METEOR-Berichte

Submarine volcanism in the western Sicilian Channel

Cruise No. M191 (GPF 21-1_036)

16.07.2023 – 05.08.2023,
Algeciras (Spain) – Piraeus (Greece)
SUAVE

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2023

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1 Cruise Summary

1.1 Summary in English

The origin and role of volcanism in passive continental rifts remains poorly understood relative to other volcano-tectonic settings. The western Sicilian Channel in the central Mediterranean Sea represents an area of pronounced crustal extension with a variety of volcanic landforms closely associated with extensional faults. The main goal of our study is to analyze how volcanism has developed in conjunction with tectonic structures in the western Sicilian Channel. Therefore, we have extensively mapped (with multibeam echo sounder, sediment echo sounder, and towed magnetometer) the seafloor and sampled (chain bag dredge) unexplored volcanic structures along the Sicilian Channel Rift Zone and the Capo-Granitola-Sciacca Fault Zone. One unexpected result is that many features shown in the predicted bathymetry as seamount-like elevation, and which were previously interpreted as presumably volcanic edifices/cones, turned out to be either non-existent or no evidence for an igneous nature (magnetometer data/dredging results) could be established. On the other hand, three previously unknown volcanic outcrops were discovered and partly sampled. The obtained data and collected samples will provide new insights into the role of magmatism in regions of continental extension, and will allow us to develop a tectonic and magmatic framework for the western Sicilian Channel.

1.2 Zusammenfassung

Der Ursprung und die Rolle des Vulkanismus in passiven kontinentalen Dehnungsgebieten ist im Vergleich zu anderen vulkanisch-tektonischen Umgebungen noch immer wenig verstanden. Der westliche Sizilianische Kanal im zentralen Mittelmeer ist ein Gebiet mit ausgeprägter Krustendehnung und einer Vielzahl von vulkanischen Bildungen, die eng mit Dehnungsstörungen verbunden sind. Das Hauptziel des Vorhabens besteht darin zu analysieren, wie sich der Vulkanismus in Verbindung mit tektonischen Strukturen im westlichen Sizilianischen Kanal zeitlich und kompositionell entwickelt hat. Daher haben wir den Meeresboden entlang der Straße von Sizilien-Grabenzone und der Capo-Granitola-Sciacca-Verwerfungszone ausgiebig kartiert (Mehrkanal-Echolot und geschleppten Magnetometer) und bisher unbeprobte Vulkanstrukturen beprobt (Kettensackdredge). Ein unerwartetes Ergebnis ist, dass viele Strukturen, die in der vorhergesagten (Satelliten-) Bathymetrie als kegelförmige Erhebungen angezeigt werden, und die bisher als vulkanische Zentren interpretiert wurden, sich entweder als nicht existent herausstellten oder keine Beweise für eine vulkanische Entstehung (Magnetometerdaten/Dredgeproben) erbracht werden konnten. Andererseits wurden drei bisher unbekannte vulkanische Strukturen neu entdeckt und zum Teil beprobt. Die gewonnenen Daten und Proben werden daher neue Erkenntnisse über die Rolle des Magmatismus in Regionen kontinentaler Ausdehnung liefern und es uns ermöglichen, ein tektonisches und magmatisches Modell für den westlichen Sizilianischen Kanal zu erstellen.

2 Participants

2.1 Principal Investigators

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2.2 Scientific Party

Name	Discipline	Institution
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Micallef, Aaron, Prof. Dr.	Co-Chief Scientist, Bathymetry	MBARI / Univ. Malta
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Ford, Jonathan, Dr.	Co-Shift-Leader Magnetometer	OGS
Watt, Sebastian, Dr.	Lead Petrology	Univ. Birmingham
Archontikis, Odysseas A.	Lead Nannoplankton Research	Univ. Oxford / NHM
Hodgetts, Alastair, Dr.	Co-Lead Petrology	Univ. Edinburgh
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Lang, Jakob	Petrology	GEOMAR
Felgendreher, Meret	Petrology	GEOMAR
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Jens, Holger	Meteorology	DWD

2.3 Participating Institutions

GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel (Germany)
MBARI	Monterey Bay Aquarium Research Institute (USA)
Univ. Malta	University of Malta (Malta)
OGS	Instituto Nazionale di Oceanografia e di Geofisica Sperimentale (Italy)
Univ. Birmingham	University of Birmingham (UK)
Univ. Oxford	University of Oxford (UK)
Univ. Edinburgh	University of Edinburgh (UK)
Univ. Wellington	University of Wellington (NZ)
NHM	The Natural History Museum London (UK)
DWD	Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt

The M191 scientific party

3 Research Program

3.1 Description of the Work Area

3.1.1 General Introduction

Continental rifting gives rise to thinned lithosphere through extensional tectonics and is often associated with volcanism. The origin of this volcanism remains poorly understood relative to other volcano-tectonic settings on Earth. Furthermore, the role of mantle decompression, melting and magmatism within rifting processes is debated and may vary between settings. Active rifting, where mantle upwelling and associated magmatism drive lithospheric extension (e.g. Kendall et al., 2005), represents one endmember process. Volcanism also occurs in passive extensional settings (Franke, 2013; Putirka & Platt, 2012), where it is interpreted to occur through local mantle decompression melting in response to crustal thinning. Knowledge of active rifting processes has been greatly advanced in regions such as Afar, Ethiopia (Armitage et al., 2015; Ferguson et al., 2010), but there remain uncertainties about the precise nature and role of volcanism in rifts that are not thought to be associated with mantle plume ascent.

3.1.2 The Sicilian Channel

The Sicilian Channel is a shallow water platform (<400 m in depth) in the central Mediterranean Sea, located between the southern coast of Sicily, eastern coast of Tunisia and the Malta Escarpment (Figure 3.1). It forms part of the northern African continental plate, thinned by extension since the late Miocene (Civile et al., 2008), and comprises a Plio-Quaternary to lower Messinian clastic sequence that overlies 6-7 km of Mesozoic-Cenozoic shallow to deep-water carbonate deposits with intercalated volcanic rocks. The submarine landforms of the Sicilian Channel include shallow continental shelves, morphological banks of sedimentary or volcanic origin, fault-controlled rift basins, and a foredeep basin. The Sicilian Channel has been characterised by complex geodynamic processes and the co-existence of multiple stress fields in space and time. There are three key tectonic phases in the western Sicilian Channel that led to the formation of the following, broad structural elements: (i) A Neogene ~NNW-SSE front of a continental collision between the African and Eurasian plates, which led to the closure of the Tethyan ocean and gave rise to the Sicilian-Maghrebian thrust belt in the north-western (Sicilian-Maghrebian thrust front) and northern part (Gela Nappe) of the Sicilian Channel. (ii) A Pliocene-Quaternary rift-related zone in the central part of the Sicilian Channel, composed of three NW-SE oriented grabens (Pantelleria, Linosa and Malta) bounded by parallel, sub-vertical normal faults. (iii) The Capo-Granitola-Sciacca Fault Zone (CGSFZ) (Civile et al., 2018), an up to 40 km wide and 70 km deep, NNE-oriented lithospheric shear zone that extends for at least 200 km from the southern coast of Sicily to Linosa Island (Calo & Parisi, 2014; Caracausi et al., 2005; Civile et al., 2018; Civile et al., 2014; Fedorik et al., 2018; Ghisetti et al., 2009).

These geodynamic processes have given to rise to a range of volcanic manifestations at the surface. The volcanic activity in the western Sicilian Channel is predominantly anorogenic. Magmatic features include the islands of Pantelleria and Linosa, several submarine volcanic edifices (e.g. Graham, Terribile, Adventure, Nameless Banks), and buried dykes and sills (Civile et al., 2018). Although some magmatic products date to 9.5 Ma (Nameless Bank; (Beccaluva et al., 1981)), the other four volcanoes that have been dated have a Pliocene/Pleistocene to recent age (Calanchi et al., 1989; Rotolo et al., 2006). Submarine eruptions have been reported up to historical times.

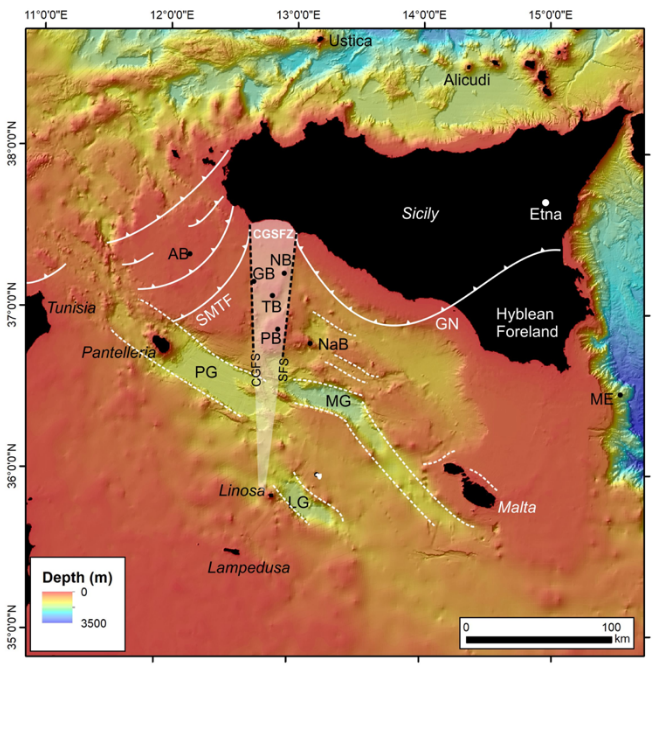


Fig. 3.1: Bathymetric map of the Sicilian Channel with main structural and geomorphic features labelled. PG: Pantelleria Graben; MG: Malta Graben; LG: Linosa Graben; GN: Gela Nappe; AB: Adventure Bank; GB: Graham Bank; TB: Terribile Bank; NB: Nerita Bank; NaB: Nameless Bank; PB: Pinne Bank; SMTF: Sicilian-Maghrebian Thrust Front: ME; Malta Escarpment; CGSFZ: Capo-Granitola-Sciacca Fault Zone: CGFS: Capo-Granitola-Sciacca Fault System; SFS: Sciacca Fault System.

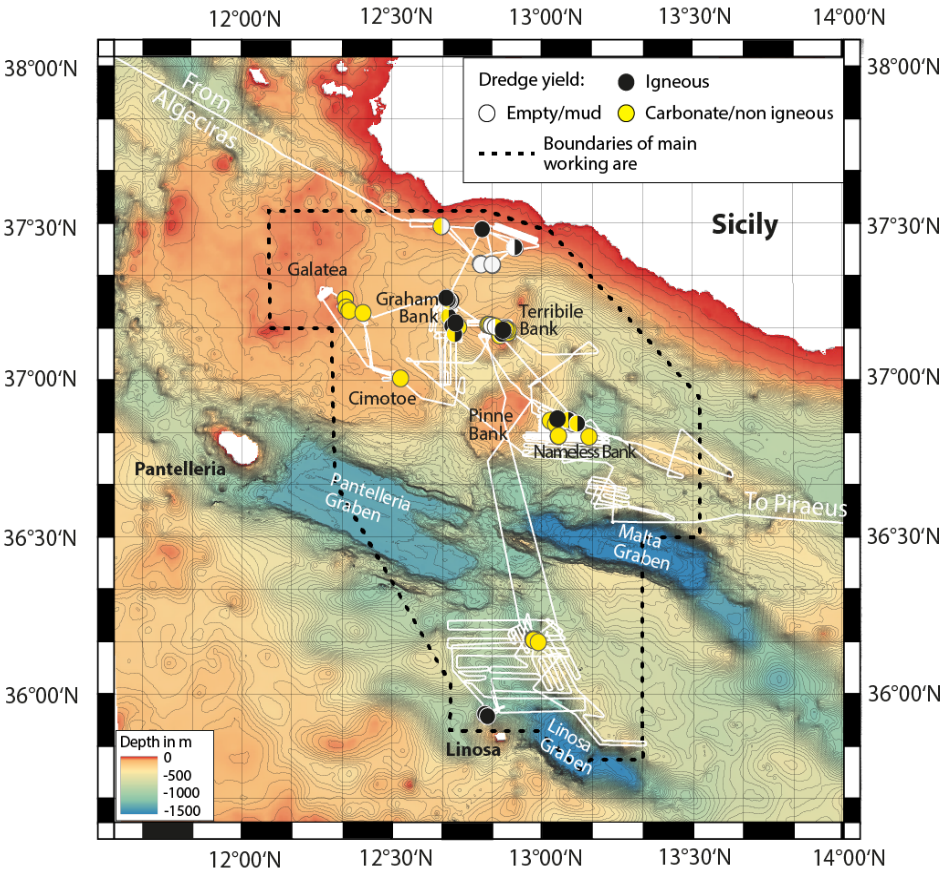


Fig.3.2: Overview map of location of dredge stations within main working area (encircled by black stippled line) with graphical symbolization of recovered material and ships path (white line).

3.2 Aims of the Cruise

In this project we will investigate how volcanism has developed in conjunction with tectonic structures in the western Sicilian Channel in order to propose a tectonic and magmatic framework for the region and improve our understanding of the role of magmatism in regions of continental extension. Specifically, the scientific objectives of the cruise were to map and sample the unexplored submarine volcanic manifestations along the CGSFZ and the Pantelleria and Linosa Grabens (Fig. 3.2). The collected data will be used to:

i. Determine the age, mantle source, melting process and crustal evolution of magmas across the area, and interpret these alongside data from volcanic centers in the central Mediterranean (Etna, Hyblean Plateau, Ustica, Alicudi) to evaluate mantle melting processes in a regional tectonic framework,
ii. Discriminate the volcanic signatures (melting, ascent and timing) of the magmatic manifestations at the seafloor between extensional and strike-slip kinematic fields,
iii. Assess the relationship between the architecture and kinematics of the CGSFZ and the Sicily Channel Rift Zone, and the spatial distribution of volcanic activity,
iv. Infer the structural framework and stress field in the southern section of the CGSFZ and its spatial and temporal evolution,
v. Assess the type, extent and age of volcanic activity across the region to evaluate present-day hazards.

3.3 Agenda of the Cruise

(J. Geldmacher)

To achieve the scientific goals of the SUAVE research project, cruise M191 conducted area-wide as well as more targeted multi-beam mapping, sediment echo sounding and magnetometer surveys, and carried out rock sampling at structures identified as possible igneous edifices or exposed lava fields/domes. Very few of these structures have been mapped or sampled before. Regarding specific working areas, the following structural features were selected for closer investigation:

- Bathymetric highs along the N-S trending Capo-Granitola-Sciacca Fault Zone (CGSFZ), including a volcanic cone field near the Sicilian coastline, Galatea shoal, Graham and Terribile Banks, Cimotoe Seamount, Pinne Bank, and the volcanic cone field around Linosa Island.
- NW-SE striking graben structures in the central Sicilian Channel (Pantelleria-, Linosa- and Malta-Graben).
- Presumable volcanic features to the east (Nameless Bank, Madrepora) and west (Pantelleria region) of the CGSFZ, which elongated outlines resemble the NW-SE direction of the graben structures. Unfortunately, no permission for work around Pantelleria was granted by the territorial authorities.

4 Narrative of the Cruise

(J. Geldmacher)

All 15 members of the scientific party arrived in Algeciras in the afternoon/evening of July 14 and boarded the vessel the next morning on July 15. The GEOMAR equipment container and the OGS magnetometer were already loaded and placed on the working deck. The vessel left the port of Algeciras on the following day, July 16 at 09:00, to start its almost 4 days transit to the main working area in the Sicilian Channel.

The transit time was used to unpack the containers, set up the laboratories, test the instruments, and to conduct other preparations for the cruise (including safety drills and rehearsal of the lab workflow). While transiting through the Spanish EEZ, surface water samples (for nannoplankton research) were collected approximately every 4 h. The water sampling continued at similar sequences in Italian and Greek waters during the entire time span of the expedition.

In the early morning on July 19, we arrived in the Italian EEZ and the EM 120 and EM 710 multibeam echo sounders (MBES) and sediment echo sounder (PARASOUND) were switched on. Shortly afterwards an SVP (sound velocity profile) probe was deployed in 1900 m water depth (to calibrate the MBES data). While the ship was stationary, the magnetometer was brought into the water to test all components of the system. Subsequently, the vessel accelerated and continued its transit to the Sicilian Channel. After a few hours, the magnetometer was recovered again.

On the morning of July 20, we arrived in the first working area located between the Sicilian coast and Graham Bank, along the northern rim of the Sicilian Channel (Fig. 3.1). Since the water is much shallower here (generally < 300m), another SVP was acquired before a systematic mapping survey (with multibeam echosounder, PARASOUND and magnetometer) was conducted. The survey covered all known submarine cone-shaped structures (believed to be of volcanic origin). Dredge site locations were identified and it was assured that each dredge track was placed at a sufficient distance from the nearest underwater cable This evaluation followed a standardized procedure applied for all dredge sites during this expedition (criteria: >1000 m and >2.5 times water depths distance from the nearest cable). In total, eight dredge hauls (M191-5,-6,-7,-8,-10,-11,-12,-13,-14) were conducted in this area in the course of July 20 and the following day, June 21. During the night, an extensive mapping and magnetometer survey was conducted in an area where no multibeam/magnetic data had been acquired before (M191-9). In the afternoon of July 21, the vessel transited southwards towards Graham Bank, where a short (c. 2 h) mapping survey (multibeam and magnetometer) was run over all sites (cones) of potential interest for dredging (M191-15), Two dredge hauls were conducted on one volcanic cone (M191-16,-17) near Graham Bank's northern edge. The summit of Graham Bank consists of two prominent cones with flat tops, the southernmost of which rises up to 9 m below sea level. This shoal, well known to local fishermen, represents the site of the most recent volcanic eruption in the working area. In July 1831, a volcanic outburst produced a short-lived island ("Ferdinandea Island") that was washed away by wave erosion a few months thereafter. According to historical records, such emergence/disappearance occurred already four times in this area since 300 BC. Accordingly, we had high hopes to obtain fresh volcanic rocks from this site. The night of July 21/22 was spent with another extensive mapping survey (M191-18) comprising the area SW of Graham Bank and the cluster of prominent cones between Cimotoe and Pinne Bank.

On the morning of July 22, another VSP was conducted (M191-19) before dredging on/near Graham Bank resumed (M191-20 to -24). At Site M191-20, active venting ("flares") was observed in the water column sonar data (Fig. 4.1) and the dredge haul recovered several tube-shaped rocks interpreted as vent chimneys (Fig. 4.2). After a short mapping/magnetometer survey (M191-25), the last dredge haul of the day targeted one of the cones between Cimotoe and Pinne Bank (M191-26) before we spent the night carrying out further mapping/magnetometer surveying in the area around the Galatea shoal (M191-27).

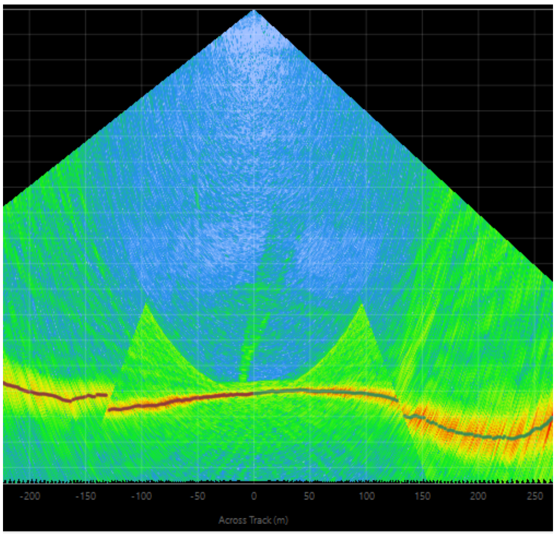


Fig. 4.1: 30 m high flare (centre of picture) observed in the water column data of the KONGSBERG EM710 multibeam echo sounder, on the NE flank of Graham Bank,

Fig.4.2: Scientist Kerys Meredew from the University of Birmingham (UK) holding a chimney structure, dredged from near the active venting site of Graham Bank (see Fig. 4.1) (Photo: J. Geldmacher).

On July 23, four sites were dredged in the newly mapped area (M191-28,-29,-30-31), none of which returned volcanic material. Since we experienced a decrease in the quality of the multibeam data, another SVP was conducted before the day was concluded with an extensive mapping/magnetometer survey (M191-33) that brought the vessel back to Graham Bank. Dredge hauls M191-34,-35,-36 were conducted along a previously unknown chain of N-S- striking cones west of the Graham Bank summit. Near the northernmost cone of Graham Bank another vent field was observed in the water column sonar data. Afterwards, we spent the remaining time of July 24 dredging at and near the summit of Terribile Bank (the eastern neighbour of Graham Bank), where magnetic and backscatter data implied the presence of igneous and exposed rocks (M191-37 to -45). However, most dredges returned carbonate crust and only one volcanic rock was recovered (site M191-37).

The night and most of the following day, July 25, was spent carrying out a more detailed mapping/magnetometer survey of Terribile Bank and the area NE and SW of Pinne Bank (M191-46). During this survey, intense flare activity was observed in the water column at 37°08'N, 13°11' indicating large-scale gas venting. Eventually, dredging resumed along the NE flank of Nameless Bank (a few miles east of Pinne Bank). Once more, the positioning of the dredge sites was guided by identified magnetic anomalies, record during the preceding mapping survey. Dredge hauls M191-47, -48,-49 were conducted up the steep NE slope of Terribile Bank (returning only consolidated limestone) before the vessel turned southwards. The night was devoted to mapping/magnetometer surveying (M191-50).

In the morning of July 26, the vessel arrived in our southernmost working area, north of the island of Linosa and the Linosa Graben. Immediately north of Linosa, numerous steep volcanic cones /seamounts were found. However, like in all previous working areas, the choice of potential dredge sites was greatly restricted by the presence of several underwater cables. In addition, the environmental protection zone around Linosa prevented all activities within approximately 2.5 nm from the shoreline (which included several volcanic cones). Dredging of the only two cones that were accessible to us (M191-51, -52, and -54 to -57), however, retrieved excellent lava samples (Fig. 4.3). The night and the following morning on July 27 were again used for mapping/magnetometer survey. No further volcanic cones were found along the northern slope of the Linosa Graben but a distinct magnetic anomaly indicated that that the large solitary seamount on the carbonate platform between the Linosa and Malta Grabens might contain igneous rock. Two dredge hauls (M191-59, -60) were carried out at the lower and upper slope of this structure.

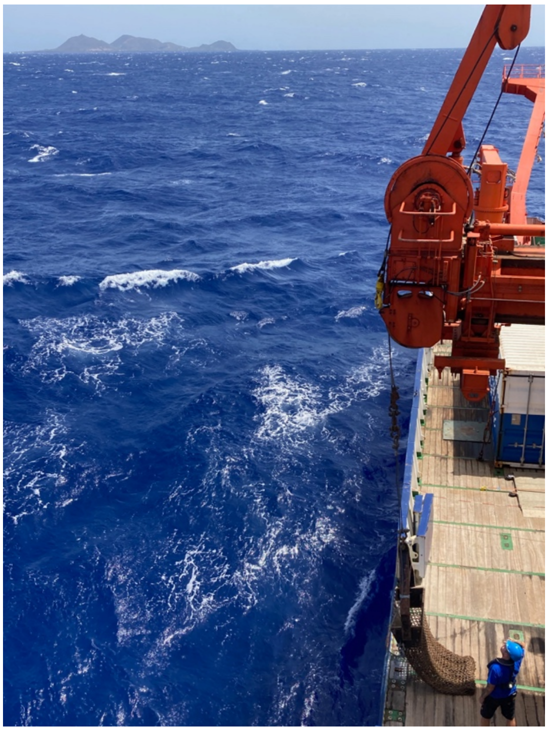


Fig. 4.3: Dredging operations within sight of Linosa (upper left corner), an Italian island of just 5.5 square kilometres in size, dominated by the 195 m high Monte Vulcano. Photo: J.G.

The night and most of the following day, July 28, was devoted to multibeam/magnetometer mapping the area north of the Linosa graben (M191-61) but no structures that could have been identified as of volcanic origin were found and the vessel returned to the dredging area that was sampled the day before to obtain more igneous material from this edifice (dredge hauls M191-62 to -66). The subsequent transit back to the northern part of the Sicilian Channel was used for multibeam/magnetometer mapping (M191-67).

On July 29, we dredged on the summit area of Terribile Bank (dredge hauls M191-68 to -73). This shoal is well-known by local fishermen and the selection of dredge tracks was therefore partly hampered by the intense fishing activity. Despite this challenge, dredging of a small pockmark field (M191-73) was particular successful and returned interesting igneous rocks. Further multibeam/magnetometer around Terribile Bank was conducted during the night (M191-74).

On July 30, dredging proceeded temporarily to Nameless Bank (around 20 nm SE of Terribile Bank) with dredge hauls M191-75, and -76, before mapping (M191-77) and dredging resumed on Terribile Bank (M191-78, -79), where fishing activity had decreased significantly in the meantime.

A further multibeam/magnetometer survey (M191-80) brought the vessel back to neighboring Nameless Bank on July 31, where two dredge hauls were conducted near its summit (M191-81, -82). The day was concluded by successfully dredging the upper southeastern slope of the Bank (M191-83,-84,-85). While mapping on Nameless Bank, an elongated, c. 100 m x 16 m long feature was found lying on the seafloor in about 100 m water depth, which looked like a ship wreck on the backscatter data.
The following day, Aug. 1 was devoted to further systematic multibeam/magnetometer mapping of the southern portion of Nameless Bank (M191-86) and four dredge hauls were subsequently carried out on the eastern part of this bank (M191-87 to -90). The last night of this expedition in the main working area was spent on multibeam/PARASOUND/magnetometer survey of the northern flank of the Malta Graben (M191-91), where several seamount-like structures were mapped. Since no magnetic anomaly was found, the search during the following morning, Aug. 2, focused on a vast bathymetric high located halfway between the Malta Graben und Nameless Bank. However, no further magnetic anomalies were found. After the final recovery of the magnetometer, a last SVP (M191-92) concluded our research in the main working area of the Sicilian Channel. Underway multibeam mapping, however, continued until the vessel left the Italian EEZ on Aug. 3. While most scientists spent the 2.5 days transit time cleaning the labs, packing the equipment and report writing, surface water sampling for nannoplankton research continued until we reached the port of Piraeus. At 08:35 on Aug. 5 the first line was fixed to the pier and Exp. M191 officially ended. In the afternoon all scientists disembarked the vessel.

In total, 18 dedicated multibeam/magnetometer surveys, covering a total length of 2886 km, were conducted to record high-resolution bathymetric data, backscatter, water column profile data and the total magnetic field intensity. We have carried out dredging at 68 stations, only 11 of which returned empty or contained just unconsolidated mud. All others delivered carbonate crusts, consolidated limestone (most likely from the continental carbonate platform) and, at 24 dredge stations, igneous rocks. In addition, 82 surface water samples for nannoplankton research were taken along our track between Algeciras and Piraeus. No deployed device was lost or seriously damaged.

5 Preliminary Results

5.1 Bathymetric Mapping and Hydroacoustics

(A. Micallef)

5.1.1 System Overview and Data Processing

a) Multibeam echosounder
RV METEOR is equipped with two Kongsberg Maritime multibeam echosounder (Fig. 5.1). The EM122 system operates at 12 kHz and covers water depths from 20 meters below the transducers up to full ocean depth; while the EM710 system offers a frequency range from 70-100 kHz of signals for water depths ranging from 3 m below transducers to roughly 1000 m. Two different transmit pulses can be selected: a CW (Continuous Wave) or FM (Frequency Modulated) chirp.

The sounding mode can be either equidistant or equiangular or mixed, depending on operation preferences and requirements. Both systems can be operated in single-ping or dual-ping mode, where one beam is slightly tilted forward and the second ping slightly tilted towards the aft of the vessel. The whole beam can also be inclined towards the front of the back and the pitch of the vessel can be compensated dynamically. The EM122 system produces 432 beams covering a swath angle of up to 150° while the EM710 system produces 432 beams for a maximum swath angle of 140°. Both systems offer a high-density beam-processing mode with up to 800 soundings per swath. The swath angle, however, can be reduced, if required. The transducers of both multibeam echosounder systems of RV METEOR are mounted in a so-called Mills cross array, where the transmit array is mounted along the length of the ship and the receive array is mounted across the ship. The system on RV METEOR is of a 1° x 2° design. The EM710 system installed on RV METEOR is of a 1° x 1° design, but transducers are much smaller. The echo signals detected from the seafloor go through a transceiver unit (Kongsberg Seapath) into the data acquisition computer or operator station. In turn, the software that handles the whole data acquisition procedure is called Seafloor Information System (SIS). In order to determine the point on the seafloor where the acoustic echo is coming from, information about the ship's position, movement and heading, as well as the sound velocity profile in the water column are required. Positioning is implemented onboard RV METEOR with conventional GPS/GLONASS plus differential GPS (DGPS) by using either DGPS satellites or DGPS land stations resulting in quasi-permanent DGPS positioning of the vessel. These signals also go through the transceiver unit (Seapath) to the operator station. Ship's motion and heading are compensated within the Seapath and SIS. Beamforming also requires sound speed data at the transducer head, which is available via a sound velocity probe. This signal goes directly into the SIS operator station. Finally, a sound velocity profile for the entire water column can be obtained either from a sound velocity probe or from a CTD (conductivity, temperature and density) probe. During cruise M191, we used direct sound velocity measurements with a special profiler probe at various stages of the cruise.

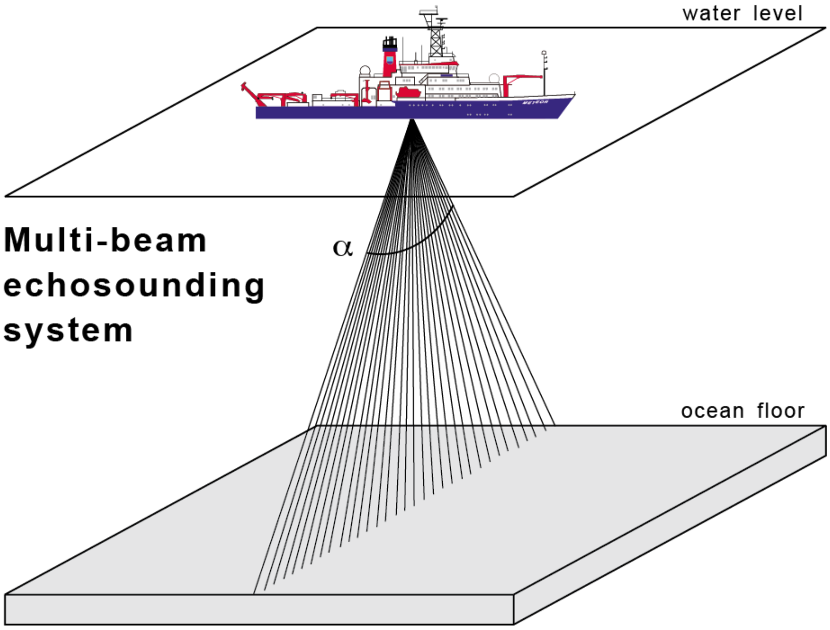


Fig. 5.1 Schematic sketch illustrating the principal mode of operation of multi-beam echo-sounding systems. The whole angular coverage sector (α) of the KONGSBERG EM 122 system is up to 150°.

In addition to bathymetric information, both the EM122 and the EM710 system register the amplitude of each beam reflection as well as a sidescan signal for each beam (so-called snippets). Both systems also allow recording the entire water column. The amplitude signals correspond to the intensity of the echo received at each beam. It is registered as the logarithm of the ratio between the intensity of the received signal and the intensity of the output signal, which results in negative decibel values. For each ping, both the EM122 and the EM710 record 432 backscatter intensity values. The water column data correspond to the intensity of the echoes recorded from the instant the output signal is produced. All echoes coming from the water column, the seabed and even below the seabed are recorded for each beam. When the water column data of one ping is divided into a starboard and portside subset, one can produce two traces, one for each subset. Each trace is built up as a time series in which for each time the highest amplitude is selected from all beams. Then the starboard and the port traces are joined together.

During cruise M191 the following settings of the Kongsberg EM122 system were used. The pulse was FM, ping mode was set to HD-equidistant, dual ping mode was set to dynamic, and depth mode was set to automatic. The beam angle was 140° during most of the survey. Survey speed varied between 4 and 10 knots. Data were acquired continuously, except when the ship was stationary during dredging operations and sound velocity profiling. Acquisition parameters for the EM710 system were the same as those for the EM122. Water column data were recorded during most of the surveys using the EM710 only. Six sound velocity probe casts were used for water sound velocity profiles (Figure 5.2).

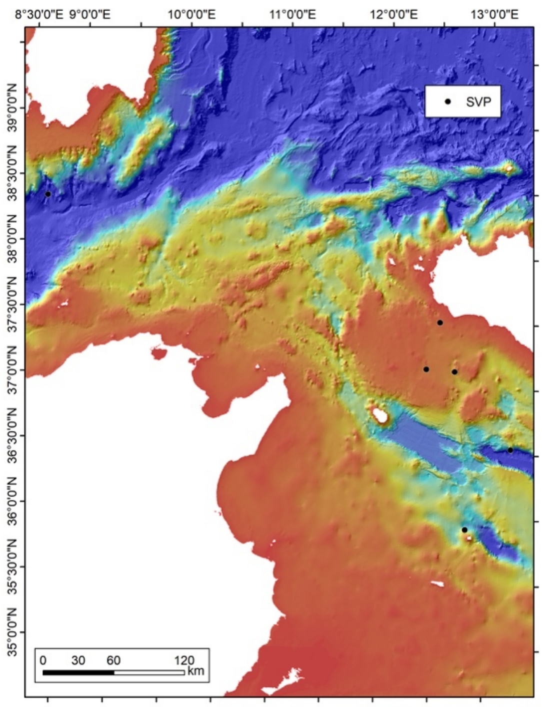


Fig. 5.2: Location of conducted sound velocity profiles (SVP) within the Italian EEZ.

Data processing was carried out onboard using QPS Qimera and FMGT software. After loading the raw data (.all files) and the correct sound velocity profile, a dynamic surface was created showing the ship's track and the raw data. Qimera allows an automatic elimination of major erratic data points using a spine filter. Furthermore, there are several tools for detailed elimination of erratic data points, for example a swatch editor, a 2D editor or a 3D editor, which enable the operator to process each single beam stepwise. All editors display not only the cleaned data but also, if desired, the rejected data points and offer a variety of visualizations of the data (according to files, depth, intensity etc.). After data cleaning, a static surface was generated from the dynamic surface creating a .sd file, which was loaded in the QPS Fledermaus software, allowing 3D visualization of the cleaned data. Furthermore, the data can be imported in FMGT to generate backscatter grids. Here, radiometric corrections, filtering, angle-varying gain and anti-aliasing filters and topographic corrections were applied to the backscatter data before outputting a georeferenced mosaic. To deliver an immediate 3D impression of the bathymetry, also uncleaned data were visualized with QPS Fledermaus and used for the quick selection of dredge tracks.

Both the EM122 and the EM710 multibeam echosounder produce a second type of raw data files with extension *.wcd, which stores water column data. These files were imported and viewed in Qimera.

b) Sediment echo sounder

RV METEOR is equipped with an ATLAS PARASOUND P70 sediment echo-sounding system. Sediment echo-sounding systems (or sub-bottom profilers) are used to image sub-seafloor geological structures such as, for example, marine sediment successions. Within the survey area the system was mainly used for analysis of sedimentary processes, such as the identification of mass transport deposits, background sedimentation, and tectonic surface deformation. In addition, the sub-bottom profiles discriminate well between volcanic and sedimentary material, as volcanic material strongly attenuates the signal and leaves vertical “blanking” zones. For the standard operation we chose a primary high frequency (PHF) of 22 kHz and a primary low frequency (PLF) of 4 kHz, which implies a secondary high frequency (SHF) of 48 kHz and a secondary low frequency (SLF) of 4 kHz. The source pulse was a continuous rectangular wavelet. The receiver amplification was -5 dB gain (PHF) and 20 dB gain (SLF). Both the 4 kHz (SLF) and 22 kHz (PHF) raw signals were recorded permanently. Due to strong interference with the EM710 multi-beam bathymetry profiler, the pulse interval was selected by the operator between 500 ms and 2000 ms (single pulse mode) depending on the anticipated slope angles and the amount of interference observed at a given water depth. The water velocity was set to 1500 ms^{-1}. Technical problems occurred rarely and could be solved during the cruise. The overall data quality and coverage was good. All raw data (for PLF, PHF, SLF and SHF frequencies) were stored in the ASD data format (Atlas Hydrographic), which contains the data of the full water column of each ping as well as the full set of system parameters. Additionally, a 200 m-long reception window starting at 90% of the seafloor depth was recorded in SEG-Y and compressed PS3 data formats after resampling the signal back at 12.1 kHz and converting from trace amplitude to envelope. This format is in wide usage in the PARASOUND user community and the limited reception window provides a detailed view of sub-bottom structures. All data were converted to SEG-Y format during the cruise using the software package ps32sgy (Hanno Keil, Uni Bremen). The software allows generation of one SEG-Y file for longer time periods, frequency filtering (low cut 2 kHz, high cut 6 kHz, 2 iterations), and subtraction of mean. All data were loaded to the seismic interpretation software IHS Kingdom. The entire PARASOUND data set will be transferred to international data banks and may be used by specialists for further shore-based processing and analyses.

5.1.2 Preliminary Results Bathymetry and Subbottom Profiling

a) Multibeam echosounder

A total of 3340 km^2 of multibeam echosounder data were acquired during M191 (Figure 5.3). The data are generally of good quality, although we did observe an interference between the EM710 and Parasound, especially at shallow depths, which resulted in significant noise in some of the bathymetric and backscatter data. The most significant observations made include new volcanic centres: (i) between Galatea and Anfitrite volcanoes (Figure 5.4), (ii) NE of Linosa island (Figure 5.5) and (iii) Nameless Bank (Figure 5.6a). The backscatter signatures of these volcanic centres were of very good quality (Figure 5.6b), and was used to guide the dredging operations. Flares in the water column data, indicative of active venting/seepage, were observed at a number of locations (Figure 5.7).

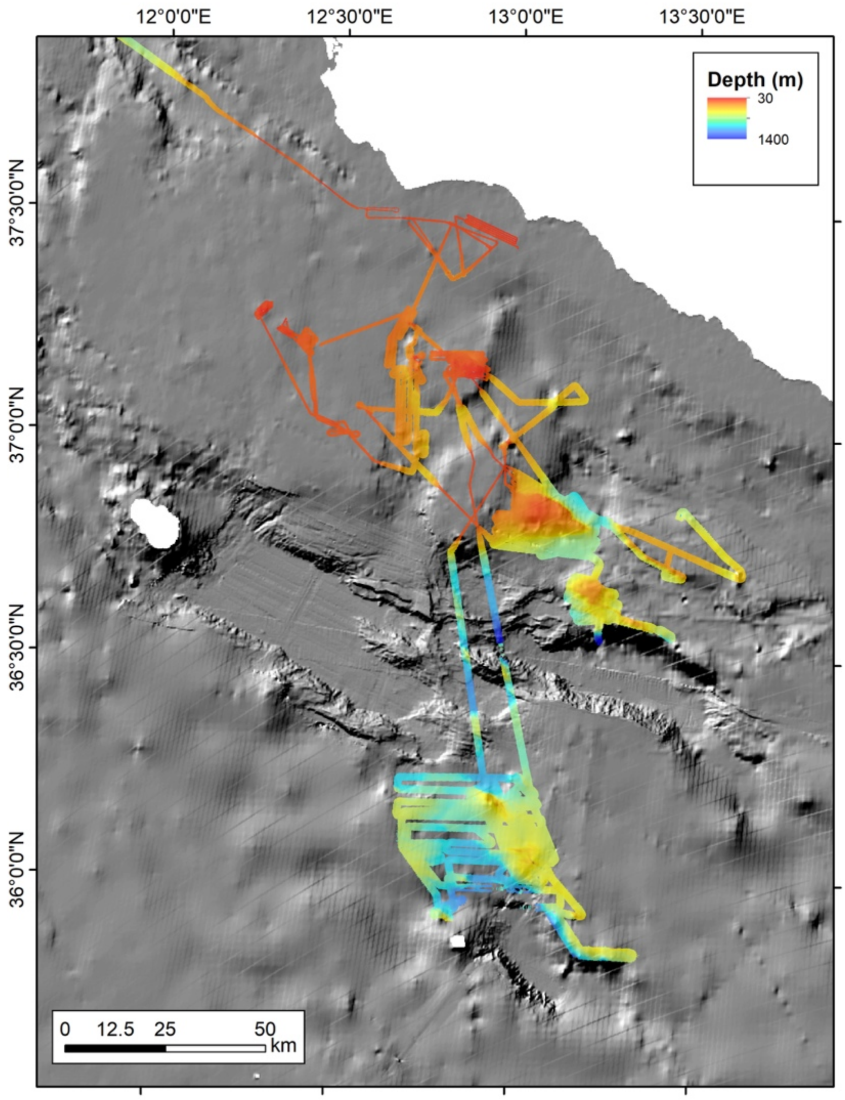


Fig. 5.3: Spatial coverage of multibeam echosounder bathymetry data acquired during M191.

