multibeam survey towards Serreta west of the island of Terceira. This was the site of a major submarine eruption from 1998 to 2001. An ROV dive in the following morning was delayed by the fact that we found numerous fishing lines, fishing boats and buoys in the immediate vicinity of the diving area and after a successful TV grab NW of Serreta we managed to have the ROV on the ocean floor at 600 m water depth NW of Serreta. Two TV grabs subsequently sampled the area 6 miles NW of Serreta. The next ROV dive started in the morning of the 8th of July at the submarine Pico ridge off the island of Pico which was extensively sampled. However, due to increasing winds and waves the ROV dive finished at midday and we continued sampling Pico Ridge by TV grab. During the night of the 8th to the 9th of July we continued a multibeam profile towards Terceira and then did an ROV profile at the northern Terceira Basin in the morning of the 9th of July. The following night we spent with an hydroacoustic survey of the basin west of the island of Terceira to investigate the rifting processes that occur in the Azores. The morning of Sunday the 10th of July started with a slow hydroacoustic survey across the submarine Serreta volcano before we started diving in one of the bathymetric deeps of this young submarine volcano.

We continued with a short hydroacoustic survey north and south of Serreta. During the night we conducted three successful TV grabs on Serreta volcanic ridge. After a bathymetric survey

across Serreta we decided to improve our understanding of Serreta with an additional dive along the southern flank. Unfortunately, the dive was delayed by the presence of fishermen. The ROV was lowered into the water at lunchtime after maritime police had finally cleared the area. The TV grab in the night of the 11th of July was used to extensively sample the volcanic system. In the morning of the 12th of July we aimed to conduct another dive at the eastern part of the Serreta volcanic ridge. However, due to technical problems the dive was delayed and commenced at lunchtime. Two TV grabs 7 to 13 km north of Serreta were then lowered during the night.

The night from Tuesday (12th) to Wednesday (13th) and the entire Wednesday were used to perform an hydroacoustic survey along the northern coastline of Graciosa heading west towards the Mid-Atlantic Ridge. Unfortunately, sampling the seamounts some 40 km's east of the Mid-Atlantic Ridge was unsuccessful as a result of technical problems with the TV grab and the hard surfaces prohibiting any samples to be grabbed.

The multibeam survey continued until the 14th of July in the morning, when we started an ROV dive west of Graciosa. The night from the 14th to the 15th was spent with a multibeam survey south of Graciosa and Terceira towards north of João de Castro seamount. We continued the stratigraphic profile from the 5th of July between 1960 m and 1200 m water depth recovering additional 20 rock samples.

The night of the 15th and morning of the 16th was used for a hydroacoustic survey along the northern Hirondelle Basin and towards São Miguel to define potential dive areas for the next days. We arrived in the harbour of Ponta Delgada in the evening of the 16th of July and stayed in port during the night before heading out for the 30-year FS METEOR anniversary cruise with members of the German Research Foundation, the Federal Ministry of Education and Research, the Leitstelle Deutsche Forschungsschiffe in Hamburg and the German Parliament. The dive on the 17th of July was performed west of the island of São Miguel and targeted a potentially young rift zone volcano. Dive #400 of Quest 4000 revealed numerous lava flows and pillow lavas with a high density of fauna on top of the lava flows. The dive unfortunately was interrupted by a fishing line caught in the ROV cable that had to be cut in order to continue diving.

During the afternoon hours of the 17th of July we drove back to Ponta Delgada to allow the guests to disembark before heading back to the rift zones west of São Miguel. During the night and in the early morning of the 18th of July we used the TV grab to sample four localities of this rift zone from south to north. The next ROV dive on the 18th of July targeted the northern rift zone of Sete Cidades volcano on São Miguel. The dive was aborted in the early evening hours because several of fishing lines and nets were caught by the ROV cable, fortunately without damaging anything of the equipment. During the night of the 18th to the 19th of July sampling continued using the TV grab along the northern rift flank of the Hirondelle Basin. During the 19th we performed an ROV dive on the southern rift wall of the Hirondelle Basin some 20 km west of São Miguel again targeting the Azores Plateau basement revealing abundant lava flows, pillow lavas and possibly also dikes. In the following night we performed a hydroacoustic survey towards the East Azores Fracture Zone in the south of the Azores Plateau where the next ROV dive started in the morning of the 20th in order to sample an almost 1700 m high cliff-wall exposed along the East Azores Fracture Zone. As a result of technical problems we reached the

