Australia's Marine National Facility

VOYAGE SUMMARY ss2012_v07

Tasmantid Seamounts: volcanic, tectonic, and carbonate record (TMD2012)

Voyage period:
23/11/2012 to 19/12/2012

Port of departure:
Brisbane, Australia

Port of return:
Brisbane, Australia

Responsible laboratory:
School of Earth Sciences

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Chief Scientist(s)
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Scientific Objectives

The Tasmantid seamounts are a chain of underwater hotspot-derived intraplate volcanoes situated 150 to 600 km east of the Australian mainland. Because of the long record of hotspot-derived volcanic activity - spanning more than 2000 km and >40 million years - the seamounts provide an exceptional and largely untapped record of Australian plate velocity. Deciphering this record by obtaining volcanic samples suitable for high-resolution $^{40}Ar/^{39}Ar$ geochronology was a major objective of this voyage. Such volcanic samples also record the chemical evolution of a long-lived mantle plume, and chemical analyses will reveal information on mantle reservoirs, melting, magma diversification, and the contrasting contamination effects of thinned continental lithosphere in the north versus oceanic lithosphere in the south. Geophysical data was also collected over the seamounts and oceanic crust of the Tasman Sea to help study the tectonic history and lithospheric structure of the region. The seamounts are variably capped by fossil and modern coral reefs. Although not targeted specifically, carbonate material recovered with the volcanic samples provides a key biologic and climatic record of the seas east of Australia. Morphologic analysis of the seamounts will allow identification of volcanic and coral-growth geomorphology, as well as any mass wasting deposits.

Voyage Objectives

1. 30 kHz swath surveying of the Tasmantid seamounts (**Figures 1, 2**): This allowed mapping of volcanic features, subsequent erosion history, carbonate reef growth, and evidence of mass wasting. Mapping was also crucial to target dredge sites.
2. Dredging volcanic rocks from the seamount flanks: Post-expedition analysis on these samples includes geochemistry and $^{40}Ar/^{39}Ar$ geochronology.
3. Geophysical data: Combined swath and gravity data will be used to study the strength and structure of the lithosphere along the chain, with particular emphasis on how the lithosphere has responded to seamount loading, and the difference in response between continental and oceanic crust. Magnetic data, where available, will also be used to help constrain seafloor-spreading rates.
4. Sample carbonate rock and sediment and deep-water organisms as 'by-catch': Samples were collected on an opportunistic basis (e.g., where organisms are attached to volcanic samples) and were identified and preserved as dictated by the material. Knowledge of the deep-water organisms of the Coral Sea is very scarce. Hence, the marine biota collected along with the volcanic samples has considerably enhanced our knowledge of life in these remote and inaccessible habitats, and provides a climatic and biologic record in the Tasman Sea, potentially extending well into the mid-Cenozoic. Post-expedition, voucher samples of modern species will be provided to the Queensland Museum for additional expert study.
5. Water sampling: Surface water samples were obtained on an opportunistic basis for post-voyage geochemical analysis. Very few surface ocean trace element geochemistry analyses exist for shallow water in the Coral Sea.

Results

During this voyage we successfully swath mapped 16 seamounts within the Tasmantid chain (**Figure 1**), covering a total of ~16,000 km^2. A wide variety of geomorphic features were identified, including volcanic cones, craters, volcanic ridges, lava flows, coral reefs, sinkholes, erosional canyons, and debris slopes (e.g., **Figure 2**). A total of 39 dredges were attempted, with 35 yielding samples (**Table 1**). In each dredge, multiple igneous rock types were frequently recovered, with a total of 123 igneous subgroups described by the shipboard scientists. Sample quality ranged from altered to very fresh, with plagioclase phenocrysts, olivine phenocrysts, and fresh glass preserved (**Table 1**, **Figure 3**). These fresher samples will be ideal for post-voyage chronological and chemical analysis. Dredging was also very successful in obtaining biological material, with shallow-water carbonate coral reef rocks, deep-water corals, and a variety of deep-water biota recovered (**Table 1**, **Figure 4**). Manganese crusts and foraminifer-rich mud were also abundant (**Table 1**). Two Smith-Mcintyre grabs yielded benthic sediment (**Table 2**). Surface water was also sampled for trace-element geochemistry (REEs, U, Th) at four localities spanning the latitudinal range of this voyage (**Table 3**). XBT's were deployed opportunistically (**Table 4**) whenever the sound velocity profile changed outside acceptable limits for the swath mapping software. For geophysics, we collected approximately 7700 line-km of gravity (**Figure 5**) and sub-bottom profiling (Topas) data and approximately 1500 line-km of magnetic data. More details of shipboard results are contained in the daily Voyage Narrative below.

Voyage Narrative

Day 1: Friday 23rd November 2012 (Julian Day 328)

10:00 (Australian Eastern Standard Time) in position 27°26.8'S; 153°04.6'E berthed at Forgacs Shipyard, Brisbane River

Wind 11 kn from 070. Nil swell.

Scientists boarded the vessel between 09:00-10:00, and, after some time to unpack, at 11:00 all members of the science crew were given a safety induction and ship tour. The gravimeter land tie was successfully undertaken using the Mt Coot-tha base station. At 16:00 we departed Forgacs Shipyard and commenced the pilotage down the Brisbane River. A muster was undertaken at 18:00 to familiarize all personnel with the life raft positions and emergency procedures, followed by a science meeting at 18:30 to explain the objectives of the expedition and introduce all science personnel. The pilot departed the vessel at 21:45 off Mooloolaba. After leaving the shipping channel, swath mapping commenced at 21:53, and the magnetometer was deployed at 23:23. Standard meteorological data were recorded continuously on the transit and throughout the remainder of the voyage. The day ended with the PM science watch members becoming familiar with the techniques of swath mapping. Weather conditions remained excellent, providing a smooth introduction to marine research.

Day 2: Saturday 24th November 2012 (Julian Day 329)

The AM watch started work with an introduction to swath mapping, followed by an abrupt drop off the edge of the continental shelf, complete with erosional scarps and canyons. The ship then proceeded to track south along the lower continental shelf, adding a swath line to a previously surveyed region off the Gold Coast. Gullies and canyons were observed, with the swath system performing well at near-abyssal depths. At 09:00 we commenced collection of sub-bottom profiling data using the Topas system. Mt Warning and mountains of the Tweed shield volcano were sighted on the horizon to the west. At 12:00 (28°36.8'S) we commenced a line headed east, to obtain a geophysical profile over the Tasman Basin and southern summit of Britannia Guyot. Topas data improved markedly after 15:00 while traversing over deep parts of the Tasman abyssal plain. There was considerable excitement in the science group after 17:45 as we began our first transit over the guyot. Debris slope features were observed on the guyot flanks, while the summit region had at least three terraces leading up to a flat top. The eastward transect was completed at 20:00, and we commenced the transit south to Stradbroke Seamount.

Day 3: Sunday 25th November 2012 (Julian Day 330)

The morning was spent swath mapping the western portion of Stradbroke Seamount, building a detailed picture of volcanic features, including craters, volcanic ridges, and lava flows. Plans began for dredge sites on this volcano, including a toolbox meeting at 11:00 to familiarize all scientists with dredging procedures.

The magnetometer was retrieved at 13:00 in preparation for dredging. Dredge TMD-01 entered the water at 14:30 and was back on deck by 17:00 with a full bag comprising volcanic rocks (**Figure 2**), some dead deep-water corals, other biota, and sediment. We then proceeded promptly to the second dredge site, with a short delay to change over to the starboard side winch. Dredge TMD-02 entered the water at 19:17 and was retrieved at 21:03, containing six pieces of igneous rock containing large feldspar phenocrysts, along with siliceous sponges and sediment. The magnetometer was then redeployed, and we proceeded to swath map the eastern portion of the seamount.

Day 4: Monday 26th November 2012 (Julian Day 331)

10:00 in position at 29°03.1'S; 156°03.5'E over the eastern end of Stradbroke Seamount.

Wind 9 kn from 011. Sea state 2/3.

The excellent weather continued, with the morning spent swath mapping the eastern side of Stradbroke Seamount, observing volcanic eruptive features such as craters and rift zones. Strong east to northeast currents often limited west-directed lines to speeds of less than 8 knots. A one-hour delay was also experienced with computer problems on the swath mapping computer and helmsman. Swath mapping was completed by 13:00, and the magnetometer retrieved at 13:07 in preparation for the third dredge, and also to repair the port side winch cable. Dredge TMD-03 entered the water at 15:30, targeting the deep southeastern flank of Stradbroke Seamount. This dredge was recovered on deck at 19:00, containing deep-sea sediment in a pipe dredge. The magnetometer was deployed at 19:30, and the transit north to Britannia Guyot commenced.

Day 5: Tuesday 27th November 2012 (Julian Day 332)

10:00 in position at 28°39.5'S; 155°24.1'E over the southern end of Britannia Guyot.

Wind 13 kn from 013. Sea state 3.