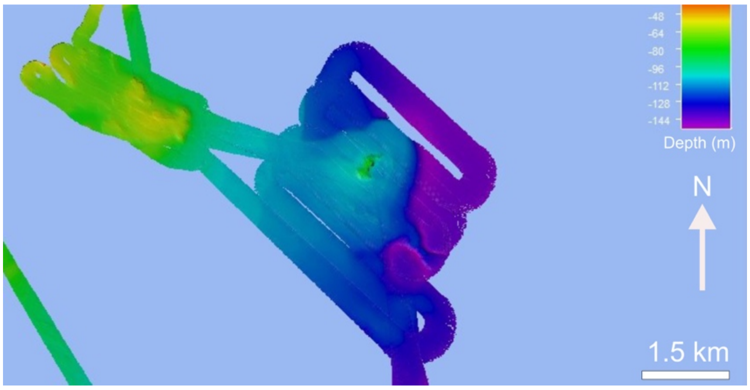


Fig. 5.4: Multibeam echosounder bathymetry data of new volcanic center located between Galatea and Anfitrite volcanoes.

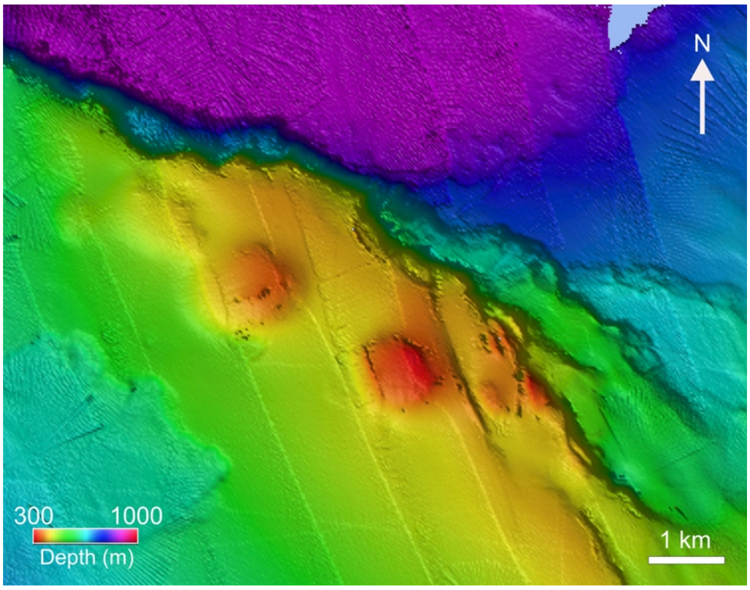


Fig. 5.5: Multibeam echosounder bathymetry data of a new volcanic center located NE of Linosa.

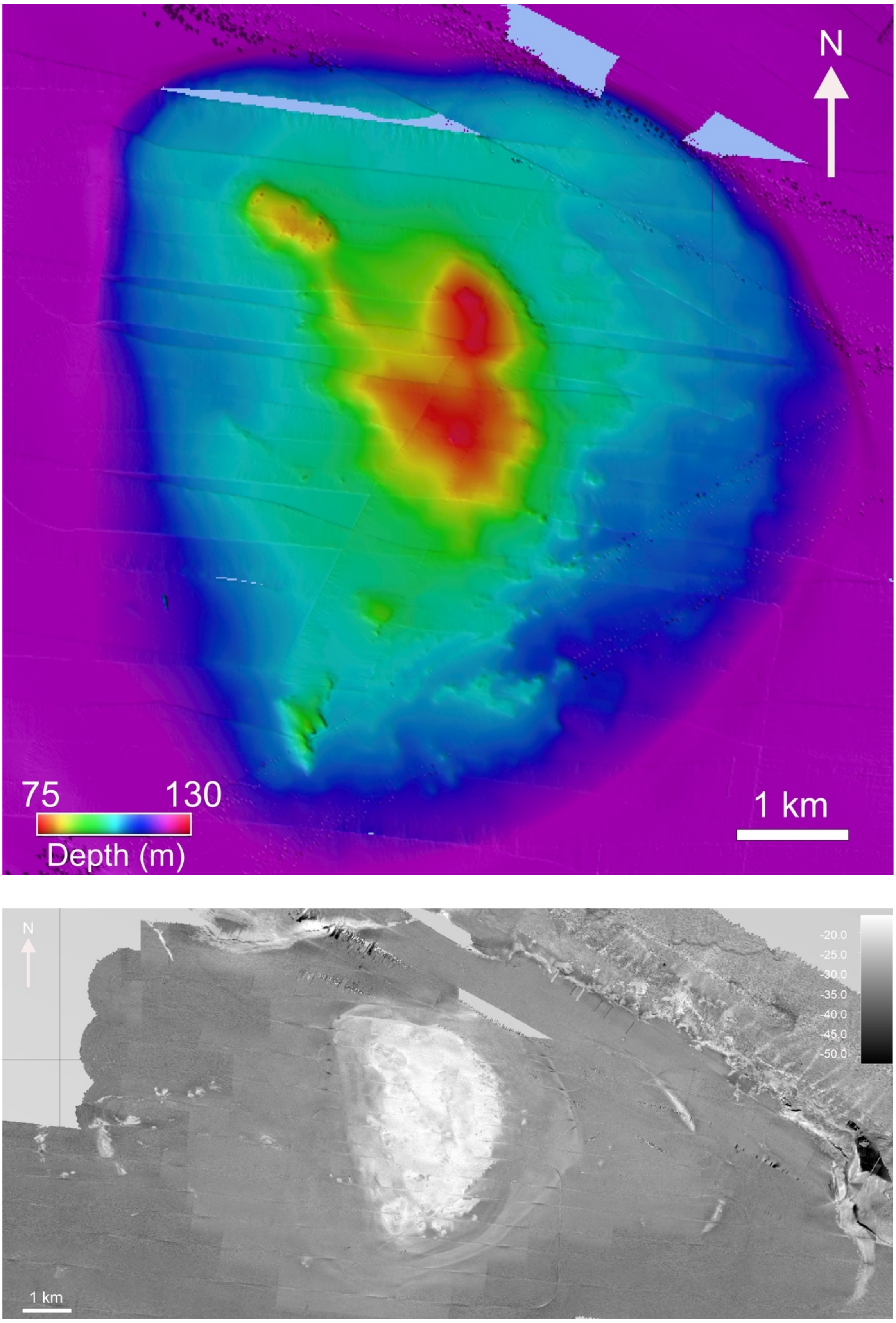


Fig. 5.6: a) Multibeam echosounder bathymetry (upper panel) and (b) backscatter data of a new volcanic centre located on Nameless Bank (lower panel).

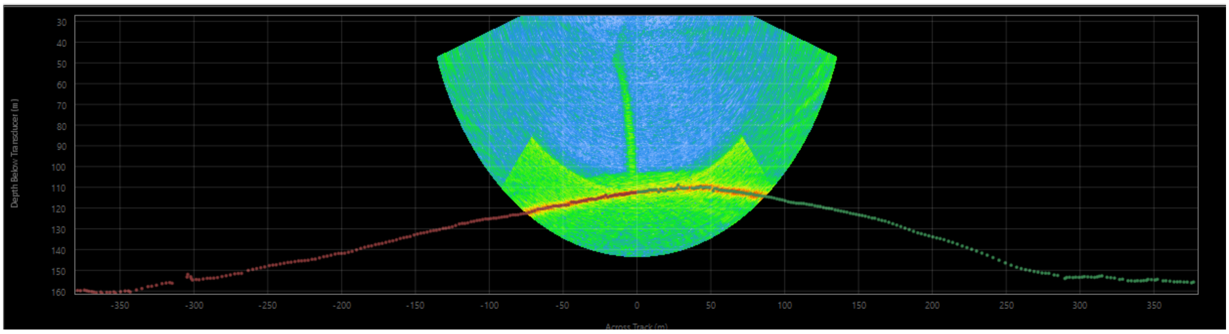


Fig. 5.7: EM710 water column data image. Flare (green elongated feature in the centre) suggesting active venting or seepage.

b) Sediment echo-sounding system

The PARASOUND P70 shows overall good penetration into the subsurface, except for areas where coarse-grained sediments, bedrock, or steep slopes scatter the transmitted energy and distort the proper imaging of the subsurface. Overall 2490 km PARASOUND profiles have been acquired during M191 (Figure 5.8). These data provide useful information to identify exposed and buried volcanic centres (Figure 5.9) and the adjacent stratigraphy, which can be used to deduce a relative age of volcano formation. In addition, sub-bottom profiles adjacent to volcanic centres frequently showed evidence of mass transport deposits (Figure 5.10) and fluid flow structures (Figure 5.11).

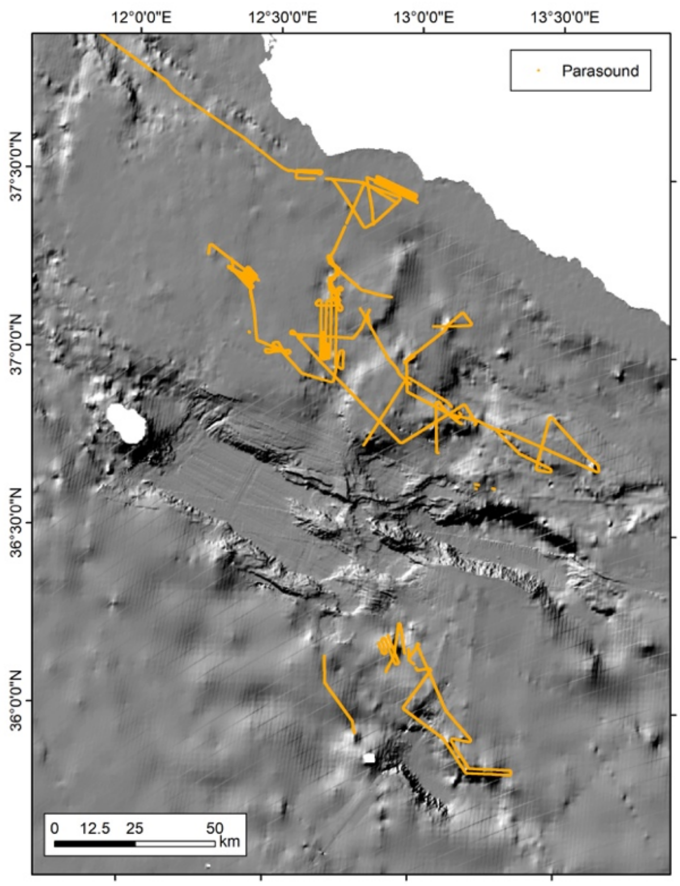


Fig. 5.8: Spatial coverage of sub-bottom profiles acquired during M191.

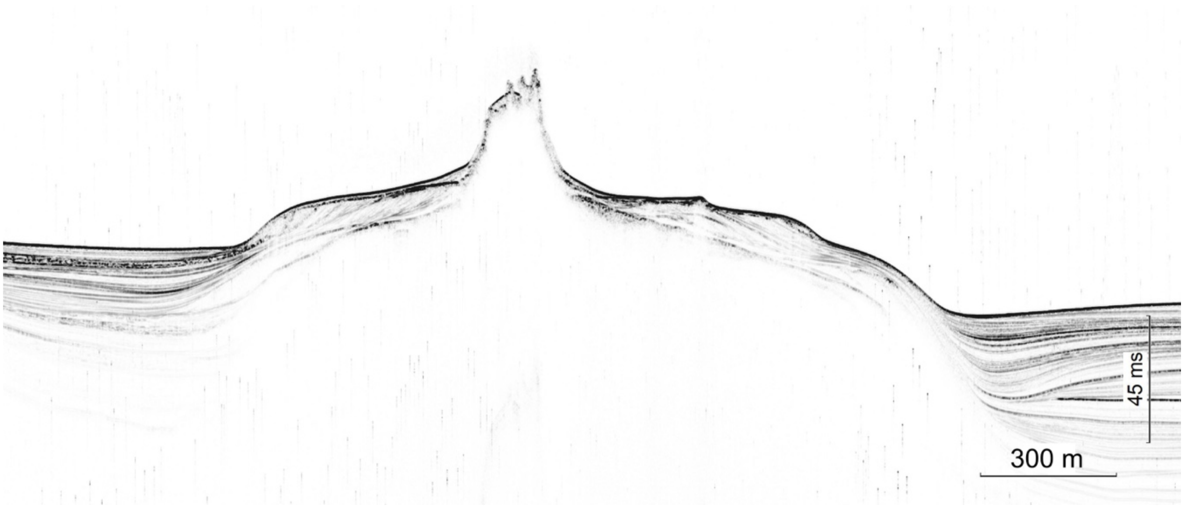


Fig. 5.9: Sub-bottom profile across Galatea volcano.

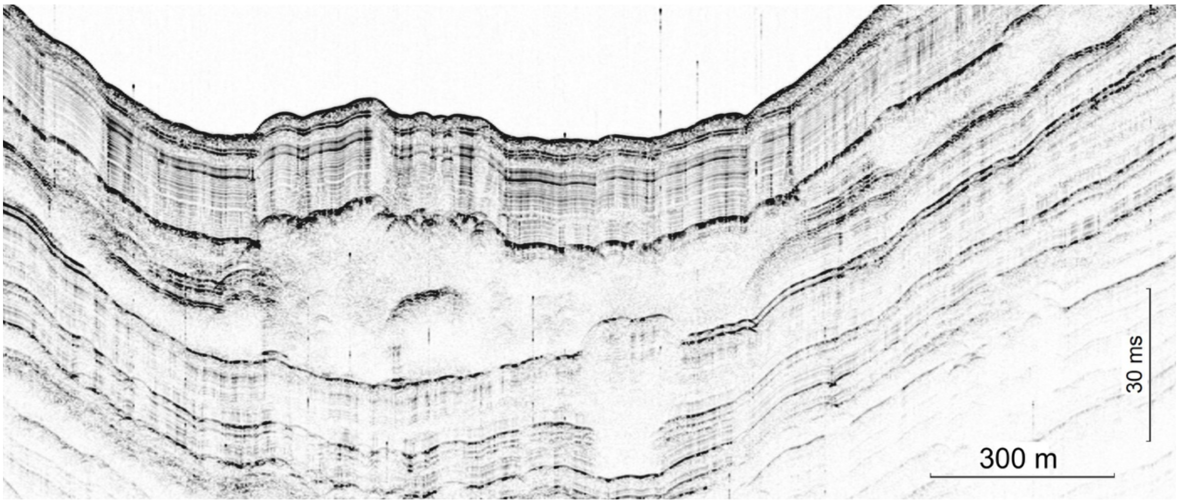


Fig. 5.10: Sub-bottom profile across a mass transport deposit west of Nameless Bank.

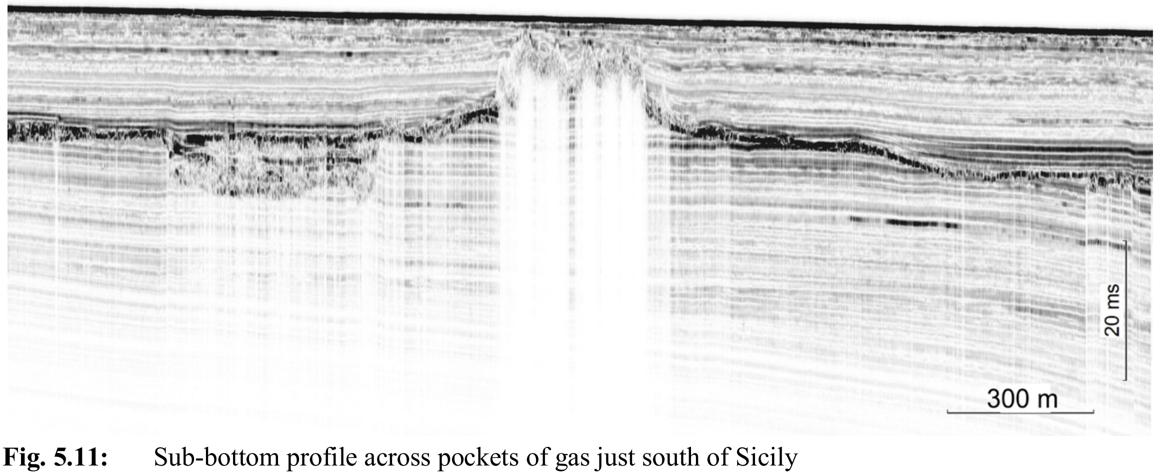


Fig. 5.11: Sub-bottom profile across pockets of gas just south of Sicily

5.2 Magnetic Field Survey

(Jonathan Ford, G. Matilde Ferrante)

Marine magnetic surveys involve measuring the Earth's magnetic field by towing a magnetometer behind a ship. Lateral magnetic susceptibility contrasts generate sharp anomalies (peaks or troughs) in the otherwise smoothly varying magnetic field. This means that the method is sensitive to the presence of contacts between sedimentary and magmatic bodies, which have very different magnetic susceptibilities due to the relative abundance of magnetic minerals in igneous rocks. The method can therefore provide an indication of the composition of submarine structures identified in the bathymetric data. For the SUAVE cruise, the magnetic anomaly data is primarily used to discriminate between volcanic cones and non-volcanic seamounts (e.g., carbonate mounds).

5.2.1 System Overview and Data Processing

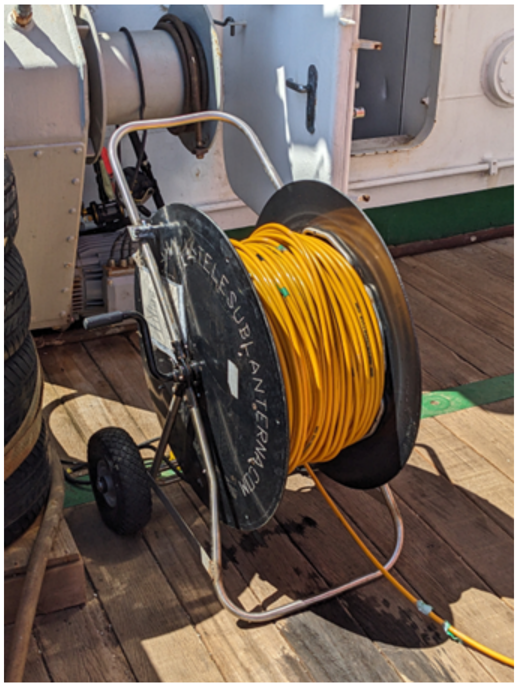


Fig. 5.12 (above): Towfish containing Overhauser magnetometer.

Fig. 5.13 (right): Cable on reel (300 m).

The magnetic data were acquired with an Overhauser proton procession magnetometer, which contains a chamber filled with a liquid rich in hydrogen. Electrons dissolved in the liquid are excited by a radio frequency power source and pass on their energy to the protons, altering their spin states. The transfer of energy from electrons to the protons in the hydrogen atoms is called the Overhauser Effect. Once the protons are spinning, the power is removed, and the protons spiral back to their original alignment with the external geomagnetic field. The rate of precession is dependent on the total intensity of the magnetic field and is measured.

The system used during Exp. 191 consists of:

1) A “SeaSpy” towfish unit (Marine Magnetics Corporation) that contains the magnetometer and driving electronics (Fig. 5.12);
2) An isolation transceiver for powering and communicating with the towfish;

3) A high-strength marine tow cable containing a single twisted wire pair (total length 300 m), housed on a reel (Fig. 5.13);
4) A deck leader cable to connect the cable reel to the isolation transceiver;
5) An RS232 interface cable that connects to isolation transceiver to a standard PC RS232 port;
6) A universal input power supply that powers the isolation transceiver and provides a 48V power supply to the towfish.

Fig. 5.14: Connecting the tow fish to the cable.

Measurement of the magnetic field is done completely inside the towed fish. The tow cable supplies power to the towfish and provides a bidirectional digital communication link (Fig. 5.14). The system has a maximum resolution of 0.001 nT and a maximum sample rate of 4 Hz. The software used for the acquisition and real-time visualisation and quality control is called “SeaLink” (Marine Magnetics Corporation), which runs on a Windows 10 operating system.

Magnetic surveys traditionally have several parallel lines perpendicular to the expected orientation of the anomalies, in order to make a grid. During M191 the magnetic data were acquired opportunistically, with the intention of using the in-profile anomalies to confirm the composition of sea mounts. Due to this, sail lines instead followed the multi-beam echosounder mapping survey, resulting in magnetic profiles which have variable orientation. The magnetometer sample rate was 0.3 Hz, except for areas where rapid changes in magnetic field and/or the presence of very short wavelengths anomalies (e.g., the Tetide survey area, in around 50 m water depth) required a higher sample rate of 1 Hz.

The deployment procedure was as follows:

1) Establish communication with the tow fish on the deck;
2) Synchronize the towfish clock with the GPS time;
3) Pay out the whole reel of cable (except for a couple of rounds left on the reel) assisted by a deck winch and a rotating drum on the edge of the ship;

4) Secure the cable to the ship with a fixed line, remove the tension in the cable between the reel and the tow point.

The recovery procedure was as follows:

1) Slow ship to 4 kn, wind cable back onto reel with assistance from deck winch.
2) When towfish is on deck, immediately (whilst towfish internal temperature is still at operating temperature in water) perform depth test to check that the pressure (depth) sensor reads 0 m, to ensure that the zero-calibration correct.

Both deployment and recovery took approximately 10-15 minutes.

The magnetic survey measured the total magnetic field intensity (in nT) with the magnetic anomaly being obtained from the total field intensity by subtracting:

1) The International Geomagnetic Reference Field (IGRF), which accounts for the magnetic field generated by the Earth's core;
2) The diurnal effects generated by the variations of the external magnetic field (largely from space weather). This was measured by the Lampedusa Magnetic Observatory (INGV), with a sample interval of 1 minute. Data for the previous day were made available to download from 00:00 UTC.

In order to provide real-time assessment of the magnetic bodies before dredging operations, preliminary grids were built onboard (see 5.2.2 below). No between-profile levelling was performed at this stage.

5.2.2 Preliminary Results Magnetic Surveys

In the following, exemplary results of specific magnetic survey areas are shown (Fig. 5.15, 5.16) and the coordinates of the conducted survey lines (start and end points) are provided (Fig. 5.17, Table 5.1).

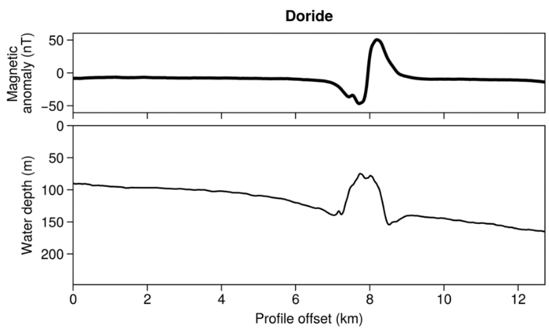


Fig. 5.15: Example of magnetic anomaly over the Doride volcano (top: magnetic anomaly, bottom: corresponding bathy-metry).

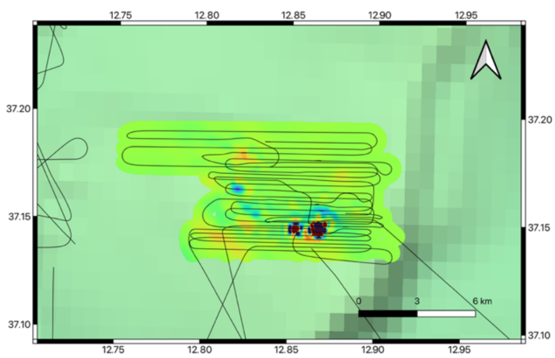


Fig. 5.16: Example of a processed magnetic anomaly grid in the Terribile Bank survey area.

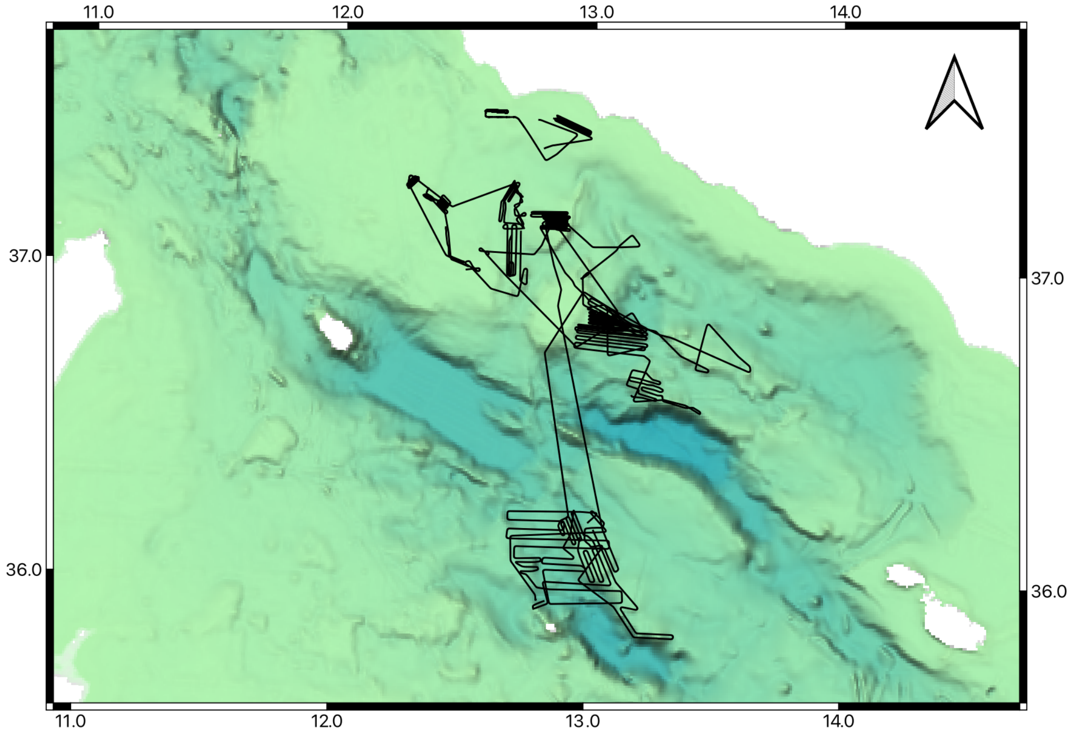


Fig. 5.17: Geographical overview of the magnetic surveys conducted during Exp. M191 in the Sicilian Channel.

Table 5.1: Overview of magnetometer deployments during Exp. 191

Deployment	Start Time		End Time		Start coordinates °E/°W		End coordinates °E/°W		Line km
Test line	19.07.2023	12:09	19.07.2023	12:40	8.85	38.36	8.92	38.36	6.00
Cable survey	20.07.2023	09:12	20.07.2023	16:00	12.56	37.51	12.77	37.48	83.53
Deployment 1	20.07.2023	22:20	21.07.2023	04:42	12.80	37.40	12.83	37.49	88.48
Deployment 2	21.07.2023	15:33	21.07.2023	18:17	12.69	37.27	12.73	37.14	32.80
Deployment 3	21.07.2023	22:19	22.07.2023	05:12	12.71	37.18	12.68	37.11	97.31
Deployment 4	22.07.2023	15:32	22.07.2023	19:57	12.71	37.12	12.50	37.00	71.32
Deployment 5	22.07.2023	21:51	23.07.2023	05:58	12.50	37.01	12.34	37.26	103.60
Deployment 6	23.07.2023	12:58	24.07.2023	05:40	12.42	37.13	12.69	37.27	244.23
Deployment 7	24.07.2023	22:10	25.07.2023	14:05	12.84	37.19	13.08	36.86	235.48
Deployment 8	25.07.2023	20:55	26.07.2023	11:22	13.11	36.87	12.84	35.95	227.06
Deployment 9	26.07.2023	23:25	27.07.2023	12:32	12.81	35.95	13.03	36.18	214.41
Deployment 10	27.07.2023	16:07	28.07.2023	13:16	13.01	36.20	12.95	36.24	338.08
Deployment 11	28.07.2023	19:43	29.07.2023	08:08	12.97	36.15	12.88	37.15	218.36
Deployment 12	29.07.2023	19:18	30.07.2023	11:22	12.84	37.18	13.08	36.85	249.05
Deployment 13	30.07.2023	15:22	30.07.2023	17:26	13.10	36.88	12.86	37.14	35.81
Deployment 14	30.07.2023	20:26	31.07.2023	11:25	12.85	37.14	13.05	36.81	241.71
Deployment 15	31.07.2023	19:41	01.08.2023	12:42	13.08	36.88	13.09	36.86	286.80
Deployment 16	01.08.2023	18:56	02.08.2023	10:54	13.14	36.83	13.17	36.61	282.10

5.3 Dredging

(Jörg Geldmacher, Sebastian Watt, Alastair Hodgetts, Folkmar Hauff, Maxim Portnyagin, Aaron Micallef)

5.3.1 Methods, Shipboard Procedure and Shore-based Analyses

(J. Geldmacher)

The search for potential dredge sites was guided by 1) predicted bathymetry, derived from gravity data and ship depth soundings (EMODnet Bathymetry: https://emodnet.ec.europa.eu/en/bathymetry), 2) our own multibeam mapping (see Chapter 5.1) and 3), the results of the magnetometer surveys (if available) (see Chapter 5.2). In addition, existing multi-beam data were available for limited parts of the working area, which were obtained from published sources or provided by our Italian colleagues (Emanuele Lodolo, Dario Civile (OGS), Danilo Cavallaro (INGV). Final positioning of the vessel at each dredge station also included considerations of wind, swell and drift conditions. During M191, however, favourable weather conditions allowed maximum flexibility in the selection of dredge track directions, except for the short time span from July 26.-27., when wind speed and wave height transiently increased. Dredge tracks were usually located - depending on the morphology of the structures - on steep slopes of scarps, canyon walls, fault zones, and the flanks of cones, ridges, and larger seamounts to avoid thick sediment cover. The small volcanic structures in the Sicilian Channel, however, often possess very shallow slopes, reducing the likelihood of a direct contact of the dredge with exposed hard rock.

A considerable challenge was the dense distribution of submarine cables across the entire working area. A careful protocol was followed to ensure that all potential dredge sites were first assessed based on cable location, and no sites were targeted where the location was within 1 km <u>and</u> <2.5 times the water depth from the nearest cable, based on whichever value was greater. As a result, several locations: Doride (Lodolo et al., 2019); various cones along the Graham Bank (Cavallaro and Coltelli, 2019); Tetide (Calanchi et al., 1989); and the majority of the Linosa III seamount structure could not be dredged. In addition, a region around Pantelleria was not permitted for access, and a marine protection zone around Linosa (as well as cable positions) limited access to the cones north-west of Linosa to those at the far northern limit of the submerged volcanic platform (cf. Romagnoli et al., 2020).

A final challenge to the recovery of volcanic material was the accumulation of unconsolidated seafloor sediment, especially in the northernmost sites of the study area and close to terrigenous sediment sources from Sicily, and in areas where a significant build-up of biogenic carbonate on the seafloor occurred, either in the form of rhodolith gravels or coralline and other bioclastic accretions. The latter was the case across much of the study area. In an effort to minimize recovery of carbonate material, seafloor backscatter data were used, targeting sites with high backscatter wherever possible. Nevertheless, many dredges recovered only marine surficial carbonate, even in sites of confirmed volcanism (e.g., the Graham Bank cones; Cavallaro and Coltelli, 2019).

Rock sampling on cruise M191 was carried out using rectangular chain bag dredges (Fig. 5.18). Chain bag dredges are essentially large buckets with a chain bag attached to their bottom and steel teeth at their openings, which are dragged along the ideally sediment-free ocean floor by the ship's winch.

Fig. 5.18: Deployment of a chain bag dredge near the Italian island of Linosa.

If volcanic rocks (or other rocks which appeared worthwhile sampling) were obtained, they were sorted and selected for further processing. First, these were cleaned and cut using a rock saw. They were then examined with a hand lens and binocular microscope, and grouped according to their lithologies and degree of submarine weathering. The immediate aim was to determine whether material suitable for geochemistry and radiometric age dating had been recovered. Best suitable volcanic samples have an unaltered groundmass, empty vesicles, glassy rims (ideally), and -if applicable- well-preserved phenocrysts. If suitable samples are present, the ship moved to the next station. If they were not, then the importance of obtaining samples from the respective site was weighed against the required time commitment for repeating a dredge haul. Due to the generally shallow water depth in the Sicilian Channel (resulting in relatively quick individual dredge hauls), unsuccessful dredges on the same target were frequently repeated.

Fresh blocks of representative (igneous) samples were then cut for post-cruise thin section and microprobe preparation, geochemistry and further procedures, to remove manganese and alteration products, and/or to extract volcanic glass (if present). Each of these sub-samples, together with any remaining bulk sample, was described, labelled, photographed, and finally sealed in plastic bags for transportation to GEOMAR.

Igneous rocks sampled during M191 from the ocean floor will be analysed using a variety of different geochemical methods: Ages of suitable rock samples will be determined by $^{40}Ar/^{39}Ar$

laser step-heating dating. Major element geochemistry by X-ray fluorescence (XRF) and electron microprobe (EMP) will constrain magma chamber processes. Trace element data, obtained by inductively coupled plasma mass spectrometry (ICP-MS), will help to define the degree of mantle melting and help to characterize the chemical composition of the source. Phenocryst assemblages and compositions will be used to quantify magma evolution. Petrologic studies of the volcanic rocks will also help to constrain the conditions under which the melts crystallized. The composition of mafic basalts and basaltic glasses, as well as mafic melt inclusions, can be used to assess mantle temperatures at which melting took place, as well as pressures and degrees of melting. Sr, Nd, Hf and Pb (double spike) isotope ratios, determined by thermal ionization mass spectrometry (TIMS) and multi-collector ICP-MS, reflect the long-term evolution of the magma source(s) and thus serve as tracers to identify mantle domains and possible crustal contamination (e.g., from the surrounding carbonate platform that all magmas have to pass through). Morphological and volcanological studies will constrain eruption processes, eruption environment and evolution of the volcanic structures

Representative non-magmatic rocks i.e., carbonate crusts or limestone samples from the carbonate platform were also collected and can be transferred to co-operating specialists for further shore-based analyses.

5.3.2 Preliminary Results Dredging

(Sebastian Watt, Alastair Hodgetts, Folkmar Hauff, Maxim Portnyagin, Aaron Micallef)

Sixty-eight sites, selected across the study area, were dredged in total. Twenty-four of these sites recovered volcanic material (Table 5.2; Figure 5.19). Only five dredges were empty, with the remainder retrieving carbonate material or mud/sediment. Most of this carbonate material, a constituent in nearly all dredges, was young surficial biological material of various types. Ten sites, however, retrieved denser carbonate in the form of broken blocks or pebbles, inferred to be derived from the local bedrock. Dredge sites were chosen based on a combination of indicators:

1. Reference in existing scientific literature to volcanic centres identified either by prior sampling of volcanic rock (e.g., Beccaluva et al., 1981; Calanchi et al., 1989; Rotolo et al., 2006), prior seafloor mapping of magnetic anomalies (Lodolo et al., 2012, 2019; Civile et al., 2018), or prior interpretation of volcanic landforms (Calanchi et al., 1989; Coltelli et al., 2016; Cavallaro and Coltelli, 2019). The site of the 1831 eruption of Ferdinandea/Graham Island (Coltelli et al., 2016) was also targeted, and more uncertain reports of other historical events (Washington, 1909; Francis, 1995; Siebert and Simkin, 2023) were revisited to locate potential eruption sites.
2. Interpretation during the expedition of our newly acquired bathymetric and total-field magnetic datasets, in order to identify magnetic anomalies, particularly those that corresponded to positive relief seafloor landforms.

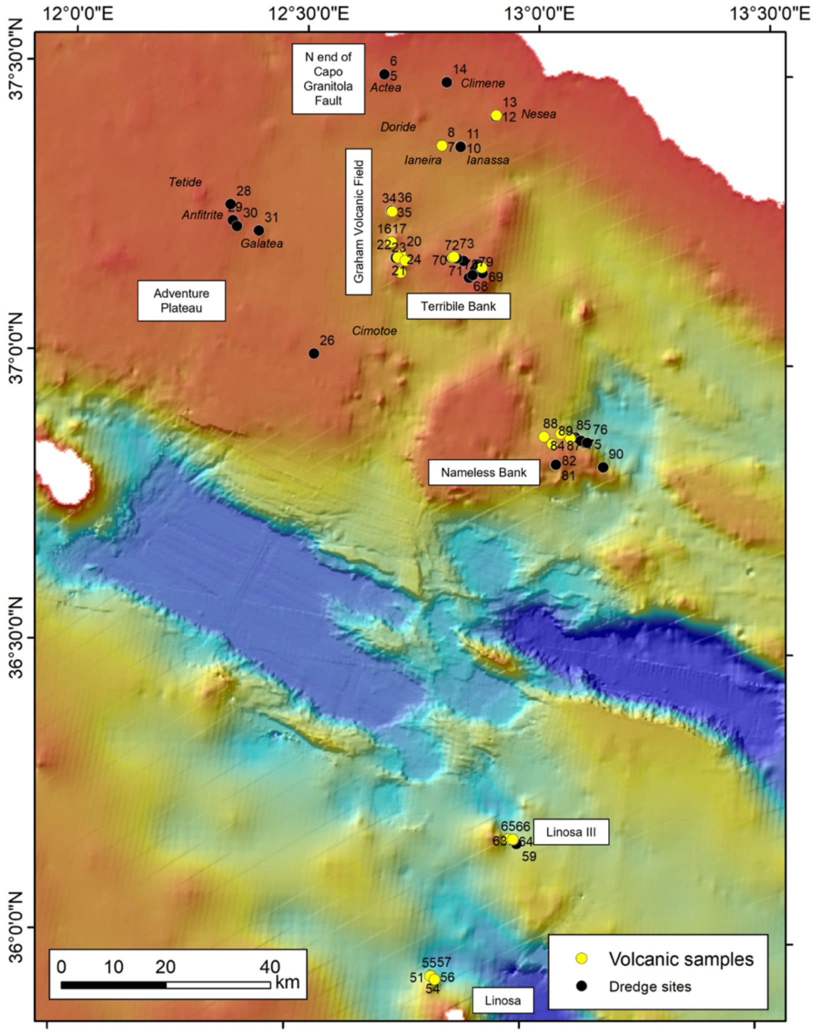


Figure 5.19: Map of of the main working region showing all dredging sites, distinguishing those that recovered volcanic material.

In several instances, our approach of using pilot seafloor mapping to evaluate the magnetic signature of bathymetric highs demonstrated that structures present on low-resolution GEBCO/EMODnet datasets were not present within our new multibeam bathymetry data (and did not display magnetic anomalies). In other instances, previously postulated but unsampled volcanic seamounts (e.g., Linosa I and Linosa II; Calanchi et al., 1989) were found to have no magnetic signatures. Accordingly, dredging targets were narrowed down to a small number of sites where we had the greatest confidence of potential volcanic seafloor outcroppings. There were some instances where magnetic signatures were found to only roughly correspond to bathymetric heights (e.g., Cimotoe; Calanchi et al., 1989; Terribile Bank). In these areas, magnetic signatures likely represent subsurface or partially buried igneous rock, and in these locations, we targeted sites with positive and steep topography that were deemed to provide the best opportunity of reaching the underlying bedrock.