bottom of the seafloor at lunchtime. During the night, the multibeam survey covered much of the vicinity of the East Azores Fracture Zone before continuing the ROV sampling profile during daytime of July 21st. A technical problem with the ROV's winch required a change in plans and we started sampling the profile using the TV grab. Two successful TV grabs recovered rock samples, a third TV grab unfortunately remained empty. During the night to July 22nd we surveyed the western extension of Princesa Alice bank by multibeam and carried out another ROV dive to sample the early Azores Plateau lavas during the 22nd. During the night and during the early morning hours of the 23rd July we sampled the volcanic rift zone west of Faial representing the submarine continuation of the Capelinhos eruption in 1958-1959. One of four successful TV grabs along Capelinhos was caught in long fishing lines causing some problems during recovery of the grab. After a short multibeam survey across the eruption side we decided to abandon this area and not risk ROV diving in the vicinity of Capelinhos. We then moved towards Condor de Terra in the morning of the 23rd of July, approximately 10 miles southwest of Faial, where we started diving along an apparently older volcanic ridge. During the early evening we headed towards the Capelinhos eruption site, where colleagues from the University of Horta in the Azores came alongside with a small vessel taking the refrigerated biological specimen collected. We then continued our work with 5 TV grab stations covering almost the entire length of the Capelinhos eruption site accessible (~5 km). During the early morning hours of the 24th of July we headed towards Princesa Alice Bank continuing the stratigraphic profile from July 22nd. The profile started in about 2000 m water depth and the ROV brought another 13 rock samples to the surface on the evening of the 24th. During the night to the 25th of January we mapped the volcanic system of Capelinhos and sampled the two northerly rift zones using the TV grab. We then continued with multibeam surveys towards the western coastline of São Jorge and across the western rift system of São Jorge. In the morning of July 25th we started the 19th and final ROV dive of cruise M128 on the submarine volcanic ridge west of São Jorge but found no sign of young activity. The five last TV grabs of the cruise on the rift zone west of São Jorge confirmed the absence of young volcanic activity. The geological sampling ended at 2:00 am of the 26th of July and we then started a 370-km long hydroacoustic survey from São Jorge, towards Faial, then north towards Graciosa and along the southern rift shoulder of the Terceira rift axis towards São Miguel.

All scientific measurements ended at 4:00 Wednesday the 27th of July 2016 and we arrived on the pier in Ponta Delgada at 9:00 where the cruise ended.

Acknowledgments

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Participants

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Station list of cruise M128 Azores Plateau. TVG = TV grab, ROV = Remotely Operated Vehicle Marum Quest 4000, multibeam = combined data from EM 122 and EM 710