In the morning the Southern Surveyor completed the eastern end of the geophysical transect across this part of the Tasman abyssal basin. Most of the day was then spent swath mapping the southern and western flanks of the very large Britannia Guyot. This revealed an extensive flat-topped plateau, with scallop-shaped edges in places, while up to four terrace surfaces are present off the plateau. Deeper parts of the edifice are covered by what appear to be debris or talus slopes, and there are volcanic rift zones on the southeastern and southwestern flanks. The weather and sea state remain good, although

with an increase of high cloud and a slight increase in wave height.

Day 6: Wednesday 28th November 2012 (Julian Day 333)

10:00 in position at 28°30.9'S; 155° 37.4'E over the eastern end of Britannia Guyot.

Wind 13 kn from 354. Sea state 2/3.

During the morning and early afternoon we swath mapped the western and eastern flanks of Britannia Guyot, and spent some time filling swath holes on the guyot top. The magnetometer was retrieved at 15:00 in preparation for the dredge. This site (TMD-04) targeted one of the terraces on the southeastern guyot flank. The dredge entered the water at 16:00 and was retrieved by 17:51, yielding ~20 kg of carbonate rock and marine organisms. A surface water sample for shore-based geochemistry was also taken at this site. We then proceeded to the southeastern rift zone of the volcano, with dredge TMD-05 entering the water at 19:06 hours. The dredge was back on deck by 21:30, yielding vesicular mafic rocks partially covered by manganese crusts and deep-water organisms. The remainder of the evening was spent swath mapping on the deep eastern flank of the guyot, heading north.

Day 7: Thursday 29th November 2012 (Julian Day 334)

10:00 in position at 28°19.5'S; 155°47.1'E over the northeastern end of Britannia Guyot.

Wind 7 kn from 326. Sea state 1/2.

After three swath lines in the central eastern portion of the guyot, sites were chosen for a Smith-McIntyre grab and a dredge. Unfortunately the winch used for the Smith-McIntyre grab required repairs, so this site had to be aborted. The dredge (TMD-06) targeted the 1000-1700 m step on the eastern flank of the central Britannia Guyot. The dredge entered the water at 07:13 and was back on deck by 09:45, recovering ~15 kg of carbonate sediments and moderately altered volcanic material. Also recovered was a bottle of a well-known liquor brand. The water beneath the cap fizzed when brought on deck, providing a clear demonstration that cold deep-sea waters contain much more dissolved CO_2 than surface waters. Another dredge (TMD-07) was planned nearby in slightly deeper water (1930-1630 m depth). This dredge entered the water at 11:03 and returned on deck by 13:40, yielding ~30 kg of vesicular volcanic rock, as well as carbonate sediments. We then sailed north to map the eastern and western guyot flanks.

Day 8: Friday 30th November 2012 (Julian Day 335)

10:00 in position at 28°05.1'S; 155°38.2'E over the northwestern end of Britannia Guyot.

Wind 4 kn from 339. Sea state 1.

The early hours of the morning were spent completing the mapping the northwestern flank of Britannia Guyot. We now have a near-complete picture of this 50 nm-long feature when the data from this expedition is combined with data previously collected by the Southern Surveyor and Marion Dufrense. The guyot is constructed of three overlapping edifices, with each capped by flat-topped summits, benches on the upper flanks, and gullies and debris slopes on the deeper flanks. In preparation for the next dredge, the magnetometer was retrieved at 09:34 and the ship was in position by 10:00, although a problem with the wire out reading on the starboard side winch delayed dredging until 10:37. A software restart in both the Operations Room and Bridge appeared to have rectified the problem. However, as wire was payed out the discrepancy increased between the winch monitor and the Brattvag display. After a long period at tensions >6000 kg, dredge TMD-08 returned on deck with ~20 kg of ooze, deep-water corals, and volcaniclastic rocks. We then continued swath mapping to the northwest. Magnetometer redeployment was delayed until 14:45 to attach a new length of sacrificial dredge wire, as the previous wire had been damaged on dredge TMD-08. The Brattvag and winch monitor displays were also recalibrated, which solved the problems experienced during TMD-08. After a few hours mapping several interesting canyon features were observed. These were targeted on dredge TMD-09, which entered the water at 19:10 and was back on deck by 22:18, yielding six pieces of volcanic rock freshly broken by dredging, as well as deep-sea sediments in the pipe dredge. The magnetometer was redeployed at 22:45, and we finished the day by transiting over the saddle between Britannia and Queensland Guyots.

Day 9: Saturday 1st December 2012 (Julian Day 336)

10:00 in position at 27°41.8'S; 155°09.1'E over the western end of Queensland Guyot.

Wind 10 kn from 006. Sea state 2.

The early morning was spent swath mapping the western flanks of Queensland Guyot. A promising steep site was identified on the western side of the guyot, and dredge TMD-10 entered the water by 09:38 and was back on deck by 13:11, yielding a single ~5 kg piece of recently broken very hard and fresh mafic volcanic rock, and mud in both pipe dredges. The rock contained quenched glassy rims, plagioclase phenocrysts, and olivine phenocrysts, and some of the olivine phenocrysts contain unaltered material. The ship then continued swath mapping the western flank of Queensland Guyot. The sacrificial wire for the dredge was replaced again, and the magnetometer redeployed. We then mapped the northern flanks of the guyot, identifying a good site on this slope. The dredge (TMD-11) entered the water by 21:04, but unfortunately the wind and current conditions rendered this site unsuitable, and the site had to be abandoned. The ship finished the day mapping the northeastern and eastern sides of the guyot.

Day 10: Sunday 2nd December 2012 (Julian Day 337)

10:00 in position at 27°33.4'S; 155° 18.8'E over the eastern end of Queensland Guyot.

Wind 13 kn from 015. Sea state 3.

After swath mapping the eastern side of the guyot, a promising target was

found that allowed dredging towards the north, into both the wind and local current. This dredge (TMD-12) entered the water at 10:53, with the wire recovered at 13:50, but the dredge was lost as the sacrificial wire had snapped, despite not exceeding the tension rating for the dredge weak link or the wire itself. The remainder of the afternoon was spent swath mapping Queensland Guyot, and at 17:00 we commenced the transit to Mooloolaba so that a scientist (Abbas Babaahmadi) could disembark, as he had been experiencing a deteriorating medical condition. We spent the remainder of the day in transit, in the process collecting swath, Topas, gravity, magnetic, underway climatic, and oceanographic data.

Day 11: Monday 3rd December 2012 (Julian Day 338)

10:00 in position at 26°50.7'S; 153° 55.3'E in transit between Mooloolaba and Brisbane Guyot.

Wind 13 kn from 344. Sea state 3.

The transit to the waters of Mooloolaba was completed around 06:15. After a rapid transfer of Abbas Babaahmadi onto the pilot vessel, the ship commenced a transit east towards Brisbane Guyot, the next volcano north in the Tasmantid chain. During transit the magnetometer experienced a GPS Synchronisation error and communication error, and was retrieved on deck by 10:00. The backup magnetometer, GPS feed, and electrical signal in the cable were also tested, but to no avail. The magnetometer was not successfully redeployed after this point, despite intense effort spanning several days by the scientists, the MNF electronics technician, and emails to the magnetometer owner and builder.

While in deep water (>4000 m) the starboard side winch wire was payed out to its full length and re-wound. This eliminated wire crossovers that had been present on the wire spool. A different batch of sacrificial wire was also used, as the previous batch seemed to bend and fray with unusual regularity. This different batch of sacrificial wire seemed substantially stronger, and was used successfully for the rest of the expedition. The southern end of Brisbane Seamount was reached approximately 18:40, and the remainder of the day was spent swath mapping the southern edifice of this volcano.

Day 12: Tuesday 4th December 2012 (Julian Day 339)

10:00 in position at 26°41.8'S; 155°01.5'E over North Brisbane Guyot.

Wind 22 kn from 322. Sea state 5.

Mapping of the Brisbane Seamounts continued overnight. This area previously lacked high-resolution swath bathymetry, and the multibeam results confirm the seamount is comprised of northern and southern edifices. The northern edifice is higher and has a flat summit, while the southern edifice is somewhat deeper and appears not to have reached wave base. The weather remained sunny, although wind and sea conditions progressively increased through the morning, reaching wind speeds of 25-30 knots for most of the day. Swath data was of generally good quality nonetheless, although lines heading into the wind and waves suffered from some data loss due to cavitation beneath the hull and increased ship motion. The wind and sea conditions prevented dredging, so the time was spent building a complete swath map of the area, and filling in swath holes or areas of bad data. Swath holes were filled by 21:00, and although the wind had decreased somewhat with increasing barometric pressure, the sea state had not eased sufficiently to permit dredging. A decision was therefore made to collect swath, Topas, gravity, and underway data between Brisbane and Queensland Guyots, and return to Brisbane Guyot at dawn to commence dredging.

Day 13: Wednesday 5th December 2012 (Julian Day 340)

10:00 in position at 26°58.3'S; 155°05.7'E over South Brisbane Seamount.