In the following, we divide the study area into sub-regions (Table 5.2; Figure 5.19). These were broadly targeted in the sequence described, although some areas (Terribile Bank; Nameless Bank) were returned to at later points in the expedition.

Table 5.2: Summary of dredge sites by sub-region

Sub-region	Dredge stations	Summary of volcanic material recovered
N end of Capo Granitola fault (for cone locations refer to Lodolo et al., 2019)	5, 6, 7, 8, 10, 11, 12, 13, 14	1. Ianeira cone: one dense lava fragment (site 7) and block with mafic volcaniclastic fragments in altered matrix (site 8) 2. Nesea cone: one glassy dark vesiculated clast (site 13)
Graham Bank (for cone locations refer to Cavallaro and Coltelli, 2019)	16, 17, 20, 21, 22, 23, 24, 34, 35, 36	1. S6 cone: blocks with scoriaceous volcaniclastic fragments in altered matrix (sites 16, 17) 2. S5 cone: hydrothermal chimney structures (site 20) and dense mafic lava blocks (site 21) 3. S4 cone (Ferdinandea): mixed volcaniclastic material (scoria, inflated blocks, palagonitised tuff fragments, dense blocks) (site 23) 4. S1 cone: block with scoriaceous volcaniclastic fragments in altered matrix (site 24) 5. Site of S10 cone: coarse ash/very fine lapilli, sparse mafic fragments embedded in surface mud (may not be locally derived) (site 34)
Adventure Plateau (Galatea, Anfitrite, Tetide; cf. Calanchi et al., 1989)	26, 28, 29, 30, 31	None
Terribile Bank	37, 38, 39, 40, 41, 42, 43, 44, 45, 68, 69, 70, 71, 72, 73, 78, 79	1. E Terribile bank: Ignimbritic surficial block, with brown fine-grained matrix encasing pumice clasts, crystals and carbonate lithics (site 37) 2. N Terribile bank: Green rounded blocks of clastic hydrothermally derived/altered material associated with pockmark field (site 70); multiple blocks of pervasively altered crystalline rock from edge of pockmark (site 73)
Nameless Bank	47, 48, 49, 75, 76, 81, 82, 83, 84, 85, 87, 88, 89, 90	1. Upper cliff and associated slopes on N side of ridge projecting on far E side of Nameless Bank, retrieved across distance of several km: dense (non-vesicular) porphyritic mafic lava blocks, variably altered and with slight variation in phenocryst assemblage (sites 83, 84, 85, 87, 88), alongside flattened red clasts of altered fragmented volcanic material. Uppermost site, above cliff, contained minor coarse volcanic clasts embedded in poorly lithified carbonate sand pebbles (site 89).
Linosa and nearby seamounts	51, 52, 54, 55, 56, 57, 59, 60, 62, 63, 64, 65, 66	1. Cone at far N edge of platform NW of Linosa: Vesicular mafic lava blocks (sites 54 and 55), including peperitic texture 2. Adjacent cone immediately SE: Vesicular mafic lava blocks (site 56) 3. Linosa III, far E edge: small pebbles of calcite-cemented scoriaceous clasts embedded within lithified carbonate mud (sites 60 and 64)

N end of Capo Granitola fault

This region preserves some of the youngest volcanic landforms in the study area (Figure 5.19), in the form of isolated small cones or rings with strong magnetic anomalies (Lodolo et al., 2019). Sub-bottom profiles indicate that these structures date from around the Last Glacial Maximum, with the bases of each structure being partially buried by younger sediment (Lodolo et al., 2019). The largest, western-most center of Actea is the most degraded landform. Doride is a well-shaped truncated cone but was inaccessible to dredging because of nearby submarine cables. The shallow setting of these sites, in water depths of just 40 m for the northern cones, presented a challenge for dredging. Their setting, close to the Sicilian shoreline, shallow depth also likely leads to a relatively high sedimentation rate and, despite their young age, has ensured a sufficiently thick biogenic/carbonate drape which makes it difficult to retrieve material from the underlying volcanic structures.

Actea was dredged twice (sites 5 and 6) recovering only fragments of encrusted bioclastic carbonate. Ianeira, in slightly deeper water to the south, was dredged at sites 7 and 8, the first recovering a single piece of moderately vesicular mafic lava amongst multiple bioclastic carbonate fragments, and the second retrieving fragments of palagonitised tuff with dispersed grey angular to sub-rounded mafic lapilli, among several other large coral-encrusted carbonate blocks. A nearby cone, Ianassa, was dredged twice (sites 10 and 11) without recovering any volcanic material, collecting only a variety of coral fragments. Nesea, further north and in shallower water (70 m), has a low-profile concentric morphology, suggestive of a tuff ring. Two dredges (sites 12 and 13) recovered large volumes of mud with coral and shell fragments, and one volcanic rock at site 13, a glassy dark mafic pyroclast with an open foamy texture. The final volcanic center in the group, Climene, has a similar morphology to Nesea but is more degraded. A dredge there (site 14) recovered only mud with several large coral fragments and bivalves.

The volcanic rocks retrieved from this region are the first samples recovered from these volcanoes, except for a coral-encrusted lapilli tuff from Actea that was dated in Lodolo et al. (2021).

Graham Bank

The Graham Volcanic Field cones comprise a N-S orientated group of ten cones (Cavallaro and Coltelli, 2019), interpreted as being generated by monogenetic explosive eruptions in a shallow-submarine to emergent environment. This interpretation is supported by observations made during the 1831 eruption of Ferdinandea (cone S4; Cavallaro and Coltelli, 2019), which briefly formed an island before erosion led to its current form of a truncated submarine cone with a wave-cut platform. Other cones in the field have a similar morphology, with more deeply submerged centers having narrow summit platforms and the deepest having a simple conical morphology. Unlike the dispersed monogenetic cones further north, the Graham Volcanic Field includes three clusters of closely spaced cones, suggesting reactivation of feeder structures, or events that were closely spaced in time within each cluster.

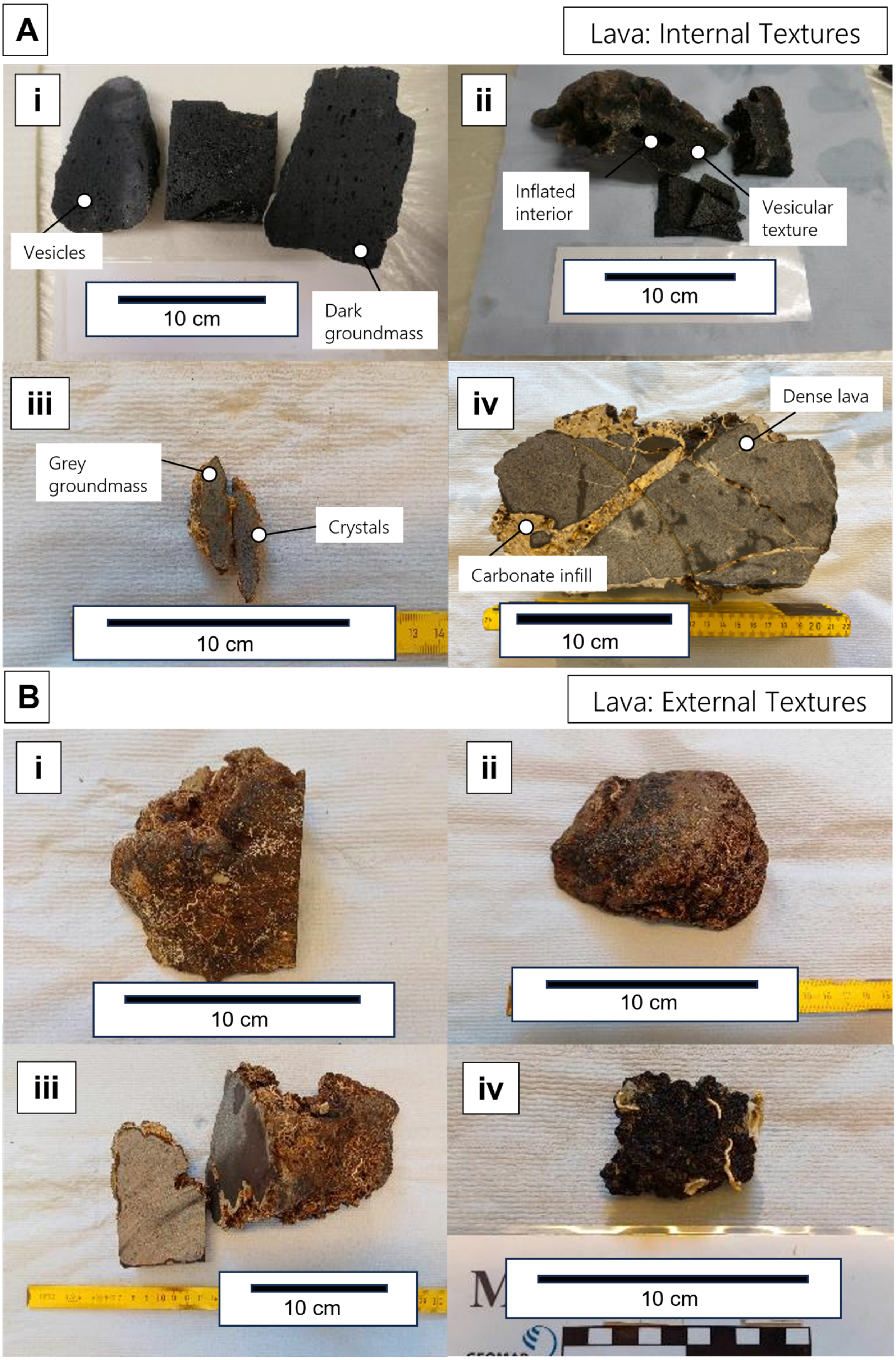
From the southernmost cluster of three cones, only S1 (Cavallaro and Coltelli, 2019) was accessible for dredging during M191, due to submarine cable locations. Here, a single dredge (site 24) recovered one volcaniclastic block, preserving angular mafic scoriaceous clasts within a green and white altered matrix, alongside several large rounded carbonated blocks. Further north lie the paired cones of Ferdinandea (S4) and the morphologically similar but much larger S5. A single dredge on Ferdinandea (site 23) recovered a large volume of loose pyroclastic debris, likely representing the wave eroded material derived from the former island and present-day wave cut platform, accumulated on the outer surface of the submerged cone. A mix of clast types (Figures 5.20 and 5.21) included breadcrusted inflated blocks, dense vesiculated fragments, rounded palagonitised tuff gravel, scoriaceous lapilli and two sedimentary xenoliths. On the nearby S5 cones, a dredge site on the NE side (site 20) retrieved several pieces of hydrothermal chimney constructions, comprising cemented sand-sized volcanic clasts with a central pipe (Figure 5.21Bi, ia). These were recovered alongside altered material and bioclastic carbonates. They are likely associated with an active vent field imaged in water column data, on the S side of a large pockmark, and represent fumarole structures. On the SW side of the same cone (site 21), fresh volcanic rock was recovered, in the form of dense, poorly-vesicular clasts, alongside a large volume of bioclastic carbonate. A dredge site at the base of the cone (site 22, west side of the cone), across a rough area of seafloor that may represent a debris field or lava flow, recovered no material.

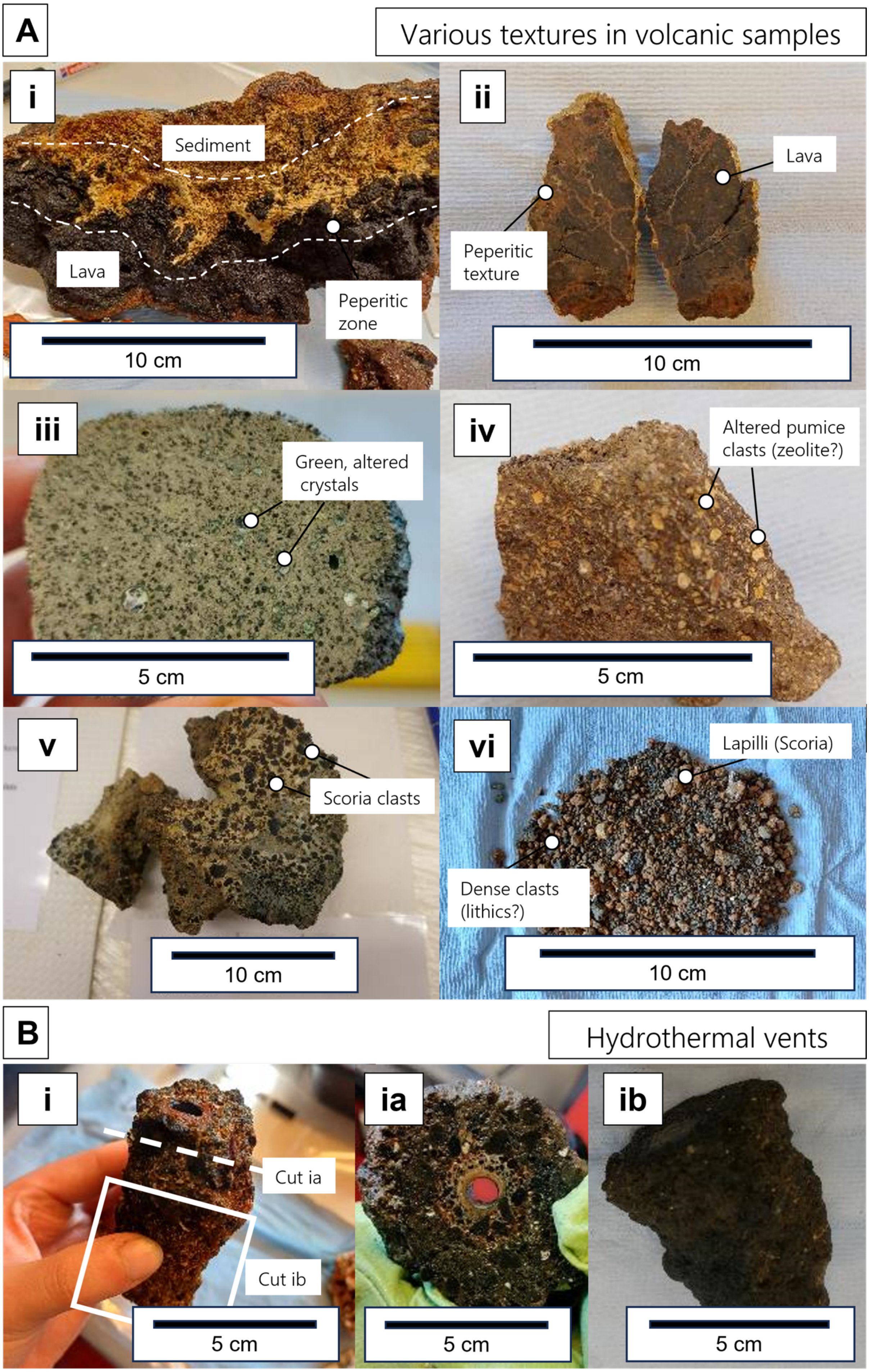
Two isolated cones lie further north, but only one of these (S6) could be dredged due to submarine cable positions. Dredge sites 16 and 17 recovered mostly bioclastic carbonate and coral fragments, with some palagonitised tuff blocks preserving dark, angular and finely vesicular clasts. The northernmost cluster in the Graham Volcanic Field comprises a number of small cones that were again mostly inaccessible due to cable positions. The western cone was dredged (sites 34-36) but both dredge hauls recovered mud and a small number of bioclastic carbonate fragments. The only volcanic material comprised sparse coarse mafic ash and lapilli (≤0.8 cm) grains accumulated in grey surface clay, embedded in some of the carbonate blocks recovered from haul 34. We cannot be confident that these are derived from this cone, and they may represent fallout deposits from another eruption in the area, such as the 1831 Ferdinandea eruption.

Adventure Plateau

South of the Graham Volcanic Field, a volcanic centre named Cimotoe is marked in several papers (Calanchi et al., 1989; Civile et al., 2018), although with slightly ambiguous positioning. A cluster of five conical structures visible in EMODnet bathymetry and aligned with the Graham Volcanic Field was initially mapped, but several of these structures were found not to exist when the area was mapped with high-resolution multibeam bathymetry during M191, and there is no distinct magnetic anomaly in the area that corresponds to a positive seafloor landform. A track to the NW, crossing onto Adventure Plateau, was then mapped, transiting over small positive landforms, which were found not to have a clear magnetic anomaly. A dredge taken on one of these (site 26) recovered only bioclastic carbonate blocks.

Further NW, an alignment of several large but highly eroded volcanic landforms has been previously identified, comprising the three centers of Tetide, Anfitrite and Galatea (Calanchi et al., 1989), with the first two being previously sampled and demonstrated to be volcanic. These are far larger than the Graham Bank and Capo Granitola cones, and likely represent much longer-lived, polygenetic structures. Their high level of degradation suggests a much older age, and these landforms would have been exposed above sea level at the last glacial maximum (cf. Civile et al., 2015). Tetide could not be dredged due to the location of submarine cables. Anfitrite was dredged on the eastern flank, but this recovered only several surficial carbonate blocks, with an open encrusted bioclastic structure (site 28), and nearby sites on a newly identified volcanic landform between Anfitrite and Galatea (29 and 30) also only recovered carbonate (dense bioclastic) material. Galatea was located based both on bathymetry (Fig. 5.3) and its corresponding magnetic anomaly, with a single dredge on its eastern slope (site 31). Again, this recovered only dense carbonate blocks.


A
Lava: Internal Textures
i
Vesicles
10 cm
Dark groundmass
ii
Inflated interior
Vesicular texture
10 cm
iii
Grey groundmass
Crystals
10 cm
iv
Dense lava
Carbonate infill
10 cm
B
Lava: External Textures
i
10 cm
ii
10 cm
iii
10 cm
iv
10 cm


A
Various textures in volcanic samples
i
Sediment
Lava
Peperitic zone
10 cm
ii
Lava
Peperitic texture
10 cm
iii
Green, altered crystals
5 cm
iv
Altered pumice clasts (zeolite?)
5 cm
v
Scoria clasts
10 cm
vi
Lapilli (Scoria)
Dense clasts (lithics?)
10 cm
B
Hydrothermal vents
i
Cut ia
Cut ib
5 cm
ia
5 cm
ib
5 cm

Previous pages:

Figures 5.20: Photographs of recovered samples in hand specimen, showing example volcanic lithologies. A: Examples of internal textures in lavas. Ai: Site 23 (Graham Bank), Aii: Site 54 (Linosa and nearby seamounts), Aiii: Site 84 (Nameless Bank), Aiv: Site 87 (Nameless Bank). B: Examples of external textures of lavas. Bi: Site 84 (Nameless Bank), Bii: Site 85 (Nameless Bank), Biii: Site 85 (Nameless Bank), Biv: Site 13 (N end of Capo Granitola fault).

Figures 5.21: A: Various textures in volcanic samples. Ai. Site 55 (Linosa and nearby seamounts), Aii. Site 83 (Nameless Bank), Aiii. Site 70 (Terribile Bank), Aiv. Site 37 (Terribile Bank), Av. Site 24 (Graham Bank), Avi. Site 23 (Graham Bank). B: Hydrothermal vents all recovered from site 20 (Graham Bank).

Terribile Bank

Terribile Bank has been cited as containing volcanic landforms in several papers (Falzone et al., 2009; Civile et al., 2018; Cavallaro and Coltelli, 2019). Civile et al. (2018) provide one sub-bottom and magnetic-anomaly profile that suggests the presence of magmatic bodies, but otherwise the interpretation of volcanic centers is based solely on the varied surficial landforms in the area, some of which have irregular, lava like morphologies or represent small rounded or truncated conical forms. Our initial dredges targeted areas identified in Civile et al. (2018) and Cavallaro and Coltelli (2019) as volcanic landforms, while a later dredge visited the MAC-06 site of Falzone et al. (2009). These sites (37-41, 45) recovered only carbonate material, including many sites with rhodoliths, varied coralline material and bioclastic carbonate. At site 68, the rounded form interpreted as a small volcano (MAC-06) by Falzone et al. (2009), the dredge recovered lithified beach or coastal carbonate sand, alongside dense carbonate pebbles, with further varied carbonate lithologies recovered at site 69, across the same structure, suggesting that it is not volcanic. The only other dredge haul from this part of Terribile Bank that recovered material interpreted as bedrock carbonate (as opposed to surficial lithified bioclastic mud, rhodoliths, or biogenic concretions) was conducted at site 37, at the eastern edge of a lobate mounded structure. This retrieved varied carbonate pebbles and was also the only site in the immediate area to recover non-carbonate material, in the form of blocks with a brown fine-grained matrix with dispersed carbonate clasts and crystals, interpreted as peperitic (Fig. 5.21Ai,ii).

All of the above sites at Terribile Bank did not show a close association between magnetic anomalies and surface landforms, despite the prior interpretation of young volcanic structures in the area. However, a number of strong magnetic anomalies were mapped on Terribile Bank, suggesting local igneous bodies and consistent with the observations of Civile et al. (2018). One prominent anomaly is on the north side of the bank. This was targeted at dredge sites 42-44 (targeting prominent topographic highs and areas with high backscatter, but again retrieving only surficial carbonate, including rhodoliths), and then later at sites 70-73. These sites were more closely associated with a magnetic anomaly, much of which did not overlap with surficial topography. In this area, on the southern edge of the anomaly, a fault bound valley with intensive pockmarks lies between two topographic highs. Sites 71 and 72, on the highs, recovered only surficial carbonate, but 70 and 73 retrieved highly altered material consistent with hydrothermal venting. At site 70, on the western edge of a pockmark on the W side of the valley, the sample contained a dense bedrock carbonate block alongside green rounded and soft blocks, containing crystals and secondary minerals, potentially derived from an extremely altered igneous protolith.

Such an interpretation is supported by the range of samples at site 74, on the margin of an adjacent pockmark. This sample contained no carbonate material, but numerous dense and crystalline volcanic, porphyritic blocks, several with angular fracture planes and all displaying varying degrees of pervasive alteration, in most cases entirely replacing primary phenocryst minerals. These observations are consistent with a shallow subsurface igneous body being the source of the magnetic anomaly in the area, rather than young volcanic constructions.

Further magnetic mapping revealed additional magnetic anomalies in various areas on Terribile Bank. Again, these generally do not correspond closely to surface landforms, but one exception is a strong anomaly in the eastern central part of the bank, where a linear anomaly corresponds to a topographic ridge. This ridge has surface morphologies consistent with carbonate areas on the bank, but given its close association with a magnetic anomaly, it was dredged at sites 78 and 79. This did not recover any volcanic material, but did retrieve rounded carbonate pebbles and a cemented carbonate sand, suggesting subaerial exposure and potential carbonate constructions on top of subsurface igneous rock.

Nameless Bank

Nameless Bank has previously been dredged three times, with igneous rocks described in Beccaluva et al. (1981), Calanchi et al. (1989) and Rotolo et al. (2006). All these dredge sites are located on the N side of a ridge that extends from the eastern side of Nameless Bank (Fig. 5.6a). Three initial dredges (sites 47-49), targeting the same areas, did not recover any volcanic material. The first two recovered only clay, while the third retrieved varied carbonate lithologies, including breccias and cherty material, interpreted as representing bedrock exposed in the north wall of the ridge. Further mapping confirmed the presence of strong magnetic anomalies across the ridge, and additional dredges targeted areas of high backscatter (sites 75 and 76) but again recovered only dense carbonate (mid part of the ridge, site 75) or reef coralline and shelly material (lower ridge, site 76). Further dredges targeted sites further east along the cliff (sites 81 and 82) and then a high backscatter area below the upper cliff (site 83), finally recovering numerous volcanic fragments, mostly highly altered and most frequently in the form of angular flattened and reddened clasts, with a fragmental fabric. Subsequent dredges targeting the cliff above this slope, and similar levels along the upper parts of Nameless Bank, retrieved blocks of dense volcanic rock with fresh broken surfaces (dredge sites 84, 85, 87, 88). These were all very dense, non-vesicular porphyritic blocks with an aphanitic and in some cases likely glassy matrix. Phenocryst assemblages vary slightly across the sites, which are spread over several kilometres, but are generally highly altered. Brown altered olivine is abundant in most specimens, rarely with fresh material in the centre of crystals. Black, tabular pyroxenes are generally less altered and of lower abundance, but still frequent. Some samples had large plagioclase laths, but others had no visible phenocryst plagioclase. The sampled sites correspond well to the intense magnetic anomaly on Nameless Bank and suggest that the upper parts at least are of volcanic construction, with in-situ outcrops of large, eroded lava bodies. The top of Nameless Bank shows a terraced but smooth morphology, likely extensively draped by sediment, with sparse outcrops in the centre. The margins of the terraces retrieved coarse sub-rounded pebbles of bioclastic sandstone, in some cases with 5-10% volcanic grains (site 89).

Linosa and nearby cones

Several bathymetric highs between Nameless Bank and Linosa were transected in an initial profile in order to verify if these corresponded to magnetic anomalies. The previously postulated seamounts of Linosa I and II (Calanchi et al., 1989) show no magnetic anomaly. In contrast, a strong and complex anomaly was observed over Linosa III and, as expected, on the submerged flanks of Linosa itself.

Dredging was conducted offshore Linosa in the only accessible region (given cable locations and a marine protection zone), which was at the far end of the submarine volcanic ridge NW of Linosa. Here, two separate cones were sampled. The first dredges at the most northerly cone at the end of the ridge (sites 51 and 52) recovered no material except for mud and small carbonate fragments (a later dredge here, site 57, again recovered only mud), but subsequent dredges recovered vesicular, mafic, porphyritic lava blocks and fluidal fragments (sites 54 and 55). A further dredge (site 56) targeted the lower flanks of the cone immediately to the SE, retrieving dense and finely-vesicular porphyritic lava blocks.

Mapping at Linosa III revealed rounded circular landforms closely corresponding to a magnetic anomaly, interpreted as volcanic. Cable locations meant that only sub-optimal sites, at the far eastern edge of these structures and on a faulted boundary, could be targeted. Site 59 recovered dense carbonate brecciated blocks, interpreted as bedrock from the fault scarp, alongside other carbonate lithologies. Site 60, slightly upslope and closer to the volcanic landforms, retrieved a bioclastic carbonate mud encasing a rounded, flattened pebble or carbonate-cemented scoria fragments, interpreted as being locally derived and then set within younger lithified bioclastic carbonate on the current seafloor. A very similar specimen was recovered in a dredge nearby (site 64), but other dredges in the vicinity were either empty (site 62 and 66) or recovered only bioclastic carbonate and encrustations (sites 63 and 65).

Biogenic and carbonate materials recovered at various locations

The dredging collected numerous and varied carbonate samples from across the study area (Fig. 3.2). This included carbonate bedrock in places, but for the most part comprised surficial and recent material, giving insights into conditions and biota on the present-day seafloor. This sample set holds potential significance in evaluating facies in bathymetric and backscatter data, including constraints on specific environments such as the presence of rhodolith gravels. The encrusting organisms and other material, particularly the extensive range of coral fragments observed at a number of sites, may also give new insights into the nature and range of seafloor colonisation.

5.4 Nannoplankton Sampling

(Odysseas A. Archontikis)

5.4.1 Introduction and Methods

Coccolithophores (Prymnesiophyceae, Haptophyta) are unicellular marine phytoplanktonic organisms distributed worldwide and one of the most prominent groups of primary producers with a key role in sediment formation. Through photosynthesis and calcification, coccolithophores play a major role in regulating the marine food web and are a key buffer of the ocean carbonate chemistry. As a result, they have attracted an increasing and interdisciplinary interest with studies of their biogeography, biodiversity and calcification serving as means for monitoring plankton response to climate change. This interest has been matched for the Mediterranean Sea, with few large-scale surveys of coccolithophores conducted in the area (Knapperbutsch, 1993; Kleijne, 1993; Oviedo et al. 2015; D' Amario et al. 2017) and new species of them having been discovered and described (e.g., Cros & Fortuño, 2002; Archontikis et al. 2020; Archontikis & Young 2021; Archontikis et al. 2023a; Archontikis et al. 2023b).

M191 Expedition provided a unique platform to perform nannoplankton sampling across the Mediterranean Sea (from Algeciras, Spain to Piraeus, Greece) and therefore, investigate living plankton assemblages and determine patterns of coccolithophore/nannoplankton biogeography, calcification, and life-cycle dynamics. Accordingly, surface seawater samples were collected in the main Exp. M191 working area in the Sicilian Channel and during transits throughout the Spanish and Greek exclusive economic zones, to assess extant coccolithophore (nannoplankton) species assemblages. Surface water samples (~12 L) were collected day and night at approximately every 2–4 hours whilst in transit and approximately every 12 hours while dredging operations were carried out. Sampling was conducted either via a plastic bucket with a nylon rope over the side of the starboard main deck or via a tap near the suction valve of the automated thermosalinograph ("Reinseewasser", supplied by the sinus pump system) located at the bow of the vessel. The sampling depth approximately represents a mixed upper 10 m of surface water. Upon retrieval, the plastic 12L bucket was transferred into the lab; latitude and longitude coordinates, the time and date of each collection (in UTC) and the water temperature, salinity, conductivity, and density were recorded (see Table in APPENDIX 11.2).

For each sampling station, c. 5–8 L of seawater were filtered using a stainless-steel filtration ramp onto 47 mm diameter, 0.8 µm pore-size Millipore polycarbonate track-etched filters (Fig. 5.23). Prefiltration through a brass 63 µm test sieve was carried out to remove larger zooplankton and contaminants. A low-pressure vacuum pump was also used during the filtration to avoid mechanical breakage of specimens. Salt was removed by washing the filters with ~3 mL of Milli-Q deionised water buffered to a pH of about 8.5 with ammonia (NH_3). After filtration, the filters were placed individually in 47 mm plastic Millipore Petri-slides and dried in an oven at 50°C. Once dry, a portion of each filter was cut out and mounted onto a glass microscope slide using Norland Optical Adhesive (NOA) 61 (refractive index= 1.56). The filter membranes were then sealed in Petri-slides, covered with Parafilm, and frozen for post-cruise analyses.

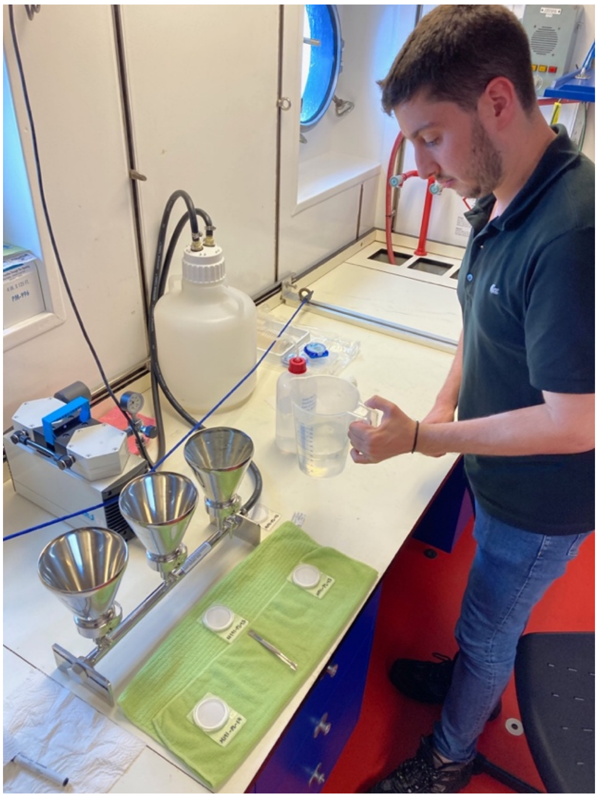


Fig. 5.23: Micropaleontologist O. Archontikes funnelling seawater through the filtration ramp.

5.4.2 Preliminary Results of Nannoplankton Sampling

Eighty-two water samples were collected during the passage across the Mediterranean Sea from Algeciras, Spain to Piraeus, Greece and in the main working area in the Sicilian Channel where dredging operations were conducted. Water temperature, salinity, conductivity, and density were measured/recorded by the ship's built-in automated thermosalinograph at all samplings locations, and these fluctuated, respectively, from 19–31°C, 36–38 PSU, 50–61 mS/cm and 1023–1025 kg/m^3. The bulk of the nannoplankton analyses will be undertaken post-cruise, together with synthesis of data from previous coccolithophore studies. Some preliminary observations are, however, made by using a Leica/Wild M3Z Stereo Microscope. These revealed the presence of 1) organic matter ranging in content across sampling stations; 2) larger planktonic organisms (e.g., juvenile planktonic foraminifera) that were found sporadically on the filter membranes; and 3) diverse assemblages of smaller (< 45 µm) plankton. Detailed nannoplankton analyses including taxonomic identification, counts and geochemical studies will be implemented post-cruise with appropriate access to geochemical labs and high-resolution microscopy (partly in cooperation with J.O. Herrle, Goethe University, Frankfurt).

In total, the 82 water samples collected during M191 expedition, represented over 510 L, while preliminary analyses were carried out on ship on 28 samples. Seawater sampling was productive in terms of recovery of plankton assemblages and will correspondingly formulate promising post-cruise research on coccolithophore diversity, ecology and calcification as means to understand and monitor effects of climate change on marine ecosystems.

6 Ship's Meteorological Station

(A. Raeke)

On the morning of 16/07/2023 at around 10 am, the research vessel RV METEOR left the port of Algeciras, Spain. A low-pressure system centered over the east coast of Spain was slowly moving southwest and weakening. Otherwise, low-pressure contrasts prevailed over much of the Mediterranean. The initially light winds in the Strait of Gibraltar later increased to westerly 6 Bft (jet effect). From midday, the wind decreased to 2-4 Bft from various directions, with significant wave heights of 1 m and low swells, which also decreased. With continued low air pressure contrasts in the Mediterranean on the following days, the wind on 17/07/2023 was still fresh with 5 to 6 Bft from northeasterly directions with a significant wave height of 1,5 m.

On 18/07/2023, the wind veered southeast and decreased to 2-3 Bft before temporarily freshening to west 4 Bft in the evening of 19/07/2023. In the further course of the transit until 20/07/2023, the wind came from different directions with 2-3 Bft, also due to local pressure systems. On the morning of 20/07/2023, RV METEOR reached the main research area near the coast of western Sicily as planned.

High pressure continued to dominate the weather. The initially weak to moderate westerly to north-westerly wind increased to 5-6 Bft in the afternoon, the wind sea was 0.5 m. Until 23/07/2023, an undisturbed high with weak pressure contrasts prevailed over the Mediterranean. With a significant wave height of less than 0.5 m and a mostly light to moderate southerly wind, sometimes veering, research could be carried out without restrictions. In the morning of 21/07/2023, fog patches appeared in the humid air mass near the coast of Sicily.

From 24/07/2023 onwards, a weak depression formed over northern Italy and moved eastwards. The high south of Sicily briefly intensified, temporarily increasing the wind force to 5 Bft. During the night of 25/07/2023, the sirocco briefly reached the working area, leaving dusty residues on the ship and instruments. Night temperatures reached 33°C. On 25/07/2023, the weather was again calm. The south-easterly wind of 4 to 5 Bft decreased temporarily during the day. In the afternoon, the wind veered northwesterly and increased steadily to 6-7 Bft during the night. In the morning of 26/07/2023, a weak cold front from the depression over northern Italy crossed the area of research. The significant wave height increased post-frontal until the evening to 2 m. The weak cold front moved into a high over the Gulf of Gabes and the Ionian Sea and weakened further.

From 27/07/2023, a ridge of high pressure over the Azores extended into the western Mediterranean and affected the working area on its eastern side. The significant wave height decreased to 0.5 m. Southerly to southeasterly winds of 4 Bft persisted until 29/07/2023. The wind then decreased, causing fog to develop in the working area during the night from 30/07/2023 to the morning. During the day, the wind veered northwest and increased to 3-4 Bft. However, the significant wave height was only 0.5 m. At the vicinity of the Azores high, which stretched from Morocco to Tunisia, the wind increased to 5-6 Bft from northwesterly directions on 31/07/2023, with a significant wave height of 1.5 m. The wind speed decreased to 3 Bft during the night until the morning of 01/08/2023. In the afternoon, the wind increased again, reaching 5 to 6 Bft from northwest, with a significant wave height of 1.5 m. This situation continued until the end of the day on 01/08/2023. This weather situation and its effects continued until the end of the research work on 02/08/2023.

The weather for the transit to Piraeus was characterized by a weak high-pressure influence and a low-pressure system over northern Italy with low-pressure differences over the Ionian Sea. RV METEOR reached the port of Piraeus in the morning of 05/08/2023, with mostly light westerly and later southerly winds from the Aegean, and a significant wave height around 0.5m.