Station	Date (UTC)	Location	Start (UTC)	Start (Position)		Water depth [m]	Ende (UTC)	End Position		Water depth [m]	Waterdepth of sample [m]	Sample position		Sample time (UTC)	comments	Size/number of samples
Meteor				*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			
716_multibeam		NW Sao Miguel	11:50	37°51.85'	25°57.04'	1309	13:47	37°56.87	25°46.76	822	/					
717_TVG	02/07/16	NW rift zone Sao Miguel	14:27	37°56.103'	25°51.380'	738	15:47	37°56.087'	25°51.372	762	684	37°56.077'	25°51.375'	15:21		2 samples of basalt
718_TVG	02/07/16	W rift zone of Sao Miguel	16:22	37°53.402'	25°55.093'		18:50	37°53.523'	25°55.041'		302	37°53.523'	25°55.041'	18:27	cables/ropes on ground	1 sample of basalt
719_multibeam		NW of Sao Miguel	18:57	37°54.05'	25°55.91'	615	04:09	38°25.38'	26°31.09'	1277	/					
720_multibeam		E of Joao de Castro	05:20	38°12.53	26°33.64	418	06:00	38°11.62	26°34.63	779	/					
721_multibeam		E of Joao de Castro	06:18	38°12.73	26°33.69	483	06:41	38°12.73	26°35.64	216	/					
722_TVG	03/07/16	fresh flow E of Joao de Castro	07:05	38°12.711'	26°33.793	421	08:45	38°12.618'	26°33.870'	350	343	38°12.619'	26°33.875'	08:30		3 total samples, glass, basaltic rock, fine material
723_TVG	03/07/16	east of Joao de Castro, station cancelled	09:13	38°13.803'	26°34.309'	797	10:12	38°13.806'	26°34.310'	805					wrong depth information from bridge; actual water depth 415m; TVG crashed into ground; no serious damage.	-
724_multibeam		N of Joao de Castro	10:49	38°12.72	26°34.40	211	12:20	38°12.72	26°34.25	253	/					
725_TVG	03/07/16	E flank of Joao de Castro	12:44	38°13.799'	26°34.393'	423	14:45	38°13.821'	26°34.392'	362	363	38°13.808'	26°34.393'	14:21	cables/nets on ground	2 total samples, basalt
726_multibeam		N of Joao de Castro	15:05	38°13.83	26°34.39	208	15:52	38°15.78	26°37.04	208	/					
727_TVG	03/07/16	rift NW of Joao de Castro	16:17	38°14.898'	26°38.104'	726	17:07	38°14.898'	26°36.106'	716	723	38°14.885'	26°38.105'	16:43		1 sample of ash tuff
728_TVG	03/07/16	small cone N of Joao de Castro	17:45	38°15.493'	26°36.314'	556	18:26	38°15.492'	26°36.317'		559	38°15.492'	26°36.317'	18:06		3 total samples, 2x glass flow, 1 ash layer
729_TVG	03/07/16	NE flank of Joao de Castro	18:57	38°14.525'	26°34.633'	530	20:40	38°14.517'	26°34.622'	574	519	38°14.517'	26°34.622'	20:08	cables/nets on ground?	4 samples, 2x basalt, 1 carbonate, 1 ash layer
730_multibeam		NW to SW of Joao de Castro	22:28	38°15.03	26°57.64	1359	02:30	38°32.18	26°38.90	907	/					