Wind 19 kn from 214. Sea state 4.

The early morning hours were spent transiting back to Brisbane Guyot. During this transit the Topas system failed, and was eventually restarted after a reboot of the program and several hours of problem finding, which was diagnosed as a network connectivity error. On previous expeditions, this network connectivity error had affected both the swath and Topas, although in this case only the Topas was affected. Brisbane seamount was reached around 05:00 hours, with weather conditions becoming progressively milder and suitable for dredging. Two potential dredge sites had to be scrapped – one because of unsuitable bottom topography, and the second because the wind and current direction changed abruptly when the dredge was being lowered to the bottom. The third site was a canyon on the eastern flank of South Brisbane Seamount, with dredge TMD-13 entering the water at 09:04 and on deck by 12:20, but no material was recovered. Dredge TMD-14 targeted the eastern flank of North Brisbane Guyot, entered the water at 14:41, and returned to deck by 17:05 containing a varied haul of fresh mafic rocks, vesicular mafic rocks, carbonates (**Figure 4**), and ooze. One of the gravimeter air shocks was noticed to be flat at 16:00, and a block of dense foam was inserted as a vibration insulator. After the dredge was on deck we then proceeded north to map the eastern side of an unnamed seamount. Various members of the science group suggested names for this seamount, with the voted winner being "Mooloolaba". The swath revealed a broad but low-elevation volcanic region, with the shallowest point being ~2530 m below the seafloor. This seamount was not listed on nautical charts and was previously known by a weak gravity expression.

Day 14: Thursday 6th December 2012 (Julian Day 341)

10:00 in position at 26°00.9'S; 154° 58.2'E over South Moreton Seamount.

Wind 5 kn from 156. Sea state 1.

Mapping of "Mooloolaba" seamount was completed just after midnight, and the ship then proceeded north to map South Moreton Seamount. Swath mapping of this volcano was completed around 07:30, revealing a steep-sided cone with a pointed top, with the backscatter and

Topas results suggesting that the summit is capped by limestone. The northeastern part of the cone was targeted in dredge TMD-15, which entered the water by 08:35 and was on deck by 10:18, yielding ~3 kg of carbonate rocks and deep-water corals in the main dredge and sediment in the pipe dredges. Whilst the dredge was in the water, the gravimeter air shock absorber was changed. The noon meal marked the mid point of the expedition, which was celebrated by a special BBQ on the deck in the sun and light breeze, much enjoyed by the scientists and P&O crewmembers. After lunch, preparations were made for the next dredge (TMD-16) on the northeastern rift zone of the volcano.

The dredge entered the water at 13:48 and returned on deck by 15:44, with a full pipe dredge of deep-sea mud, a cobble of vesicular volcanic rock in the main dredge, a large sponge, and several benthic biota. We then proceeded to the north-northeast to swath map North Moreton Seamount. After swath mapping for a few hours a small ridge on the southwestern volcano flank was targeted in dredge TMD-17. This entered the water at 22:30 and was retrieved on deck after midnight.

Day 15: Friday 7th December 2012 (Julian Day 342)

10:00 in position at 25°44.0'S; 155°05.4'E over North Moreton Seamount.

Wind 14 kn from 061. Sea state 3.

The day started with the recovery of dredge TMD-17 at 01:05, which yielded a small boulder of altered olivine-phyric mafic rock, as well as deep-sea sediments in the pipe dredge. After more time undertaking swath mapping, a second dredge on this seamount (TMD-18) sought rocks from one of the peaks near the summit. This yielded a near-full bag, dominated by hyaloclastites, as well as some deep-sea carbonate (**Figure 4**), biota, and sediments. There were multiple types of hyaloclastites in the dredge, mostly altered, although some may be fresh enough for chronology and chemistry, pending thin section examination on land. In an attempt to recover fresh volcanic rock a third site dredge was planned, this time on another ridge on the SW flank of the volcano. Dredge TMD-19 entered the water at 08:36 and was on deck by 11:42 with ¼ of a bag of limestone and volcanic rocks, as well as sediments in the pipe dredge. The Southern Surveyor then sailed north-northwest in transit to Recorder Seamount, the next volcano in the Tasmantid chain. The remainder of the day was spent mapping the southern side of South Recorder Guyot.

Day 16: Saturday 8th December 2012 (Julian Day 343)

10:00 in position at 25°15.2'S; 154°46.5'E over South Recorder Guyot.

Wind 10 kn from 113. Sea state 2.

The swath mapping of South Recorder Guyot was completed by midmorning, and we headed to dredge site TMD-20 on the southwestern rift flank of the volcano. The dredge was deployed at 12:43 and returned to deck by 14:01 with ~30 kg of limestone, vesicular mafic rock, manganese encrustations, a large sponge, numerous barnacle shells, and some deep-water coral. The ship then proceeded to the next dredge site in a canyon on the western flank of the guyot. This dredge (TMD-21) entered the water at 15:52 and, after numerous periods of high wire tension, was recovered on deck by 19:45 with approximately 20 kg, comprising mud and two pieces of volcanic breccia containing very hard and fresh cobbles. After filling in a large swath hole on the summit, we then proceeded to the eastern summit region to determine if one of the numerous ridges on the crest of the edifice was comprised of volcanic versus carbonate substrate. Dredge TMD-22 was deployed at 21:50 and recovered at 23:45 with ~100 kg of carbonate rocks (**Figure 4**), mud, and marine organisms, ending the day with another successful dredge.

Day 17: Sunday 9th December 2012 (Julian Day 344)

10:00 in position at 25°02.3'S; 155°00.2'E over North Recorder Guyot.

Wind 14 kn from 088. Sea state 3.

Our plan was to start the day with a Smith-McIntyre grab sample on the northeast of the volcano to investigate a patch of very low backscatter response. Unfortunately one of the pumps to operate the winch required repairs, so this attempt was delayed. Instead, the ship proceeded to North Recorder Guyot and undertook swath mapping until late afternoon. We then returned to the Smith-McIntyre site, with deployment at 17:39 and retrieval by 18:18, with ~20 cubic centimetres of foraminifer-rich sediment and other organisms. The ship then proceeded to TMD-23 on North Recorder Guyot, with the dredge entering the water at 19:27 and back on deck by 22:26 containing ~20 kg of ooze with pebbles and a few small carbonate cobbles.

Day 18: Monday 10th December 2012 (Julian Day 345)

10:00 in position at 24°31.5'S; 155°13.8'E over Fraser Guyot.

Wind 22 kn from 141. Sea state 4.

After midnight a further dredge (TMD-24) was attempted on the northwestern rift flank of North Recorder Guyot. Deployment occurred at 01:00 and returned to deck by 03:54, with approximately 30 kg of ooze in the pipe dredges, a large boulder of semi-lithified white mudstone, and a freshly broken piece of volcanic breccia. This volcanic breccia is particularly notable as it contains 1-2 cm wide fragments of very fresh volcanic glass. The Southern Surveyor then steamed north, reaching South Fraser Guyot around 08:00. We then proceeded to swath map this volcano until 18:00.

Dredge TMD-25 entered the water at 18:24, targeting the western slopes of the volcano, and was returned on deck by 21:00 with ~40 kg of limestone cobbles, a broken piece of volcanic rock (a vesicular olivine phyric rock, with altered olivine), deep-sea sediments, and biota. A further dredge (TMD-26) aimed to test if a bench at ~1200 m of water was composed of carbonate or volcanic rock. This was deployed at 21:55 and returned at 23:44 containing ~100

kg of carbonate rock (Figure 4) and ooze, completing operations for the day.

Day 19: Tuesday 11th December 2012 (Julian Day 346)

10:00 in position at 24°07.5'S; 155°18.6'E over North Fraser Guyot.

Wind 21 kn from 136. Sea state 4.

The day commenced with deployment of a third dredge on South Fraser Guyot, targeting an isolated block on the southern side of this edifice. The dredge (TMD-27) entered the water at 00:52 and returned on deck by 03:20, yielding three large broken pieces of volcaniclastic rock and pillow fragments (Figure 3). The pillows were comprised of vesicular olivine and plagioclase-phyric rocks, with fresh glass on the outer rim, but altered olivine. The ship then continued northward to map North Fraser Guyot (**Figure 2**). Mapping was completed around noon, with dredge TMD-28 entering the water at 13:02 and back on deck by 15:15 with ~100 kg of carbonate rocks and deep-sea sediments. An additional dredge (TMD-29) was planned on North Fraser Guyot, but unfortunately was aborted due to worsening weather and wave conditions, with winds above 30 knots and sea state conditions up to 6. Instead the Southern Surveyor proceeded north to the next volcano in the chain, around Cato Island, which was reached around 21:00. Swath mapping continued for the three hours until midnight.

Day 20: Wednesday 12th December 2012 (Julian Day 347)

10:00 in position at 23°08.8'S; 155°37.5'E over Cato Volcano.