7 Station List M191

Station	Date / Time UTC	Device	Action	Latitude	Longitude	Depth (m)
M191_1-1	19.07.23 08:43	Sound Velocity Profiler	max depth/on ground	38° 20,979' N	008° 41,937' E	1954
M191_2-1	19.07.23 09:40	Magnetometer	in the water	38° 20,854' N	008° 41,882' E	1973
M191_2-1	19.07.23 12:50	Magnetometer	on deck	38° 21,839' N	008° 55,563' E	1852
M191_3-1	20.07.23 08:17	Sound Velocity Profiler	max depth/on ground	37° 30,670' N	012° 32,302' E	90
M191_4-1	20.07.23 08:44	Magnetometer	in the water	37° 30,660' N	012° 32,310' E	88
M191_4-1	20.07.23 16:10	Magnetometer	on deck	37° 29,126' N	012° 45,749' E	80
M191_5-1	20.07.23 16:57	Dredge	max depth/on ground	37° 29,435' N	012° 39,964' E	44
M191_6-1	20.07.23 17:40	Dredge	max depth/on ground	37° 29,447' N	012° 39,980' E	35
M191_7-1	20.07.23 19:32	Dredge	max depth/on ground	37° 22,315' N	012° 47,758' E	166
M191_8-1	20.07.23 20:52	Dredge	max depth/on ground	37° 22,141' N	012° 47,922' E	179
M191_9-1	20.07.23 22:10	Magnetometer	in the water	37° 23,268' N	012° 47,653' E	156
M191_9-1	21.07.23 04:59	Magnetometer	on deck	37° 29,778' N	012° 48,912' E	71
M191_10-1	21.07.23 06:18	Dredge	max depth/on ground	37° 22,023' N	012° 50,205' E	177
M191_11-1	21.07.23 07:38	Dredge	max depth/on ground	37° 22,157' N	012° 50,131' E	174
M191_12-1	21.07.23 09:04	Dredge	max depth/on ground	37° 25,320' N	012° 54,717' E	78
M191_13-1	21.07.23 10:33	Dredge	max depth/on ground	37° 25,465' N	012° 54,611' E	81
M191_14-1	21.07.23 13:09	Dredge	max depth/on ground	37° 28,877' N	012° 48,135' E	76
M191_15-1	21.07.23 15:25	Magnetometer	in the water	37° 16,801' N	012° 41,717' E	191
M191_15-1	21.07.23 18:28	Magnetometer	on deck	37° 07,585' N	012° 44,083' E	210
M191_16-1	21.07.23 19:23	Dredge	max depth/on ground	37° 11,911' N	012° 41,466' E	228
M191_17-1	21.07.23 20:46	Dredge	max depth/on ground	37° 12,208' N	012° 41,424' E	226
M191_18-1	21.07.23 22:05	Magnetometer	in the water	37° 11,328' N	012° 41,886' E	229
M191_18-1	22.07.23 05:23	Magnetometer	on deck	37° 07,298' N	012° 40,926' E	284
M191_19-1	22.07.23 05:47	Sound Velocity Profiler	max depth/on ground	37° 08,128' N	012° 41,322' E	320
M191_20-1	22.07.23 06:54	Dredge	max depth/on ground	37° 10,960' N	012° 42,798' E	154
M191_21-1	22.07.23 09:50	Dredge	max depth/on ground	37° 10,363' N	012° 42,219' E	143
M191_22-1	22.07.23 12:02	Dredge	max depth/on ground	37° 10,374' N	012° 42,097' E	167
M191_23-1	22.07.23 13:04	Dredge	max depth/on ground	37° 10,168' N	012° 43,416' E	114
M191_24-1	22.07.23 14:20	Dredge	max depth/on ground	37° 08,833' N	012° 42,596' E	182
M191_25-1	22.07.23 15:23	Magnetometer	in the water	37° 08,203' N	012° 42,872' E	218
M191_25-1	22.07.23 20:05	Magnetometer	on deck	36° 59,935' N	012° 29,358' E	117
M191_26-1	22.07.23 20:46	Dredge	max depth/on ground	37° 00,356' N	012° 31,820' E	114
M191_27-1	22.07.23 21:42	Magnetometer	in the water	37° 00,569' N	012° 30,898' E	110
M191_27-1	23.07.23 05:59	Magnetometer	on deck	37° 15,568' N	012° 20,595' E	57

Station	Date / Time UTC	Device	Action	Latitude	Longitude	Depth (m)
M191_28-1	23.07.23 06:26	Dredge	max depth/on ground	37° 15,524' N	012° 20,768' E	80
M191_29-1	23.07.23 08:11	Dredge	max depth/on ground	37° 13,920' N	012° 20,913' E	74
M191_30-1	23.07.23 09:40	Dredge	max depth/on ground	37° 13,301' N	012° 21,490' E	78
M191_31-1	23.07.23 11:00	Dredge	max depth/on ground	37° 12,865' N	012° 24,300' E	104
M191_32-1	23.07.23 12:26	Sound Velocity Profiler	max depth/on ground	37° 08,984' N	012° 25,027' E	139
M191_33-1	23.07.23 12:48	Magnetometer	in the water	37° 08,515' N	012° 24,925' E	138
M191_33-1	24.07.23 05:49	Magnetometer	on deck	37° 16,363' N	012° 40,837' E	183
M191_34-1	24.07.23 06:19	Dredge	max depth/on ground	37° 15,183' N	012° 41,538' E	141
M191_35-1	24.07.23 07:20	Dredge	max depth/on ground	37° 15,364' N	012° 41,271' E	158
M191_36-1	24.07.23 08:24	Dredge	max depth/on ground	37° 15,379' N	012° 41,316' E	158
M191_37-1	24.07.23 11:10	Dredge	max depth/on ground	37° 09,629' N	012° 53,325' E	54
M191_38-1	24.07.23 12:44	Dredge	max depth/on ground	37° 09,984' N	012° 52,827' E	98
M191_39-1	24.07.23 13:36	Dredge	max depth/on ground	37° 09,686' N	012° 52,892' E	68
M191_40-1	24.07.23 14:24	Dredge	max depth/on ground	37° 09,416' N	012° 52,410' E	55
M191_41-1	24.07.23 15:09	Dredge	max depth/on ground	37° 09,583' N	012° 53,295' E	53
M191_42-1	24.07.23 17:01	Dredge	max depth/on ground	37° 10,435' N	012° 49,881' E	126
M191_43-1	24.07.23 17:42	Dredge	max depth/on ground	37° 10,426' N	012° 49,973' E	112
M191_44-1	24.07.23 18:35	Dredge	max depth/on ground	37° 10,231' N	012° 50,765' E	97
M191_45-1	24.07.23 19:47	Dredge	max depth/on ground	37° 09,771' N	012° 53,036' E	52
M191_46-1	24.07.23 20:54	Magnetometer	in the water	37° 09,704' N	012° 52,903' E	71
M191_46-1	25.07.23 14:15	Magnetometer	on deck	36° 52,102' N	013° 04,625' E	173
M191_47-1	25.07.23 14:52	Dredge	max depth/on ground	36° 52,377' N	013° 05,787' E	604
M191_48-1	25.07.23 16:31	Dredge	max depth/on ground	36° 52,383' N	013° 05,373' E	460
M191_49-1	25.07.23 18:25	Dredge	max depth/on ground	36° 51,709' N	013° 07,146' E	554
M191_50-1	25.07.23 20:44	Magnetometer	in the water	36° 51,855' N	013° 07,077' E	656
M191_50-1	26.07.23 11:38	Magnetometer	on deck	35° 57,436' N	012° 51,746' E	1127
M191_51-1	26.07.23 12:40	Dredge	max depth/on ground	35° 56,172' N	012° 48,670' E	689
M191_52-1	26.07.23 14:13	Dredge	max depth/on ground	35° 55,999' N	012° 48,743' E	694
M191_53-1	26.07.23 16:15	Sound Velocity Profiler	max depth/on ground	35° 55,675' N	012° 49,181' E	663
M191_54-1	26.07.23 17:06	Dredge	max depth/on ground	35° 56,113' N	012° 48,848' E	749
M191_55-1	26.07.23 18:13	Dredge	max depth/on ground	35° 56,168' N	012° 48,667' E	688
M191_56-1	26.07.23 20:08	Dredge	max depth/on ground	35° 55,739' N	012° 49,195' E	733
M191_57-1	26.07.23 21:57	Dredge	max depth/on ground	35° 56,069' N	012° 48,841' E	757
M191_58-1	26.07.23 23:08	Magnetometer	in the water	35° 56,178' N	012° 48,730' E	713
M191_58-1	27.07.23 12:41	Magnetometer	on deck	36° 11,210' N	013° 01,248' E	750
M191_59-1	27.07.23 13:32	Dredge	max depth/on ground	36° 09,899' N	012° 59,362' E	533
M191_60-1	27.07.23 14:59	Dredge	max depth/on ground	36° 10,460' N	012° 58,274' E	419
M191_61-1	27.07.23 15:56	Magnetometer	in the water	36° 11,424' N	012° 59,472' E	814
M191_61-1	28.07.23 13:26	Magnetometer	on deck	36° 15,058' N	012° 57,042' E	1051
M191_62-1	28.07.23 14:29	Dredge	max depth/on ground	36° 10,287' N	012° 58,418' E	429
M191_63-1	28.07.23 15:25	Dredge	max depth/on ground	36° 10,325' N	012° 58,774' E	407
M191_64-1	28.07.23 16:59	Dredge	max depth/on ground	36° 10,377' N	012° 58,784' E	390
M191_65-1	28.07.23 17:58	Dredge	max depth/on ground	36° 10,414' N	012° 58,306' E	423
M191_66-1	28.07.23 18:51	Dredge	max depth/on ground	36° 10,292' N	012° 58,412' E	431
M191_67-1	28.07.23 19:32	Magnetometer	in the water	36° 10,101' N	012° 58,414' E	428
M191_67-1	29.07.23 09:05	Magnetometer	on deck	37° 09,442' N	012° 54,589' E	93
M191_68-1	29.07.23 09:55	Dredge	max depth/on ground	37° 09,056' N	012° 53,294' E	48
M191_69-1	29.07.23 12:00	Dredge	max depth/on ground	37° 09,052' N	012° 53,342' E	45
M191_70-1	29.07.23 14:52	Dredge	max depth/on ground	37° 10,603' N	012° 49,413' E	115
M191_71-1	29.07.23 16:04	Dredge	max depth/on ground	37° 10,611' N	012° 49,251' E	85

Station	Date / Time UTC	Device	Action	Latitude	Longitude	Depth (m)
M191_72-1	29.07.23 17:01	Dredge	max depth/on ground	37° 10,533' N	012° 49,956' E	138
M191_73-1	29.07.23 18:24	Dredge	max depth/on ground	37° 10,623' N	012° 49,516' E	112
M191_74-1	29.07.23 19:10	Magnetometer	in the water	37° 10,556' N	012° 49,763' E	110
M191_74-1	30.07.23 11:32	Magnetometer	on deck	36° 51,320' N	013° 03,956' E	110
M191_75-1	30.07.23 12:16	Dredge	max depth/on ground	36° 51,889' N	013° 06,543' E	495
M191_76-1	30.07.23 14:16	Dredge	max depth/on ground	36° 51,731' N	013° 07,339' E	656
M191_77-1	30.07.23 15:13	Magnetometer	in the water	36° 52,455' N	013° 06,583' E	725
M191_77-1	30.07.23 17:39	Magnetometer	on deck	37° 08,870' N	012° 51,151' E	62
M191_78-1	30.07.23 18:04	Dredge	max depth/on ground	37° 08,527' N	012° 51,607' E	50
M191_79-1	30.07.23 19:27	Dredge	max depth/on ground	37° 08,868' N	012° 52,062' E	49
M191_80-1	30.07.23 20:18	Magnetometer	in the water	37° 08,841' N	012° 51,754' E	56
M191_80-1	31.07.23 11:36	Magnetometer	on deck	36° 49,074' N	013° 02,487' E	138
M191_81-1	31.07.23 12:23	Dredge	max depth/on ground	36° 49,295' N	013° 03,351' E	105
M191_82-1	31.07.23 13:42	Dredge	max depth/on ground	36° 49,369' N	013° 03,382' E	108
M191_83-1	31.07.23 15:06	Dredge	max depth/on ground	36° 52,144' N	013° 05,176' E	280
M191_84-1	31.07.23 16:48	Dredge	max depth/on ground	36° 52,148' N	013° 05,173' E	283
M191_85-1	31.07.23 18:16	Dredge	max depth/on ground	36° 52,105' N	013° 05,145' E	225
M191_86-1	31.07.23 19:34	Magnetometer	in the water	36° 52,281' N	013° 04,889' E	297
M191_86-1	01.08.23 12:57	Magnetometer	on deck	36° 52,057' N	013° 04,507' E	159
M191_87-1	01.08.23 13:36	Dredge	max depth/on ground	36° 52,608' N	013° 03,899' E	261
M191_88-1	01.08.23 14:51	Dredge	max depth/on ground	36° 52,269' N	013° 01,743' E	255
M191_89-1	01.08.23 16:04	Dredge	max depth/on ground	36° 51,601' N	013° 02,800' E	151
M191_90-1	01.08.23 17:58	Dredge	max depth/on ground	36° 49,188' N	013° 09,488' E	250
M191_91-1	01.08.23 18:47	Magnetometer	in the water	36° 49,287' N	013° 09,141' E	225
M191_91-1	02.08.23 12:06	Magnetometer	on deck	36° 38,742' N	013° 14,657' E	403
M191_92-1	02.08.23 13:11	Sound Velocity Profiler	information	36° 32,732' N	013° 14,216' E	1485

8 Data and Sample Storage and Availability

(J. Geldmacher, A. Micallef, G.M. Ferrante, O.A. Archontikis)

The rock samples recovered during cruise M191 will be stored at the rock repository at GEOMAR Helmholtz Centre for Ocean Research Kiel. They will be analysed at the home institutions of the participating scientists and possibly further cooperating institutions, and the obtained analytical results will be published in English language in peer-reviewed journals and thus made publicly available. Upon request, individual samples will be made available to third parties after analysis, data interpretation and publication. Filter membranes of seawater samples will be stored at the facilities of NHM, London and resulting datasets from analyses will be made available after peer-reviewed publication. The bathymetric and sediment echo sounding data as well as the sound probe data will be archived in the IT storage infrastructure at GEOMAR. Magnetic field data will be stored at National Institute of Oceanography and Applied Geophysics (OGS), Trieste (with a copy at GEOMAR).

Data sharing and exchange will take place within the Ocean Science Information System (OSIS) maintained by the GEOMAR data management team. Bathymetric raw data are submitted to the Federal Maritime and Hydrographic Agency (Bundesamt für Seeschifffahrt und Hydrographie, BSH). Processed magnetic data will be stored at the World Data Center PANGAEA, bathymetric data will be uploaded to the World Data Center PANGAEA and the International Hydrographic Organization Data Centre for Digital Bathymetry (IHO DCDB). For a three-year moratorium, however, the high-resolution bathymetric data from the working area will be available to the project members only. A 100 m grid will be submitted to EMODnet Bathymetry at the end of 2024. Availability of the geochemical and micropaleontological data is restricted until publication.

Table 8.1 Overview of data availability

Type	Database	Available	Free Access	Contact
M191 metadata	OSIS	Oct. 2023	Oct. 2023	jgeldmacher@geomar.de
Rock sample data	OSIS, Georoc, PetDB	n/a	After publication	jgeldmacher@geomar.de
Echo-sounding data (working area) (KONGSBERG EM 122, EM710, PARASOUND)	BSH, OSIS, PANGAEA	Oct. 2023	Oct. 2026	jgeldmacher@geomar.de aaron.micallef@um.edu.mt
Sound probe data (XSV-02)	BSH, OSIS, PANGAEA	Oct. 2023	Nov. 2023	jgeldmacher@geomar.de
Magnetic field data (Magnetometer)	PANGAEA	Oct. 2023	After publication	elodolo@ogs.it, gferrante@ogs.it
Seawater sample data	PANGAEA	After publication	After publication	odysseas.archontikis@univ.ox.ac.uk

9 Acknowledgements

First of all, we would like to thank Master Derk Apetz and his skilful crew for their excellent support, professionalism and for providing a very pleasant working atmosphere on board, which contributed enormously to the success of this expedition. We also thank Andreas Raeke and Holger Jens from the German National Meteorological Service (DWD) for the daily weather briefings. We are grateful to Danilo Cavallaro for providing existing multi-beam bathymetric data of Terribile Bank, and Dario Civile and Emanuele Lodolo (both OGS) for being part of the SUAVE project team and their ongoing shore-based support. Filippo Muccini (INGV, La Spezia) is especially thanked for providing the magnetometer which was of vital importance for localizing and identifying the possible presence of volcanic outcrops. Maik Lange, Mia Schumacher, Bettina Domeyer, Anke Bleyer and Karin Junge (all GEOMAR) are thanked for help with cruise preparations at GEOMAR. Special thanks are due to Jens O. Herrle (Goethe University Frankfurt) for kindly providing the equipment and supplies for filtration of seawater, and his encouragement. We are also grateful to the Geschäftsstelle des Gutachterpanels Forschungsschiffe (GPF), the Leitstelle Deutsche Forschungsschiffe (LDF) and Briese Research for their support. We are very grateful to Briese Research and the LDF for obtaining detailed data on the distribution of submarine cables in the working area, without which dredging at most positions could not have been carried out. Last but not least, we would like to thank the countries of Spain, Italy, Malta and Greece for permitting our research. This cruise was funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the GEOMAR Helmholtz Centre for Ocean Research Kiel. Aaron Micallef was supported by the David and Lucile Packard Foundation.

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11 Appendices

11.1 M191 Dredge Station Details and Rock Description (including graphical rock descriptions)

11.2 Underway Water Sampling List for Nannoplankton Research

M191 Dredge Station Details and Rock Description

Abbreviations in Table Header:
TS: thin section billet
CHEM: chemistry slab to prepare materials for geochemical analysis
Ar/Ar: estimate of sample quality for $^{40}Ar/^{39}Ar$ dating
Gl/MIN: potential glass and / or mineral separates
SED: sediment
REF: reference sample for immediate transport to home institution after cruise

Abbreviations for Minerals and Materials:
Amph: amphibole
Apt: apatite
Bi: biotite
Cc: calcite
Chl: chlorite
Cpx: clinopyroxene
Fsp: feldspar
Gc: geochemistry
Gm: groundmass
Ilm: ilmenite
MI: melt inclusions
Mn: manganese
Mt: magnetite
Ol: olivine
Opx: orthopyroxene
Pl: plagioclase
Px: pyroxene
Qz: quartz
Zr: zircon
Cc: carbonate
Pp: phosphate

M191-5-1

Conical smt. at edge of plateau structure small 10m step in top region of cone

Dredge on bottom UTC, hrs, °N, °E, depth m	16:58	37°29,434'N	12°39,968'E	42.8
Dredge off bottom UTC, hrs, °N, °E, depth m	17:05	37°29,436'N	12°39,991'E	37.2
total volume:	few rocks			

Comments: Six pieces of carbonate encrusted material, irregular shape, colonised by biota, relatively dense, open textured, unclear if volcanic material in centre of fragments. Largest piece 15x10x10. Others ca. 5cm in diamater.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-5-1-1	1. Rock Type: Bioclastic - carbonate block, mainly encrustation of tubular bioclasts, denser in centre 2. Size: 15x12x9 3. Shape / Angularity: irregular and angular, larger cavities and borings in outer part 4. Color of cut surface: pale grey to yellow brown 5. Texture / Vesicularity: open, porous 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: entirely composed of crudely layered biogenic encrustation 10. Comment:							Retain for potential radiocarbon dating of cone colonisation	

M191-6-1

See 5, repeat of 5, same track

Dredge on bottom UTC, hrs, °N, °E, depth m	17:39	37°29,447'N	12°39,980'E	35.3
Dredge off bottom UTC, hrs, °N, °E, depth m	17:49	37°29,441'N	12°40,001'E	36.5
total volume:	few rocks			

Comments: biology only, six small fragments of coral/biogenic encrustations. No samples.

M191-7-1

Cone, northern flank from bottom to top (Area 1 seamount 3)

Dredge on bottom UTC, hrs, °N, °E, depth m	19:33	37°22,32'N	12°47,76'E	165.9
Dredge off bottom UTC, hrs, °N, °E, depth m	20:13	37°22,19'N	12°47,71'E	94.4
total volume:	few rocks			

Comments: 7 bioclastic encrustations, open textured with coral; 1 dense platy dark grey volcanic block, 10cm across, moderately vesicular

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-7-1-1	1. Rock Type: Dark (mafic) lava fragment, vesicular, microcrystalline with smooth outer surface (squeeze out) 2. Size: 10 x 7 x 3 cm 3. Shape / Angularity: sub-rectangular block, platy form with smooth pocked surface/ridged form 4. Color of cut surface: mid-grey 5. Texture / Vesicularity: finely vesicular with sparse large vesicles defining flow and following clast margin suggesting a primary form 6. Phenocrysts: rare, less than 1%, green/orange sub-mm 7. Matrix: very finely crystalline groundmass 8. Secondary Minerals: some minor of vesicles at edges 9. Encrustations: up to 0.5 mm pale carbonate coating, open textured 10. Comment:	x	x						

M191-7-1-2	1. Rock Type: Branching coral encrusted by younger biogenic carbonate 2. Size: 10 x 9 x 3 3. Shape / Angularity: branching, irregular open textured surface 4. Color of cut surface: yellow to brown, pale grey interior 5. Texture / Vesicularity: radiating interior of branches, porous encrustation 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: carbonate biogenic and other encrustation 10. Comment: potential for radiocarbon								
M191-7-1-3	1. Rock Type: Large coral and tubular biogenic encrustations 2. Size: 15 x 11 x 8 3. Shape / Angularity: irregular block 4. Color of cut surface: mid-grey to yelow interior, yellow to brown exterior 5. Texture / Vesicularity: dense in centre, but mostly very open textured from encrusting corals 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: entirely encrusted material coral and other carbonate bioclasts 10. Comment: potential for radiocarbon dating								
M191-7-1-4	1. Rock Type: smaller coral and tubular biogenic encrustation 2. Size: 8 x 8 x 7 3. Shape / Angularity: irregular block 4. Color of cut surface: mid grey to yellow 5. Texture / Vesicularity: denser than sample 3, open textured in centre part 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: enirely encrusted material dominated by small bioclasts with coral in outer parts 10. Comment: potential for radiocarbon dating								

M191-8-1

SSE slope of cone from base to top (Area 1 seamount 3)

Dredge on bottom UTC, hrs, °N, °E, depth m	20:52	37°22,14'N	12°47,92'E	176
Dredge off bottom UTC, hrs, °N, °E, depth m	21:31	37°22,18'N	12°47,72'E	98.1
total volume:	half full			

Comments: several very large coral/carbonate encrusted blocks. Open textured irregular to platy forms. 3 clasts have smoother rounder forms, their sawn surface shows encrusted clastic rock with angular volcanic fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-8-1-1	1. Rock Type: volcaniclastic; angular to sub-rounded lapilli (grey lava fragments) in orange altered matrix/palagonitised tuff 2. Size: 8x8x5 3. Shape / Angularity: sub rounded block, lithic clasts prominent on surface 4. Color of cut surface: orange to brown with grey fragments 5. Texture / Vesicularity: banded, three distinct slightly irregular bands. Middle band is finer and open textured. 6. Phenocrysts: N/A (grey to grey-brown volcanic clasts) 7. Matrix: orange altered ash (soft weathering) 8. Secondary Minerals: altered ash 9. Encrustations: thin sub-mm patchy pale carbonate crusts 10. Comment:	x							

M191-8-1-2	1. Rock Type: volcaniclastic palagonitised tuff. Angular fragments. Coarse ash to fine lapilli in fine matrix. 2. Size: 22x15x6 3. Shape / Angularity: angular flattened block, 2 bands following plane of block 4. Color of cut surface: orange-brown with rust-coloured to grey fragments 5. Texture / Vesicularity: banded, two layers with gradational contact, one with clearer clasts, the second more pelletal/open textured 6. Phenocrysts: n/a Angular fragments aligned with bands 7. Matrix: orange altered ash. some cut sections around large lava clasts are coarse ash to fine lapilli fragments 8. Secondary Minerals: altered ash 9. Encrustations: thin sub-mm patchy carbonate crust 10. Comment:	x							
M191-8-1-3	1. Rock Type: volcaniclastic with coarse ash (lava) fragments, angular to sub rounded, matrix is dark grey to orange, centre is slightly vesiculated 2. Size: 11x7x4.5 3. Shape / Angularity: subrounded block, little clasts prominent on surface, as above 4. Color of cut surface: dark grey to orange, darker than above 5. Texture / Vesicularity: banded planar stratification, textured with prominent clasts 6. Phenocrysts: n/a 7. Matrix: orange to grey, altered/palagonitised, possibly occurred shortly after eruption 8. Secondary Minerals: altered tephra 9. Encrustations: thin sub-mm white to cream carbonate crust 10. Comment:	x							

M191-10-1

Small cone (Area 1 cone 4)

Dredge on bottom UTC, hrs, °N, °E, depth m	06:19	37°22,024'N	12°50,20'E	178
Dredge off bottom UTC, hrs, °N, °E, depth m	06:50	37°22,15'N	12°50,12'E	170
total volume:	few rocks			

Comments: biology only, corals and some shells and silt, 4 samples

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-10-1-1	1. Rock Type: Shell fossils, gastropods and bivalves 2. Size: 4 shells, about 5 cm across 3. Shape / Angularity: complete form 4. Color of cut surface: cream/brown 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor borings/breakage 10. Comment:								
M191-10-1-2	1. Rock Type: branching coral fragments, non-encrusted 2. Size: 5 fragments, up to 12 cm long, about 1 cm across 3. Shape / Angularity: branching stems 4. Color of cut surface: beige 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor serpulid worms/bryozoan? 10. Comment:								

M191-10-1-3	1. Rock Type: branching coral fragments, heavily encrusted 2. Size: 2 fragments, 12 cm long, 2cm diameter 3. Shape / Angularity: branching stems 4. Color of cut surface: grey/beige 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: strongly encrusted tubules of various sizes, small corals etc. 10. Comment:								
M191-10-1-4	1. Rock Type: solitary coral fossil 2. Size: 1 specimen, 3 cm, 12 mm diameter 3. Shape / Angularity: horn shaped 4. Color of cut surface: beige 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment:								

M191-11-1

Area 1, volcano 4, second attempt. Sampling of northern flank of volcano 4.

Dredge on bottom UTC, hrs, °N, °E, depth m	07:32	37°22,16'N	12°50,13'E	173
Dredge off bottom UTC, hrs, °N, °E, depth m	07:58	37°22,10'N	12°50,12'E	131
total volume:	empty			

M191-12-1

Area 1, volcano 5, first attempt. Shallow "caldera like" volcano structure with max elevation of c 15 m.

Dredge on bottom UTC, hrs, °N, °E, depth m	09:05	37°25,320'N	12°54,717'E	78.2
Dredge off bottom UTC, hrs, °N, °E, depth m	09:14	37°25,317'N	12°54,59'E	69.6
total volume:	limited material			

Comments: mud and some biology, no samples taken

M191-13-1

Area 1, volcano 5, second attempt, dredge direction west to east, 090, shallow volcanic structure less than 15 m high

Dredge on bottom UTC, hrs, °N, °E, depth m	10:34	37°25,47'N	12°54,61'E	81.5
Dredge off bottom UTC, hrs, °N, °E, depth m	10:58	37°25,45'N	12°54,69'E	68.4
total volume:	one quarter full			

Comments: a lot of mud, a small volcanic rock, some corals and shells

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-13-1-1	1. Rock Type: Volcanic rock, black bubbly foamy clast, fairly fresh glassy clast with little alteration 2. Size: 6.5x5x2.5 3. Shape / Angularity: sub angular flattened clast 4. Color of cut surface: black with white specks/crystals 5. Texture / Vesicularity: some vesicles, very glassy, irregular, spiny outer surface. 50% vesicles, some interconnected 6. Phenocrysts: very small white crystals, less than 5% (some within vesicles), subhedral. Black crystals, euhedral, 1-2mm. Some red clasts, 8-9mm across, 5% of sample. 7. Matrix: Aphanitic glassy groundmass with high vesicularity. 8. Secondary Minerals: none observed 9. Encrustations: thin sub-mm crust carbonate material. 10. Comment:	x	x		x				

M191-13-1-2	1. Rock Type: Multi branched coral fossil with platy encrustation 2. Size: 2 fragments, up to 14 cm long, 10-15 mm diameter 3. Shape / Angularity: elongated stem with multiple broken branches 4. Color of cut surface: pinkish pale yellow 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: flattened conical shelly overgrowths, minor tubules 10. Comment:								
M191-13-1-3	1. Rock Type: Micritic bioclastic encrustation 2. Size: Several fragments, up to 3 cm across 3. Shape / Angularity: angular 4. Color of cut surface: grey with pale brown bioclasts 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: Mixed bioclasts, bryozoan, tubular worm clasts 10. Comment:								

M191-14-1

Area 1, volcano 6. Pancake-like flat volcano, dredge track covers high reflective area on backscatter

Dredge on bottom UTC, hrs, °N, °E, depth m	13:10	37°28,88'N	12°48,14'E	76
Dredge off bottom UTC, hrs, °N, °E, depth m	13:44	37°28,75'N	12°48,124'E	64.5
total volume:	one third full			

Comments: Mud, coral fragments and shells. All fossils.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-14-1-1	1. Rock Type: Large branched coral fossil 2. Size: 35 cm long, up to 25 mm diameter at base 3. Shape / Angularity: antler-like form, multiple broken branches 4. Color of cut surface: grey 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: tubule encrustation in patches 10. Comment:								
M191-14-1-2	1. Rock Type: Thick branched coral, heavily encrusted 2. Size: 26 cm long, up to 5 cm diameter 3. Shape / Angularity: multi-branched form 4. Color of cut surface: grey to rusty brown 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: Intensely encrusted with variety of organisms with bryozoan, tubules of various sizes, corals, shelly plates etc. 10. Comment:								
M191-14-1-3	1. Rock Type: Bivalves, 2 x pecten plus other 2. Size: two 4-cm shells, one 11cm shell 3. Shape / Angularity: complete form 4. Color of cut surface: grey/brown 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: large pecten shell, grey, heavily encrusted with tubules and bryozoa 10. Comment:								

M191-16-1

Area 2 seamount 2, southern flank of circular shaped cone, basal diameter 650 m, track from 220 to 122 m

Dredge on bottom UTC, hrs, °N, °E, depth m	19:23	37°11,91'N	12°41,47'E	228
Dredge off bottom UTC, hrs, °N, °E, depth m	20:04	37°12,06'N	12°41,47'E	128
total volume:	quarter full			

Comments: coral fragments, carbonate crust, pyroclastic rock!

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-16-1-1	1. Rock Type: volcaniclastic rock, subangular to angular, finely vesicular clasts (generally 0.5 cm or less) in a fine grained matrix, alteration within the matrix, some borings by biology. 2. Size: 21x11x6cm 3. Shape / Angularity: angular volcaniclasts 4. Color of cut surface: Black clasts (lava), set within a finer white to orange matrix. Some small clasts are reddened, as well as the outsides of larger clasts. Large clasts have glassy rims. 5. Texture / Vesicularity: Clasts are suspended in finer matrix. Not a well developed imbrication. Clasts have sharp planar surfaces and are finely vesicular. 6. Phenocrysts: Clasts appear aphanitic. Some feldspars. 7. Matrix: fine grained white matrix, massive, no texture 8. Secondary Minerals: secondary borings. 9. Encrustations: thin carbonate encrustation 10. Comment:	x							
M191-16-1-2	1. Rock Type: The same as sample 1, except clasts are up to 1 cm, vesicles are slightly larger in the clasts, and they display less glassy rims. There is more interstitial sediment between clasts. This is often containing shells/hard parts of biological material. 2. Size: 10x5x3 cm 3. Shape / Angularity: angular volcaniclasts 4. Color of cut surface: Black clasts (lava), set within a finer white to orange matrix. Some small clasts are reddened, as well as the outsides of larger clasts. Large clasts have glassy rims. 5. Texture / Vesicularity: Clasts are suspended in finer matrix. Not a well developed imbrication. Clasts have sharp planar surfaces and are finely vesicular. 6. Phenocrysts: Clasts appear aphanitic. Some feldspars. 7. Matrix: fine grained white matrix, massive, no texture 8. Secondary Minerals: secondary borings. 9. Encrustations: thin carbonate encrustation 10. Comment:	x							
M191-16-1-3	1. Rock Type: Similar to description 1 and 2, but most clasts are very fine and less than 2 mm. Higher clast to sediment ratio, 80% clasts to 20% matrix compared to 50:50 in previous samples. Large holes containing carbonate and hard material. No shelly clasts. 2. Size: 13.5 x 9 x 4 cm 3. Shape / Angularity: angular volcaniclasts 4. Color of cut surface: Black clasts (lava), set within a finer white to orange matrix. Some small clasts are reddened, as well as the outsides of larger clasts. Large clasts have glassy rims. 5. Texture / Vesicularity: Clasts are suspended in finer matrix. Not a well developed imbrication. Clasts have sharp planar surfaces and are finely vesicular. 6. Phenocrysts: Clasts appear aphanitic. Some feldspars. 7. Matrix: fine grained white matrix, massive, no texture 8. Secondary Minerals: secondary borings. 9. Encrustations: thin carbonate encrustation 10. Comment:	x							

M191-16-1-4	1. Rock Type: Similar to sample 2, but no presence of shelly material. Clasts are generally more sorted into layers based on grainsize (layers are up to 1 cm thick). Finer clasts are redder in colour than previous samples. 2. Size: 6x5x3cm 3. Shape / Angularity: angular volcaniclasts 4. Color of cut surface: Black clasts (lava), set within a finer white to orange matrix. Some small clasts are reddened, as well as the outsides of larger clasts. Large clasts have glassy rims. 5. Texture / Vesicularity: Clasts are suspended in finer matrix. Not a well developed imbrication. Clasts have sharp planar surfaces and are finely vesicular. 6. Phenocrysts: Clasts appear aphanitic. Some feldspars. 7. Matrix: fine grained white matrix, massive, no texture 8. Secondary Minerals: secondary borings. 9. Encrustations: thin carbonate encrustation 10. Comment:	x							
M191-16-1-5	1. Rock Type: Sample is material similar in appearance and texture to samples 1 to 4, encased in hard carbonate material. Volcaniclastic material is eroded and has irregular contact with the surrounding casing. 2. Size: 23x12x5.5cm 3. Shape / Angularity: Angular with subangular volcanic clasts 4. Color of cut surface: red/yellow/black 5. Texture / Vesicularity: as in samples 1 to 4, coarse clasts with limited matrix 6. Phenocrysts: mostly aphanitic, some plagioclase 7. Matrix: fine matrix 8. Secondary Minerals: n/a 9. Encrustations: thin encrustations 10. Comment:	x							
M191-16-1-6	1. Rock Type: Coral organism, Different in morphogy to other biological material sampled so far. 2. Size: 6.5x5x3 3. Shape / Angularity: Funnel/mushroom in shape 4. Color of cut surface: Sandy brown/pale beige 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: no encrustations 10. Comment:								

M191-17-1

Area 2, seamount 2. Repeat of 16 on opposite side. Northern flank of seamount as described at dredge site 16

Dredge on bottom UTC, hrs, °N, °E, depth m	20:46	37°12,21'N	12°41,41'E	226
Dredge off bottom UTC, hrs, °N, °E, depth m	21:24	37°12,07'N	12°41,47'E	128
total volume:	1/6 full			

Comments: Mud and one piece of solid pyroclastic

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-17-1-1	1. Rock Type: Volcaniclastic similar in appearance to the volcnaiclasics recovered in station 16 2. Size: 11 x 5 x 4 cm 3. Shape / Angularity: Angular fragment: glassy crust. Angular in shape overall. 4. Color of cut surface: White/beige with black clasts. 5. Texture / Vesicularity: Fragmental deposit with fine matrix and coarse ash to lapilli sized clasts. 6. Phenocrysts: mostly aphanetic 7. Matrix: fine grained matrix 8. Secondary Minerals: not observed/some small round black circles (mm-scale) 9. Encrustations: highly encrusted with carbonate material 10. Comment:								

M191-20-1

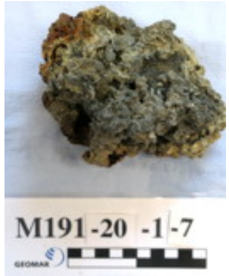
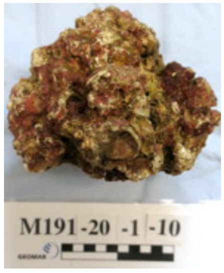
Area 2, Largest volcano on Graham Bank. Sampling of NE flank of volcano, dredging up flank that appears to have had a mass wasting event

Dredge on bottom UTC, hrs, °N, °E, depth m	06:54	37°10,96'N	12°42,80'E	153
Dredge off bottom UTC, hrs, °N, °E, depth m	07:41	37°10,79'N	12°42,72'E	58.4
total volume:	30% full			

Comments: 1 volcanic, some volcaniclastic, mostly sedimentary/biogenic (coral-like)

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-20-1-1	1. Rock Type: Volcanic, small degree of alteration 2. Size: 13 x 10 x10 cm 3. Shape / Angularity: Subroudned. 4. Color of cut surface: Black with yellowish patches of soft mud (sometimes indurated). 5. Texture / Vesicularity: Highly vesicular (40-50% vesicles). Vesicles vary in size - these are infilled by mud/sediment (yellowish in colour). 6. Phenocrysts: None observed 7. Matrix: Aphanitic groundmass - glassy 8. Secondary Minerals: Mud, secondary? 9. Encrustations: Covered in thin, yellowish hardened mud coating as well as some biology (small shells) 10. Comment:	x	x						
M191-20-1-2	1. Rock Type: Volcaniclastic, some alteration - highly concentrated around holes (interpreted to be fumarolic vents) 2. Size: 12 x 12 x 10 cm 3. Shape / Angularity: Subrounded 4. Color of cut surface: Originally black with grey, yellow and reddish-brown altered/oxidised patches, mostly around the (interpreted) fumarolic holes . Fairly brittle and fragile. 5. Texture / Vesicularity: Most clasts appear vesicular (40-50%) with vesicle siyes proportional to clast size (i.e., larger clasts have larger vesicles). 6. Phenocrysts: Some white phenocrysts observed. Most are to small to identify. 7. Matrix: Poorly sorted matrix: majority of clasts are in the fine to medium lapilli size range. Some coarse lapilli and some coarse ash. 8. Secondary Minerals: None observed - sample taken. 9. Encrustations: Some biology (<1 cm in size) attached around the clast (<5% coverage) 10. Comment:	x							

M191-20-1-3	1. Rock Type: Volcaniclastic, some alteration - highly concentrated around holes (interpreted to be fumarolic vents) 2. Size: 15 x 7.5 x 4 3. Shape / Angularity: Elongated, wide sausage-like, rough surface 4. Color of cut surface: Similar to 2, some differences, - yellowish brown matrix throughout with black clasts within, - alteration similar to 2, less pronounced 5. Texture / Vesicularity: Vesicalarity like rock 2 6. Phenocrysts: No phenocrysts observed 7. Matrix: Same as Rock 2 with some differences: a) fine-medium ash matrix; b) matrix supported with c. 50% clasts; c) medium-sized lapilli more common 8. Secondary Minerals: Same as 2 9. Encrustations: Fumarole hole filled with semi-hardened sediment; same as 2 for biota plus white, carbonate thin. vein 1/6 of the original size. 10. Comment:	x	x							
M191-20-1-4	1. Rock Type: Same as 2 & 3 2. Size: 13 x 5 x 5 3. Shape / Angularity: Elongated, pipe-like with bottle-neck shape 4. Color of cut surface: Mostly yellowish orange & brown matrix with black clasts & red/grey alteration patches 5. Texture / Vesicularity: Rough surface - matrix supported in some sections, clast supported in others; up to 50% vesicularity in lava clasts/shards, rest not vesicular. 6. Phenocrysts: None observed. 7. Matrix: Exterior largelz clast supported with a variety of clasts. a) clasts of vesiculated lava (50% vesicularity) - glassy. b) bioclasts - comprise exterior of rock (e.g., shells 5 more than 5 mm size). c) clasts with white fine rim, altered. d) fluidal ropy texture. Matrix appears to be yellowish-brown, coarse ash size. Sulfur smell observed. 8. Secondary Minerals: Same as 2. 9. Encrustations: Some wormy biota encrustations, rest of biology seems embedded within clast. 10. Comment:									
M191-20-1-5	1. Rock Type: Possibly volcanic, possibly coralliferous. Highly altered to grey with fine micritic mud throughout. 2. Size: 11.5 x 8 x 12 cm 3. Shape / Angularity: Angular clast with verz irregular surface 4. Color of cut surface: Black groundmass with light grey mud in spaces between holes. could also contain bioclasts but very difficult to tell. 5. Texture / Vesicularity: Fine grained, although it is possible that it is a bioclastic carbonate rock. 6. Phenocrysts: No observed phenocrysts - aphanetic matrix/groundmass. 7. Matrix: Hard matrix, lots of loose to semi-indurated grey mud. 8. Secondary Minerals: None observed. 9. Encrustations: Thin veneer. 10. Comment:	x								
M191-20-1-6	1. Rock Type: Same description as M191-20-1-5 2. Size: 10 X 8 X 7 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:									

M191-20-1-7	1. Rock Type: Same description as M191-20-1-5 2. Size: 12 X 8 X 7 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:								
M191-20-1-8	1. Rock Type: Bioclastic carbonate rock 2. Size: 20 x 14 x 14 3. Shape / Angularity: Irregular, angular, large cavities, ample borings (burrows) 4. Color of cut surface: Creamy yellow + red 5. Texture / Vesicularity: Open cavities 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Entirely composed of encrustations (ot larger than 1-5 cm) 10. Comment:								
M191-20-1-9	1. Rock Type: Bioclastic carbonate rock 2. Size: 15 x 11 x 8.5 3. Shape / Angularity: Same as M191-20-1-8. 4. Color of cut surface: Same as 8, mostly yellowish, some creamy carbonate patches. 5. Texture / Vesicularity: Some cavities 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Entirely composed of encrustations (crustaceans, worms, etc.) 10. Comment:								
M191-20-1-10	1. Rock Type: bioclastic carbonate rock 2. Size: 13 x 14.5 x 13 3. Shape / Angularity: Same as M191-20-1-8 & 9. 4. Color of cut surface: Same as M191-20-1-8, Mostly creamy, some red, some yellow. 5. Texture / Vesicularity: Some cavities 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Entirely composed of encrustations (cructaceans, worms, shells - up to 2 cm diameter), layer thicker than 8 & 9. 10. Comment:								
M191-20-1-11	1. Rock Type: Same description as M191-20-1-5, 6, 7 2. Size: 2.5 X 4.5 X 2.5 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:								
M191-20-1-12	1. Rock Type: Similar description to 8, 9, 10. Some more mud in the burrows, slightly darker with some white patches 2. Size: 10 X 13 X 10 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment: Block A.								