731_multibeam		NW to SW of Joao de Castro	03:02	38°34.25	26°36.45	836	06:29	38°18.57	26°57.60	1112	/					
732_ROV	04/07/16	NW top of Joao de Castro	09:35	38°12.535'	26°34.641'	292	18:05	38°12.719'	26°34.672'	177					some biology on outcrops, corals, sponges	12 total samples, lava fragments, lappili tuff, volcanoclastic breccia, coarse sand
733_TVG	04/07/16	small cone S of Joao de Castro	19:21	38°10.629'	26°35.097'	832	21:41	38°10.695'	26°35.179'		684	38°10.735'	26°35.281'	21:18		1 deep sea coral -/baffelstone
734_TVG	04/07/16	cone S of Joao de Castro	22:12	38°10.104'	26°35.823'	1040	22:12	38°10.231'	26°35.838'	1097	1103	38°10.233'	26°35.831'	23:55	ash, sediments, coral fragments	3 total samples, basalt, sand and ash
735_TVG	05/07/16	ridge NW of Joao de Castro	01:42	38°16.761'	26°42.239'	1255	03:23	38°16.722'	26°42.239'	1230	1230	38°16.721'	26°42.302'	02:48	carbonate ooze	3 total samples, carbonate breckzia, basalt and sand
736_TVG	05/07/16	ridge NW of Joao de Castro	03:46	38°17.838'	26°42.381'	1386	05:59	38°17.741'	26°42.276'		1353	38°17.753'	26°42.277'	05:22	fine carbonate ooze	1 sample, basaltic glass
737_TVG	05/07/16	cones NW of Joao de Castro	06:24	38°18.687'	26°44.366'	1343	07:56	38°18.663'	26°44.305'	1352	1350	38°18.661'	26°44.304'	07:20	sediments; malfunction of posidonia	1 sample, volcanoclastica
738_ROV	05/07/16	cliff N of Joao de Castro	11:24	38°22.819'	26°33.304'	2554		38°23.376'	26°32.696'	1937					biology in rocks, corals, sponges	13 total samples, basalt, 1 coral, 1 extra basalt sample (No. 14)
739_multibeam		N of Joao de Castro	21:36	38°19.36	26°38.86	2108	22:27	38°14.90	26°35.86	640	/					
740_TVG	05/07/16	rift NE of main rift zone	23:03	38°16.221'	26°36.887'	975	0:42 (06.07.2016)	38°16.154'	26°36.849'	983	967	38°16.164'	26°36.842'	0:12 (06.07.2016)	fresh lava	1 sample of basalt
741_TVG	06/07/16	N' Joao de Castro	01:06	38°14.060'	26°35.283'	293	02:05	38°14.029'	26°35.270'		264	38°14.036'	26°35.258'	01:48	ash layers	1 sample of ash tuff
742_TVG	06/07/16	W slope of Joao de Castro	02:35	38°13.214'	26°37.827'	487	05:35	38°11.837'	26°38.314'		523	38°13.202'	26°37.870'	04:05	volcanic sand, glass, cpx	2 total samples, fine volcanic sand into 3 bags, breccia/conglomerate
743_TVG	06/07/16	ridge structure Joao de Castro	06:14	38°12.787'	26°34.045'	321	07:04	38°12.775'	26°34.046'	334	335	38°12.781'	26°34.032	06:35	in situ pillow segment	2 total samples, lava fragments