Wind 29 kn from 116. Sea state 6/7.

Throughout this 24-hour period winds remained in the 25-30 knot range, with occasional gusts above 35 knots. Unfortunately the worsening sea conditions dictated the gravimeter be shut down just after midnight. Swath mapping of the distal portions of Cato volcano continued through this 24-hour period. The prevailing wind and wave direction dictated that all traverses be oriented along SE-NW directed lines (i.e., either with or directly into the wind and waves) as these headings minimised ship motion. The swath system performed well, although with degradation in data quality for lines headed SE into the wind and waves. Swath performance was nonetheless assisted by water depths of typically 1800-1300 m, within in the optimal range for the EM300 system. Numerous small volcanic cones and regions of carbonate reef growth were observed. During the day one of the gravimeter air shock absorbers developed a leak, and that side of the gravimeter was supported by two dense foam blocks. A highlight for scientists and crew was the sighting of Cato Island and weather station just after the noon meal.

Day 21: Thursday 13th December 2012 (Julian Day 348)

10:00 in position at 23°18.6'S; 155°32.8'E over Cato Volcano.

Wind 22 kn from 136. Sea state 5.

Swath mapping of the Cato volcano continued, allowing us to build a detailed picture of the seafloor in this region. Winds had eased somewhat through the night and early morning, but gusts of over 30 knots were still present, and the sea conditions were still not suitable for dredging or for gravity data collection. Cato Island and Reef were seen at several points during the day. By 21:00 a near-complete bathymetric map had been built of the area. Unfortunately, weather and sea conditions had not moderated sufficiently to allow dredging, so the decision was made to head north to the next volcano north in the chain, surrounding Wreck Reefs. Fortunately the northerly ship heading with a following sea permitted more stable conditions aboard ship, and the gravimeter was restarted after 21:00.

Day 22: Friday 14th December 2012 (Julian Day 349)

10:00 in position at 22°10.3'S; 155°04.3'E over Wreck Volcano.

Wind 21 kn from 174. Sea state 5.

The vicinity of Wreck Volcano was reached after 01:00 local time, and swath and gravity mapping of this feature commenced. Fortunately mapping of the northern side of this volcano put the ship on the downwind side of the coral reefs, allowing somewhat calmer sea conditions. A dredge (TMD-30) targeted the northern side of this volcano, and entered the water at 21:13, with recovery by 23:30 yielding ~20 kg comprised of ooze, a conglomerate with fresh igneous cobbles, and a fossiliferous volcanogenic sandstone.

Day 23: Saturday 15th December 2012 (Julian Day 350)

10:00 in position at 22°16.4'S; 155°11.9'E over Wreck Volcano.

Wind 10 kn from 135. Sea state 2.

Highlights of the day were tours of the engine room for the scientists and the sighting of two moderate-sized cetaceans tentatively identified as false killer whales bow-riding alongside the ship. During the night the southeasterly winds had finally moderated, although a considerable long-period southerly swell remained, becoming progressively smaller during the day. Swath mapping proceeded along the eastern and southern margins of this edifice. Dredge TMD-31 targeted a ridge on the western flank of the volcano, and entered the water at 12:57, returning on deck by 15:46. This site yielded two large broken rocks containing breccia and pillow fragments, some with glassy rinds (**Figure 3**). Another dredge (TMD-32) targeting a canyon on the southern flank entered the water at 18:47 and was still in the water at midnight.

Day 24: Sunday 16th December 2012 (Julian Day 351)

10:00 in position at 22°13.1'S; 155°33.9'E over Wreck Volcano.

Wind 11 kn from 200. Sea state 2.

The day started with the continuation of epic dredge TMD-32, which spent a grand total of eight hours in the water (spanning over parts of both scientific watches, and parts of three bridge watches), with six hours stuck on various obstacles on the seafloor. The dredge finally returned on deck by 02:38, containing a wide variety

of fresh igneous rock types, both as rounded cobbles and as carbonate-cemented breccia (**Figure 3**). Mud, sand, pebbles, and lag deposits containing evidence for a wide variety of biota were also collected in the pipe dredges. Despite the long period of time spent hung up at high tension, the dredge and sacrificial wire were undamaged. Swath mapping then occurred until 10:00, when dredge TMD-33 entered the water on the eastern flank of the volcano. The dredge was retrieved at 12:59, containing carbonate sediments in the pipe dredge. We then proceeded to fill gaps in the swath data on the eastern portion of Wreck Seamount until ~16:00 hours, and then commenced the transit south to Cato Volcano to complete dredging there, as these dredges had been postponed because of the poor weather experienced on days 19-21. During transit the Smith-Mcintyre grab was deployed in order to obtain a sample of deep-water sediments away from the seamounts. This entered the water at 18:52 and was retrieved by 20:13, containing deep-sea sediments from 2448 m depth. Styrofoam cups decorated by the scientists were also deployed on this grab. The transit to Cato then recommenced and was completed around midnight.

Day 25: Monday 17th December 2012 (Julian Day 352)

10:00 in position at 23°12.8'S; 155°22.4'E over Cato Volcano.

Wind 10 kn from 274. Sea state 2.

As Cato Volcano had been comprehensively swath mapped earlier in the expedition, dredging commenced immediately upon arrival. The first target was a steep-sided symmetrical cone in the north of the volcano. Dredge TMD-34 was deployed at 00:20 and recovered by 02:04, containing half a dozen pieces of carbonate-cemented volcaniclastic material, possibly comprised of highly altered scoria. These rocks had thick manganese encrustations and biota attached. There was also ooze in the pipe dredge. The next locality (TMD-35) was a ridge in the north of Cato Volcano. This dredge entered the water at 03:42 and was recovered by 05:57 with half a dozen pieces of vesicular mafic rock, ooze, and attached biota. We then proceeded to dredge TMD-36, on the southern side of a satellite guyot. Deployment commenced at 08:21 and was on deck by 10:52, containing limestone and mud. We then sailed to TMD-37, on a ridge in the western portion of Cato volcano. After ~1 hour testing the variable currents in this area, the dredge entered the water at 15:55 and was recovered by 18:00, yielding a single large piece of fresh volcanic rock containing abundant plagioclase megacrysts and vesicles. The Southern Surveyor then commenced the transit WSW towards the volcanoes in the Capricorn Trough. In transit the ship crossed the Cato Trough, and also observed a deeply incised canyon on the eastern side of the South Marion Plateau.

Day 26: Tuesday 18th December 2012 (Julian Day 353)

10:00 in position at 23°50.5'S; 153°34.9'E over the Capricorn Volcanoes.

Wind 7 kn from 358. Sea state 2.

The transit continued, and the Capricorn volcanoes were reached around 03:00 hours. After two short lines to map these features, two dredges were deployed. Dredge TMD-38 targeted the eastern volcano, and was in the water from 05:43 until 07:23, yielding a few cobble-sized fragments of manganese encrustations, deep-water corals, sponges, and other biota. One specimen also contained a <10 cm fragment of vesicular volcanic rock containing altered olivine phenocrysts.

The western volcanic cone was targeted in dredge TMD-39, which entered the water at 08:16 and was back on deck by 10:05. The dredge yielded a very large (~100 kg) boulder of carbonate rock containing fragments of probable hyaloclastic volcanic origin. In addition, there were a few cobbles of volcaniclastic material, with some clasts containing vesicular volcanic rock with altered olivine phenocrysts. The pipe dredges also contained some mud, as well as deep-water corals and other biota. This was the final dredge of the expedition, concluding a very successful aspect of this voyage. The ship then commenced the final transit southward to Brisbane, in the process collecting new swath data over the canyons east of Fraser Island, over north and south Gardner Bank, and the continental shelf. As for other transits, swath, Topas, gravity, and other underway data were collected continuously. During transit over the continental shelf off Fraser Island, three bottlenose dolphins were observed bow riding, and at 13:00 a biological slick was observed on the water surface. The southward velocity of the ship was enhanced by the East Australian current.

Day 27: Wednesday 19th December 2012 (Julian Day 354)

11:00 in position in position 27°26.8'S; 153°04.6'E berthed at Forgacs Shipyard, Brisbane River

The transit south towards Brisbane continued, reaching the pilot point off Mooloolaba around 04:00 hours. At this point swath and Topas data collection ceased, but gravity data was collected until after the ship had docked. The pilotage was completed at 11:00 hours, with docking at Forgacs Shipyard. The scientific samples were offloaded onto the docks and transported by vehicle to the University of Queensland. The gravimeter land tie to the base station at Mt Coot-tha was also completed that afternoon, and the gravimeter disassembled. All scientific personnel had departed the ship by 16:00 hours, bringing an end to a very productive voyage.

Summary

Overall this voyage was a success, addressing or exceeding each of the stated objectives.