M191-21-1

Area 2, largest flat-topped volcano (vs 3). Dredge track up the SW flank, covering sections below and above flat, and the top part

Dredge on bottom UTC, hrs, °N, °E, depth m	09:51	37°10,37'N	12°42,22'E	142
Dredge off bottom UTC, hrs, °N, °E, depth m	11:16	37°10,48'N	12°42,33'E	47.5
total volume:	1/4 full			

Comments: Mostly bioclastic carbonates, few fragments of aphyric volcano rocks, angular fresh broken.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-21-1-1	1. Rock Type: Volcanic (Dense grey, microcrystalline) 2. Size: 8 x 11 x 5.5 3. Shape / Angularity: Subangular/Subrounded 4. Color of cut surface: Light grey with specks of white euhedral to subhedral crystal laths. 5. Texture / Vesicularity: less than 5%. however vesicles present are elongated & up to 1 cm in diameter. 6. Phenocrysts: Feldspar laths up to 1 mm and imbricated in the same direction as flow (c. 30% crystals). 7. Matrix: Aphinitic fine-grained matrix, porphyritic texture with very small crystals (dominated by feldspar and some tiny black crystals). 8. Secondary Minerals: None observed. 9. Encrustations: Thin layer of encrustations made up of biological material. 10. Comment:	2	x						
M191-21-1-2	1. Rock Type: Volcanic - same description as sample 1, except to note some banding in the same direction as vesicle elongation. Some olivine observed, and glassy matrix 2. Size: 6.5x5.5x2.5 cm 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:	x	x						
M191-21-1-3	1. Rock Type: Same as Rock 1 (5 pieces) 2. Size: a) 5.5 x 2.5 x 1.5. b) 6 x 6 x 3. c) 4.5 x 4.5 x 2. d) 4.5 x 2.5 x 1.5. e) 3 x 2 x 1.5. 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:								
M191-21-1-4	1. Rock Type: Biological - bioclastic carbonate 2. Size: 12x11.5x9 3. Shape / Angularity: Rounded overall, with irregular angular surface, ample borings 4. Color of cut surface: creamy yellow 5. Texture / Vesicularity: open cavities 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: n/a 10. Comment: thin 1 mm layer of encrustations/biological								

M191-21-1-5	1. Rock Type: Same as description 4, note that the middle section of clast, around 5 cm diameter, concave carbonate texture with orange vesicular texture. 2. Size: 10x5x5cm approx. 3. Shape / Angularity: 4. Color of cut surface: 5. Texture / Vesicularity: 6. Phenocrysts: 7. Matrix: 8. Secondary Minerals: 9. Encrustations: 10. Comment:								

M191-22-1

Area 2, large volcano, lava flow (?) at lower eastern side of volcano

Dredge on bottom UTC, hrs, °N, °E, depth m	12:02	37°10,37'N	12°42,10'E	170
Dredge off bottom UTC, hrs, °N, °E, depth m	12:19	37°10,42'N	12°42,08'E	132.8
total volume:	empty			
Comments:				

M191-23-1

Area 2, volcano SW of large first volcano, younger volcano, active in 1831, formed an island, SW flank

Dredge on bottom UTC, hrs, °N, °E, depth m	13:04	37°10,17'N	12°43,42'E	114
Dredge off bottom UTC, hrs, °N, °E, depth m	13:35	37°10,16'N	12°43,31'E	42
total volume:	ne third full			

Comments: fresh lava, dense to scoriaceous, plus many small fragments (lapilli) looks like samples of a flow top, some biology is attached.

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-23-1-1	1. Rock Type: Dense vesicular lava block, sub-rounded 2. Size: 16x8x10cm 3. Shape / Angularity: irregular form, sub-rounded 4. Color of cut surface: dark grey 5. Texture / Vesicularity: vesicles with faint elongated orientation, glassy groundmass, approximately 15% vesicles 6. Phenocrysts: pale feldspar, possibly darker minerals 7. Matrix: glassy groundmass 8. Secondary Minerals: n/a 9. Encrustations: fine and patchy biogenic colonisation 10. Comment:	x	x						
M191-23-1-2	1. Rock Type: vesiculated platy lava crust 2. Size: 26x18x8cm 3. Shape / Angularity: platy form, highly irregular, angular 4. Color of cut surface: grey interior with red outer rim 5. Texture / Vesicularity: highly vesicular, 50% 6. Phenocrysts: not easily visible 7. Matrix: glassy groundmass 8. Secondary Minerals: no 9. Encrustations: red surface coating 10. Comment:								
M191-23-1-3	1. Rock Type: inflated block with dense crust, cut surface reveals concentric inflation 2. Size: 18x15x10cm 3. Shape / Angularity: highly angular, irregular, slightly jointed exterior 4. Color of cut surface: dark grey 5. Texture / Vesicularity: dense, moderately vesicular, about 10% vesicles 6. Phenocrysts: not easily visible 7. Matrix: micro-crystalline 8. Secondary Minerals: no 9. Encrustations: red surface coating with lots of bioclastic colonisation 10. Comment:	x	x						

M191-23-1-4	1. Rock Type: crudely layered agglutinated monomict block, crumbly, lapilli to ash grade clasts 2. Size: 20x13x9cm 3. Shape / Angularity: sub-angular block 4. Color of cut surface: dark grey to black 5. Texture / Vesicularity: crumbly agglutination of 1-10mm angular clasts of dark scoria 6. Phenocrysts: crystal fragments of pyroxene and possibly olivine 7. Matrix: scoria, ash and crystals 8. Secondary Minerals: no 9. Encrustations: minor encrustations 10. Comment: thin section at a later point, too crumbly	at later stage							
M191-23-1-5	1. Rock Type: breadcrusted block, with strongly vesiculated interior 2. Size: 17.5x13x6.5cm 3. Shape / Angularity: angular block 4. Color of cut surface: mid grey, with a brown glassy surface 5. Texture / Vesicularity: glassy expanded exterior surface, and highly vesicular interior which grades towards the surface 6. Phenocrysts: difficult to see 7. Matrix: glassy 8. Secondary Minerals: no 9. Encrustations: red coating on one surface 10. Comment:								
M191-23-1-6	1. Rock Type: four scoria clasts 2. Size: a-6x9x5.5, b-7.5x7.5x4, c-3.5x4x3.5, d-5x4x2.5 cm 3. Shape / Angularity: irregular shapes, sub-angular 4. Color of cut surface: dark grey to brownish grey 5. Texture / Vesicularity: low desnity, highly vesicular, more than 50% vesicles 6. Phenocrysts: not easily visible 7. Matrix: glassy 8. Secondary Minerals: no 9. Encrustations: minor biogenic encrustations 10. Comment:								
M191-23-1-7	1. Rock Type: Fluidal surface-textured scoria clast 2. Size: 6x4x2cm 3. Shape / Angularity: sub-rounded form, platy 4. Color of cut surface: dark grey 5. Texture / Vesicularity: finely vesicular, low density 6. Phenocrysts: no visible crystals 7. Matrix: glassy 8. Secondary Minerals: no 9. Encrustations: no 10. Comment:								
M191-23-1-8	1. Rock Type: xenolith, altered basement carbonate (marble) 2. Size: 3.5x3x2.5cm 3. Shape / Angularity: sub-angular, rounded corners 4. Color of cut surface: white interior with brownish fractures, cream exterior (baked/metamorphosed?) 5. Texture / Vesicularity: dense, microcrystalline 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: no 10. Comment:								

M191-23-1-9	1. Rock Type: xenolith, bioclastic block, likely seafloor sediment (carbonate) 2. Size: 4.5x3.5x3cm 3. Shape / Angularity: sub-rounded 4. Color of cut surface: white interior, cream exterior 5. Texture / Vesicularity: open textured with fossil forms, looks like previous carbonate samples 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: no 10. Comment:								
M191-23-1-10	1. Rock Type: Bulk mafic lapilli deposit 2. Size: clasts range from 1 mm to 2 cm approx 3. Shape / Angularity: variety of angular to rounded clasts 4. Color of cut surface: dominated by dark grey clasts with brown clasts and white bioclasts 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: n/a 10. Comment: needs detailed componentry and sieving, good for picking crystals, textures etc.								

M191-24-1

Area 2 seamount 4, cone base diameter 675m, 190-80m SW flank from base to top

Dredge on bottom UTC, hrs, °N, °E, depth m	14:20	37°08,83'N	12°42,59'E	182
Dredge off bottom UTC, hrs, °N, °E, depth m	14:59	37°08,92'N	12°42,76'E	76
total volume:	one third full			

Comments: large number of rounded carbonate blocks and one volcaniclastic cemented block and two with minor volcaniclastic components in the carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-24-1-1	1. Rock Type: Volcaniclstic mafic scoriaceous, angular clasts encased in green, white and yellow muddy matrix with convolute boundaries 2. Size: 19x14x11cm 3. Shape / Angularity: highly angular irregular block 4. Color of cut surface: white to green with dark brown clasts of 1mm to 1cm scale 5. Texture / Vesicularity: angular mafic clasts in a muddy matrix. 6. Phenocrysts: none visible 7. Matrix: white ?carbonate mud and green to white mud, all well indurated 8. Secondary Minerals: matrix? greesish/white mud 9. Encrustations: minor biogenic encrustations, carbonate 10. Comment:	x	Mafic clasts could be separated for chemistry						
M191-24-1-2	1. Rock Type: dense bioclastic limestone with more open outer encrustation and minor volcaniclastic content (carbonate hardground?) 2. Size: 24x13x10cm 3. Shape / Angularity: angular elongate block 4. Color of cut surface: pale yellow with white-grey bioclasts 5. Texture / Vesicularity: faintly layered bioclastic material 6. Phenocrysts: not applicable 7. Matrix: carbonate mud, well lithified 8. Secondary Minerals: not applicable 9. Encrustations: more open biological carbonate encrustation on rim 10. Comment: Suitable for radiocarbon dating								

M191-26-1

Area 3, Cimotoe (?) Very small oval shaped NE-SE striking positive bathymetric anomaly, track along northern flank, bright backscatter here

Dredge on bottom UTC, hrs, °N, °E, depth m	20:46	37°00,36'N	12°31,82'E	114
Dredge off bottom UTC, hrs, °N, °E, depth m	21:04	37°00,29'N	12°31,82'E	100
total volume:	one fifth full			

Comments: several carbonate blocks, open encrustations of mixed biogenic material

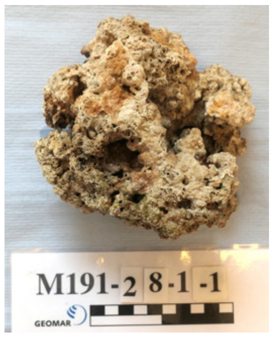
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-26-1-1	1. Rock Type: Grey carbonate, tubules and rounded forms. 2. Size: 8x6x3cm 3. Shape / Angularity: irregular and subangular 4. Color of cut surface: pale grey 5. Texture / Vesicularity: biogenic fossil material and cemented micritic mud 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: biogenic encrusted block 10. Comment:								
M191-26-1-2	1. Rock Type: yellow brown carbonate block, open structured and comprised of cemented tubules and almost all of the recovered material is of this type 2. Size: 12x8x5cm 3. Shape / Angularity: irregular open structure 4. Color of cut surface: yellow brown 5. Texture / Vesicularity: agglomerated biogenic tubuar and rounded forms 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: all biogenic carbonate encrustation 10. Comment:								

M191-28-1

Volcano Anfitrite, area 4. Dredge track up eastern flank in northern part of the volcano, from deepest part up to the ridge.

Dredge on bottom UTC, hrs, °N, °E, depth m	06:27	37°15,52'N	12°20,77'E	80.2
Dredge off bottom UTC, hrs, °N, °E, depth m	07:23	37°15,55'N	12°20,51'E	47
total volume:	10% full			

Comments: several carbonate rocks, open encrustation of mixed biogenic material

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-28-1-1	1. Rock Type: carbonate bioclastic rock 2. Size: 11x12x8m 3. Shape / Angularity: irregular, angular, large cavities, ample bivalves. 4. Color of cut surface: creamy yellow and grey, some black coating 5. Texture / Vesicularity: open cavities 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: some encrustations, small patches of thin layers of biogenic material 10. Comment: Note large volume of bivalves in bulk deposit, up to 6cm diameter, accounts for about 20% of the bulk dredge								

M191-29-1

Working area 4, flat W to E elongated hill, N slope

Dredge on bottom UTC, hrs, °N, °E, depth m	08:12	37°13,92'N	12°20,91'E	73.9
Dredge off bottom UTC, hrs, °N, °E, depth m	08:59	37°13,89'N	12°20,87'E	60.6
total volume:	around 5% of the dredge			

Comments: Carbonate rocks and some biology, no volcanic rocks recorded

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-29-1-1	1. Rock Type: dense carbonate block with irregular shape. 2. Size: 15.5x13x9cm 3. Shape / Angularity: angular irregular surface to block 4. Color of cut surface: pale yellow to red, some black patches 5. Texture / Vesicularity: some diffuse laminations 6. Phenocrysts: n/a 7. Matrix: carbonaceous mud, indurated/hardground/crust material? 8. Secondary Minerals: n/a 9. Encrustations: minor encrusted veneer 10. Comment:								

M191-30-1

Area 4, volcano (?) 2b.

Dredge on bottom UTC, hrs, °N, °E, depth m	09:40	37°13,30'N	12°21,49'E	75
Dredge off bottom UTC, hrs, °N, °E, depth m	10:06	37°13,31'N	12°21,41'E	63
total volume:	5-10% of dredge			

Comments: Carbonate rocks and biology, no volcanic rocks recovered

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-30-1-1	1. Rock Type: Dense carbonate block sub-angular in shape. 2. Size: 20.7x12.3x8.6cm 3. Shape / Angularity: subangular block, slightly elongated 4. Color of cut surface: pale yellow to red, lots of white patches of bioclastic material 5. Texture / Vesicularity: diffuse sorting but generally massive 6. Phenocrysts: n/a 7. Matrix: carbonaceous mud, indurated/hardground 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment:								

M191-31-1

Area 4, Galatea seamount, eastern slope, upper part.

Dredge on bottom UTC, hrs, °N, °E, depth m	11:01	37°12,87'N	12°24,30'E	104
Dredge off bottom UTC, hrs, °N, °E, depth m	11:25	37°12,91'N	12°24,25'E	78.6
total volume:	5% of the dredge			

Comments: Carbonate rocks and some shells, no volcanic rocks recorded

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-31-1-1	1. Rock Type: Dense carbonate block 2. Size: a-7x6x4cm, b-7.5x5x5.5, c-10x7x7cm 3. Shape / Angularity: subangular blocks, a is more rounded in shape, b and c are more elongated 4. Color of cut surface: pale yellow to red in colour 5. Texture / Vesicularity: slightly laminated but generally massive, clasts and biogenic material. 6. Phenocrysts: n/a 7. Matrix: carbonaceous mud, indurated 8. Secondary Minerals: n/a 9. Encrustations: minor encrustrations 10. Comment:								

M191-34-1

Area 2, northernmost volcano at Graham Bank. Dredge up western flank

Dredge on bottom UTC, hrs, °N, °E, depth m	06:19	37°15,18'N	12°41,54'E	141
Dredge off bottom UTC, hrs, °N, °E, depth m	06:41	37°15,23'N	12°41,44'E	89.7
total volume:	5-10% full			

Comments: carbonate sample with many displaying small volcanic clasts within the softer calcareous muddy parts

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-34-1-1a	1. Rock Type: Dense carbonate bioclastic block (two fragments) 2. Size: 11x11x7cm, 11x10.5x7cm 3. Shape / Angularity: irregular surfacesub-rounded, some borings 4. Color of cut surface: creamy yellowish grey (surrounding the block and within the cavities is grey mud with black glassy rounded clasts, coarse ash to fine lapilli sized) 5. Texture / Vesicularity: Calcrete hardground centre with a more open exterior, forming the clasts. This does not contain the volcanic clasts. Clasts dispersed in mud at boundary. 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations, biological, even coverage 10. Comment:							See attached sketch	
M191-34-1-1b	1. Rock Type: Volcanic clasts, scoriaceous and some glassy. 2. Size: Maximum of 8x4x3mm, minimum of 2x1x1mm 3. Shape / Angularity: subangular to subrounded; some clasts display sharp edges 4. Color of cut surface: black glassy to orange in parts, maybe palagonite?, mostly black/dark grey 5. Texture / Vesicularity: some finely vesicular fragments, around 60%, however 40% are glassy and difficult to see many textures 6. Phenocrysts: possible small crystals but no obvious phenocrysts in clasts 7. Matrix: clasts are derived from a clayey matrix surrounding sample 1a. 8. Secondary Minerals: n/a 9. Encrustations: possibly very minor, may need additional claning with a fine brush 10. Comment: More detail included in sketch	Could be resin mounted	Could be mounted in resin for analysis					See attached sketch	
M191-34-1-2	1. Rock Type: carbonate material, all hardground/calcrete (carbonate clast without the muddy exterior seen in 1a) 2. Size: 15x15x5cm 3. Shape / Angularity: angular, irregular morphology 4. Color of cut surface: dark grey in centre, red in parts 5. Texture / Vesicularity: comprised of hard shelly components 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment:								

M191-35-1

Area 2, northernmost volcano on Graham Bank

Dredge on bottom UTC, hrs, °N, °E, depth m	07:21	37°15,36'N	12°41,27'E	157
Dredge off bottom UTC, hrs, °N, °E, depth m	07:46	37°15,29'N	12°41,32'E	108
total volume:	mud, mostly empty			

Comments: only one carbonate sample recovered

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-35-1-1	1. Rock Type: carbonate material, calcareous hardground 2. Size: 10x6x2.5cm 3. Shape / Angularity: angular to subangular clast, irregular surface 4. Color of cut surface: dark grey to white 5. Texture / Vesicularity: carbonaceous clasts within shelly fragments 6. Phenocrysts: n/a 7. Matrix: carbonaceous calcrete matrix 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment:								

M191-36-1

Same volcano as dredge 34 and 35, area 2

Dredge on bottom UTC, hrs, °N, °E, depth m	08:24	37°15,38'N	12°41,32'E	154
Dredge off bottom UTC, hrs, °N, °E, depth m	08:52	37°15,28'N	12°41,36'E	95
total volume:	10% of dredge, all mud			

Comments: Loose mud washed out quickly, very few rock samples left

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-36-1-1	1. Rock Type: Carbonate rock, calcareous hardground 2. Size: 13x9.5x5cm 3. Shape / Angularity: angular block, very irregular surface 4. Color of cut surface: dark grey to white 5. Texture / Vesicularity: carbonaceous clasts 6. Phenocrysts: n/a 7. Matrix: calcareous matrix 8. Secondary Minerals: n/a 9. Encrustations: heavily encrusted with tubule bioclastic material 10. Comment:								
M191-36-1-2	1. Rock Type: similar to sample 1, but branch shaped (encrusted organism) 2. Size: 11x4x2cm 3. Shape / Angularity: branch shaped, angular 4. Color of cut surface: dark grey to white 5. Texture / Vesicularity: carbonate 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: heavily encrusted 10. Comment:								

M191-37-1

Terribile Bank

Dredge on bottom UTC, hrs, °N, °E, depth m	11:10	37°09,63'N	12°53,33'E	53.8
Dredge off bottom UTC, hrs, °N, °E, depth m	11:39	37°09,62'N	12°53,23'E	32
total volume:	5-10 % recovery			

Comments: mix of different clasts: volcanic, marble (?), flow stone (?), carbonates; dredge got stuck briefly and broke at the base

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-37-1-1	1. Rock Type: Clastic rock, predominantly containing 1-6mm subangular altered yellow (zeolitised?) pumice lapilli, set within a fine brown matrix. Pumice is soft and recessively weatehring. Free crystals - fresh tabular black and pale grey - in matrix. this all envelops angular dense carbonate blocks on a several-cm scale, inferred to be locally sourced. Interpret as an ignimbritic (i.e. flow) deposit on local surface (source/distance unknown) 2. Size: several fragments from original block, which was highly angular and extensively colonised by organisms (demonstrating that material formed local seafloor layer). Original block 40x25x18cm. 3. Shape / Angularity: Highly irregular form and shape to surface (erosional surface form?) 4. Color of cut surface: Brown matrix, yellow pumice clasts, pinky white carbonate blocks embedded 5. Texture / Vesicularity: Matrix supported texture, dispersed abundant subangular pumice, infilling fractured ?bedrock carbonate blocks and enveloping these lithics 6. Phenocrysts: Free crystals in matrix, and rarely within the pumice, igneous crystals. Fresh black px, a greenish phase, and transparent laths (fsp?). 7. Matrix: Fine grained, dense, well indurated/cemented 8. Secondary Minerals: Altered pumice, zeolitised 9. Encrustations: Patchy carbonate encrustation	x	Separate crystals for geochem to identify nature of magma source					See additional sheets for description and interpretations. Complicated lithology.	
M191-37-1-2	1. Rock Type: bioclastic carbonate with hard cemented carbonate infill, encrusting dense hardground 2. Size: 20x11x6 cm 3. Shape / Angularity: angular block 4. Color of cut surface: grey, milky white; dense carbonate, pale brown 5. Texture / Vesicularity: grades from dense hard base to dense encrustation to a upper surface 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: rock is predominant, thick encrustantions on harder carbonate 10. Comment:								
M191-37-1-3	1. Rock Type: angular elongated clast of brown, laminated accumulation, parallel with clast surface. Iron carbonate/flowstone? 2. Size: 15x4x2 cm 3. Shape / Angularity: Irregular cuboidal block 4. Color of cut surface: brown/orange (iron-rich?) 5. Texture / Vesicularity: very dense, laminated rock 6. Phenocrysts: very fine grained laminated with large white clasts 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: encrustations on every surface: a loose clast? 10. Comment:								

M191-37-1-4	1. Rock Type: subrounded pebble: dense (chert?) infillings from borings 2. Size: 12x8x6 cm 3. Shape / Angularity: subrounded shape 4. Color of cut surface: white interior, grey/black exterior 5. Texture / Vesicularity: dense and massive 6. Phenocrysts: n/a 7. Matrix: na/a 8. Secondary Minerals: n/a 9. Encrustations: thick (up to 10mm) encrusted casing around exterior 10. Comment:								
M191-37-1-5	1. Rock Type: rounded pebble, very dense crystalline, saccharoidal/sugar texture, marble? 2. Size: 11x8x5 cm 3. Shape / Angularity: rounded/slightly flattened 4. Color of cut surface: white 5. Texture / Vesicularity: saccharoidal/sugar texture 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: biogenic bioclast (thin up to 2 mm), patchy crust 10. Comment:								

M191-38-1

Terribile Bank, small cone

Dredge on bottom UTC, hrs, °N, °E, depth m	12:44	37°09,98'N	12°52,83'E	98.8
Dredge off bottom UTC, hrs, °N, °E, depth m	13:02	37°09,93'N	12°52,82'E	69.7
total volume:	25% full			

Comments: mostly mud, ca. small carbonates up to 10 cm

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-38-1-1 (a-c)	1. Rock Type: carbonate material with irregular surface/shape 2. Size: a) 6x6x2 cm, b) 6.5x8.5x3 cm, c) 8.5x5.5x2 cm 3. Shape / Angularity: irregular surface/angular clast 4. Color of cut surface: white to light grey 5. Texture / Vesicularity: carbonte/calicified clastic rock 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: tubular/worm-like spiraly calcified structures, likely coraline algae 10. Comment:								

M191-39-1

Terribile bank, small cone

Dredge on bottom UTC, hrs, °N, °E, depth m	13:36	37°09,69'N	12°52,89'E	67.8
Dredge off bottom UTC, hrs, °N, °E, depth m	13:44	37°09,66'N	12°52,95'E	67.8
total volume:	10 % full			

Comments: mud with carbonate gravel

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-39-1-1	1. Rock Type: carbonate-bioclastic -> coraline algae 2. Size: 11x rubble, ranging 4.5x2 cm across 3. Shape / Angularity: subrounded to subangular 4. Color of cut surface: pale cream ro mid grey, some rusty orange colour 5. Texture / Vesicularity: irregular surface some have an open/pitted surface others are smoothed by mineralised coating 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: slightly mineralisation encrusted, some biogenic 10. Comment:								

M191-40-1
Terribile bank, NE-SW elongate dredge, NW-flank

Dredge on bottom UTC, hrs, °N, °E, depth m	14:23	37°09,42'N	12°52,41'E	55
Dredge off bottom UTC, hrs, °N, °E, depth m	14:37	37°09,39'N	12°52,39'E	42.4
total volume:	10 % full			

Comments: few carbonates, mussel shells, two areas taken

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-40-1-1	1. Rock Type: carbonate, biogenic clast 2. Size: 12x8x5 cm 3. Shape / Angularity: irregular/angular/subangular 4. Color of cut surface: light brown, cream 5. Texture / Vesicularity: open texture, irregular surface, heavily bored surface 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: moderatily encrusted with red/purple material and other biogenic material								
M191-40-1-2	1. Rock Type: carbonate, biogenic clast 2. Size: 5x5x4 cm 3. Shape / Angularity: irregular/angular/subangular 4. Color of cut surface: light, brown cream 5. Texture / Vesicularity: denser than M191-40-1-1/ more cemented irregular surface, bored 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: min encrustations, purple/red/yellow biogenic material								

M191-41-1
Terribile bank, repeat of dredge 37 where volcanic was obtained in the morning, east-facing slope of plateau structure

Dredge on bottom UTC, hrs, °N, °E, depth m	15:09	37°09,58'N	12°53,29'E	53
Dredge off bottom UTC, hrs, °N, °E, depth m	15:55	37°09,59'N	12°53,28'E	42
total volume:	10%			

Comments: very few carbonates

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-41-1-1	1. Rock Type: carbonate-bioclastic 2. Size: 6.5x6x2 cm 3. Shape / Angularity: irregular, subangular, subroundend 4. Color of cut surface: greyish cream 5. Texture / Vesicularity: irregular, pitted open texture on the surface, denser in the center (more cemented?) 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: encrusted in biogenic material on outer surface 10. Comment:								

M191-42-1
Western working area onTerribile bank, prominent oval-shaped cone rising over small basin; SW facing slope

Dredge on bottom UTC, hrs, °N, °E, depth m	17:01	37°10,43'N	12°49,88'E	125
Dredge off bottom UTC, hrs, °N, °E, depth m	17:16	37°10,48'N	12°49,90'E	73
total volume:	1/6 full			

Comments: mud and a few pieces of carbonates

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-42-1-1	1. Rock Type: bioclastic carbonate 2. Size: 12.5x9x5cm 3. Shape / Angularity: regular, angular 4. Color of cut surface: grey/cream 5. Texture / Vesicularity: open texture, denser in centre, pitted surface 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: encrusted rock with reddish surface crust 10. Comment:								

M191-43-1				
Western working area ofTerribile bank, same cone as dredge 42 SE flank				
Dredge on bottom UTC, hrs, °N, °E, depth m	17:42	37°10,43'N	12°49,97'E	112
Dredge off bottom UTC, hrs, °N, °E, depth m	17:58	37°10,46'N	12°49,95'E	70
total volume:	1/8 full			
Comments: coral, mussel shells, sea urchins, red coral				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-43-1-1	1. Rock Type: Red coral, broken fragments 2. Size: Up to 10cm long, max. 12mm in diameter 3. Shape / Angularity: Multi-branching 4. Color of cut surface: Bright red to pinky read to purplish red 5. Texture / Vesicularity: Ribbed surface, tubular interior 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Minor serpulid encrustations 10. Comment:								
M191-43-1-2	1. Rock Type: Pitted bioclastic carbonate 2. Size: 7 x 4.5 x 2 cm 3. Shape / Angularity: Sub-angular block 4. Color of cut surface: Yellow-grey 5. Texture / Vesicularity: Open pitted texture on mm scale 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Surface serpulid encrustations 10. Comment:								
M191-43-1-3	1. Rock Type: Open corallinw and biogenic encrustations 2. Size: 9 x 8 x 7 cm 3. Shape / Angularity: High irregular block 4. Color of cut surface: Brownish yellow 5. Texture / Vesicularity: Open structure of overgrown biogenic tubular and rounded encrustations 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Thin surface crust over the bulk sample 10. Comment:								

M191-44-1				
Western working area ofTerribile bank, NW-SE elongated high with area of high reflection in backscatter. Dredge across high				
Dredge on bottom UTC, hrs, °N, °E, depth m	18:35	37°10,23'N	12°50,77'E	96.6
Dredge off bottom UTC, hrs, °N, °E, depth m	19:02	37°10,28'N	12°50,84'E	86
total volume:	1/8 full			
Comments: biogenic blocks, rhodoliths and encrusted material - all carbonate				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-44-1-1	1. Rock Type: Large biogenic block, open textured, encrustation of coral and tubular forms 2. Size: 15 x 12 x 10 cm 3. Shape / Angularity: Irregular and sub-angular 4. Color of cut surface: Yellow brown 5. Texture / Vesicularity: Open structure of intertwining biogenic material 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Minor surface crust - red coating 10. Comment:								
M191-44-1-2	1. Rock Type: Sub-rounded rhodoliths 2. Size: 2 pieces approx. 5cm across 3. Shape / Angularity: Sub-rounded 4. Color of cut surface: Cream coloured 5. Texture / Vesicularity: Open texture with cavities 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Red surface coating, white underside 10. Comment:								

M191-45-1
Eastern working area, Terribile Bank - northern slope of plateau, high reflective area according to geophysics

Dredge on bottom UTC, hrs, °N, °E, depth m	19:43	37°09,77'N	12°53,105'E	58
Dredge off bottom UTC, hrs, °N, °E, depth m	20:32	37°09,76'N	12°53,04'E	51
total volume:	very few			

Comments: Carbonate fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-45-1-1	1. Rock Type: Carbonate - bioclastic x2 2. Size: A. 5 x 5 x 4 cm B. 4 x 4 x 2 cm 3. Shape / Angularity: Irregular and sub-angular 4. Color of cut surface: A. Dark cream, coated in red-purple encrustation B. Pale cream 5. Texture / Vesicularity: Irregular open pitted texture (B is slightly denser than A) 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Heavily encrusted 10. Comment:								

M191-47-1
Northern edge of the Nameless Bank, NE facing slope, middle part

Dredge on bottom UTC, hrs, °N, °E, depth m	14:51	36°52,37'N	13°05,78'E	600
Dredge off bottom UTC, hrs, °N, °E, depth m	15:34	36°52,22'N	13°05,75'E	441
total volume:	lud- 1/2 full			

Comments: No samples, all sticky clay

M191-48-1
Nameless Bank, Area 2 - North facing slope of Nameless Bank, close to 47, further up

Dredge on bottom UTC, hrs, °N, °E, depth m	16:31	36°52,38'N	13°05,37'E	481
Dredge off bottom UTC, hrs, °N, °E, depth m	17:10	36°52,20'N	13°05,29'E	348
total volume:	full with mud			

Comments: No samples, all sticky clay

M191-49-1
Nameless B, Area 1 - North, north east facing slope in area of highest backscatter deployed just beneath break in slope; aims at steep cliff

Dredge on bottom UTC, hrs, °N, °E, depth m	18:25	36°51,71'N	13°07,14'E	554
Dredge off bottom UTC, hrs, °N, °E, depth m	19:53	36°51,68'N	13°07,01'E	448
total volume:	2/3 full			

Comments: carbonate rocks, lithified cemented carbonates, no igneous rocks

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-49-1-1	1. Rock Type: hard, very dense limestone, carbonate 2. Size: 23x17x13 cm (original block); kept block size: 16x6.5x11 cm 3. Shape / Angularity: angular block 4. Color of cut surface: pale orange brown (iron carbonate?) 5. Texture / Vesicularity: nodular form (nodules are darker red brown), dark, wavy irregular textures around nodules, deformed fabric, dark brown, dendritic growth, some are black (manganese???) 6. Phenocrysts: NA 7. Matrix: Extremely fine grained 8. Secondary Minerals: NA 9. Encrustations: Very minimal 10. Comment: Strong reaction with acid								
M191-49-1-2	1. Rock Type: Carbonate - basal surface with ribbed texture and black coating, dense orange, lower half interior, irregular burrowed/discontinued boundary, infilled bioclastic limestone forming upper half 2. Size: 14x7x5 cm 3. Shape / Angularity: angular, slightly flattened 4. Color of cut surface: rusty orange and pale yellow (black surface) 5. Texture / Vesicularity: lower is dense, upper is dense but pitted 6. Phenocrysts: NA 7. Matrix: very fine grained, lower upper carbonate mud 8. Secondary Minerals: NA 9. Encrustations: Minor 10. Comment:								
M191-49-1-3	1. Rock Type: Complex layered carbonate. Basal flat surface with a very dark to black botriodal crust (manganese?) which penetrates material above and down fractures. 2. Size: Original block = 43x20x14 cm Sampled block = 22x13x12 cm. 3. Shape / Angularity: see comments (10) 4. Color of cut surface: see comments (10) 5. Texture / Vesicularity: see comments (10) 6. Phenocrysts: see comments (10) 7. Matrix: see comments (10) 8. Secondary Minerals: see comments (10) 9. Encrustations: see comments (10) 10. Comment: A partly laminated bracciated fabric, with.a white extremely dense carbonate. Black crust fizzes with acid so it cannot be manganese, white material does not fizz. Cherty in texture, lower part is brecciated but some boundaries are very convoluted, almost dissolution textures. This is all infilled by bioclastic limestone encrusted on the top surface.							See attached sketch	
M191-49-1-4	1. Rock Type: A large block of bioclastic packstone dispalying a wide variety of fossil types dominated by corals, but includes bivalves, worms, etc. 2. Size: Original block = 37x20.5x14 cm Sampled block = 20x12x12 cm 3. Shape / Angularity: Highly angular 4. Color of cut surface: Beige 5. Texture / Vesicularity: Dense bioclastic texture with some cavities linked to organsims 6. Phenocrysts: n/a 7. Matrix: very fine carbonate mud 8. Secondary Minerals: n/a 9. Encrustations: very encrusted 10. Comment:								

M191-49-1-5	1. Rock Type: Bioclastic packstone carbonate with mix of shelly (bivalves) and other fragments 2. Size: 20x12x7 cm 3. Shape / Angularity: Subangular block 4. Color of cut surface: Yellow-grey 5. Texture / Vesicularity: Dense with pitted weathered outer surface 6. Phenocrysts: n/a 7. Matrix: calcareous mud 8. Secondary Minerals: n/a 9. Encrustations: minor surface worm encrustation 10. Comment:								
M191-49-1-6	1. Rock Type: Amalgamation of large (up to 20 cm across) platy biological forms with oyster-like laminated white shelly internal structure and bracket fungus like forms at a range of angles and bound together by their growth pattern. Platy coral? 2. Size: 20x20x18 cm 3. Shape / Angularity: Composing two main plates at a 90 degree angle. 4. Color of cut surface: White interior, brown outer surface. 5. Texture / Vesicularity: Platy internally shelly laminae. Flaky shelly ineterior. 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor worm and coral encrustations 10. Comment:								
M191-49-1-7	1. Rock Type: Biological plate - leather coral? 2. Size: Large frgament = 20x13x2 cm 3. Shape / Angularity: Wavy slightly plate like form. Slightly distorted. 4. Color of cut surface: Pale yellow/brown 5. Texture / Vesicularity: Internally dense, structureless with faint internal wavy fabric. Later broings. 6. Phenocrysts: n/a 7. Matrix: n/ 8. Secondary Minerals: n/a 9. Encrustations: worm and coral encrustation on one surface and bored on the other. 10. Comment:								
M191-49-1-8	1. Rock Type: Similar to sample 7 but smaller ear-like forms abour 8 cm across. Cupped at edges. A different species of leather coral? Some with distorted form. 2. Size: 2 pieces: a) 12x9.5x3 cm b) 11x7.5x2 cm 3. Shape / Angularity: Ear-like 4. Color of cut surface: pale yellow-brown 5. Texture / Vesicularity: dense, no clear growth fabric 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: Coral and worm encrusted on lower side? Not encrusted on concrete? Upper side, but this is slightly pitted/ bored 10. Comment:								

M191-49-1-9	1. Rock Type: Coral fossil, short stem, ribbed flared lower part and smoother upper part with three short branches with radial platy interior. 2. Size: 8x4x3 cm 3. Shape / Angularity: life form broken along length 4. Color of cut surface: pinkish grey 5. Texture / Vesicularity: Platy internal growth fabric, dense outer parts 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: very minor worm encrustations and borings 10. Comment:									

M191-51-1
Area 7, volcanic field NW Linosa. Northernmost trianglular seamount. N-facing slope.

Dredge on bottom UTC, hrs, °N, °E, depth m	12:40	35°56,17'N	12°48,67'E	387
Dredge off bottom UTC, hrs, °N, °E, depth m	13:10	35°56,05'N	12°48,63'E	580
total volume:	empty			

Comments: No samples

M191-52-1
Area 7 volcanic field NW Linosa. Northernmost seamount. SE facing slope.