Station	Date (UTC)	Location	Start (UTC)	Start (Position)		Water depth [m]	Ende (UTC)	End Position		Water depth [m]	Waterdepth of sample [m]	Sample position		Sample time (UTC)	comments	Size/number of samples
Meteor				*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			
744_TVG	06/07/16	cone SE of Joao de Castro	07:19	38°12.240'	26°33.447'	430	08:02	38°12.248'	26°33.424'	425	429	38°12.262'	26°33.420'	07:40	lava pieces, biology (corals, sponges), fresh rocks	3 total samples, lava fragments
745_ROV	06/07/16	N flank of Joao de Castro	10:29	38°15.368'	26°36.718'	892	18:46	38°14.742'	26°36.356'	564					basaltic rocks, lot of biology on samples,	13 total samples, basaltic rocks, pillow, ashes, 3 biology samples
746_TVG	06/07/16	cone W of E rift zone NW of Joao de Castro	20:38	38°17.476'	26°37.969'	1356	22:39	38°17.367'	26°37.888'	1416	1355	38°17.429'	26°37.892'	22:03	dark ash	1 samples volcanic ash
747_multibeam		W of Joao de Castro, southeastern flanks of Graciosa	22:56	38°19.06	26°38.96	1961					/					
748_multibeam		southeastern flanks of Graciosa	05:52	38°48.53	27°31.24	780	07:24	38°46.45	27°25.21	356	/					
749_TVG	07/07/16	Serreta rift	08:19	38°50.601'	27°30.504'	1146	10:02	38°50.715'	27°30.418'	1224	1185	38°50.631'	27°30.436'	09:20	pillow pieces to 50cm, older but not altered	3 total samples, pillow/basalt
750_multibeam		Serreta rift	11:12	38°49.42	27°28.59	700	11:43	38°50.79	27°31.27	1572	/					
751_ROV	07/07/16	N of Serreta rift	14:08	38°49.125'	27°28.549'	612	20:14	38°48.827'	27°28.276'	484					biology on samples (corals, sponges, bryozoa, molluscs)	12 total samples, basalt and fine material
752_TVG	07/07/16	NW Serreta rift	21:55	38°52.357'	27°32.547'	1720	23:53	38°52.338'	27°32.509'	1724	1756	38°52.358'	27°32.523'	23:12	lots of sediment, smaller dark blocks; TVG empty	no sample
753_TVG	07/07/16	Ridge NW' of 751_ROV	00:29	38°49.846'	27°29.287'	746	01:22	38°49.836'	27°29.272'	765	765	38°49.847'	27°29.274'	00:49	rough surface, thin sediment layer, maybe pillows	2 total samples, basalt/pillow
754_multibeam		Pico Ridge	05:57	38°18.90	27°50.51	397	07:56	38°24.47	27°58.64	204	/					
755_ROV	08/07/16	Pico Ridge	09:26	38°23.317'	27°55.466'	555	13:33	38°23.253'	27°55.615'	452					coral debris, basaltic lava fragments, carbonate	8 total samples, lava fragments, carbonate, volcanoclastic rock, 2 biology samples
756_TVG	08/07/16	Pico Ridge	14:40	38°24.051'	27°57.534'	436	15:28	38°24.051'	27°57.532'	215	216	38°24.051'	27°57.534'	15:05	biogenic sediment with volcanic rock fragment	1 sample carbonate grainstone
757_TVG	08/07/16	Pico Ridge	16:08	38°21.896'	27°53.156'	308	16:54	38°21.882'	27°53.142'	310	309	38°21.889'	27°53.146'	16:36	unconsolidated coral, no sample	no rock sample, 1 sample of coral debris
758_TVG	08/07/16	mound on Pico Ridge	17:14	38°20.902'	27.52.734'	292.5	18:30	38°20.865'	27°52.695'	304	302	38°20.851'	27°52.732'	18:20	one piece of lava, altered with biology	1 sample volcanic breckzia
759_TVG	08/07/16	volcanic mounds on Pico Ridge	19:01	38°19.916'	27°51.638'	370	21:01	38°19.	27°51.	450	-	38°19.817'	27°51.541	20:35	too hard surface, empty TV-Grab	no sample
760_TVG	08/07/16	Pico Ridge	21:25	38°18.913'	27°50.603'	397	22:42	38°18.818'	27°50.456'	460	402	38°18.818'	27°50.507'	22:24	hard surface; carbonate crust	2 total samples, basaltic rock and volcanoclastic breckzia
761_TVG	08./09.07.2016	Pico Ridge	23:00	38°18.133'	27°49.460'	685	00:27	38°18.121'	27°49.458'	687.7	667	38°18.123'	27°49.458'	23:53	too hard surface, empty TV-Grab	no sample
762_multibeam		SW of Graciosa/ Northeast of Faial	00:40	38°19.27	27°52.12	713	01:37	38°22.55	27°56.78	555	/					
763_multibeam			01:46	38°21.76	27°56.45	765	02:39	38°18.46	27°53.05	922	/					
764_ROV	09/07/16	N flank Terceira basin	09:48	39°01.476'	27°30.675'	1733	19:22	39°02.090'	27°30.172'	1028					lava flows, lava tubes, biology on some rocks	12 total samples, lava fragments, pillows, 2 biology samples
765_multibeam		Serreta	20:42	39°02.64	27°29.59	797	04:00	39°02.54	27°29.31	848						
766_multibeam			04:15	39°01.37	27°27.19	1485	06:09	38°52.61	27°22.72	633						
767_ROV	10/07/16	central Serreta volcanic ridge	08:30	38°47,457'	27°27,938'	377	19:14	38°47.748'	27°27.623'	242					loose deposits of lappili, basalt outcrops, lot of biology	15 total samples, fresh lava, basalt, 2 biology samples
768_multibeam		NW of Graciosa	20:33	38°48.51	27°29.26	489	22:07	38°48.15	27°29.87	386						
769_TVG	10/07/16	Serreta	22:37	38°47.179'	27°26.898'	195	0:11 (11.07.2016)	38°47.199'	27°26.714'	200	204	38°47.192'	27°26.725'	23:54	very hard surface, steep slopes	4 total samples, 2x pillow, 2x volcanic breckzia
770_TVG	11/07/16	Serreta	00:42	38°48.335'	27°30.854'	550.7	01:43	38°48.320'	27°30.845'	551.2	552	38°48.324'	27°30.844'	01:08	problems with TV grab's battery,	no sample