Weather was generally sunny and mild, although winds of greater than 30 knots and high seas prevented dredging on three days. Strong currents over 2 knots were experienced in places over the seamounts. These currents – often highly variable over short (10 km) scales – complicated the planning and execution of dredging, although suitable locations were always found. Mobilisation and demobilisation occurred on time, and the voyage track proceeded largely as planned, with the notable exceptions of the medical evacuation required on day 10, and insufficient time to examine Kenn and Frederic seamounts in the north of the chain, in part due to the need to return to Cato Volcano in conditions suitable for dredging.

Sixteen volcanic edifices within the Tasmantid hotspot chain were mapped in detail using the EM300 system. This mapping allows detailed examination of volcanic structure, carbonate growth, and erosion of the seamounts. The swath system performed well, with the exception of a 'divot' produced beneath the centre beams, which was most pronounced in medium mode, and was likely caused by signal interference.

The dredging program was also fruitful; 39 dredges were attempted, with 35 recovering samples, exceeding the target number of 30 dredges. A wide variety of volcanic rocks, carbonate samples, and deep-sea biota were recovered (**Table 1**). In terms of eruption style, many samples displayed typical characteristics of submarine eruption, such as pillow lava fragments, hyaloclastite textures, or quenched glassy rims (**Table 1**, **Figure 3**).

A variety of drowned Neogene shallow carbonate facies, including reef facies, were recovered along with lithified and unlithified deeper foraminiferal sediments. These samples will allow investigation of earlier reef growth at relatively high latitude in the Coral Sea, along with deep-sea diagenetic processes.

Live- and dead-collected biotas include a diverse range of cnidarians, sponges, echinoderms, molluscs, brachiopods, arthropods and vertebrates, including whalebones, shark teeth and abundant fish otoliths. The data will significantly extend our knowledge of deep-sea biodiversity in this region.

Surface water samples will allow analysis of shallow rare earth element patterns and U and Th concentrations in this part of the Coral Sea for the first time.

The geophysical program of gravity, magnetic, and sub-bottom profiling data was largely successful. The gravimeter performed well, collecting data continuously throughout the expedition, excluding when shut down during high seas (as is typical for this instrument). Topas sub-bottom profiling data was collected semi-continuously, with the exception being during dredges when this instrument was switched off. Typically the seamounts had thin or no sediment cover, resulting in 'hard' reflections in the Topas data. Generally the best sub-bottom profiling data was obtained over the abyssal plain and continental shelf.

The magnetometer collected data from days 1 to 11, covering Stradbroke, Britannia, and Queensland seamounts, and two transits to Mooloolaba. Unfortunately the magnetometer system ceased working on Day 11, and despite repeated efforts no additional data was collected on this instrument. In addition, the magnetometer failed to accurately record time and position data during approximately half of the time it was nominally running (despite no error or warning messages). Currently, approximately 1500 line-km of magnetic data have correct navigation data; if the remaining data can be successfully relocated, the total could increase to up to 3100 line-km of magnetic data.

The data and specimens collected on this expedition will allow construction of an integrated volcanic, geomorphological, plate tectonic, subsidence, erosional, and biological history for the Tasmantid seamounts.

Principal investigators

A. Benjamin Cohen, The University of Queensland, Brisbane, Australia

B. Gregory Webb, The University of Queensland, Brisbane, Australia

C. Paulo Vasconcelos, The University of Queensland, Brisbane, Australia (did not sail)

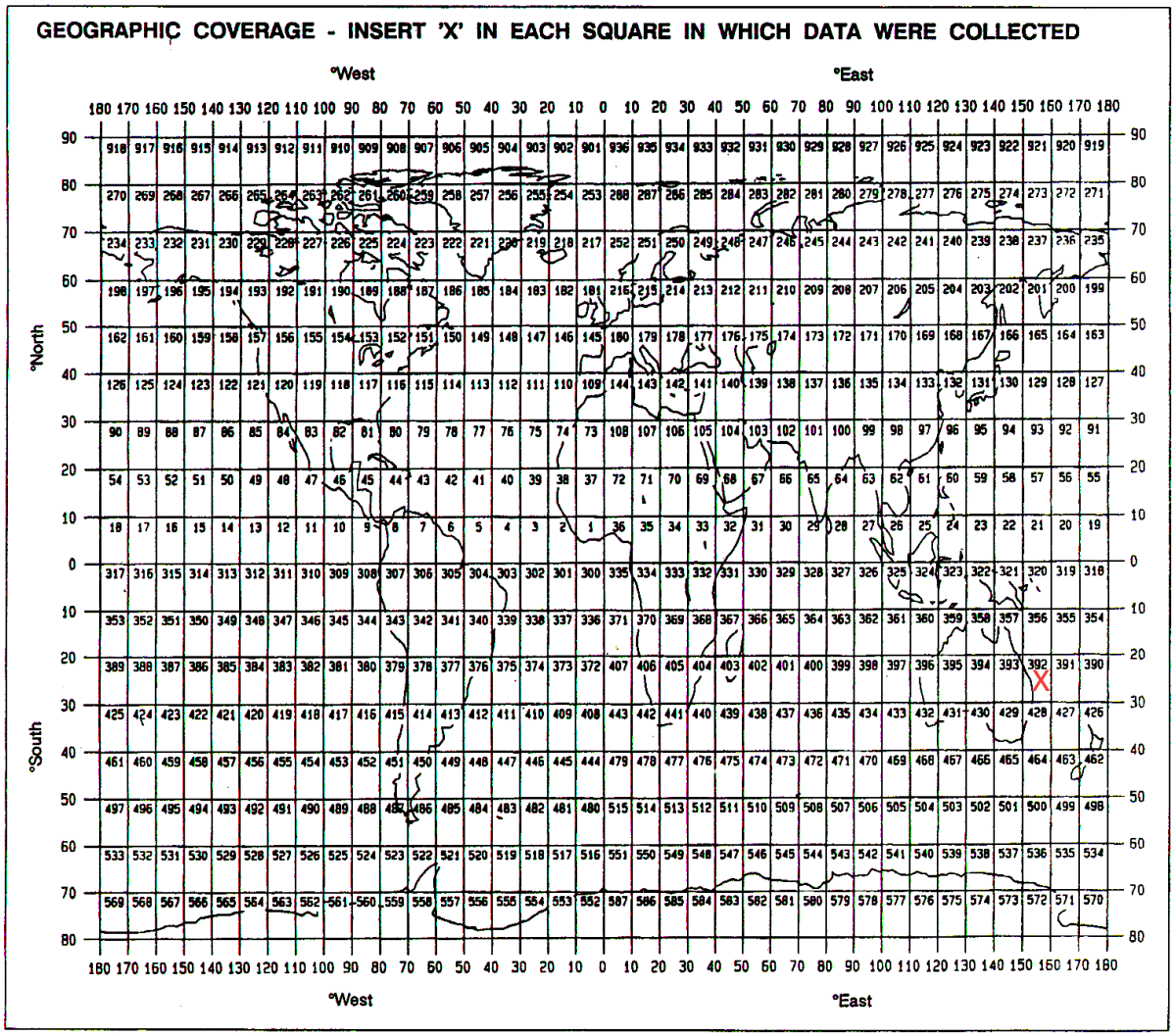
D. Kurt Knesel, The University of Queensland, Brisbane, Australia (did not sail)

E. Richard Arculus, The Australian National University, Canberra, Australia (did not sail)

F. Lara Kalnins, The University of Oxford, United Kingdom (not PI in the proposal)

Marsden Squares

A red "x" indicates where data was collected.



SUMMARY OF MEASUREMENTS AND SAMPLES TAKEN

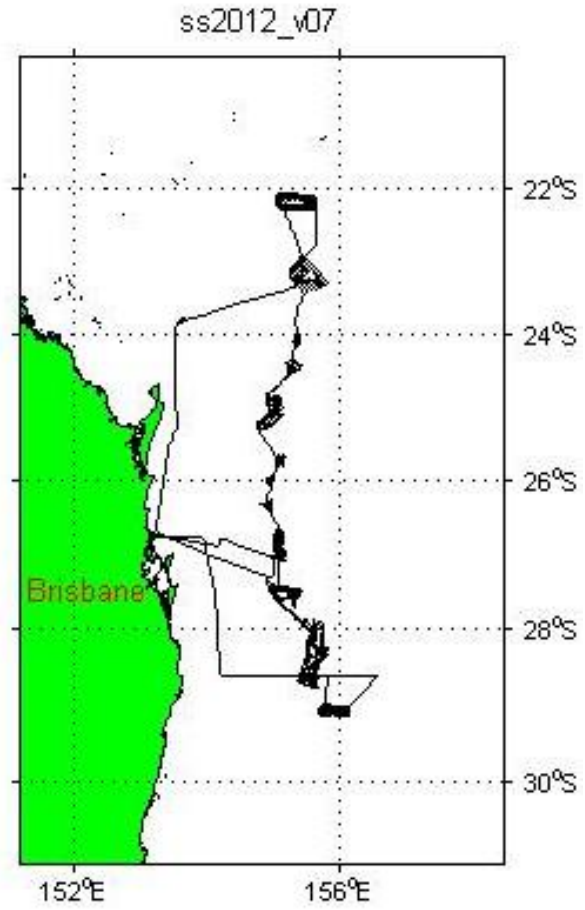
ITEM NO.	PI	NO	UNITS	DATA TYPE	DESCRIPTION
1	A, B, C, D, E	35	stations	G01	Dredged volcanic, carbonate, and biological samples from the seamounts. For chronologic and chemical analyses, and biological characterisation for fossiliferous and organic material.
2	B	2	stations	G02	Smith-McIntyre grab samples of marine sediment.
3	A, B, F	8050	line km	G74	EM300 multibeam data collected continiously during the expedition, except during dredging.
4	A, F	7800	line km	G75	Topas sub bottom profiler data collected continiously during the expedition, except during dredging.
5	A, F	7752	line km	G27	Gravity measurements collected continiously during the expedition, except during high sea conditions.
6	A, F	1481^	line km	G28	Magnetic measurements from towed magnetometer deployed from days 1 to 11, except while dredging.
7	A, F	17	stations	H13	Expendable bathythermograph (XBT) deployed opportunistically when the sound velocity profile changed outside acceptable limits for the swath mapping software.
8	B	6	stations	H09	Surface water sample for trace-element analysis.
9	-	underway	underway	G73	Single beam echosounder data collected continiously during expedition.
10	-	underway	underway	D71	ADCP data collected continuously during the expedition.
11	-	underway	underway	H71	Air temperature, air pressure, other underway ship data.