Dredge on bottom UTC, hrs, °N, °E, depth m	14:13	35°56,00'N	12°48,74'E	694
Dredge off bottom UTC, hrs, °N, °E, depth m	14:41	35°56,05'N	12°48,74'E	577
total volume:	1/4 full			

Comments: mud, two pieces of carbonate

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-52-1-1	1. Rock Type: Bioclastic carbonate blocks (2 blocks) 2. Size: a) 5x5x3.5 cm b) 10x6x3 cm 3. Shape / Angularity: Irregular to subangular 4. Color of cut surface: grez-beige, dark outer coating, black whisps internally 5. Texture / Vesicularity: dense with minor pitting 6. Phenocrysts: n/a 7. Matrix: fine grained matrix 8. Secondary Minerals: n/a 9. Encrustations: minor worm encrustations 10. Comment:								

M191-54-1
Working Area 7, north of Linosa, eastern slope of cone that has been attempted at 51 & 52. Along ridge

Dredge on bottom UTC, hrs, °N, °E, depth m	17:06	35°56,12'N	12°48,85'E	748
Dredge off bottom UTC, hrs, °N, °E, depth m	17:30	35°56,10'N	12°48,74'E	659
total volume:	1 rock			

Comments: volcanic rock, vesicular

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-54-1-1	1. Rock Type: Inflated mafic lava block with clustered minerals 2. Size: 23x16x8 cm 3. Shape / Angularity: flattened, ductile form with rounded furrowed surface - fluidal appearance and overall elongated, flattened slab 4. Color of cut surface: dark, mid-brown grey, slightly browner towards centre, brown centre 5. Texture / Vesicularity: Surface texture - ropy, poorly vesicular outer edge. Amygdaloidal round outer edges. Internal texture overall is concentric zoned defined by colour and vesicularity. Outermost (1mm) brown rim - glass? Approximately 1cm darker, finely vesicular zone. Grading over a short transition into a browner, more coarser vesicular interior. With large 1-2 cm cavities in the centre, with a more rusty brown colour. Throughout, there is a texture of dispersed rounded to subrounded crystal clots. 6. Phenocrysts: Within vesicular matrix, isolated greenish and white crystals (plagioclase, olivine, nepheline?), crystal clots are blocky crytal-rich, approximately 0.5 cm across with glassy matrix around them - could be nepheline? 7. Matrix: Aphanitic to finely crystalline groundmass 8. Secondary Minerals: Altered edge 9. Encrustations: minimal biogenic coral and wormy surface, more on one surface than the other 10. Comment: Description and interpretation on attached sketch	X	X					See attached sketch	

M191-55-1
Area 7 north of Linosa, repeat of dredge 51

Dredge on bottom UTC, hrs, °N, °E, depth m	18:13	35°56,17'N	12°48,67'E	688
Dredge off bottom UTC, hrs, °N, °E, depth m	18:44	35°56,05'N	12°48,63'E	577
total volume:	very few rocks but lava!			
Comments: vesicular lava				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-55-1-1	1. Rock Type: Fresh lava, mafic, vesicular, contact with carbonate mud (fizzes with acid), pepperitic 2. Size: 25x24x12.5 cm 3. Shape / Angularity: furrowed, ropy, ductile, fluid surface (primary surface) - broken off revealing a fresh face 4. Color of cut surface: Very dark grey with a greater than 5 mm brown rim, pepperitic contact is a yellow/cream colour with black fragments 5. Texture / Vesicularity: Lava - porphyritic texture with megacrysts, banding concentric form picked out by changes in vesicularity - larger vesicles in the centre following the form of the sample. Concentric appearance picked out by vesicles in sawn off section alongside 5 cm cavity. Coarse/large phenocrysts (tabular up to 1.2 cm in elongated direction). Clotted texture can be seen in freshly cut surface - some have very clear crystals - green (olivine?) crystals up to 6 mm across, subhedral to anhedral. Blocky, wavy pepperitic contact with sediment penetrating fractures up to 2 cm into the lava, at the margin pepperite envelopes fluidal clasts up to 1 cm across rapidly grading into dispersed, subangular fragments (1-3 mm) 6. Phenocrysts: See number 5 (Texture/Vesicularity) 7. Matrix: Microcrystalline, very fresh 8. Secondary Minerals: NA 9. Encrustations: Very minor coral and worms 10. Comment: Description and interpretation on attached sketch	X	X				Several thin sections to capture several textures as well as the margins/contact	See attached sketch	

M191-55-1-2	1. Rock Type: vesicular mafic lava pebble similar in texture to 54-1-1 2. Size: 6.5x6.5x4.5 cm 3. Shape / Angularity: Similar to 54-1-1, irregular, fluidal shape (primary? eruptive block), rope-like surface 4. Color of cut surface: dark grey interior, 2 mm brown surface crust 5. Texture / Vesicularity: Even vesicular texture throughout, sub-mm to 10 mm scale, rich in sub-rounded, not vesiculated clasts, up to 4 mm across. Some with very clear phenocrysts (1 mm scale) 6. Phenocrysts: Very pale green phenocryts, blocky mm scale - brownish 7. Matrix: Microcrystalline aphanitic 8. Secondary Minerals: NA 9. Encrustations: Very minor marine organisms 10. Comment:								
M191-55-1-3	1. Rock Type: Mafic folded ductile original form (vesicles follow margin), vesicular fragment, similar to M191-55-1-2 2. Size: 10x7x7 cm 3. Shape / Angularity: fluidal shape, subrounded form, fold-like form with rounded edges 4. Color of cut surface: dark-grey with prominent large, infilled vesicles (pale yellow to cream carbonate mud) 5. Texture / Vesicularity: Very large irregular vesicles. Rest is more finely vesicular following the clast's form. Rounded clots are mroe obviously crystalline than M191-55-1-2. Overall, richer in large green phenocrysts (olivine?). Thin section specifically to capture white, rounded, notable bleb, frothy oval 1 cm diameter. 6. Phenocrysts: Refer to 5 (Texture/Vesicularity) 7. Matrix: Same as M191-55-1-2 8. Secondary Minerals: NA 9. Encrustations: Colonised within the foam by coral and bacterial mats 10. Comment:								

M191-56-1
Area 7, North of Linosa, North flank of cone, 1000m SE of cone that has been dredged all day

Dredge on bottom UTC, hrs, °N, °E, depth m	20:07	35°55,74'N	12°49,20'E	737
Dredge off bottom UTC, hrs, °N, °E, depth m	20:48	35°55,70'N	12°49,19'E	683
total volume:		1/8 full		

volcanic (lava) plus coral, one piece of sheet lava, aphyric and dense lava

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-56-1-1	1. Rock Type: dense, mafic moderately vesicular lava rock 2. Size: 15x13x11 cm 3. Shape / Angularity: subrounded, potentially primary surface (thin brown rim), ropy-like vesicular, broken on all other surfaces making angular edges 4. Color of cut surface: dark brown 5. Texture / Vesicularity: equivesicular textures, vesicles up to 1 mm, wavy 5 mm bands which are poorly vesicular and broadly aligned to the primary surface. Other irregular patches (1 cm) which are poorly vesicular and abundant glomerocrysts up to 5 mm. 6. Phenocrysts: greenish olivine in glomerocrysts (0.5 cm) and as individual in matrix and fine plagioclase. Porphyritic. 7. Matrix: Microcrystalline 8. Secondary Minerals: NA 9. Encrustations: Minor biological encrustations 10. Comment:	X	X						

M191-56-1-2	1. Rock Type: large, curved, platy lava block. Spalled crust from extruded lava? 2. Size: 29x20x4 cm 3. Shape / Angularity: curved slab 4. Color of cut surface: dark grey 5. Texture / Vesicularity: equivesicular 1 mm scale vesicles, faint boundary in vesicles parallel to slab surface. Altered brown glass outer surface with amygdaloidal texture up to 5 mm thick. Lower surface has sub-mm brown alterations. Blebby texture, less well-developed. 6. Phenocrysts: Olivine phenocrysts? Less abundant than in sample M191-56-1-1. 7. Matrix: Microcrystalline 8. Secondary Minerals: NA 9. Encrustations: Minimal 10. Comment:	X	X						
M191-56-1-3	1. Rock Type: Spalled lava (mafic), likely broken by dredge from a rounded block surface. Very similar to M191-56-1-1. Potentially more vesicular but overall very similar. 2. Size: 15x10x6 cm 3. Shape / Angularity: See sample M191-56-1-1 4. Color of cut surface: See sample M191-56-1-1 5. Texture / Vesicularity: See sample M191-56-1-1 6. Phenocrysts: See sample M191-56-1-1 7. Matrix: See sample M191-56-1-1 8. Secondary Minerals: See sample M191-56-1-1 9. Encrustations: See sample M191-56-1-1 10. Comment: Has a 5 mm moderately vesicular rim with amygdaloidal texture with more extensively vesicular zone (2.4 cm). Blebby texture is similar to sample M191-56-1-1.	X							
M191-56-1-4	1. Rock Type: Similar spalling lava, very similar to M191-56-1-1, but has a more rounded rib-form, chilling margin wraps around 2. Size: 24x13x11 cm 3. Shape / Angularity: similar to M191-56-1-1 4. Color of cut surface: similar to M191-56-1-1 5. Texture / Vesicularity: similar to M191-56-1-1 6. Phenocrysts: similar to M191-56-1-1 7. Matrix: similar to M191-56-1-1 8. Secondary Minerals: similar to M191-56-1-1 9. Encrustations: encrustations are red coral colonising (3-7 mm) 10. Comment: Chilled rim up to 8 mm with onion skin fracturing and amygloidal texture	X	X						
M191-56-1-5	1. Rock Type fossilised horn-shaped coral with radial interior being recolonised with red coral in upper 4.5 cm 2. Size: 12x7x6 cm 3. Shape / Angularity: Flared horns with slightly distorted radial interior 4. Color of cut surface: pale interior, black dark brown outer surface 5. Texture / Vesicularity: NA 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Recolonising with red coral 10. Comment: dead, drowned coral reefs								
M191-56-1-6	1. Rock Type: Thin red coral, multi-branching 2. Size: 9 mm diameter but mostly 5 mm, varying lengths of up to 15 cm 3. Shape / Angularity: multibranching 4. Color of cut surface: bright red to pinkish red 5. Texture / Vesicularity: ribbed outer, tubular interior 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: very minor other white coral encrustation 10. Comment:								

M191-57-1
Area 7, N of Linosa. SSE slope of cone. Similar to DR54 but slightly offset to ESE to dredge steepest section

Dredge on bottom UTC, hrs, °N, °E, depth m	21:56	35°56,07'N	12°48,84'E	755
Dredge off bottom UTC, hrs, °N, °E, depth m	22:23	35°56,11'N	12°48,75'E	675
total volume:		1/8 full		

mud only

M191-59-1
Area 7 (NE part). E facing slope of NW-SE trending scarp

Dredge on bottom UTC, hrs, °N, °E, depth m	13:32	36°09,90'N	12°59,36'E	531
Dredge off bottom UTC, hrs, °N, °E, depth m	14:14	36°09,92'N	12°59,25'E	430.5
total volume:		few rocks		

carbonates, lithified

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-59-1-1	1. Rock Type: Brecciated dense limestone with younger bioclastic-micritic carbonate infill 2. Size: Original block (photo A): 40x20x17 cm, samples block: 19x13x11 cm 3. Shape / Angularity: Large angular block 4. Color of cut surface: Brecciated dense limestone - pale musty yellow Younger infill bioclastic carbonate - beige 5. Texture / Vesicularity: Angular polygonal fragments broken along plane close to continuous. Clast-supported at the base, with matrix support across the bulk of the block. Matrix infill of muddy carbonate with mm-scale fossil fragments. Sparse black fragements in the dense textureless carbonate fragments. 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: very minor. Dark 1mm outer surface orientation. Pitted. 10. Comment:								
M191-59-1-2	1. Rock Type: Coraliferous bioclastic packstone with calcareous matrix 2. Size: 14x9x8 cm 3. Shape / Angularity: Highly irregular bored form 4. Color of cut surface: Pale yellow brown, greyer brown in outer 1.5 cm surface layer of muddy bioclastic carbonate 5. Texture / Vesicularity: Amalgamated coral fragments with carbonate mud cement. Open cavities and mm-scale pits, denser surface layer of 1-5 mm scale carbonate fragments in muddy matrix. 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: Black surface, sparesly colonised 10. Comment:								
M191-59-1-3	1. Rock Type: Dense massive carbonate with sparse crytal fragments. Small irregular pebble. 2. Size: 7x5x3.5 cm 3. Shape / Angularity: Very irregular curved form, as if interior of rounded clast has eroded out 4. Color of cut surface: Pale rusty brown 5. Texture / Vesicularity: No overall fabric, but scattered crytals, black/colourless types and brownish clasts up to 3mm across 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: Very minor colonising biogenic material 10. Comment:								

M191-60-1
Area 7, NE part

Dredge on bottom UTC, hrs, °N, °E, depth m	14:49	36°10,46'N	12°58,27'E	426
Dredge off bottom UTC, hrs, °N, °E, depth m	15:19	36°10,429'N	12°58,234'E	394
total volume:	few rocks			

carbonates, lithified

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-60-1-1	1. Rock Type: Dense crabonate block containing a dark clast/fragment of volcanic material 2. Size: 12x11x6 cm 3. Shape / Angularity: Irregular top surface (undulates), smoother bottom surface - fresh surface ripped off from the sea floor. Sub-angular to subrounded as a whole 4. Color of cut surface: Cream/pale-yellow interior, dark brown/grey outer crust 5. Texture / Vesicularity: Dense-hard carbonate formed from bioclastic material. Contains a dark brown-grey clast, which on a fresh cut surface with a hand lens appears to contain a series of small <1cm scoriaceous fragments bound together by carbonate. The boundary of the clast is eroded (cuts through a scoria fragment) giving the appearance it has been weathered and transported. 6. Phenocrysts: n/a 7. Matrix: fine grained carbonate mud binding biogenic material 8. Secondary Minerals: n/a 9. Encrustations: minro coral and worm encrustations on top surface 10. Comment:	x							

M191- 62 -1
Area 7 Northeast. Small cone in the eastern group. W facing

Dredge on bottom UTC, hrs, °N, °E, depth m	14:29	36°10,29'N	12°58,42'E	430
Dredge off bottom UTC, hrs, °N, °E, depth m	14:49	36°10,35'N	12°58,46'E	385
total volume:	empty			

M191- 63 -1
Area 3. Cone at NW-SE striking fault line, W facing slope.

Dredge on bottom UTC, hrs, °N, °E, depth m	15:25	36°10,33'N	12°58,77'E	407
Dredge off bottom UTC, hrs, °N, °E, depth m	15:48	36°10,37'N	12°58,84'E	357
total volume:	one rock, x1 carbonate			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-63-1-1	1. Rock Type: Carbonate fragment, one small fresh surface (fizzes strongly with HCL acid) 2. Size: 6.5x6x4 cm 3. Shape / Angularity: Irregular, subangular to subrounded 4. Color of cut surface: Grey cream interior, very dark exterior 5. Texture / Vesicularity:Dense carbonate, contains bioclasts 6. Phenocrysts: n/a 7. Matrix: very fine matrix 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations (worms) 10. Comment:								

M191-64-1
Area 3. Cone at NW-SE striking fault line. W facing slope, c. 90m NW of

Dredge on bottom UTC, hrs, °N, °E, depth m	16:59	36°10,38'N	12°58,78'E	395
Dredge off bottom UTC, hrs, °N, °E, depth m	17:15	36°10,41'N	12°58,81'E	357
total volume:	1 rock			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-64-1-1	1. Rock Type: Carbonate block with one fresh basal surface containing a singular mafic fragment. Fragment is a dark red/brown (altered). c.3 cm, sub-angular microcrystalline -red/brown crystals (possibly altered olivine?). Clear boundary with carbonate. Carbonate within fragment - may represent infilling into the fractures or vesicles, or potentially a series of fragments cemented together. Similar to sample collected at station 60 - likely the same. Cut surface appears more like clastic fragment. 2. Size: 8x10x4.5 cm 3. Shape / Angularity: Flat bottom surface, irregular top surface - subangular to subrounded as a whole. 4. Color of cut surface: Dark brown outer surface, cream - grey 5. Texture / Vesicularity: dense biolcastic carbonate containig volcanic fragment 6. Phenocrysts: highly altered olivine(?) in fragment 7. Matrix: carbonate 8. Secondary Minerals: n/a 9. Encrustations: encrusted in red coral and worm like encrustations 10. Comment: bite at top of dredge track, suggests sample retrieved from uppermost part	x							

M191-65-1
Area 3, 100 m SSE of DR 60, base of largest dredgegraben cone in the area

Dredge on bottom UTC, hrs, °N, °E, depth m	17:57	36°10,41'N	12°58,31'E	434
Dredge off bottom UTC, hrs, °N, °E, depth m	18:13	36°10,39'N	12°58,25'E	380
total volume:		few rocks		

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-65-1-1	1. Rock Type: large carbonate block, containing abundant bioclasts 2. Size: 14x12x9 cm (see sawing block sheet for original dimensions) 3. Shape / Angularity: angular - irregular surface 4. Color of cut surface: dark grey/brown exterior, light cream-grey interior 5. Texture / Vesicularity: Contains significant number of bioclasts, e.g. shells tubules, contains borings, creating an open pitted texture 6. Phenocrysts: na 7. Matrix: very fine carbonate 8. Secondary Minerals: na 9. Encrustations: minor encrustations of shells and worms 10. Comment:								
M191-65-1-2	1. Rock Type: large carbonate block, containing abundant bioclasts 2. Size: 13x11x9 cm 3. Shape / Angularity: angular - irregular surface 4. Color of cut surface: dark grey/brown exterior, light cream-grey interior 5. Texture / Vesicularity: Contains significant number of bioclasts, e.g. shells tubules, contains borings, creating an open pitted texture 6. Phenocrysts: na 7. Matrix: very fine carbonate 8. Secondary Minerals: na 9. Encrustations: minor encrustations of shells and worms 10. Comment:								

M191-66-1				
Area 3, repeat of DR 62, station info for bridge see DR 62				
Dredge on bottom UTC, hrs, °N, °E, depth m	18:51	36°10,29'N	12°58,41'E	438
Dredge off bottom UTC, hrs, °N, °E, depth m	19:08	36°10,35'N	12°58,46'E	367
total volume:		empty		

M191-68-1				
Terribile Bank, Central part, small ?donat?-like structure, la possible				
Dredge on bottom UTC, hrs, °N, °E, depth m	09:58	37°09,05'N	12°53,30'E	48
Dredge off bottom UTC, hrs, °N, °E, depth m	10:35	37°09,05'N	12°53,29'E	48
total volume:	few rocks (limestone)			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-68-1-1 (A and B)	1. Rock Type: carbonaceous sandy deposit, strongly fizzes with 10 % HCl acid. Generally massive with some bioclasts, e.g., shelly fragments. Fragments are up to 0.5 cm in size. Sand is coarse and subrounded in shape. It is is generally clast/grain supported but this forms the matrix for the shelly clasts. 2. Size: A) 14x10x6 cm B) 10.5x8x3 cm 3. Shape / Angularity: block are rounded to subrounded, grains are subrounded in shape. Bioclasts look like spalled edges of shelly material. 4. Color of cut surface: light golden brown, beige in colour, some shelly clasts are white 5. Texture / Vesicularity: generally massive 6. Phenocrysts: na 7. Matrix: grain/clast supported coarse sand 8. Secondary Minerals: na 9. Encrustations: very minor (worm-like) 10. Comment: B has larger and more shelly fragment than A. A does have fragments but they are up to 2 mm rather than 5 mm. Also account for 5 % rather than 15%.							Interpretation: once subareal exposed carbonate island/atoll? Now buried, coarse sand - washed up? Fragments -> broken parts	
M191-68-1-2	1. Rock Type: very fine carbonaceous indurated rock. Difficult to scratch with a knife. More dense than sample M191-68-1-1. Massive deposit/rock with large cavities throughout. Monolithologic/mineralic - 100% carbonaceous fine sand/mud (lithified). 2. Size: 16x8.5x5.5 cm 3. Shape / Angularity: generally rounded in shape 4. Color of cut surface: light grey to white colour 5. Texture / Vesicularity: massive, no internal structure, some cavities due to weathering 6. Phenocrysts: na 7. Matrix: very fine, indurated different to friable to sample M191-63-1-1. 8. Secondary Minerals: na 9. Encrustations: minor/ red worm 10. Comment:								
M191-68-1-3	1. Rock Type: cherty/hard limestone, pebbles which fizz with dilute HCl acid, dense pebble (grey to dark grey), very fine texture 2. Size: A) 5x4x1 cm B) 6x5.5x2 cm 3. Shape / Angularity: round/smooth in shape, slighty elongated in one direction (flattened) 4. Color of cut surface: grey to dark grey 5. Texture / Vesicularity: A) Has some dark bands/internal texture, generally following the sample orientation. B) is more generally massive, no internal texture 6. Phenocrysts: na 7. Matrix: na 8. Secondary Minerals: na 9. Encrustations: red thin crust coating both A) and B) 10. Comment:								

M191-69-1					
Terribile bank, same cone as DR68, S-N profile					
Dredge on bottom UTC, hrs, °N, °E, depth m	11:35	37°09,14'N	12°53,32'E	47.5	
Dredge off bottom UTC, hrs, °N, °E, depth m	12:35	37°09,05'N	12°53,34'E	46.5	
total volume:		limestone?			

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GI/MIN	SED	REF	NOTES	PICTURE
M191-69-1-1	1. Rock Type: cream coloured carbonaceous rock. With open texture and calcrete, hard ground interior. Slightly altered at edges. 2. Size: 20x9x8 cm 3. Shape / Angularity: Subangular block, irregular surface 4. Color of cut surface: beige sandy colour with whiter interior. Some bioclasts white to grey. 5. Texture / Vesicularity: Open texture with hardground interior. 6. Phenocrysts: NA 7. Matrix: calcerous mud (lithified) matrix 8. Secondary Minerals: na 9. Encrustations: minor encrustations 10. Comment:								
M191-69-1-2	1. Rock Type: dark coloured carbonaceous rock. Fizz with dilute HCl acid. Clasts of pink to orange carbonaceous material as well as white to cream bioclasts. Well indurated and dense. Clasts are subangular in shape. 2. Size: 8x5x7 cm 3. Shape / Angularity: Well-rounded pebble 4. Color of cut surface: Dark grey interior, cream-grey exterior, pink-orange bioclasts 5. Texture / Vesicularity: Dense carbonate with minor pitting around the larger bioclasts. Shells and coral comprise the bioclasts. No grain size changes. 6. Phenocrysts: NA 7. Matrix: Hardground compacted, very fine dark carbonaceous mud 8. Secondary Minerals: NA 9. Encrustations: Veneer of encrustations (white) 1-2 mm thick 10. Comment: Thin section as different to other carbonates that we have seen in other M191 dredge sites	x							
M191-69-1-3	1. Rock Type: Mid-grey carbonaceaous grainstone containing abundant bioclasts mm-size angular to subrounded dark grey clasts - likely dark grey carbonate like M191-69-1-2 (fizz with dilute HCL acid). Thin section just to be sure. 2. Size: 17x9x6 cm 3. Shape / Angularity: Rounded (slightly elongated) pebble 4. Color of cut surface: Mid-grey interior - orange to white exterior 5. Texture / Vesicularity: Packstone texture? Clasts peppered in a mid-grey, fine indurated matrix 6. Phenocrysts: NA. Clasts of dark material in sample 7. Matrix: very fine indurated mid grey 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment:	x							

M191-69-1-4	1. Rock Type: open texture relatively less dense carbonate sample. Pitted texture, carbonaceous mud (very fine grained), some bioclasts, many may have weathered out and be a reason for the pits. 2. Size: 10x5.5x4.5 cm 3. Shape / Angularity: angular/irregular block 4. Color of cut surface: mid to light grey/brown. Some darker and lighter parts. 5. Texture / Vesicularity: Pitted, open texture 6. Phenocrysts: n/a 7. Matrix: fine with fine mud? 8. Secondary Minerals: n/a 9. Encrustations: very minor white 10. Comment:								
M191-69-1-5	1. Rock Type: Dark brown, dense, very fine grained carbonaceous rock. Fizzes with HCL acid, massive, no texture. Some open cavities. Two small white clasts (1-2 mm). 2. Size: 9x6x3.5 cm 3. Shape / Angularity: subrounded rock - pebble of carbonate 4. Color of cut surface: dark brown (greenish tinge) 5. Texture / Vesicularity: massive, no texture. Not a lot going on, really. 6. Phenocrysts: n/a 7. Matrix: very fine lithified brown carbonaceous mud 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations (bobbly texture, like texture). 10. Comment:								
M191-69-1-6	1. Rock Type: thin, flat sample of orange carbonaceous rock. Internal structure, undulating surface. 2. Size: 8x7.5x 2 cm 3. Shape / Angularity: flat, rounded pebble 4. Color of cut surface: orange to light brown carbonate. Whiter upper half of cut surface (see sketch for which is upper surface). 5. Texture / Vesicularity: hardground upper part, more grain/clast-supported lower part (see sketch in rock description). 6. Phenocrysts: n/a 7. Matrix: calcrete (upper part) and more open texture (lower) - see sketch 8. Secondary Minerals: n/a 9. Encrustations: red colour of thin veneer of encrustations 10. Comment:							See sketch in rock description sheet	
M191-69-1-7	1. Rock Type: Coralline algae, very bobbly agglomerate texture. Branching nodules (stuck together?). 2. Size: 5.5x3.5x2.5 cm 3. Shape / Angularity: subrounded with rounded bobbly texture 4. Color of cut surface: light grey to brown in colour 5. Texture / Vesicularity: bobbly, irregular texture 6. Phenocrysts: n/a 7. Matrix: fine grained light grey to brown mud 8. Secondary Minerals: n/a 9. Encrustations: no encrustastions - possibly very small worms...but tiny (mm scale) 10. Comment:								

M191-70 -1
East of Bank Terribile. Pochmark of SW edge of basin between the two prominent hills

Dredge on bottom UTC, hrs, °N, °E, depth m	14:52	37°10,60'N	12°49,41'E	114
Dredge off bottom UTC, hrs, °N, °E, depth m	15:37	37°10,60'N	12°49,39'E	110
total volume:		few rocks		

one large white carbonate block, very dense; and several rounded

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-70-1-1	1. Rock Type: Loosely bound clastic green rock, does not fizz with HCL acid, contains darker and lighter denser clasts <6 mm, strong sulphur smell. 2. Size: 12x8x6 cm 3. Shape / Angularity: rounded and tumbled appearance 4. Color of cut surface: greyish green - hyrothermal alteration? 5. Texture / Vesicularity: very weak (crumbly), contains clastic (?) fragments with a very soft mud (?) - no clear fabric 6. Phenocrysts: n/a 7. Matrix: As above 8. Secondary Minerals: n/a 9. Encrustations: None 10. Comment: would be good to thin section but too crumbly to do here	later date							
M191-70-1-2	1. Rock Type: grey (slightly blue - green but not as much as M191-70-1-1), weakly bound clastic rock containing highly spherical clasts. 2. Size: 6x5x4 cm 3. Shape / Angularity: rounded smooth surface, tumbled appearance. 4. Color of cut surface: Grey - green/blue hue 5. Texture / Vesicularity: crumbly, contains spherical clasts (darker on the outside and hollow white interior) mm-scale, potential darker tabular fragments on mm-scale - crystals?? No fabric 6. Phenocrysts: n/a (?) 7. Matrix: very fine mud (?) 8. Secondary Minerals: n/a 9. Encrustations: none 10. Comment: Thin section later - strong sulphur smell	later date							
M191-70-1-3	1. Rock Type: loosely bound clastic green to grey rock, no fizzing. Larger paler irregular mottled patches less than or equal 3 mm with inner frothy texture and samller darker fragments - very irregular in shape. 2. Size: 9x6x4.5 cm 3. Shape / Angularity: very rounded surface - tumbled appearance. 4. Color of cut surface: grey - green 5. Texture / Vesicularity: crumbly, weakly consolidated containing fragments descirbed above. 6. Phenocrysts: n/a 7. Matrix: altered mud (?) 8. Secondary Minerals: n/a 9. Encrustations: none 10. Comment: strong sulphur smell, thin section later	later date							
M191-70-1-4	1. Rock Type: green-grey, very rounded, weakly consolidated rock, very similar to sample M191-70-1-3 (see description) 2. Size: 10x6x4.5 cm 3. Shape / Angularity: See M191-1-3 4. Color of cut surface: See M191-1-3 5. Texture / Vesicularity: See M191-1-3 6. Phenocrysts: See M191-1-3 7. Matrix: See M191-1-3 8. Secondary Minerals: See M191-1-3 9. Encrustations: See M191-1-3 10. Comment: Same as M191-70-1-3, differences are: higher proportion of light yellowy fragments, mm-scale, irregular shape - 10% of sample.	later date							

M191-70-1-5	1. Rock Type: Same as M191-70-1-3 and M191-70-1-4 2. Size: 9x7x5 cm 3. Shape / Angularity: Same as M191-70-1-3 and M191-70-1-4 4. Color of cut surface: Same as M191-70-1-3 and M191-70-1-4 5. Texture / Vesicularity: Same as M191-70-1-3 and M191-70-1-4 6. Phenocrysts: Same as M191-70-1-3 and M191-70-1-4 7. Matrix: Same as M191-70-1-3 and M191-70-1-4 8. Secondary Minerals: Same as M191-70-1-3 and M191-70-1-4 9. Encrustations: Same as M191-70-1-3 and M191-70-1-4 10. Comment: Differences: 1) larger number of darker fragments - some have highly tabular form 2) lighter, yellower fragments. Some (not all) also display a more tabular form								
M191-70-1-6	1. Rock Type: Very pale - white, dense, monomineralic, contains laths of spar (?), darker beige veining, crystalline, saccharoidal (sugary)texture 2. Size: 27x22x17 cm = original block; current block = 19x15x17 3. Shape / Angularity: subangular to subrounded 4. Color of cut surface: very pale white 5. Texture / Vesicularity: Sugary texture with a <2 cm laths (spar) 6. Phenocrysts: laths of spar 7. Matrix: generally fine-grained - crystalline 8. Secondary Minerals: NA 9. Encrustations: Thin coating, pitted texture, minor tubules 10. Comment: Fizzes with acid								
M191-71-1									
West park of Terribile Bank. 100 m away from Dredge 70									
Dredge on bottom UTC, hrs, °N, °E, depth m		16:04	37°10,62'N	12°49,25'E	89				
Dredge off bottom UTC, hrs, °N, °E, depth m		16:22	37°10,58'N	12°49,23'E	79				
total volume:			1/5 full						
full of rhodolith gravel (all carbonate) with a few shells									
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-71-1-1	1. Rock Type: (Marl) Rhodolith gravel, some with red surface. Other are white. 2. Size: c.20 fragments, 2-4 cm across 3. Shape / Angularity: highly irregular shape: bobbly and rounded surface texture 4. Color of cut surface: white interior 5. Texture / Vesicularity: Pelletal/accreted texture forming amalgamations of rounded forms 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: red surface on some clasts. Thin (less than 1 mm) white surface crust on all clasts. 10. Comment:								
M191-72 -1									
Terribile bank, west portion. Seamount in the centre of the graben									
Dredge on bottom UTC, hrs, °N, °E, depth m		17:01	37°10,53'N	12°49,95'E	139				
Dredge off bottom UTC, hrs, °N, °E, depth m		17:33	37°10,51'N	12°49,95'E	127				
total volume:			a rock						
a carbonate									

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-72-1-1	1. Rock Type: Carbonate - hard brown to grey rock with bobbly, pitted exterior, calcareous mud in cavities. Dense specimen. 2. Size: 12x9x6 cm 3. Shape / Angularity: subrounded to subangular 4. Color of cut surface: brown to grey (very few black/white patches) 5. Texture / Vesicularity: hardground, massive carbonate. Some bioclasts. 7. Matrix: calcareous hardground with some calcaerous mud 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations (exterior). Is very pitted. Some worm (white) encrustations. 10. Comment:								

M191-73-1
Terribile bank, west are. Anther pochmark, ENE of dredge 71 from base to NE top

Dredge on bottom UTC, hrs, °N, °E, depth m	18:24	37°10,63'N	12°49,52'E	113
Dredge off bottom UTC, hrs, °N, °E, depth m	18:49	37°10,67'N	12°49,57'E	103
total volume:	1/4 full + 2 large blocks			

very large number of dense blocks: angular to subrounded, mostly

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-73-1-1	1. Rock Type: Porphyritic mafic igneous rock, moderately altered 2. Size: 10x8x5 cm 3. Shape / Angularity: angular block, planar fractrured surfaces 4. Color of cut surface: dark grey, with extensive rusty brown phenocrysts and white plag laths 5. Texture / Vesicularity: dense, with sparse large vesicles up to 5 mm diameter. Plag. laths have broadely consistent orientation. 6. Phenocrysts: Abundant 20-30% brown phase - blocky, some euhedral, altered? pyroxene, less frequent mid-green phase, abundant approximately 10%. White, plag. laths, 2mm max. 7. Matrix: Microcrystalline 8. Secondary Minerals: Need to include in thin section 9. Encrustations: Extensive encrusted crust. 10. Comment:	X	X						
M191-73-1-2	1. Rock Type: Very similar to M191-73-1-1 (slightly redder in tone, maybe a little more altered) 2. Size: 15x10x7 cm 3. Shape / Angularity: subangular block with irregular, broken surfaces 4. Color of cut surface: dark, reddish-grey 5. Texture / Vesicularity: As above (M191-73-1-1) - green phase in here more obviously a secondary infill included in 1-2 mm sparse vesicles - at least in places, elsewhere a replacement texture 6. Phenocrysts: As in M191-73-1-1. Brown phenocrysts with dark rim developed in places. 7. Matrix: Dark, grey microcrystalline with plag. laths and patchy reddish brown altered products. 8. Secondary Minerals: Need ID in thin section 9. Encrustations: Extensive white biological crust. less than 1 mm on all block surfaces 10. Comment:	X	X						

M191-73-1-3	1. Rock Type: Pinkish brown, porphyritic rock, similar texturally to M191-73-1-1 and M191-73-1-2. More pervasive alteration. 2. Size: Very large original block (A in photo) - 32x27x29 cm; smaller block: 13x12x8 cm 3. Shape / Angularity: Angular with planar surfaces, reminiscent of large, polygnal jointed block, but the rest is now soft and degraded, suggesting breakage from an earlier pre-altered stage 4. Color of cut surface: Pinkish brown 5. Texture / Vesicularity: Porphyritic, no directional fabric; sparse but very large vesicles (up to 2 mm), ooid-like, some with darker grey 0.5 mm rim. 6. Phenocrysts: Abundant (20%) equant to elongate euhedral brown phase, not all are altered as in M191-73-1-1 and M191-73-1-2 - colour veins from black with brown rim to dark brown to rusty brown. Boobly green clusters, yellow/green - skeletal, full replacement of primary mineral (less than 5%). Plag. laths less prominent due to colour but still abundant (10%) 7. Matrix: As above but reddish-brown microcrystalline 8. Secondary Minerals: As above 9. Encrustations: Patchy white carbonate crust 10. Comment:	X	X						
M191-73-1-4	1. Rock Type: Very similar to M191-73-1-3 2. Size: Very large block (B in photos) - 33x28x20 cm original; sampled block 16x12x11 cm 3. Shape / Angularity: As with M191-73-1-3, planar surfaces and polygonal form. 4. Color of cut surface: Pinkish brown 5. Texture / Vesicularity: Broken surface has uneven bobbly surface manifested on cut face as subangular flaky texture on 1 cm scale, associated with pervasive microfracturing through rock with no preferred orientation. 6. Phenocrysts: Very similar to M191-73-1-3 - dark/brown phase has well developed elongate tabular forms in places (altered pyroxene); green phase (entirely altered olivine?) is more frequent, approximately 5%. 7. Matrix: Plag. laths remain abundant, prominent in finely crystalline groundmass (crystals after the two mafic phases) 8. Secondary Minerals: Brown assemblage replacing pyroxene: green? serpentinised/chloritised olivine, plag. also likely altered, white coloured 9. Encrustations: Colonised on all surfaces, serpulids 10. Comment:	X	X						

M191-73-1-5	1. Rock Type: Reddish brown porphyry, like a more pervasively altered version of 4, very highly altered 2. Size: 12x10x9cm 3. Shape / Angularity: sub angular and irregular block, extensive microfracturing and alteration to soft minerals along margins gives a pseudo-clastic texture on broken surface 4. Color of cut surface: red to brown 5. Texture / Vesicularity: Sparse tubular vesicles, 5mm to 1 cm long, many phenocrysts? the green phase entirely lost leaving cavities. 6. Phenocrysts: Porphyritic texture. Similar mineral proportions to 4. Brown phase has dull brown interior and black rim. Green phase variably replaced, entirely lost in patches and in other patches pseudomorphed by red microcrystalline replacement (with dark oxides) 7. Matrix: Finely crystalline groundmass, abundant plag laths and brown altered mafic minerals 8. Secondary Minerals: See above 9. Encrustations: Extensive serpulid and bryozoan encrustation 10. Comment:	X	X						
M191-73-1-6	1. Rock Type: Purplish brown porphyry, highly altered, texturally similar to all the above but slightly less abundant phenocryts and finer groundmass with ?less plag 2. Size: 12x11x9cm 3. Shape / Angularity: subangular with fractured surfaces 4. Color of cut surface: purplish brown 5. Texture / Vesicularity: dense, sparse cavities from phenocryst degradation 6. Phenocrysts: similar phases to above. Brown phase (px?) shows some well developed euhedral forms, rusty brown with dark rim in places, 15%. Green phase infrequent, approx 2%. 7. Matrix: Fine, 0.5 mm plag laths abundant in groundmass, set within dark microcrystalline matrix 8. Secondary Minerals: Need identification in thin section 9. Encrustations: As above, serpulid dominated 10. Comment:	X	X						
M191-73-1-7	1. Rock Type: Similar to 3, pinkish brown porphyry, highly altered. 2. Size: 13x7.5x6cm 3. Shape / Angularity: Subangular with planar fracture surfaces 4. Color of cut surface: pinkish brown 5. Texture / Vesicularity: dense 6. Phenocrysts:brown phenocrysts pick out poorly developed alignment. Similar to 3, green phase approx 5%, highly altered, subhedral clusters 7. Matrix: plag laths up to 1mm long 8. Secondary Minerals: Need id, same as in 3 and 4 9. Encrustations: Minor serpulids encrustation 10. Comment:	X							
M191-73-1-8	1. Rock Type: Very similar to 7 2. Size: 9x8x5.5cm 3. Shape / Angularity: Subrounded block 4. Color of cut surface: Pinkish brown 5. Texture / Vesicularity: Dense, aligned fabric moderately developed and defined by elongate crystals of brown phenocrxsts, ?px 6. Phenocrysts:same as 7 7. Matrix: same as 7 8. Secondary Minerals: same as 7 9. Encrustations: minor serpulid encrustation 10. Comment:	X							

M191-73-1-9	1. Rock Type: Vesicular, deep purple brown porphyritic rock 2. Size: 6x4x3.5cm 3. Shape / Angularity: Subangular block, broken across vesicular surfaces 4. Color of cut surface: Purplish brown, dark 5. Texture / Vesicularity: Scattered coarse vesicles, elongate and slightly irregular, up to 6mm length. 6. Phenocrysts: Similar to 6 but slightly less altered. Extensive green to brown phase. Equant-blocky ?altered olivine. Seems distinctive from other samples in preserving more of crystal interior and fewer elongate crystals. 7. Matrix: Plag up to 2mm in length, less abundant, less than 5%, than in other samples. 8. Secondary Minerals: Need id. 9. Encrustations: Patchy surface crust, white carbonate 10. Comment:	X							
M191-73-1-10	1. Rock Type: Extremely altered granular round clast preserving a crystal texture. Greenish grey interior with 1cm rusty brown alteration rim. Similar in colour and texture to the soft blocks at site 70, but those were even more altered. The rocks across sites 70 and 73 may all be derived from a similar protolith but represent gradations of alteration. 2. Size: 10x8x5cm 3. Shape / Angularity: Rounded slightly elongate, following internal fabric 4. Color of cut surface: Greenish grey interior, 0.3-1.2cm rusty brown alteration rim. 5. Texture / Vesicularity: Dense but with a granular fabric due to softness and loss of matrix. May be relict large vesicles up to 8mm, in centre of clast, slightly developed planar fabric running through clast, may reflect an original crystal texture. 6. Phenocrysts: Hard to determine if a prophyritic texture, but dark green crystals are frequent, and a paler green phase, likely replacement minerals. 7. Matrix: Fine, sugary and slightly open textured grey matrix taking on the fabric of the rock 8. Secondary Minerals: May see entirely secondary minerals, need id. 9. Encrustations: Very minor serpulid encrustation on outer surface. 10. Comment:	X							

M191-75-1
Nameless Bank, NE facing, middle part

Dredge on bottom UTC, hrs, °N, °E, depth m	12:19	36°51,89'N	13°06,54'E	495
Dredge off bottom UTC, hrs, °N, °E, depth m	13:35	36°51,85'N	13°06,52'E	430
total volume:	Few rocks			

Two small dense carbonate fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-75-1-1	1. Rock Type: Hard very dense limestone,white to grey to pale grey with infill of micritic mud, vein like texture 2. Size: 10.5x7x4.5cm 3. Shape / Angularity: soubrounded to subangular 4. Color of cut surface: Brown to organe exterior, white to light grey interior with dark brownish veining 5. Texture / Vesicularity: Massive with some veining 6. Phenocrysts: n/a 7. Matrix: Cement, well indurated hardground 8. Secondary Minerals: n/a 9. Encrustations: minor encrustations 10. Comment: Branching hard coral also found alongside the rocks, with encrusted specimens, see sample 2.							Similar location to dredge 49, plus similar recovery	

M191-75-1-2	1. Rock Type: Indurated hard fossilised branching coral. Internal structures of branches can be seen 2. Size: 6.5x3x1.5cm 3. Shape / Angularity: Branching stick shaped coral 4. Color of cut surface: light brown to orange 5. Texture / Vesicularity: Coral, internal spoked structure 6. Phenocrysts: n/a 7. Matrix: hard carbonate replacement 8. Secondary Minerals: n/a 9. Encrustations: minor 10. Comment:								

M191-76-1
Nameless Bank, central part of NE facing slope. Scarp in the lower part of the slope.