Station	Date (UTC)	Location	Start (UTC)	Start (Position)		Water depth [m]	Ende (UTC)	End Position		Water depth [m]	Waterdepth of sample [m]	Sample position		Sample time (UTC)	comments	Size/number of samples
Meteor				*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			
771_TVG	11/07/16	Serreta	02:05:00	38°48.324'	27°30.847'	552.3	03:11	38°48.319'	27°30.798'	567	567	38°48.314'	27°30.810'	02:50	pieces of lava	2 total samples, lava ballons
772_TVG	11/07/16	Serreta NW crater	03:43	38°48.127'	27°29.107'	360	04:47	38°48.144'	27°29.150'	343	344	38°48.144'	27°29.150'	04:22	several pieces of lava	4 total samples, basalt
773_multibeam		Serreta/ W of Graciosa	05:37	38°51.54	27°25.94	943	07:00	38°45.00	27°30.40	1603						
774_ROV	11/07/16	central Serreta volcanic ridge	11:40	38°47.466'	27°28.148'	329	18:59	38°47.667'	27°28.932'	313					biology, bactrial mats (former hydrothermal activity?)	8 total samples, lava, lava bombs, lapilli, fine material
775_TVG	11/07/16	Serreta ridge (SW part)	20:46	38°47.708'	27°29.127'	347	21:39	38°47.708'	27°29.124'	355.7	305	38°47.719'	27°29.125'	21:05	fresh lava balloons	2 total samples, lava ballons
776_TVG	11/07/16	E part of central Serreta volcanic ridge	22:05	38°47.854'	27°28.707'	372	23:15	38°47.873'	27°28.732'	400	353	38°47.870'	27°28.719'	22:54	vesicular lava fragments	2 total samples, basaltic lava fragments
777_TVG	11./12.07.2016	W edge of central Serreta volcanic ridge	23:32	38°47.936'	27°29.197'	284	0:21 (12.07.)	38°47.929'	27°29.242'	303	286	38°47.941'	27°29.199'	23:50	Posidonia off!!	2 total samples, basaltic lava fragments
778_TVG	12/07/17	WSW Serreta Ridge	00:38	38°48.058'	27°29.505'	321	01:04	38°48.060'	27°29.509'	326	323.5	38°48.059	27°29.507'	00:50	several pieces of lava balloons and fine material	3 total samples, lava fragments/lava ballons
779_TVG	12/07/17	W' Serreta Ridge	01:37	38°48.176'	27°30.078'	313	02:29	38°48.167'	27°30.037'	317	315	38°48.169	27°30.041'	02:11	lot of biology, ropes, no posidonia!, small pieces of lava with corals	1 samples, basaltic lava
780_TVG	12/07/16	S Serreta Ridge	03:36	38°47.024'	27°27.249'	356	04:22	38°47.046'	27°27.258'	356	352	38°47.046'	27°27.258'	04:01	lots of corals, no posidonia! pieces of lava balloons	2 total samples, basaltic lava fragments
781_ROV	12/07/16	E end of Serreta volcanic ridge	12:01	38°46.981'	27°27.519'	455	20:19	38°47.440'	27°28.102'	334					biology on rocks, some rocks covered with hydrothermal sediment	11 total samples, pillow, lapilli, lava fragments
782_TVG	12/07/16	NW of Terceira	21:46	38°52.662'	27°25.450'	975	23:32	38°52.676'	27°25.488'	1007	975	38°52.674'	27°25.474'	23:04	3 failed grabs, Sediment: hard stuff at some places, not much topography	1 sample, tiny piece of lava fragment
783_TVG	12/07/16	NW of Terceira. Station cancelled	23:58	38°53.216'	27°25.066'	985	01:28	38°53.246'	27°25.070'	977	-	-	-	-	empty grab	no sample
784_multibeam		N of Faial/track to MAR	01:47	38°55.77	27°24.08	1013	4:01 (next day)	39°06.13	28°30.11	2440						
785_TVG	13/07/16	Segment near MAR, E-flank of seamount	13:24	39°13.766'	29°22.050'	1172	15:13	39°13.760'	29°22.001'	1178	1151	39°13.759'	29°22.004'	14:34	one tiny piece of black fine grained lava hosted in sand	1 sample of fine biogenic sand and fragments of lava
786_multibeam		track to MAR	05:27	39°07.73	28°12.52	803	07:42	39°08.95	28°13.17	987						
787_ROV	14/07/16	Graciosa Ridge	09:18	39°07.029'	28°11.518'	670	19:23	39°07.818'	28°11.319'	503					lot of biology on rocks, carbonate debris,	14 total samples, volcanoclastic breccia, carbonates, 1 biology sample
788_multibeam	14/07/16	Graciosa Ridge	20:35	39°06.20	28°13.46	1309	07:00	38°29.19	26°34.39	813						
789_ROV	15/07/16	N' wall Hirondelle Basin	09:54	38°23.336'	26°32.685'	1985	18:29	38°23.736'	26°32.444'	1270					biology on rocks (corals, sponges, clams)	22 total samples, pillow lavas, vesicular lava fragments,fine layered sediment,carbonate, 2 biology samples
790_multibeam	16/07/16	W of Sao Miguel	20:18	38°27.05	26°27.88	1552	12:50	37°53.02	25°55.91	615						
791_ROV	17/07/16	ridge W of Sabrina	10:48	37°53.377'	25°55.040'	400	15:07	37°53.567'	25°54.887'	278					lot of biology on rocks	8 total samples, lava fragments, volcanoclastic breccia, 1 biology sample
792_TVG	07.2016/18.07.20	cone SW' of Sete Cidades	22:47	37°50.667'	25°55.889'	750	00:59 (18.07.2016)	37°50.671'	25°55.865'	751	733	37°50.666'	25°55.852'	00:27	lot of sediment (mud), partly biology on seafloor	2 cups fine material
793_TVG	18/07/16	cone WNW' of Sete Cidades	01:42	37°55.299'	25°52.274'	749	02:55	37°55.317'	25°52.228'	750	723	37°55.330'	25°52.215'	02:32	smooth seafloor covered with fine sediment, but difficult to grab, probably ash layers, piece of consolidated ash	1 sample, consolidated ash layers
794_TVG	18/07/16	crater structure NW (?) of Sete Cidades	03:20	37°56.360'	25°50.123'	368	04:48	37°56.307'	25°50.117'	360	365	37°56.337'	25°50.046'	04:30	biology on rocks , cliffs	1 sample, lava fragment