CURATION REPORT

ITEM NO.	DESCRIPTION
1	Volcanic, carbonate, and biological material held at the School of Earth Sciences, The University of Queensland by PIs A-D. To be curated at the Queensland Museum.
2	Grab sample sediments held by Gregory Webb, School of Earth Sciences, The University of Queensland, email: g.webb@uq.edu.au
3	EM300 multibeam data held by Benjamin Cohen, School of Earth Sciences, The University of Queensland, email: b.cohen@uq.edu.au or benco8@gmail.com, Lara Kalnins, Department of Earth Sciences, The University of Oxford, email larak@earth.ox.ac.uk, and by MNF.
4	Topas sub-bottom profiler data held by Benjamin Cohen, School of Earth Sciences, The University of Queensland, email: b.cohen@uq.edu.au or benco8@gmail.com, Lara Kalnins, Department of Earth Sciences, The University of Oxford, email larak@earth.ox.ac.uk, and by MNF.
5	Gravity measurements held by Benjamin Cohen, School of Earth Sciences, The University of Queensland, email: b.cohen@uq.edu.au or benco8@gmail.com, Lara Kalnins, Department of Earth Sciences, The University of Oxford, email larak@earth.ox.ac.uk, and by MNF.
6	Magnetometer measurements held by Benjamin Cohen, School of Earth Sciences, The University of Queensland, email: b.cohen@uq.edu.au or benco8@gmail.com, Lara Kalnins, Department of Earth Sciences, The University of Oxford, email larak@earth.ox.ac.uk, and by MNF.
7	XBT data held by Benjamin Cohen, School of Earth Sciences, The University of Queensland, email: b.cohen@uq.edu.au or benco8@gmail.com, Lara Kalnins, Department of Earth Sciences, The University of Oxford, email larak@earth.ox.ac.uk, and by MNF.
8	Water samples held by Gregory Webb, School of Earth Sciences, The University of Queensland, email: g.webb@uq.edu.au
9	Single beam echosounder data, held by MNF.
10	ADCP data, held by MNF.
11	Air temperature and air pressure data, held by MNF.

Ship Track for ss2012_v07

Figure 1.



General Ocean Area(S)

Tasman Sea

Coral Sea

Specific Areas

Tasmantid Seamounts
(Stradbroke, Britannia, Queensland, Brisbane, Moreton, Recorder, Fraser, Cato, Wreck)

Capricorn Trough

Gardner Bank

Personnel list

Scientific Participants

Benjamin Cohen	The University of Queensland	Chief Scientist
Lara Kalnins	The University of Queensland/ The University of Oxford	Geophysics/Geomorphology. Co-chief.
Gregory Webb	The University of Queensland	Carbonates
James Sadler	The University of Queensland	Carbonates
Tracey Crossingham	The University of Queensland	Igneous Petrology
Beatriz Britto Pereira	The University of Queensland	Igneous Petrology
Ian Fortes	The University of Queensland	Igneous Petrology
Toby Cunningham	The University of Queensland	Igneous Petrology
Abbas Babaahmadi	The University of Queensland	Petrology/Geophysics
Dario Hogg	The University of Queensland	General assistance
Lisa Woodward	CMAR	MNF Voyage manager
Tara Martin	CMAR	MNF Swath Mapping
Rod Palmer	CMAR	MNF Electronics Support
Anoosh Sarraf	CMAR	MNF Computing Support

Marine Crew

Name	Role
Michael Watson	Master
John Boyes	First Mate
Simon Smeaton	Second Mate
Fred Rostron	Chief Engineer
Mike Yorke-Barber	First Engineer
Mike Sinclair	Second Engineer
Stephen Leslie	Chief Cook
Bret Brooker	Second Cook
Ricky Johnston	Steward
Graham McDougall	Boatswain
Nathan Arahanga	Integrated Rating
Kel Lewis	Integrated Rating
Jonathon Lumbs	Integrated Rating
Rod Langham	Integrated Rating

Acknowledgements

This voyage would not have been successful without the invaluable and much appreciated assistance of many people and organisations. In particular, the Marine Crew led by Master Michael Watson enabled the scientific activities to proceed smoothly - despite the seamounts desperately trying to keep the dredges as 'souvenirs'. The MNF team also provided invaluable assistance before and during the voyage. The National Oceanographic Centre (UK) and Geoscience Australia are acknowledged for providing the gravimeter and magnetometer, respectively. Maria Seton and the voyage ss2012_v06 are thanked for jointly sharing the costs for gravimeter and magnetometer mobilisation and demobilisation. Simon Williams also provided assistance during gravimeter mobilisation. Rob Beaman, Tony Ewart, Neville Exon, Anthony Koppers, Ian McDougall, Chris Peirce, and Tony Watts provided helpful discussion and advice. Staff at Geoscience Australia also provided advice, with particular thanks to Ray de Graaf (magnetometer), Michele Spinoccia (bathymetry), and Ray Tracey (gravity base stations), and to Jon Seddon (gravimeter) at the National Oceanographic Centre (UK). Support staff at The University of Queensland, especially Hannah Hartig and Tracy Paroz, were wonderful during pre-voyage preparations. Keith Cohen, Grant Dawson, and Ryan Petterson also assisted during mobilisation and demobilisation. Voyage funds were gratefully received from CSIRO, the UQ-AGES laboratory, the Marine Geoscience Organisation of Australia (MARGO), Australian Geographic, the Geological Society of London, the Jeremy Wilson Charitable Trust, and InterRidge. Lastly, the Coral Sea Conservation Zone and Great Barrier Reef National Park World Heritage Area are thanked for providing Scientific Permits allowing this voyage to proceed in these remote and fascinating parts of Australia's marine jurisdiction.