Dredge on bottom UTC, hrs, °N, °E, depth m	14:16	36°51,73'N	13°07,34'E	655
Dredge off bottom UTC, hrs, °N, °E, depth m	14:34	36°51,68'N	13°07,32'E	592
total volume:	One eighth full			

Very large oysters

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-76-1-1	1. Rock Type: Dense bioclastic carbonate. 2. Size: 14x8x3cm 3. Shape / Angularity: Flat elongated shape, subangular irregular surface, no fresh surfaces 4. Color of cut surface: Dark beige interior, bark brown to black exterior 5. Texture / Vesicularity: Dense carbonate, minor cavities around edges, pitted exterior 6. Phenocrysts: N/a 7. Matrix: carbonate mud 8. Secondary Minerals: n/a 9. Encrustations: mm scale crust all over, worm and coral encrustation 10. Comment:								
M191-76-1-2	1. Rock Type: Various corals, inc. Branching coral, rugosa, and oyster like shells 2. Size: Various 3. Shape / Angularity: Life forms 4. Color of cut surface: n/a 5. Texture / Vesicularity: organic structures 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: minor 10. Comment:								

M191-78-1
Terribile Bank. Central portion of bank, small step in N facing flank

Dredge on bottom UTC, hrs, °N, °E, depth m	18:04	37°08,53'N	12°51,61'E	50
Dredge off bottom UTC, hrs, °N, °E, depth m	18:38	37°08,53'N	12°51,61'E	45
total volume:	One eighth full			

Carbonate fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-78-1-1	1. Rock Type: Dense carbonate, massive, 2. Size: 6.5x5.5x.3.5cm 3. Shape / Angularity: Rounded encrusted pebble, no fresh surfaces 4. Color of cut surface: Light cream to beige 5. Texture / Vesicularity: Massive, some pits on both interior and exterior 6. Phenocrysts: N/A 7. Matrix: carbonate mud, hardground 8. Secondary Minerals: n/a 9. Encrustations: Thin mm encrusting layer and minor biogenic encrustations 10. Comment:								

M191-78-1-2	1. Rock Type: Pitted mid grey carbonate 2. Size: 5.5x4.5x3 3. Shape / Angularity: Subrounded irregular surface 4. Color of cut surface: Mid grey interior, white crust 5. Texture / Vesicularity:Massive with abundant pitting 6. Phenocrysts: n/a 7. Matrix: carbonate mud, calcrete 8. Secondary Minerals: n/a 9. Encrustations: crust, thick, white 10. Comment:								
M191-78-1-3	1. Rock Type: 6 x rhodoliths 2. Size: Max 5.5x4x1.5, min 3x2.5xs1.5cm 3. Shape / Angularity: Bobbly uneven irregular surface and shape 4. Color of cut surface: Various colours, ranging from white to mid grey, purple and speckled 5. Texture / Vesicularity: n/a 6. Phenocrysts: n/a 7. Matrix: n/a 8. Secondary Minerals: n/a 9. Encrustations: 10. Comment:								

M191-79-1
Terribile Bank, N facing slope of step in central portion of bank

Dredge on bottom UTC, hrs, °N, °E, depth m	19:27	37°08,87'N	12°52,06'E	48
Dredge off bottom UTC, hrs, °N, °E, depth m	19:59	37°08,82'N	12°52,06'E	43.5
total volume:	Few carbonate pebbles			

Carbonate pebbles. Large fishing net attached to dredge

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-79-1-1	1. Rock Type: Dense bioclastic carbonate pebble 2. Size: 9x5x3.5cm 3. Shape / Angularity: subangular to subrounded 4. Color of cut surface: beige 5. Texture / Vesicularity: bioclastic, very dense, minor fine pitting 6. Phenocrysts: n/a 7. Matrix: carbonate mud 8. Secondary Minerals: n/a 9. Encrustations: less than 2mm white crust all over, purple patchy encrustations, some biogenic encrustation 10. Comment:								
M191-79-1-2	1. Rock Type: Dense mottled dark grey and cream carbonate pebble 2. Size: 8x6x3.5cm 3. Shape / Angularity: subangular to subrounded 4. Color of cut surface: mottled, dark grey and cream interior 5. Texture / Vesicularity: Bioclastic, large mm scale pitting throughout, concentrated at edges 6. Phenocrysts: N/A 7. Matrix: Carbonate mud 8. Secondary Minerals: n/a 9. Encrustations: Thin mm scale encrusting all over, purple and white 10. Comment:								

M191-79-1-3	1. Rock Type: Concentric layered cream carbonate pebble 2. Size: 9x6.5x4cm 3. Shape / Angularity: flattened, subrounded 4. Color of cut surface: beige in centre, white to cream rim, less than 1cm thick 5. Texture / Vesicularity: centre is a dense beige carbonate, pitted, lightly bioclastic, coated in concentric layers of white encrustation 6. Phenocrysts: n/a 7. Matrix: carbonate 8. Secondary Minerals: n/a 9. Encrustations: completely encrusted, as above 10. Comment:								
M191-79-1-4	1. Rock Type: Concentric carbonate pebble, dark grey in centre. 2. Size: 8.5x6.5x5.5cm 3. Shape / Angularity: Description as above, except centre is dark grey 4. Color of cut surface: as above 5. Texture / Vesicularity: as above 6. Phenocrysts: n/a 7. Matrix: as above 8. Secondary Minerals: n/a 9. Encrustations: encrustation is less than 1cm. 10. Comment:								

M191-81-1
Nameless Bank. SW part of the bank, NE-SW elongated ridge structure

Dredge on bottom UTC, hrs, °N, °E, depth m	12:24	36°49,30'N	13°03,35'E	105
Dredge off bottom UTC, hrs, °N, °E, depth m	13:10	36°49,32'N	13°03,31'E	98
total volume:	5-10%			

Carbonate fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-81-1-1	1. Rock Type: Carbonate rock, hardground, borings, open texture, bioclasts 2. Size: 15x9x7cm 3. Shape / Angularity: subrounded, slightly elongated 4. Color of cut surface: Exterior is a light brown, interior is a light brown with white/black bioclasts 5. Texture / Vesicularity: Hardground with cavities and pits, particularly around edges 6. Phenocrysts: n/a 7. Matrix: hardground with bioclasts 8. Secondary Minerals: n/a 9. Encrustations: minore red and white, thin patches 10. Comment:								
M191-81-1-2	1. Rock Type: Carbonate rock, white open texture, with more abundant cavities, borings than rock 1. The interior comprised of lithified white to grey mud, easily scratched. 2. Size: 9x6.5x2.5cm 3. Shape / Angularity: Subangular irregular shape 4. Color of cut surface: White exterior with grey mud infilling pits and borings 5. Texture / Vesicularity: Open grainy texture 6. Phenocrysts: N/a 7. Matrix: fine grained mud 8. Secondary Minerals: n/a 9. Encrustations: thin layer of encrustations covering entire clast, white bioclasts, some worms 10. Comment:								

M191-82-1
Nameless Bank, SW part summit area.

Dredge on bottom UTC, hrs, °N, °E, depth m	13:42	36°49,37'N	13°03,39'E	109
Dredge off bottom UTC, hrs, °N, °E, depth m	14:11	36°49,33'N	13°03,34'E	99
total volume:	One ninth full			

Carbonates

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-82-1-1	1. Rock Type: Open textured carbonate pebble 2. Size: 9x5x4.5cm 3. Shape / Angularity: Irregular surface, subangular to subrounded 4. Color of cut surface: White to cream 5. Texture / Vesicularity: Lots of cavities, pitting, creating an open texture, minor bioclasts 6. Phenocrysts: n/a 7. Matrix: carbonate 8. Secondary Minerals: n/a 9. Encrustations: encrusted in biogenic material 10. Comment:								

M191-83-1
Nameless bank, plateau edge in NW cone of survey area

Dredge on bottom UTC, hrs, °N, °E, depth m	15:06	36°52,14'N	13°05,18'E	280
Dredge off bottom UTC, hrs, °N, °E, depth m	16:00	36°52,12'N	13°05,16'E	251
total volume:	1/8 full			

good recovery of volcanic material

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-83-1-1	1. Rock Type: Bulk of rock is dark grey, highly irregular, pitted clast with patchy infill, at the boundaries are small fragments. Some material bound in a brown matrix, fine grained volcanic pyroclast? Possible pyroclasts at margins? Altered appearance. 2. Size: 10x8x3.5cm 3. Shape / Angularity: Highly angular, flattened 4. Color of cut surface: Dark brownish-purple grey 5. Texture / Vesicularity: Sparsely vesicular, ielongate infilled vesicles 6. Phenocrysts: Sparse balck crystals and greenish to brown altered crystals 7. Matrix: Very fine crystalline matrix 8. Secondary Minerals: Appears altered 9. Encrustations: Extensive encrustations in bioclasts and lithified muddy carbonate 10. Comment:	x						See sketch	
M191-83-1-2	1. Rock Type: Mid to dark grey, dense porphyry, altered. 2. Size: 7x4x2cm 3. Shape / Angularity: Angular, irregular, slightly flattened 4. Color of cut surface: Mid dark grey 5. Texture / Vesicularity: Porphyritic dense, potentially sparse infilled vesicles 6. Phenocrysts: Abudnant brown phase, eihedral clasts on a sub mm scale. Less frequent black euhedral phase, coarser. 7. Matrix: Microcrystalline 8. Secondary Minerals: Altered 9. Encrustations: Encrusted on all surfaces, thin 10. Comment:	x							
M191-83-1-3	1. Rock Type: Altered vesicular volcanic clast with carbonate infill. 2. Size: 7x4.5x3.5 3. Shape / Angularity: Very irregular shape, angular, slightly flattened 4. Color of cut surface: Centre purplish dark grey 5. Texture / Vesicularity: Microfractured, slightly vesicular texture, really dense parts in patches (dark grey), in other patches towards centre, large infilled vesicles and amygdaloidal 6. Phenocrysts: Potential sparse red brown altered 7. Matrix: Very finely crystalline 8. Secondary Minerals: Altered 9. Encrustations: Completely encrusted on all surfaces, worms and carbonate mud 10. Comment:	x							

M191-83-1-4	1. Rock Type: Two parts, A and B. Hyaloclastite texture, granular dark fragments which are angular to subrounded within an orange matrix, but note no glassy rims. Crumbly to fragile. 2. Size: A: 3.5x4x2.5cm, B: 5x3.5x1.5cm 3. Shape / Angularity: Irregular slightly flattened rough granular surface texture 4. Color of cut surface: Mid to dark grey 5. Texture / Vesicularity: Fragments of the same type, fragmental texture grading from one end of the clast to the other, with more interstitial matrix. 6. Phenocrysts: Not visible 7. Matrix: Orange fine grained altered material, sedimnt? or ash? 8. Secondary Minerals: Altererd 9. Encrustations: Minor worms 10. Comment: B is slightly redder in colour	x (A)							
M191-83-1-5	1. Rock Type: A and B. Dense magmatic block, flattened, fused with carbonaceous material. Smaller angular fragments of magmatic material within carbonate. 2. Size: A:12x7x4cm, B:6.5x4x2.5cm 3. Shape / Angularity: Flattened, angular, irregular surface 4. Color of cut surface: Lower section dark red brown, upper (carbonate) light yellow cream 5. Texture / Vesicularity: Lower (magmatic) part, dense, contains clasts or crystals, sparse potential vesicles, infilled, at points fragmental, particularly at the margin. Part of B has much higher proportion of vesicles, which have been infilled. Upper half of samples is a massive carbonate with some bioclasts, containing less than 4mm angular to subangular fragments of the lower (magmatic)material. 6. Phenocrysts: Not visible 7. Matrix: Microcrystalline gm; carbonate 8. Secondary Minerals: altered 9. Encrustations: minor, worms in carbonate mud 10. Comment:	x (A)						See sketch	no pics
M191-83-1-6	1. Rock Type: Similar in description to 5, but not with the lithified carbonate part. Highly fragmented, gives a clastic appearance. 2. Size: 4.5x4x2.5cm 3. Shape / Angularity: Subrounded to subangular, flattened 4. Color of cut surface: Red dark brown to pink, matrix is white grey 5. Texture / Vesicularity: Lowermost part same as lower in 5. There is a zone of whiter, fine grained fragmented material with many small red fragments. 6. Phenocrysts: As in sample 5 7. Matrix: Fine grained suspending larger fragments 8. Secondary Minerals: altered and secondary infilling with carbonate 9. Encrustations: Moderately worm encrusted 10. Comment:								

M191-83-1-7	1. Rock Type: A and B. See sample 5 lower half description. No attached lithified carbonate. 2. Size: A:9x8.5x2.5, B:8.5x6.5x1cm 3. Shape / Angularity: Flattened 4. Color of cut surface: same as 5 5. Texture / Vesicularity: same as 5 6. Phenocrysts: same as 5 7. Matrix: same as 5 8. Secondary Minerals: same as 5 9. Encrustations: same as 5 10. Comment: Differences from 5 are dark grey black middle zone and no attached carbonate. Hard to tell but possibly fragmental texture. B has a large fracture filled with crystalline carbonate.								
M191-83-1-8	1. Rock Type: See sample 5 (but without lithified carbonate) 2. Size: 4 fragments - A:6.5x4.5x3, B:7x4x2.5, C:11x8.5x1.5, D:6x5x2cm 3. Shape / Angularity: see 5 4. Color of cut surface: see 5 5. Texture / Vesicularity: see 5 6. Phenocrysts: see 5 7. Matrix: see 5 8. Secondary Minerals: see 5 9. Encrustations: see 5 10. Comment: Differences from 5 are that A has a vein with small black clasts, B is more abundant in black green clasts/crstals, black zone in lower half, C has 6mm thick carbonate band/vein, lots of smaller veins, D has 1mm vein of carbonate surrounded by black clasts.	x(A)							
M191-83-1-9	1. Rock Type: 3 bivalve fossils with attached lithified carbonate infilling concave part of shell, forming a rounded flattened pebble. 2. Size: A:8.5x6x2.5cm B:8.5x6.5x2.5, C:11.5x4.5x2cm 3. Shape / Angularity: Shell shape on one half, smooth top surfaces, rounded 4. Color of cut surface: Beige, darker exterior 5. Texture / Vesicularity: Massive with varying proportion of bioclasts in carbonate 6. Phenocrysts: NA 7. Matrix: Carbonate mud 8. Secondary Minerals: NA 9. Encrustations:Minor encrustationa and worms 10. Comment:								

M191-83-1-10	1. Rock Type: Hardground sparite carbonate. 2. Size: A:8.5x3.5x2cm, B:6x5.5x2cm, C:6x4x3cm 3. Shape / Angularity: Angular, irregular, elongated 4. Color of cut surface: White, light grey to cream 5. Texture / Vesicularity: Massive 6. Phenocrysts: NA 7. Matrix: Calcrete 8. Secondary Minerals: NA 9. Encrustations: Heavily biogenically encrusted, shells, worms, corals 10. Comment: Calcrete concentric exterior, internal soft carbonate mud								
M191-83-1-11	1. Rock Type: Singular shell or possible coral, with undulated fan like shape 2. Size: 14x13.5x0.6cm 3. Shape / Angularity: Fan like 4. Color of cut surface: Mid brown to cream 5. Texture / Vesicularity: Undulated surface 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Minor 10. Comment:								
M191-83-1-12	1. Rock Type: Fresh dense dark grey lava containing crystals. 2. Size: 4x4x1cm 3. Shape / Angularity: Flattened, subrounded. Undulating wavy surface 4. Color of cut surface: Dark grey, uniform 5. Texture / Vesicularity: Glassy surface, minor proportion of vesicles concentrated towards margins 6. Phenocrysts: Subhjedral mm scale fsp, large black subhedral crystals, altered, and possible altered olivine, smaller sub-mm 7. Matrix: Microcrystalline gm 8. Secondary Minerals: NA 9. Encrustations: Minor worm encrustations 10. Comment: No fresh fractured surface, pebble	x						Freshest lava fragment, small piece, found in remaining sampled material after initial sorting	

M191-84-1
Nameless bank , across edge of plateau of NW cone of survey area.
Exact repeat of M191-83-1

Dredge on bottom UTC, hrs, °N, °E, depth m	16:48	36°52,15'N	13°05,17'E	283
Dredge off bottom UTC, hrs, °N, °E, depth m	17:42	36°52,11'N	13°05,15'E	237
total volume:	mud and rocks			
Large volume of fragments embedded in mud. Mostly flattened				

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-84-1-1	1. Rock Type: Dense grey porphyritic lava block 2. Size: 12x9x3.5cm 3. Shape / Angularity: Angular, irregular, broken planes, flat form 4. Color of cut surface: Dark grey 5. Texture / Vesicularity: Porphyritic approx 10% crystals 6. Phenocrysts: Ol? as brown altered material, most abundant phase, also black euhedral phase, px? 7. Matrix: Microcrystalline 8. Secondary Minerals: Altered (ol). Carbonate filled fractures throughout 9. Encrustations: Minor crust 10. Comment:	x	x						

M191-84-1-2	1. Rock Type: Two small clasts of dense volcanic rock similar to 1 2. Size: A:5x3x2cm, B:5.5x3.5x3.5cm 3. Shape / Angularity: angular 4. Color of cut surface: dark grey 5. Texture / Vesicularity: as in 1 6. Phenocrysts: as in 1 7. Matrix: as in 1 8. Secondary Minerals: as in 1 9. Encrustations: Carbonate crust in some places, other fresh fractures. 1 and 2 may all be from the same fragment 10. Comment:	x							
M191-84-1-3	1. Rock Type: Flattened red fine grained and irregular lithology, two fragments. Encased in yellow shelly carbonate, lithified. 2. Size: 9x6x4.5 3. Shape / Angularity: Highly irregular form with subrounded edges 4. Color of cut surface: Dep red, and yellow carbonate 5. Texture / Vesicularity: red material is massive, flattened, fractured along plane, with secondary carbonate veining. Patchy pseudoclastic internal fabric with extensive jigsaw microveining, small fragments, some rounded-eroded, embedded in adjacent carbonate, which contains bivalve fossil fragments 6. Phenocrysts: not visible 7. Matrix: See above description 8. Secondary Minerals: altered appearance 9. Encrustations: Minore serpulids 10. Comment:	x							
M191-84-1-4	1. Rock Type: Red clast. Granular internal fabric. Could be highly altered bound volcanic clasts. Graded grey to red across clast. 2. Size: 4x3.5x2.5cm 3. Shape / Angularity: Irregular shape, subangular edges. 4. Color of cut surface: Deep red grading into dark grey 5. Texture / Vesicularity: Hints of clastic/fragmented texture with vein infill between. Rouded infilled cavities and infrequent euhedral crystal fragments, black and green. 6. Phenocrysts: May not be phenocrysts, but crystal fragments present 7. Matrix: Very fine grained 8. Secondary Minerals: Extremely altered volcanic clasts, e.g. peperitic fabric? 9. Encrustations: very minor carbonates on surface 10. Comment:								
M191-84-1-5	1. Rock Type: Flattened and irergular red clasts x 3, A to C 2. Size: A:7x5x2cm, B:8x5x1.5cm, C:7x4.5x2cm 3. Shape / Angularity: Flattened irregular surfaces with sub rounded perimeter 4. Color of cut surface: Deep purplish red (A) to brick red (B and C) 5. Texture / Vesicularity: Jigsaw microtexture picked out by carbonate veining, pseudoclastic, with black euhedral crystals and greenish crystals, similar proportions, around 10% overall. B and C similar, but purplish patches in a more crystal poor red matrix. 6. Phenocrysts: Infer derived from fragmented volcanic material, scattered with green and black phenocrysts 7. Matrix: Very fine grained 8. Secondary Minerals: Need id. 9. Encrustations:Minor carbonate crust 10. Comment:								

M191-84-1-6	1. Rock Type: Very small angular tabular clast, soft, poorly cemented medium sand with red fragments (crystals?) 2. Size: 3x2x1.5cm 3. Shape / Angularity: yellow brown with scattered wine-red fragments 4. Color of cut surface: tabular, planes following faint internal layering. 5. Texture / Vesicularity: clastic texture with hints of pelletal structure 6. Phenocrysts: NA, but note red fragments (could be altered lithology, but look crystalline) 7. Matrix: Medium to fine, clastic, tuffaceous? 8. Secondary Minerals: NA 9. Encrustations: None 10. Comment:	x (fragile, needs resin to stabilise)							
M191-84-1-7	1. Rock Type: Platy encrusted bioclast, leather coral? 2. Size: 10x8x2cm 3. Shape / Angularity: Yellow brown 4. Color of cut surface: Rounded platy form with raised edges 5. Texture / Vesicularity: Porous texture with infilled cavities, outer part bored 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Minor carbonate biogenic 10. Comment:								
M191-84-1-8	1. Rock Type: Micritic bioclastic grey carbonate, open textured, encrusted and colonised block (several fragments of this were recovered, including two large 30 cm pieces) 2. Size: 12x9x4cm 3. Shape / Angularity: Highly irregular open texture 4. Color of cut surface: yellow grey 5. Texture / Vesicularity: Bioclastic fragments 6. Phenocrysts: NA 7. Matrix: Very fine carbonate mud 8. Secondary Minerals: NA 9. Encrustations: Coralline encrustations 10. Comment:								

M191-85-1
Nameless Bank, NW edge of Nameless Bank, similar to 83 and 84, but start at middle of track to avoid hang up

Dredge on bottom UTC, hrs, °N, °E, depth m	18:15	36°52,10'N	13°05,15'E	225
Dredge off bottom UTC, hrs, °N, °E, depth m	19:12	36°52,10'N	13°05,15'E	210
total volume:	Few rocks			

Lava fragments

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-85-1-1	1. Rock Type: Dense lava ,mid grey, purplish, highly porphyritic, with primary subrounded smooth and glassy surface 2. Size: 20x12x7cm 3. Shape / Angularity: Sharp angular to subrounded tapered edges, with smooth surfaces 4. Color of cut surface: Mid grey with green and brown phenocrysts 5. Texture / Vesicularity: Porphyritic, dene, with distinct lack of vesicles, glassy rim, although dark green mineral may be infilling a very fine vesicular fabric internally 6. Phenocrysts: Large feldspar laths, rarely up to 1cm, round euhedral phenocrysts (altered ol?), deep green phase, euhedral, the same assemblage may be infilling fine vesicles in interior 7. Matrix: fine aphanitic 8. Secondary Minerals: Needs id. Phenocrysts too extensively replaced 9. Encrustations: Thick abundant crust, up to 6mm, worms and coral, slightly patchy 10. Comment: Has fresh broken surface where dredged up from cliff	x	x						
M191-85-1-2	1. Rock Type: Dense lava similar to 1, but with less pervasive dark green mineral 2. Size: 13.5x10x6cm 3. Shape / Angularity: Similar form overall to 1, but some srufaces rounded. Smooth still, glassy, one fresh broken surface 4. Color of cut surface: mid to dark grey 5. Texture / Vesicularity: as in 1, but without intense green mineral concentration in central part 6. Phenocrysts: Black crystals, px?, up to 2mm, small tabular plag, finer than in 1, brown phase up to 4mm rarelty, more commonly 1-2mm, irregular to subhedral ol? Dark green phase is present but less abundant than in 1. 7. Matrix: Fine, aphanitic 8. Secondary Minerals: Needs id 9. Encrustations: Up to 1 cm carbonate crust, patchy, biogenic, worms, corals.	x	x						
M191-85-1-3	1. Rock Type: Smaller volcanic fragment, dense and similar in form to 1 and 2 but with fresher phenocrysts. Blotchy texture 2. Size: 13x5.5x4.5cm 3. Shape / Angularity: Irregular form, with subrounded edges and smooth rounded surfaces, tapered 4. Color of cut surface: mid to dark grey 5. Texture / Vesicularity: Dense no vesicles, hairline fractures running through, porphyritic. 6. Phenocrysts: Black crystals, euhedral, tabular px?, up to 2mm, most abundant. Brown phase, altered ol up to 2mm but generally smaller. Laths of plag, sub-mm. 7. Matrix: Very finely crystalline 8. Secondary Minerals: Replacement phenocryst minerals needs id 9. Encrustations: Similar to others, patchy 10. Comment:	x	x						

M191-85-1-4	1. Rock Type: Similar overall to 3, slightly lighter grey, golden brown phjenocryst phase most abundant. 2. Size: 7.5x5x4cm 3. Shape / Angularity: Similar to 3 with rounded surface with fresh fractured base 4. Color of cut surface: Mid grey 5. Texture / Vesicularity: Dense, porphyritic but less than in 1, 2 and 3. 6. Phenocrysts: Golden brown phase, smaller than phenocrysts in 1 to 3, and less well formed but some tabular. No visible plag laths 7. Matrix: Very finely crystalline 8. Secondary Minerals: As above 9. Encrustations: Minor encrustation of coral and worms 10. Comment:								

M191-87-1
Nameless Bank, N edge, small nose in the uppermost slope

Dredge on bottom UTC, hrs, °N, °E, depth m	13:37	36°52,61'N	13°03,19'E	260
Dredge off bottom UTC, hrs, °N, °E, depth m	14:05	36°52,54'N	13°03,88'E	182
total volume:	One rock, corals			

Fragments of volcanic rock in carbonaceous matrix, some fresh

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	GI/MIN	SED	REF	NOTES	PICTURE
M191-87-1-1	1. Rock Type: Dense, fractured porphyritic mafic volcanic (lava), altered 2. Size: 19x19x11cm 3. Shape / Angularity: Tabular shape, subrounded edges, one small fresh surface 4. Color of cut surface: Mid to dark grey 5. Texture / Vesicularity: Overall brecciated texture infilled by bioclastic carbonate. Smaller microfractures also infilled by carbonate, jigsaw like, porphyritic 6. Phenocrysts: Most abundant is the brown phase, 5-10%, large equant grains likely altered ol, some have fresher cores, max 2mm across. Black blocky px, less abundant, 2%, smaller than ol but still mm scale. No visible plag. 7. Matrix: Microcrystalline gm 8. Secondary Minerals: Altered 9. Encrustations: Up to 2cm open coralline encrustation on top of the bioclastic carbonate 10. Comment:	x	x						
M191-87-1-2	1. Rock Type: Thick branching coral x 3 2. Size: Largest is 16 cm tall, 2cm diameter 3. Shape / Angularity: Branching stems, antler like 4. Color of cut surface: Grey cream 5. Texture / Vesicularity: Ribbed outer surface, radial interior 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Very minor worms 10. Comment:								

M191-88-1
Nameless Bank. Plateau margin near eastern end where slope bends from WNW -ESE to N-S

Dredge on bottom UTC, hrs, °N, °E, depth m	14:51	36°52,27'N	13°01,74'E	255
Dredge off bottom UTC, hrs, °N, °E, depth m	15:17	36°52,22'N	13°01,74'E	214
total volume:	One rock, three carbonate (			

Dense lava block, broken form, plus two large open textured coral

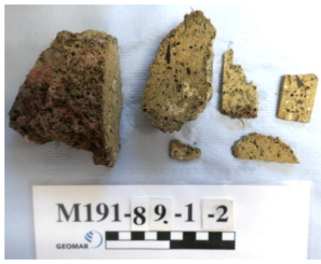
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-88-1-1	1. Rock Type: Dense microfractured mafic volcanic rock (lava), altered and porphyritic 2. Size: 13x9x5cm 3. Shape / Angularity: Rounded smooth, slightly undulated top surface. One fresh surface on base. Overall shape subrounded 4. Color of cut surface: Mid to dark grey 5. Texture / Vesicularity: Porpyritic, potentially clustering of large altered crystals towards centre-lower half. May just be an alteration fabric. Microfractures throughout picked out by very thin sub-mm carbonate veining 6. Phenocrysts: Most abundant is altered brown golden phenocrysts, altered ol, less than 2 mm, equant, 5-10% abundance. Less abundant 1% black euhedral crystals likely px. 7. Matrix: Microcrystalline gm 8. Secondary Minerals: Altered 9. Encrustations: Minor, very thin carbonate and biogenic worms on top surface 10. Comment:	x	x						
M191-88-1-2	1. Rock Type: open texture net like carbonate block 2. Size: 20x17x7cm 3. Shape / Angularity: Highly irregular, subangular, no major fresh surfaces 4. Color of cut surface: Dark cream brown exterior, beige interior 5. Texture / Vesicularity: Dense carbonate, potential bioclasts 6. Phenocrysts: NA 7. Matrix: Carbonate mud 8. Secondary Minerals: NA 9. Encrustations: Encrusted all over in worms, shells and other biogenic material 10. Comment:								

M191-89-1
Nameless Bank, small step at N end of central plateau. Possibly the remnants of a shield volcano?

Dredge on bottom UTC, hrs, °N, °E, depth m	16:04	36°51,60'N	13°02,80'E	151
Dredge off bottom UTC, hrs, °N, °E, depth m	16:37	36°51,48'N	13°02,83'E	122
total volume:	Few carbonates			

Several subrounded and generally flattened carbonate pebbles of

SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-89-1-1	1. Rock Type: Cemented carbonate sst/sand, containing mm scale volcanic clasts, massive 2. Size: 14.5x10x4.5cm 3. Shape / Angularity: Subrounded, flattened, slightly irregular pebble. No fresh surface. 4. Color of cut surface: Yellow with dark specks 5. Texture / Vesicularity: Granular porous texture. Poorly cemented sand. Mostly bioclasts. 6. Phenocrysts: NA, but contains mafic volcanic clasts similar to those on other locations on Nameless Bank 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: In top of one surface, fine seagrass growning, no major encrustation 10. Comment:	x							

M191-89-1-2	1. Rock Type: Similar to 1, slightly more volcanic grains and greyer colour, but essentially the same. 2. Size: 12x9x5cm 3. Shape / Angularity: Subrounded 4. Color of cut surface: As 1, greyer 5. Texture / Vesicularity: As 1 6. Phenocrysts: As 1 7. Matrix: As 1 8. Secondary Minerals: As 1 9. Encrustations: As 1 10. Comment:	x							
M191-89-1-3	1. Rock Type: Similar to 1 and 2, slightly yellower, purer carbonate sand 2. Size: 11x9x3cm 3. Shape / Angularity: Very flat, undulated surface 4. Color of cut surface: As in 1, less dark specks and volcanic grains 5. Texture / Vesicularity: As in 1 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: As in 1 10. Comment:								
M191-89-1-4	1. Rock Type: Concentric/spiralled open texture, carbonate block made of bioclasts, tubules and corals. 2. Size: 14x10x9cm 3. Shape / Angularity: Irregular, overall rounded, bobbly surface. No fresh surfaces 4. Color of cut surface: Grey cream 5. Texture / Vesicularity: Open network of biogenic and carbonate material 6. Phenocrysts: NA 7. Matrix: Carbonate 8. Secondary Minerals: NA 9. Encrustations: Entirely encrusted biogenic material 10. Comment:								

M191-90-1
Nameless Bank, eastern edge of terraced? shield like structure on top of Nameless Bank

Dredge on bottom UTC, hrs, °N, °E, depth m	17:58	36°49,19'N	13°09,49'E	250
Dredge off bottom UTC, hrs, °N, °E, depth m	18:20	36°49,16'N	13°09,42'E	230
total volume:	approx 20%			

Mud, with mixed coral fragments and shelly platy fragments

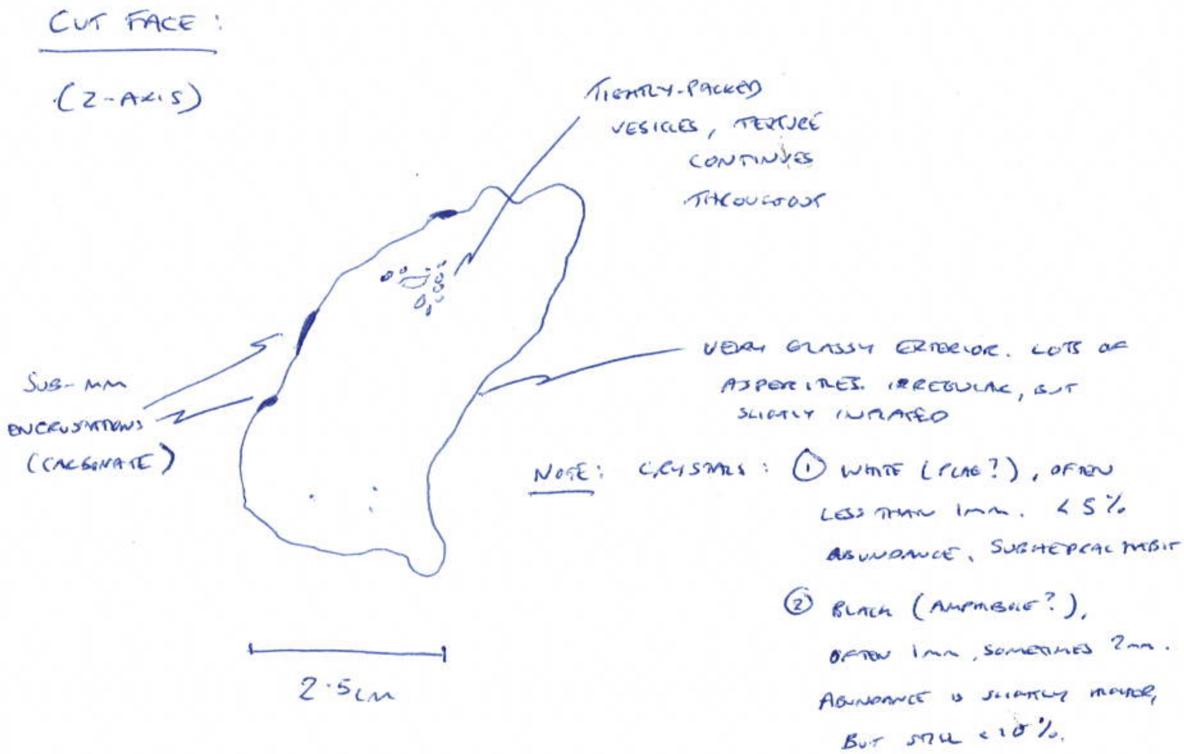
SAMPLE #	SAMPLE DESCRIPTION	TS	CHEM	Ar/Ar	Gl/MIN	SED	REF	NOTES	PICTURE
M191-90-1-1	1. Rock Type: Yellow brown irregular pebble of coarse carbonate bioclastic sand with spare volcanic grains 2. Size: 5x4.5x4cm 3. Shape / Angularity: Very irregular form, subrunded edges 4. Color of cut surface: yellow brown 5. Texture / Vesicularity: poorly cemebnted granular texture 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Minore biogenic organisms 10. Comment:								

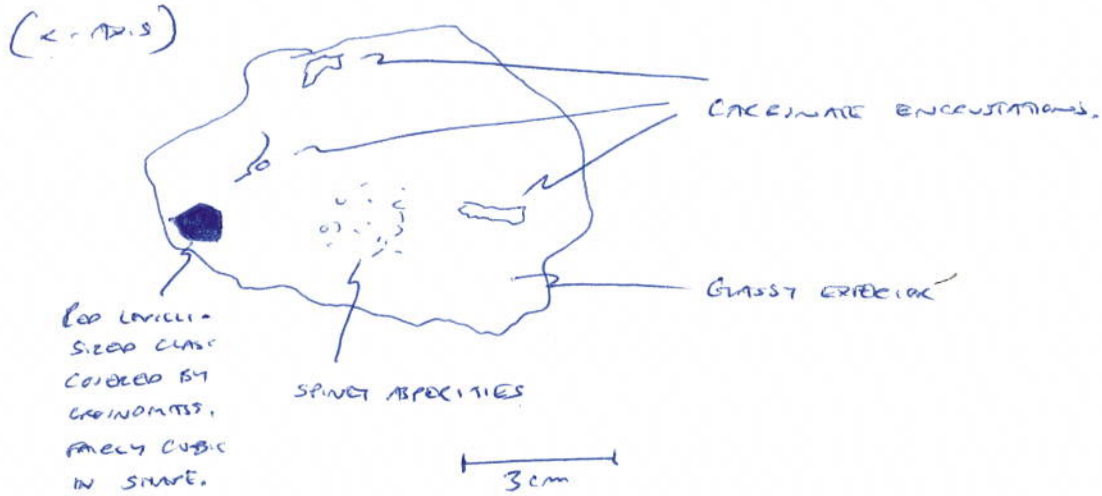
M191-90-1-2	1. Rock Type: Branching coral (abundant in dredge) 2. Size: 14x10x4cm 3. Shape / Angularity: Multi branching 4. Color of cut surface: Dirty white 5. Texture / Vesicularity: Ribbed exterior, radial interior 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: serpulid and shelly colonisation on surface 10. Comment:								
M191-90-1-3	1. Rock Type: Platy coral? Fragment (abundant in dredge) 2. Size: 10x11x2cm 3. Shape / Angularity: Fan like with ruffled edges 4. Color of cut surface: Beige 5. Texture / Vesicularity: Dense internally, rough surface 6. Phenocrysts: NA 7. Matrix: NA 8. Secondary Minerals: NA 9. Encrustations: Serpulid and shelly colonisation 10. Comment:								

Sample #: M191-13-1-1 [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

Photo/Sketch

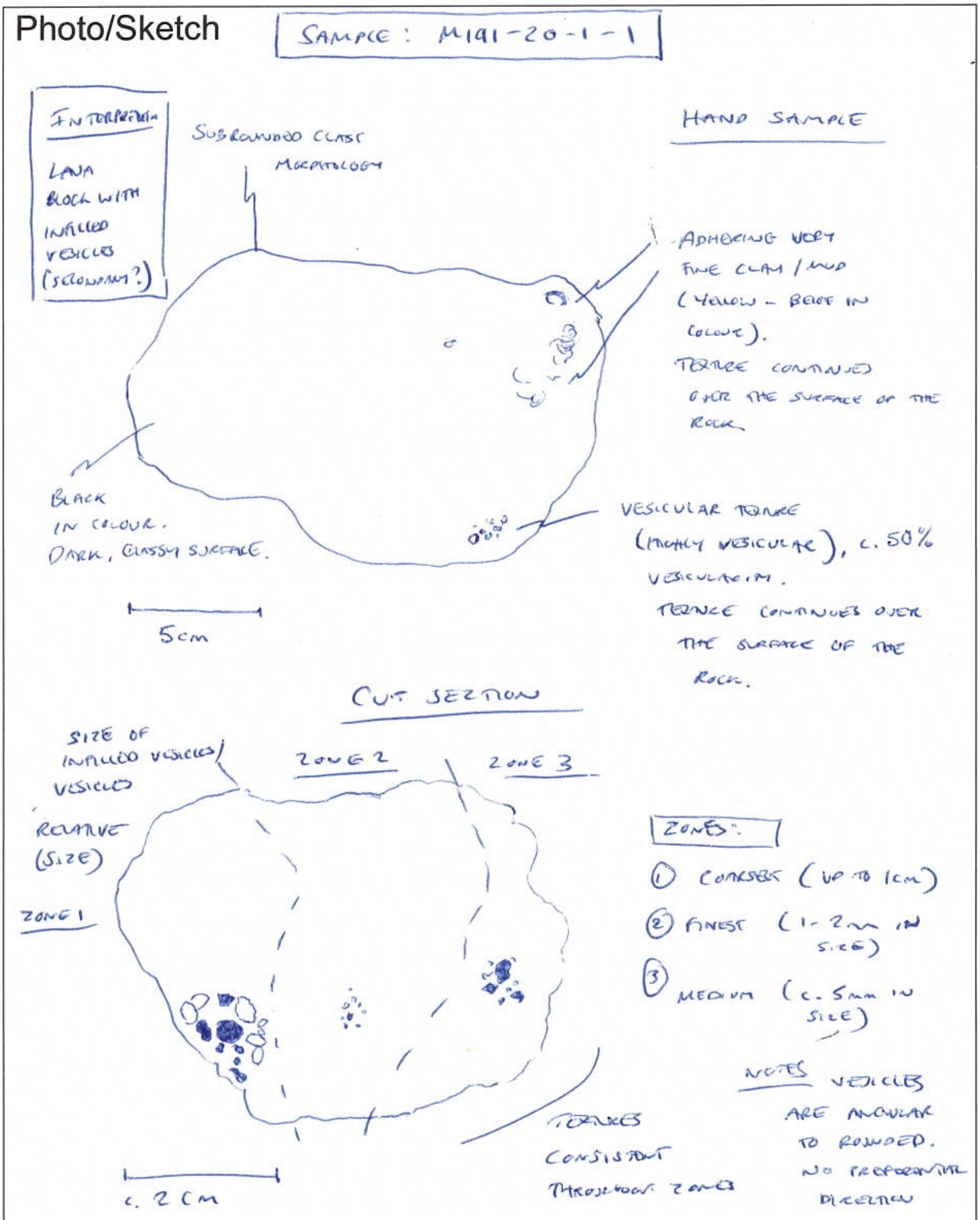




Sample #: M191- 20 **-1-** 1 [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