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Meteor				*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			
795_TVG	18/07/16	Ridge NW of Sao Miguel	05:07	37°57.263'	25°50.779'	642	06:31	37°57.199'	25°50.794'	621	639	37°57.213'	25°50.748'	06:02	Sediment cover, corals, quite flat	1 sample, different carbonates
796_ROV	18/07/16	W flank Sao Miguel off Mosteiros	09:00	37°55.826'	25°51.482'	763	17:54	37°56.101'	28°51.024'	547					biology on rocks, some ash	14 total samples, lava and pillow samples, mostly aphyric and vesicular, 1 carbonate-ash mix, 2 biology samples
797_TVG	18/07/16	Ridge on N flank Hirondelle Basin	21:34	38°14.933'	26°14.041'	686	22:37	38°14.929'	26°14.056	677	655	38°14.918'	26°14.049'	22:14	very hard, no biology	1 sample, possibly gneiss
798_TVG	07.2016/19.07.20	Ridge on N flank Hirondelle Basin	23:05	38°13.627'	26°13.292'	441	00:42	38°13.723'	26°13.217'	428	414	38°13.736'	26°13.212'	00:28	hard surface, no morphology, lot of nets	1 sample, carbonate
799_TVG	19/07/16	Ridge on N flank Hirondelle Basin	01:19	38°11.808'	26°12.590'	770	02:38	38°11.818'	26°12.627'	762	731	38°11.823'	26°12.616'	02:13	steep topography, problems to grab, lot of coral debris	1 sample, carbonate mudstone
800_TVG	19/07/16	Rift structure of documented 19th century eruption	03:36	38°10.539'	26°03.048'	883	04:34	38°10.538'	26°03.052'	883	874	38°10.531'	26°03.041'	04:04	fresh rocks, maybe pillows, biology on rocks	1 sample, pillow fragment
801_TVG	19/07/16	ESE' of 800_TVG	04:52	38°10.169'	26°01.728'	890	05:58	38°10.166'	26°01.725'	887	870	38°10.156'	26°01.716'	05:29	carbonate	1 sample, corals
802_ROV	19/07/06	S rift wall Hirondelle Basin	10:20	37°49.604'	26°04.334	2255	17:03	37°49.145	26°04.620	1644					some coral debris, sediment, flow and dike structure	10 total samples, lava and pillow fragments
803_multibeam		transit S' wall of Hirondelle Basin to S' border of Azores Plateau	19:07	37°50.96	26°07.37	1739	07:45	36°50.58	27°26.48	3596						
804_ROV	20/07/16	East Azores Fracture Zone	12:34	36°51.532	27°25.736	2786	18:36	36°52.313	27°25.620	2345					ROV dive aborted	8 total samples, peridotite, carbonate, sediment
805_multibeam	20/07/16	Azores Fracture Zone	21:44	36°38.98	27°26.41	3040	07:55	36°52.38	27°25.79	2316						
806_TVG	21/07/16	Azores Fracture Zone	12:10	36°52.243'	27°25.709'	2382	14:35	36°52.253'	27°25.670'	2460	2464m	36°52.232	27°25.702'	13:50	rocks covered with fine sediment, different to assess morphology, a few fragments of altered peridotite recovered+sediment	4 total samples, peridotite
807_TVG	21/07/16	Azores Fracture Zone, steep cliff section N-S	14:55	36°52.257'	27°25.664	2312	16:55	36°52.258'	27°25.677	2352	2395	35°52.266	27°25.657	15:44	rough morphology of outcrop, thin sediment cover/patches, large pieces of (altered) peridotite-> in situ	5 total samples, peridotite
808_TVG	21/07/16	Azores Fracture Zone, steep cliff section N-S													empty grab	no sample
809_multibeam	21/07/16	EAFZ to Princesse Alice Bank	20:00	36°52.59	27°26.02	2233	07:37	38°11.58	29°33.28	2400						
810_ROV	22/07/16	Rift of Princesse Alice Bank	10:28	38°11.779'	29°33.673'	2536	18:36	38°12.211'	39°33.550	1723					less biology on rocks, sediment covered outcrops	13 total samples, altered basalts, 2 biology samples
811_TVG	07.2016/23.07.20	cone SW Capelinos	23:57	38°36.878'	28°54.912'	748	00:47 (23.07.)	38°36.877'	28°54.906'	743	720	38°36.888'	28°54.902'	00:25	less topography, shallow; ash and volcanic fragments	2 total samples, lava fragments
812_TVG	23/07/16	ridge NW' of Capelinos	01:14	38°37.277'	28°53.978'	527	02:06	38°37.278'	28°53.978'	524	527	38°37.288'	28°53.982'	01:46	maybe large pillows, ash	1 sample of consolidated ash
813_TVG	23/07/16	NW' of Capelinos	02:23	38°37.277'	28°53.975'	524	03:25	38°37.270'	28°53.952'	523	519	38°37.280'	28°53.953'	03:03	steep slope, old reef bodies?; lava fragments	1 fresh lava sample
814_TVG	23/07/16	W end of Capelinhos	03:45	38°37.401'	28°54.537'	665	04:25	38°37.268'	28°54.537'	680	663	38°37.402'	28°54.538'	04:05	no posidonia, steep topography, pillow-like structures, fresh lava flows	2 total samples, lava fragments
815_TVG	23/07/16	cone eastern Capelinhos	04:52	38°36.344'	28°51.869'	144	05:31	38°36.396'	28°51.869'	186	146	38°36.340'	28°51.871'	05:19	no posidonia, fresh lava flows	1 large piece of lava with lots of biology
816_multibeam	23/07/16	Capelinhos	06:00	38°37.85	28°55.29	1333	07:42	38°37.37	28°55.58	1406						