Benjamin Cohen
Chief Scientist

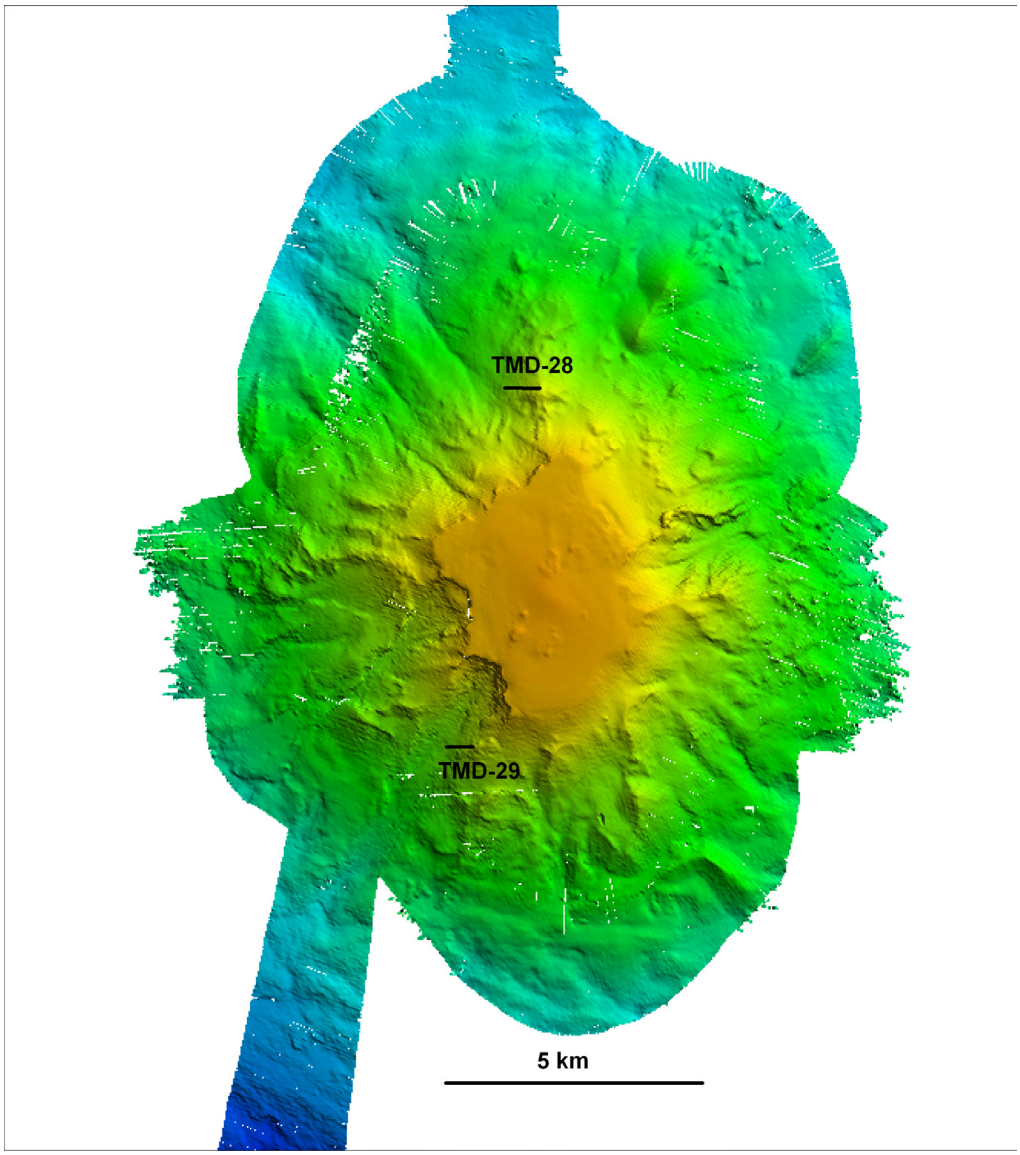


Figure 2: Bathymetric data from North Fraser Guyot. This relatively small volcano has a flat upper surface, capped by submerged coral reefs. The flanks of the seamount have numerous canyons and gullies. Volcanic features such as ridges and cones are also apparent. Orange indicates depths of ~1200m, and blue ~4000 m.

(a)

(b)

(c)

(d)

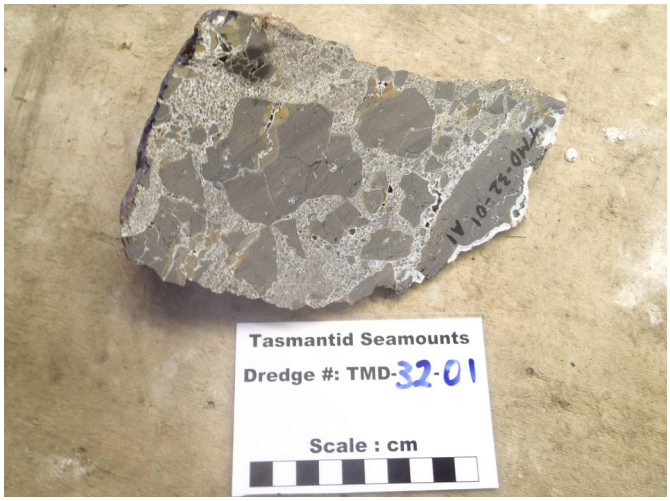
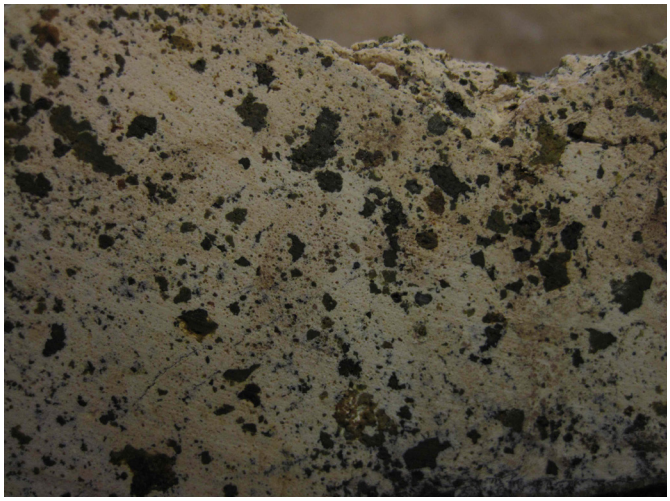


Figure 3: (a) Multi-lithic volcanic breccia with thick manganese crust, dredge TMD-01. (b) Pillow lava with quenched glassy rim, pipe vesicles (filled by carbonate) and a fresh glassy rim. The orange areas in the main rock are olivine phenocrysts altered to iddingsite. TMD-27.
(c) Breccia with black angular fragments of fresh glass, TMD-31. (d) Carbonate-cemented breccia with fresh fragments of plagioclase phyric rock, TMD-32.

(a)

(b)



(c)

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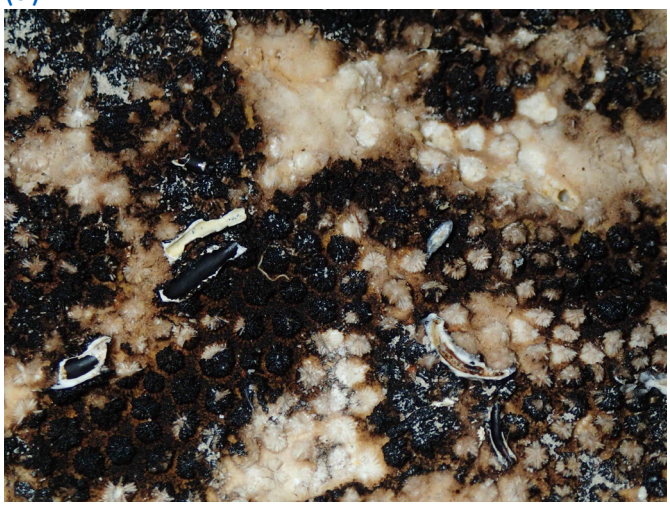

Figure 4: (a) Bioturbated foraminiferal packstone, TMD-14. (b) Hyaloclastite(?) fragments in foraminiferal packstone, TMD-18. (c) Deep water coral assemblage and other organisms, TMD-22. (d) Fossil reef coral, TMD-26