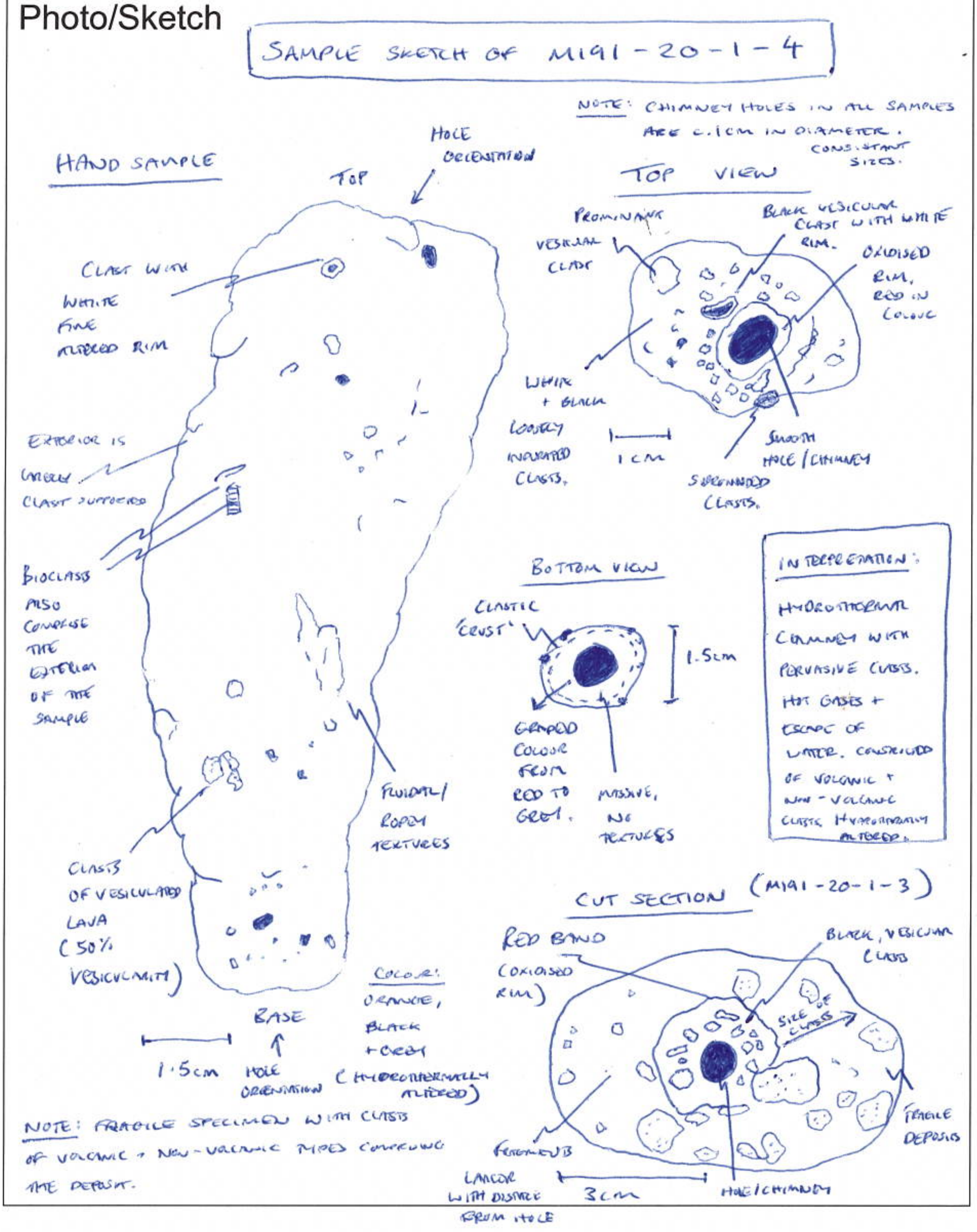
Photo/Sketch



Sample #: M191- 20 **-1-** 2 THROUGH TO 4. [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

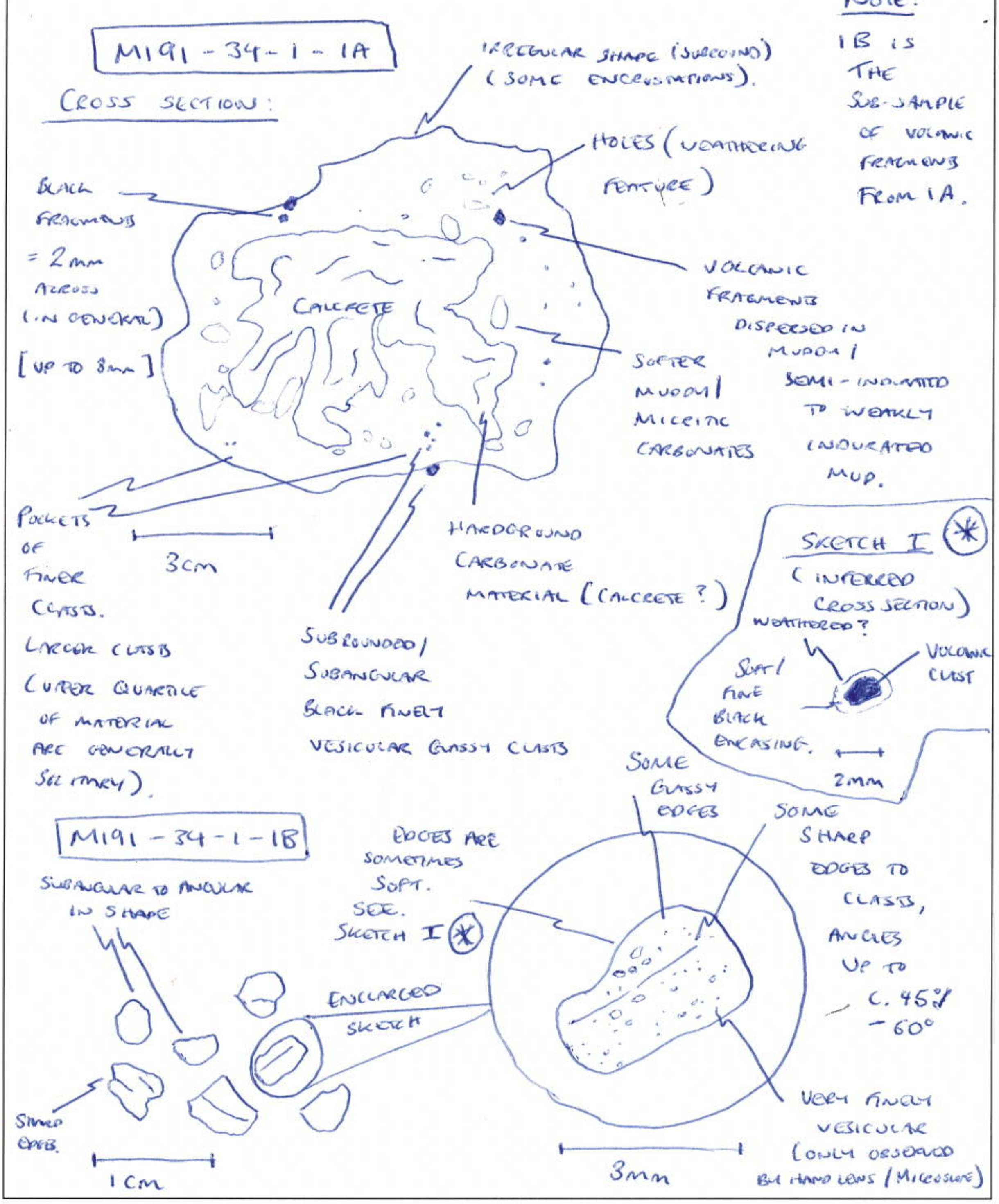
Photo/Sketch



Sample #: M191- 34 **-1-** 1A / 1B [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

Photo/Sketch



INTERPRETATION(S): ① POSSIBLE TEPHRA FALL DEPOSIT FROM A 'NEARBY' VOLCANIC ERUPTION WHICH HAS SETTLED ON THE SEABED + IS INCORPORATED IN THE MUD.

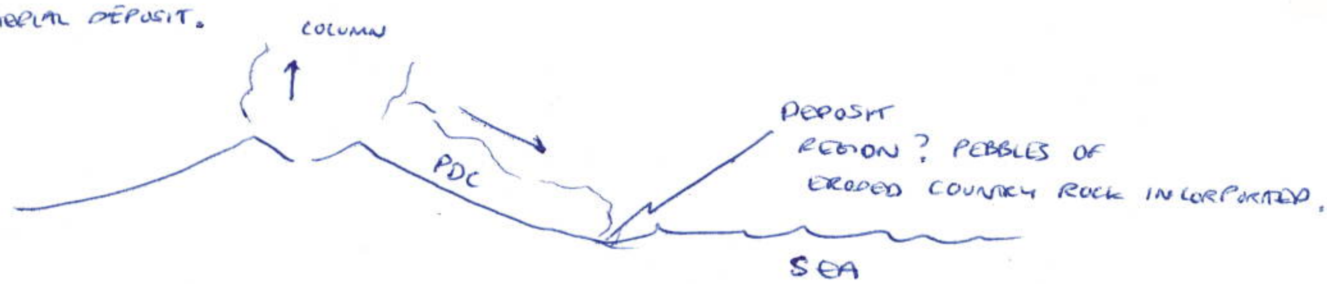
② POSSIBLE ERODED CLASTS FROM THIS STRUCTURE. WOULD EXPECT THESE TO BE MORE ROUNDED.

NOTE: FINE BLACK ENCASING COULD BE ORGANIC MATERIAL.

POSSIBLE INTERPRETATIONS

(1) PYROCLASTIC DENSITY CURRENT:

- PLUCKING UP BLOCKS / PEBBLES OF COUNTRY ROCK MATERIAL (NEAR SHORE ENVIRONMENT)
- PUMICES / ERUPTION EITHER INTERSECTED A HYDROTHERMAL FIELD OR INCORPORATED WATER FROM THE SURROUNDING ENVIRONMENT (SEAWATER ?). THIS LOWERED EMPLACEMENT TEMPERATURES + INCREASED THE WATER CONTENT LEADING TO ALTERATION OF THE PUMICES TO ZEOLITE (?)
- FLOW MAY HAVE BEEN SUBMARINE, BUT IT IS LIKELY THIS REPRESENTS A SUBAERIAL DEPOSIT.



(2) FALL DEPOSIT FROM EVOLVED ERUPTION FROM PANTELLERIA, LINOSA, ETNA?:

- IT IS POSSIBLE THAT THIS IS NOT FROM NAMELESS BANK ITSELF, BUT REPRESENTS THE FALLOUT FROM A MAJOR ERUPTION FROM A MAJOR (LOCAL) VOLCANIC CENTRE.

  ↳ EXPECTATIONS WOULD BE THAT:

  (A) IT WOULD BE FINER GRAINED (BUT IT MAY BE ON THE DISPERSAL AXIS)

  AND

  (B) WOULD BE FOUND ELSEWHERE - E.G. AT GRAHAM BANK.

- THIS WOULD HAVE BEEN ZEOLITISED STRICTLY AFTER DEPOSITION.

NOTE: THE PRESENCE OF PUMICE (MICROVESICULAR / MORE EVOLVED, CHEMICALLY) CLASTS IS INDICATIVE OF A HIGHER SiO_2 CONTENT ERUPTION. MORE EVOLVED MAGMA IS GENERALLY MORE EXPLOSIVE. POSSIBLE THAT IT IS AN UNUSUAL TYPE OF ERUPTION...? E.G. PUMICE CONE VOLCANISM?

UPDATED SKETCH

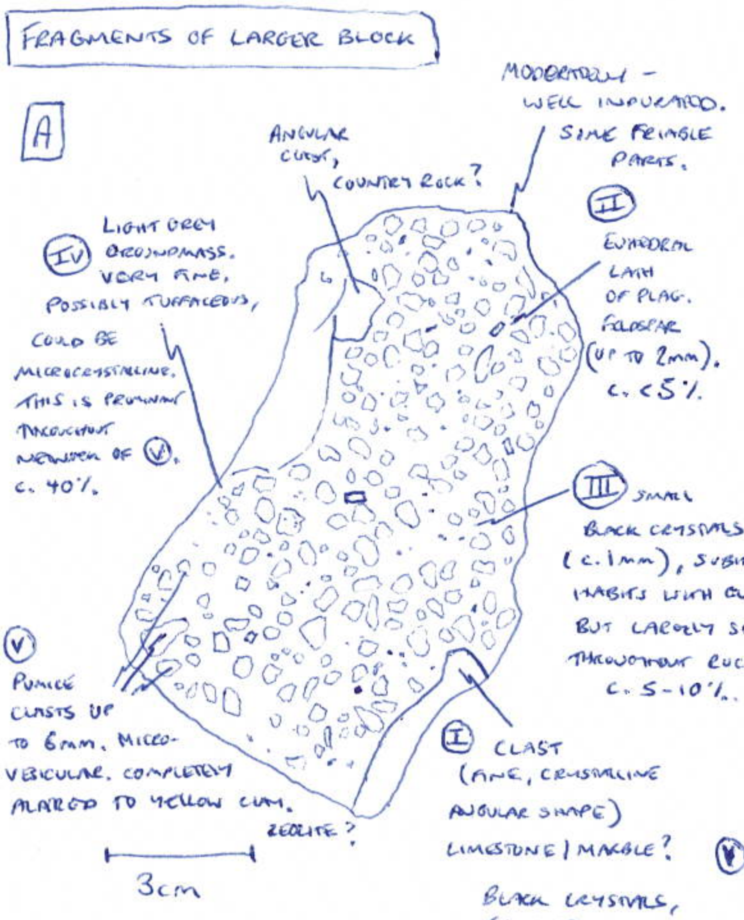
Sample #: M191-37-1-1 [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

[REVERSE HAS POSSIBLE INTERPRETATIONS]

Photo/Sketch

M191-37-1-1



DETAILS:

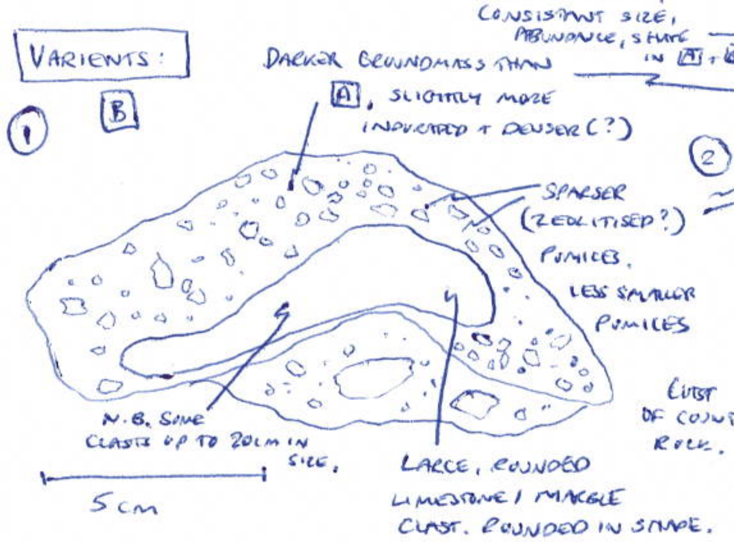
(I) CLASTS: COUNTRY ROCK? MARBLE / LIMESTONE. WELL LITHIFIED / DIAGENESIS. NO OXIDISED RIM / BAKED MARGIN / EXTERIOR.

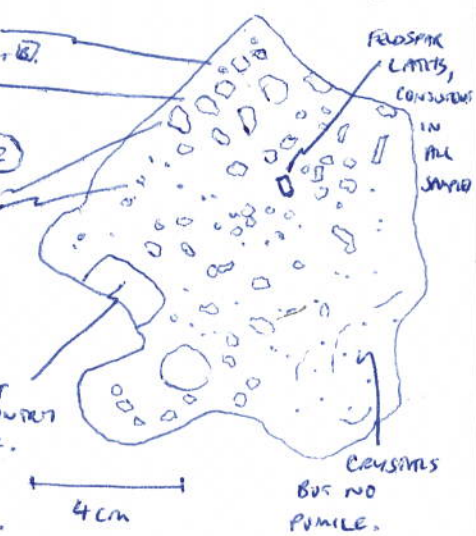
(II) PLAG: LATHS OF EUHEDRAL CRYSTALS, NO FRACTURES / BREAKS IN CRYSTALS. TWINNED.

(III) BLACK CRYSTALS: SUBHEDRAL, PYROXENE OR AMPHIBOLE? POSSIBLE BROKEN OR NOT PERFECTLY FORMED. IN HIGHER ABUNDANCE THAN PLAG.

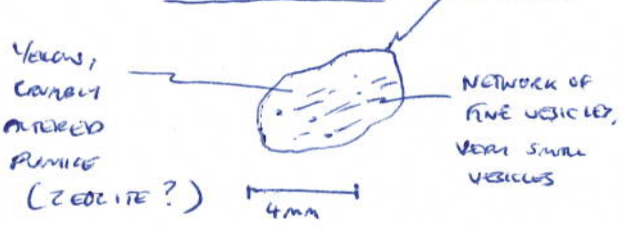
(IV) GROUNDMASS: POSSIBLE TUFFACEOUS, GRADES ACROSS SAMPLE (WELDING VARIETY??)
← LESS WELDED — DENSELY WELDED? →
MAY ALSO BE FINELY MICRO-CRYSTALLINE

(V) PUMICE CLASTS: SEE BELOW (*)





* PUMICE CLASTS:



- IN LIGHTER PARTS, PUMICES ARE MORE ABUNDANT + SLIGHTLY SMALLER ON AVERAGE (C. 1-2 mm). ACCOUNT FOR C. 50% OF ROCK TEXTURE.
- IN DARKER PARTS, PUMICES ARE SLIGHTLY LARGER (1-2 mm) + MORE SPARSE (WITH MORE GROUNDMASS). ACCOUNTS FOR C. 40% OF ROCK TEXTURE.
- FULLY ALTERED (ZEOLITISED) — NO RIMS OR GRADE IN PUMICE.

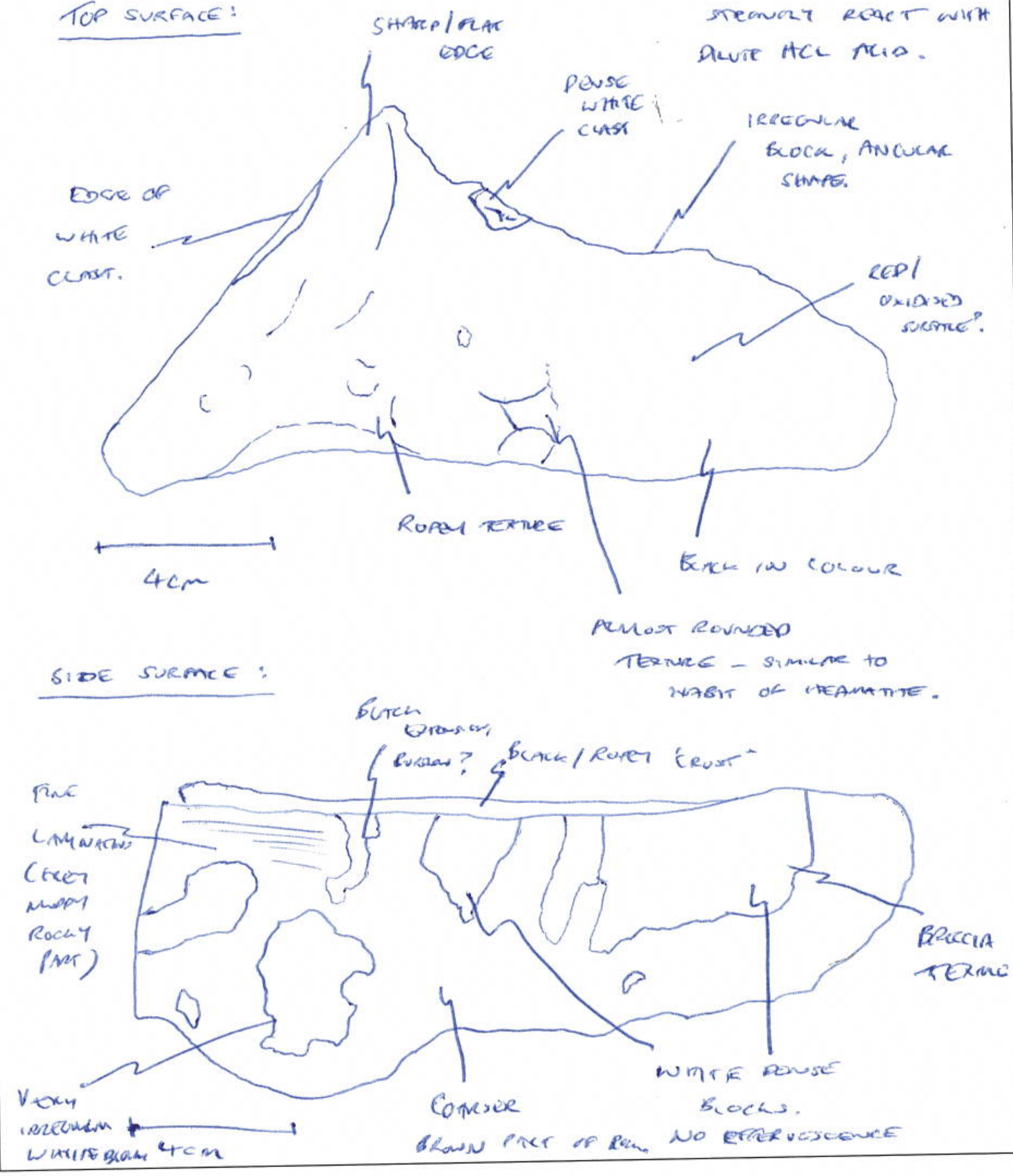
Sample #: M191- 49 -1- 3

[PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

Photo/Sketch

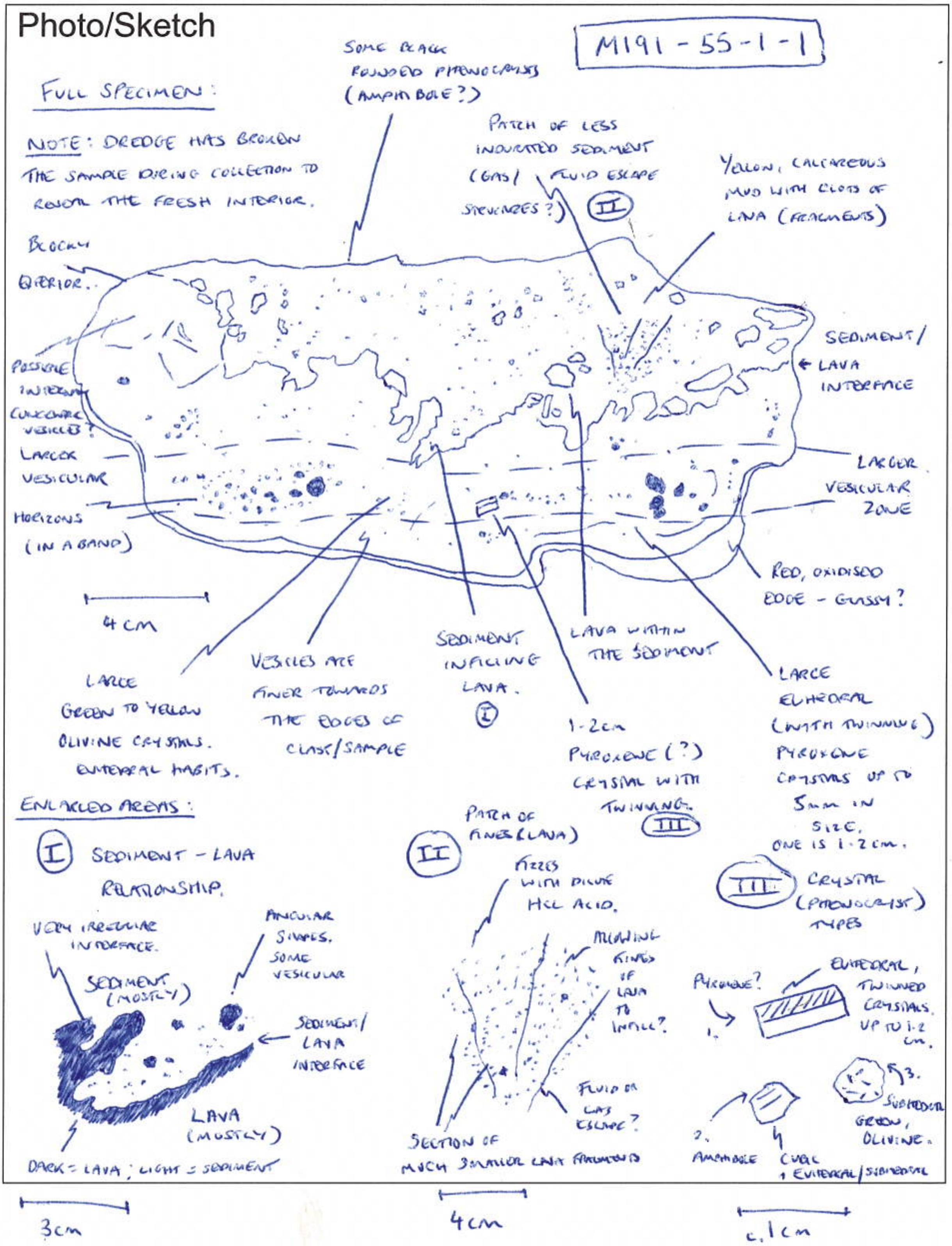
NOTE: • WHITE DENSE ROCKS = NO EFFERVESCENCE
• BLACK + OTHER PARTS STRONGLY REACT WITH DILUTE HCL ACID.



Sample #: M191- 55-1- 1 [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

Photo/Sketch



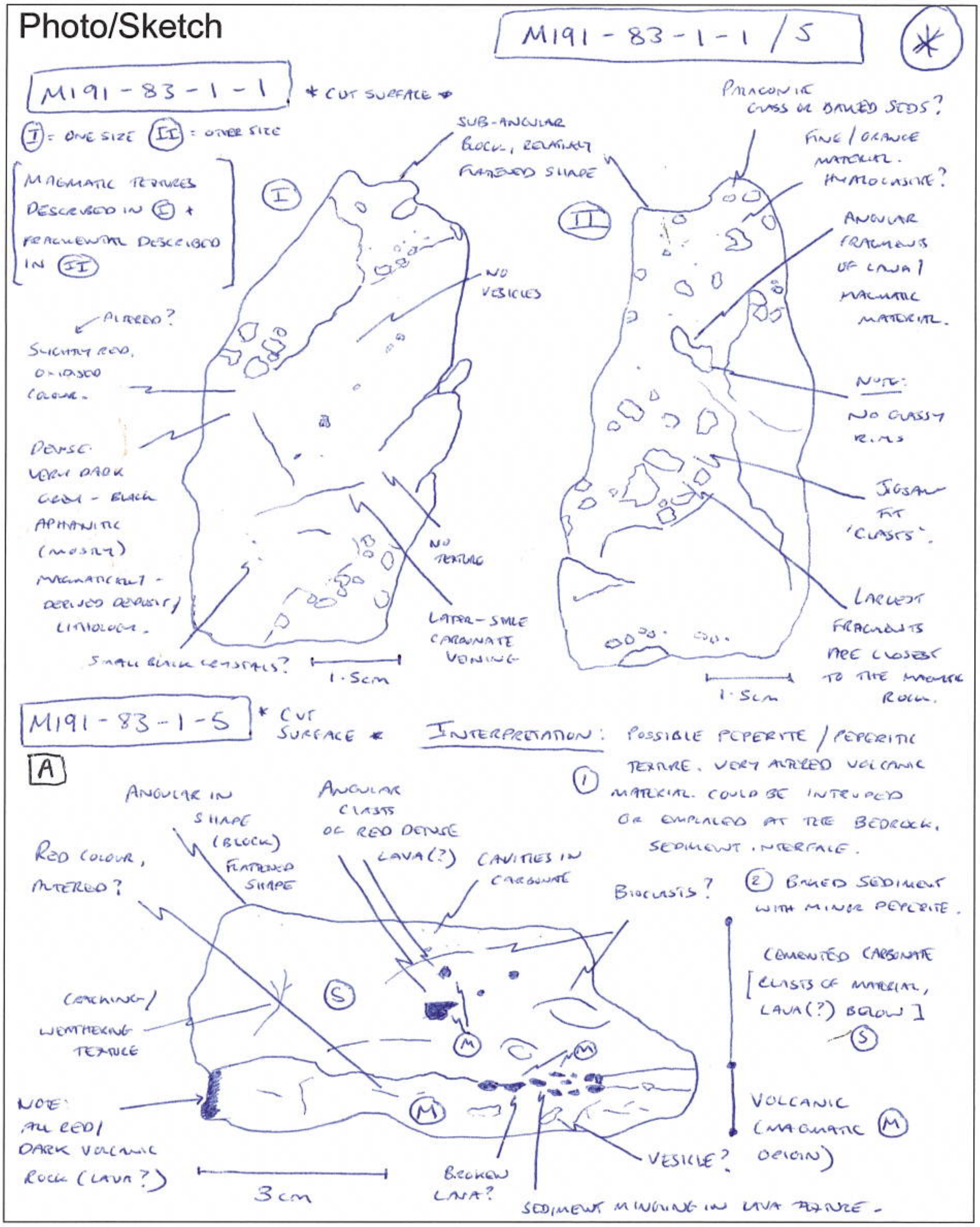
INTERPRETATION: PEPERITIC CONTACT/RELATIONSHIP BETWEEN MAGMA (LAVA) + WET SEDIMENT. SEDIMENT IS CALCAREOUS IN COMPOSITION. PERHAPS LAVA OVERRODE THE SEDIMENT OR SQUEEZED OUT INTO IT. THIS MAY EXPLAIN THE PEPERITIC CONTACT ON ONE SIDE OF THE BLOCK? RIM IS SURROUNDING WHOLE SPECIMEN, SUGGESTING TEXTURE IS PRIMARY.

NOTE: THIN SECTIONS, PHOTOS, LEACHING + SAMPLES FOR ANALYSIS.

Sample #: M191- 83 -1- 1/5 [PLEASE FILL OUT]

TO BE APPENDED TO SAMPLE DESCRIPTION SHEET

Photo/Sketch



(*) INTERPRETATION FOR M191-83-1-1:

(1) PEPERITIC TEXTURE FROM INTRUSIVE / EMPLACED MAGMATIC BODY (E.G. LAVA) WITH ORANGE SEDIMENT BEING BAKED SEDS? NO GLASSY RIMS DUE TO SEDIMENT CONTACT.

(2) HYALOCLASTITE FORM - IN SITU BRECCIATION OF THE MAGMATIC MATERIAL + FINER 'SEDIMENT' BEING ASH QUENCHED GLASS + PALAGONITE FUSING THE MAGMATIC FRAGMENTS IN PLACE. Q: WHERE ARE THE GLASSY RIMS IN THIS MODEL?

Appendix 11.2

Underway Water Sampling List for Nannoplankton Research

Water samples taken within the Spanish EEZ:

Sample	Date	Time (UTC)	Depth (m)	Latitude (°N)	Longitude (°E)	Tempera-ture (ºC)	Salinity (PSU)
M191-PL-1	16.07.23	08:45:20	0-5	36°03,086'	–05°22,111'	19.2	-
M191-PL2	16.07.23	12:35:48	0-5	36°05,054'	–04°38,177'	24.6	36.35
M191-PL2b	16.07.23	12:52:00	0-5	36°05,345'	–04°35.683'	24.8	36.35
M191-PL3	16.07.23	18:20:11	0-2	36°12,678'	–03°31,374'	20.8	36.33
M191-PL4	16.07.23	22:16:20	0-2	36°18,041'	–02°46,118'	26.4	36.74
M191-PL5	16.07.23	02:05:15	0-2	36°24,450'	–02°01,598'	27.5	36.83
M191-PL6	16.07.23	06:21:55	0-2	36°39,327'	–01°12,518'	27.1	36.96
M191-PL7	16.07.23	10:23:55	0-2	36°59,058'	00°02,977'	27.3	37.12
M191-PL8	16.07.23	14:16:30	0-2	37°21,397'	00°08,706'	27.8	36.97
M191-PL9	16.07.23	17:54:17	0-2	37°41,589'	00°45,490'	28	36.74
M191-PL10	16.07.23	21:42:33	0-2	37°46'	01°24'	28.3	37.32

Water samples taken within the Italian EEZ:

Sample	Date	Time (UTC)	Depth (m)	Latitude (°N)	Longitude (°)	Tempera-ture (ºC)	Salinity (PSU)
M191-PL11	19.07.23	01:44:19	0-2	38°15,363'	07°17,526'	28.9	37.33
M191-PL12	19.07.23	04:52:28	0-2	38°17,372'	08°00,563'	28.8	37.38
M191-PL13	19.07.23	08:31:36	0-2	38° 21,045'	08° 41,979'	27.3	37.69
M191-PL14	19.07.23	00:05:18	0-5	38°21,523'	008°50,448'	30.5	37.7
M191-PL15	19.07.23	17:14:51	0-5	38°25,301'	009°51,648'	30.9	38
M191-PL16	19.07.23	21:22:54	0-2	38°27,884'	010°43,451'	29.1	37.76
M191-PL17	20.07.23	01:36:45	0-2	38°05,901'	011°27,052'	29.7	36.8
M191-PL18	20.07.23	05:26:24	0-2	37°44,707'	012°06,141'	28	37
M191-PL19	20.07.23	08:32:28	0-2	37°30,656'	012°32,320'	25.1	37.69
M191-PL19b	20.07.23	08:23:27	0-5	37°30,666'	012°32,307'	26.3	37.74
M191-PL20	20.07.23	13:09:39	0-5	37°25,857'	012°44,642'	27.7	37.74
M191-PL21	20.07.23	17:30:55	0-5	37°29,434'	012°39,973'	25.4	37.75
M191-PL22	20.07.23	21:19:52	0-5	37°22,176'	012°47,719'	26.7	37.69
M191-PL23	21.07.23	01:12:44	0-5	37°28,129'	012°54,625'	26.7	37.78
M191-PL24	21.07.23	05:59:16	0-5	37°21,978'	012°50,270'	26.8	37.75
M191-PL25	21.07.23	15:54:26	0-5	37°25,953'	012°54,153'	26.6	37.78
M191-PL26	21.07.23	15:59:48	0-2	37°14,578'	012°42,588'	28.1	37.63

M191-PL27	21.07.23	09:49:05	0-5	37°14,168'	012°43,140'	28.4	37.75
M191-PL28	21.07.23	20:01:25	0-5	37°12,064'	012°41,471'	28.7	37.77
M191-PL29	22.07.23	00:05:16	0-5	37°04,202'	012°39,717'	27.9	37.77
M191-PL30	22.07.23	03:56:11	0-5	37°01,677'	012°41,035'	27.8	37.75
M191-PL31	22.07.23	08:21:56	0-5	37°10,305'	012°42,200'	27.2	37.78
M191-PL32	22.07.23	14:14:03	0-5	37°08,834'	012°42,597'	26.6	37.82
M191-PL33	22.07.23	18:31:11	0-5	36°58,452'	012°33,705'	27.8	37.77
M191-PL34	22.07.23	21:58:28	0-5	37°00,953'	012°29,650'	28.2	37.75
M191-PL35	23.07.23	01:02:38	0-5	37°13,457'	012°23,952'	26.8	37.7
M191-PL36	23.07.23	05:55:03	0-5	37°15,437'	012°20,533'	27.1	37.69
M191-PL37	23.07.23	13:48:43	0-5	37°02,011'	012°27,888'	28.8	37.77
M191-PL38	23.07.23	21:50:05	0-5	37°12,794'	012°24,377'	28.6	37.74
M191-PL39	24.07.23	11:01:45	0–5	37°09,625'	012°53,321'	28.4	37.66
M191-PL40	24.07.23	20:02:18	0-5	37°09,718'	012°53,066'	28.9	37.68
M191-PL41	25.07.23	11:50:57	0-5	36°49,943'	013°07,809'	28.9	37.69
M191-PL42	25.07.23	23:31:50	0-5	36°45,793'	012°50,191'	28.1	37.51
M191-PL43	26.07.23	10:45:41	0-5	35°55,770'	012°49,110'	28.8	37.56
M191-PL44	26.07.23	21:45:47	0-5	35°56,070'	012°48,838'	27.9	37.38
M191-PL45	27.07.23	11:11:54	0-5	35°59,398'	013°08,717'	27.5	37.43
M191-PL46	27.07.23	21:55:04	0-5	36°08,777'	012°46,023'	27.3	37.22
M191-PL47	28.07.23	10:12:22	0-5	36°03,511'	012°59,616'	26.4	37.22
M191-PL48	28.07.23	22:12:30	0-5	36°01,095'	013°03,266'	27.4	37.25
M191-PL49	29.07.23	12:01:11	0-5	37°09,051'	012°53,340'	26.2	37.71
M191-PL50	29.07.23	21:43:01	0-5	37°11,014'	012°46,491'	26.3	37.75
M191-PL51	30.07.23	10:14:53	0-5	36°49,261'	013°10,539'	26.7	37.71
M191-PL52	30.07.23	21:34:41	0-5	37°06,890'	012°48,881'	26.3	37.69
M191-PL53	31.07.23	10:36:23	0-5	36°47,944'	013°12,174'	27	37.73
M191-PL54	31.07.23	21:37:00	0-5	36°51,133'	013°04,572'	25.5	37.55
M191-PL55	01.08.23	10:01:33	0-5	36°43,369'	013°24,115'	26.5	37.71
M191-PL56	01.08.23	20:22:28	0-5	36°46,554'	013°04,134'	25.6	37.55
M191-PL57	02.08.23	10:27:23	0-5	36°35,762'	013°15,156'	26.4	37.69
M191-PL58	02.08.23	22:14:19	0-5	36°26,010'	015°00,728'	27.3	37.71
M191-PL59	03.08.23	01:11:57	0-2	36°22,047'	015°36,569'	27.6	38.41
M191-PL60	03.08.23	04:07:49	0-2	36°20,068'	016°12,335'	28.1	38.39
M191-PL61	03.08.23	09:11:01	0-2	36°16,664'	017°14,807'	28.6	37.39
M191-PL62	03.08.23	12:14:49	0-2	36°14,772'	017°52,052'	27.8	37.84

Water samples taken within the Greek EEZ:

Sample	Date	Time (UTC)	Depth (m)	Latitude (°N)	Longitude (°E)	Tempera-ture (ºC)	Salinity (PSU)
M191-PL63	3.8.23	15:11	0-2	36°12,883'	018°28,390'	29.8	37.68
M191-PL64	3.8.23	6:21	0-2	36°11,511'	019°06,533'	28.9	38.47
M191-PL65	3.8.23	20:59	0-2	36°10,403'	019°37,530'	28.7	38.81
M191-PL66	3.8.23	23:09	0-2	36°09,498'	020°02,901'	28.6	39.05
M191-PL67	4.8.23	0:53	0-2	36°08,769'	020°23,200'	28.4	38.99
M191-PL68	4.8.23	3:03	0-2	36°07,918'	020°46,928'	28.2	38.42
M191-PL69	4.8.23	5:00	0-2	36°07,112'	021°09,405'	27.8	38.64
M191-PL70	4.8.23	7:07	0-2	36°06,209'	021°35,098'	28.2	39.03
M191-PL71	4.8.23	9:07	0-2	36°05,318'	021°59,349'	27.7	38.63
M191-PL72	4.8.23	11:08	0-2	36°04,352'	022°23,161'	27.4	38.94
M191-PL73	4.8.23	13:12	0-2	36°03,579'	022°47,888'	28.2	39.35
M191-PL74	4.8.23	14:48	0-2	36°03,755'	023°06,881'	27.6	38.96
M191-PL75	4.8.23	17:14	0-2	36°22,521'	023°20,736'	27.9	39.02
M191-PL76	4.8.23	19:01	0-2	36°38,638'	023°26,700'	28.4	38.94
M191-PL77	4.8.23	21:10	0-2	36°57,852'	023°33,223'	28	39.33
M191-PL78	4.8.23	23:03	0-2	37°14,587'	023°38,176'	28.3	38.7
M191-PL79	5.8.23	1:02	0-2	37°31,848'	023°43,174'	28.2	38.88
M191-PL80	5.8.23	3:02	0-2	37°45,333'	023°42,544'	28.4	38.97