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Meteor				*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			*Latitude (°N)*	*Longitude (°W)*			
817_ROV	23/07/16	Condor de Terra														13 total samples
818_TVG	23/07/16	sampling Capelinhos	20:48	38°36.139'	28°51.815'	341	21:24	38°36.139'	28°51.815'	339	333	38°36.149'	28°51.818'	21:08	flat surface, black lapilli & ash	2 total sample, glass, lava fragment
819_TVG	23/07/16	sampling Capelinhos	21:57	38°36.625'	28°51.546'	152	22:25	38°36.625'	28°51.547'	152	142	38°36.618'	28°51.556'	22:08	flat surface, ripples, consolidated ash	2 total sample, ash
820_TVG	23/07/16	cone W' of Capelinhos	22:49	38°37.107'	28°53.501'	419	23:29	38°37.103'	28°53.503'	402	427	38°37.102'	28°53.505'	23:08	pillow-like structures, lot of biology	1 total sample,pillow
821_TVG	23./24.07.2016	cone western part of Capelinhos	23:48	38°37.473'	28°53.609'	442	00:29 (24.07.)	38°37.470'	28°53.611'	446	445	38°37.470'	28°53.610'	00:13 (24.07.)	no posidonia, ash layers, partly glassy	1 fine Material, 4 total sample
822_TVG	24/07/16	northern part of Capelinhos	01:17	38°38.029'	28°52.279'	617	02:08	38°38.020'	28°52.279'	610	609	38°38.023'	28°52.279'	01:47	no Posidonia, layered ash, lava fragment	3 total samples, layered ash, lava fragment
823_multibeam	24/07/16	southeast of faial, condor seamount?	03:07	38°31.04	28°58.11		0.302777778	38°10.058	29°29.5	1650						
824_ROV	24/07/16	Rift of Princesse Alice Bank	10:03	38°12.060'	29°33.540'		18:33	38°12.500'	29°33.560'							13 total samples, 12 geological, one biological
825_multibeam	24/25.07.2016		19:56	38° 14.02' N	29°33.74	1216	00:50	38°39.65	29°07.01	1935						
826_TVG	25/07/16	rift NW of Capelinhos	01:00	38°39.467'	28°52.360'	746	02:43	38°39.434'	28°52.362'	726	708	38°39.428'	28°52.372'	02:20	flat hard surface	1 cup of sediment
827_TVG	25/07/16	rift zone N' of Capelinhos	03:16	38°40.706'	28°47.506'	659	04:11	38°40.699'	28°47.500'	660	647	38°40.692'	28°47.509'	03:49	no morphology, rel. Hard surface	2 cups fine material,
828_multibeam	25/07/16		05:47	38°47.97	28°29.10	1084										
829_ROV	25/07/16	W' Rift of Sao Jorge	09:31	38°46.440'	28°27.710'		18:25	38°47.040'	28°27.580'						mostly sediments, some pillow-lava outcrops	6 samples
830_TVG	25/07/16	Rift Zone W' of Sao Jorge	19:38	38°47.769'	28°27.161'	688	20:27	38°47.772'	28°27.163'	690	683	38°47.764'	28°27.177'	19:57	some topography, platty surface, problems to grab	just biology samples (corals)
831_TVG	25/07/16	Rift Zone W' of Sao Jorge	20:48	38°47.143'	28°27.729'	476	21:59	38°47.241'	28°27.299'	558	545	38°47.238'	28°27.753'	21:38	very steep, cabonate crust	1 total sample carbonate
832_TVG	25/07/16	Rift Zone W' of Sao Jorge	22:20	38°47.024'	28°26.628'	332	23:06	38°46.975'	28°26.615'	335	342	38°46.968'	28°26.625'	22:50	less topography, carbonate crust, biology	just biology samples (corals)
833_TVG	07.2016/26.07.20	Eastern Rift Zone W' of Sao Jorge	23:30	38°46.288'	28°24.965'	261	00:17	38°46.255'	28°25.055'	273	266	38°46.247'	28°25.061'		less topography, carbonate crust, biology	3 total samples, volcanoclastic breccia with lava fragments and carbonate
834_TVG	26/07/16	Eastern Rift Zone W' of Sao Jorge	00:34	38°47.109'	28°42.254'	269.3	01:27	38°47.070'	28°24.260'	275.6	267	38°47.064'	28°24.272'	01:12	less topography, carbonate crust, biology	2 total samples, volcanic rock
835_multibeam	26/07/16	São Jorge, Faial, southern rift shoulder of Terceira rift	02:13	38°49.13'N	28°41.09'W	1108	27/072016 04.00	37°44.630'	26°15.081						final station	