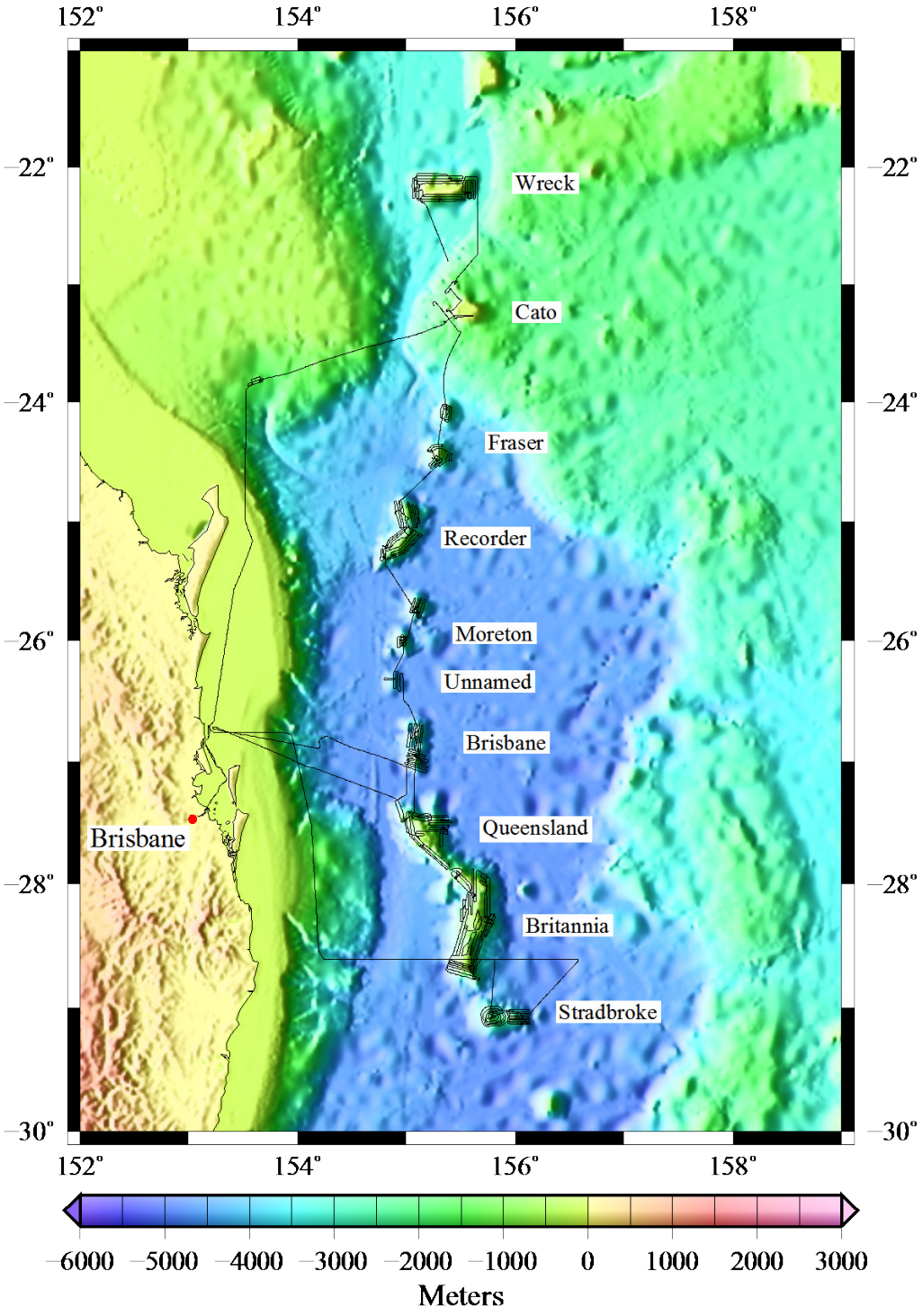

Figure 5: Track map showing the portions where gravity data was collected. Gravity data was collected consciously throughout the voyage, with the exception of parts of Cato seamount, where the gravimeter was locked down due to high seas. Note that the Fraser, Recorder, Moreton, Brisbane, and Britannia are comprised of multiple edifices.

TABLE 1. SUMMARY OF DREDGES, SS2012_V07

Latitude, longitude, and depth values in square brackets [ ] are for the end of the dredge

DREDGE NO.	LOCATION	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	RECOVERY (KG)	SHIPBOARD SUMMARY OF MATERIAL RECOVERED
TMD-01	Summit ridge of Stradbroke Seamount	29°04.9' [29°05.1']	155°47.4' [155°47.2']	1460 [1250]	300	**Igneous:** vesicular and non-vesicular mafic rocks, some with plagioclase and/or iddingsite phenocrysts, pillow lava, hyaloclastite, breccia, volcanogenic(?) sandstone. **Sedimentary:** cobbles of paraconglomerate containing igneous pebbles floating in foraminiferal packstone to wakestone matrix. Larger fossils rare, commonly Mn stained or moulds. Mn dendrolites common within matrix. Some potentially nodular rocks consist of intermixed carbonate and Mn dendrolites that appear to have grown together. Mn crusts. **Biota:** variety of deep-sea corals [alcyonarians, zoantharians, including abundant dendroid scleractinians (Lophelia) and hydrozoans], siliceous sponges, echinoderms, etc. **Ooze:** contains abundant foraminifers, includes lag component (whale bones and two shark teeth among diverse abraded biota).
TMD-02	Volcanic dome, N flank of Stradbroke Seamount	29°02.8' [29°03.1']	155°47.4' [155°47.2']	2000 [1790]	5	**Igneous:** plagioclase phyric vesicular mafic rocks. **Sedimentary:** Mn crusts. **Biota:** a variety of siliceous sponges and deep-sea corals in small quantities. **Ooze:** contains abundant foraminifers.
TMD-03	Volcanic dome, SE flank of Stradbroke Seamount	29°07.1' [29°07.2']	156°04.4' [156°04.3']	3480 [3380]	5	**Ooze:** contains abundant foraminifers.
TMD-04	Bench on SE flank of South Britannia Guyot	28°40.3' [28°40.3']	155°36.0' [155°35.7']	910 [750]	30	**Sedimentary:** cobbles of heavily bioeroded, recrystallised bioclastic and coralliferous limestone; paraconglomerate with foraminiferal packstone matrix; bioeroded and Mn stained foraminiferal packstone with variable induration. Mn crusts **Biota:** a variety of alcyonarians and echinoderms (crinoids and ophiuroids). **Ooze:** contains abundant foraminifers.
TMD-05	Rift zone on SE flank of South Britannia Guyot	28°45.8' [28°45.6']	155°37.9' [155°37.9']	1480 [1330]	100	**Igneous:** vesicular mafic rocks, some plagioclase phyric, at least one pillow lava, volcaniclastic(?) sandstone. **Sedimentary:** minor carbonate rock in matrix of conglomerate. Mn crusts. **Biota:** crinoid and alcyonarians with siliceous sponge.
TMD-06	Slope on E flank of Central Britannia Guyot	28°18.9' [28°18.9']	155°45.2' [155°44.9']	1400 [1200	15	**Igneous:** altered volcanic breccia, vesicular plagioclase+iddingsite-phyric mafic rock. **Sedimentary:** Mn crusts. **Biota:** alcyonarian and hydrozoans. **Ooze:** contains abundant foraminifers. **Other:** Glass bottle.
TMD-07	Rift zone on E flank of Central Britannia Guyot	28°17.4' [28°17.4']	155°46.3' [155°45.9']	1930 [1630]	30	**Igneous:** vesicular mafic rock, some with iddingsite and/or plagioclase phenocrysts, volcanic breccia. **Sedimentary:** minor conglomerate with foraminiferal packstone matrix beneath Mn crusts as well as cobbles of heavily bioeroded foraminiferal packstone. Mn crusts. **Ooze:** contains abundant foraminifers with some discrete clay-rich bands.

TABLE 1. SUMMARY OF DREDGES, SS2012_V07 CONTINUED

Latitude, longitude, and depth values in square brackets [ ] are for the end of the dredge

DREDGE NO.	LOCATION	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	RECOVERY (KG)	SHIPBOARD SUMMARY OF MATERIAL RECOVERED
TMD-08	Canyon on W flank of Britannia Guyot (in between north and central edifices)	28°05.6' [28°05.8']	155°37.7' [155°37.6']	1710 [1420]	20	**Igneous:** iddingsite-phyric mafic rock, volcaniclastic sediments with ~1 cm plagioclase crystals. **Sedimentary:** a few pebbles of recrystallised bioclastic grainstone, a rhodolith. Mn crusts. **Biota:** large collection of the dead scleractinian coral Desmophyllum(?), siliceous sponges, alcyonarians, brachiopods, molluscs. **Ooze:** contains abundant foraminifers and waterlogged pumice
TMD-09	Canyon on W flank of North Britannia Guyot	27°57.4' [27°57.2']	155°27.3' [155°27.2']	2520 [2220]	15	**Igneous:** iddingsite and pyroxene(?) phyric vesicular mafic rock, clast- and matrix-dominated volcanic breccia. Glass is present in some breccias. **Sedimentary:** Mn crusts. **Ooze:** contains abundant foraminifers.
TMD-10	Canyon on W side of Queensland Guyot	27°41.7' [27°41.3']	155°09.1' [155°09.2']	2060 [1700]	25	**Igneous:** olivine and plagioclase phyric mafic rock (with preserved fresh olivine) and glassy quenched rims. **Sedimentary:** thin Mn crusts. **Biota:** one large ophiuoroid and a golden coral. **Ooze:** contains abundant foraminifers.
TMD-11	Slope on N side of Queensland Guyot	27°27.0' [27°27.2']	155°07.4' [155°07.4']	NA	NA	Site aborted due to unfavourable wind direction
TMD-12	Canyon on E side of Queensland Guyot	27°32.9' [27°32.7']	155°19.9' [155°19.9']	2360 [1760]	NA	Dredge lost due to snapped sacrificial wire.
TMD-13	Canyon on E South Brisbane Seamount	26°58.2' [26°58.4']	155°05.8' [155°05.7']	2280 [2010]	NA	Dredge empty, despite hitting bottom with several good 'bites'.
TMD-14	Eastern rift flank of North Brisbane Seamount	26°45.4' [26°45.6']	155°05.1' [155°04.9']	1550 [1370]	100	**Igneous:** non-vesicular mafic rock with plagioclase+iddingsite phenocrysts, vesicular mafic rock, volcanic breccia. **Sedimentary:** large blocks and cobbles of foraminiferal packstone, bioeroded. Some small pebbles of older recrystallised limestone with mouldic porosity occur as clasts in conglomerate. Mn crusts. **Biota:** solitary scleractinian corals attached to blocks, siliceous sponges, molluscs. **Ooze:** contains abundant foraminifers.
TMD-15	NE flank of South Moreton Guyot	26°00.5' [26°00.6']	154°58.0' [154°57.8']	1190 [970]	15	**Sedimentary:** small pebbles of recrystallised coralliferous limestone with mouldic porosity and larger cobbles of bioeroded and Mn stained foraminiferal packstone. **Biota:** several types of solitary deep sea scleractinian corals and Desmophyllum and alcyonarians. A single small xenophorid gastropod (carrier shell) with a single pumice pebble attached. **Ooze:** contains abundant foraminifers, but overall is probably a lag sediment, including a shark tooth.

TABLE 1. SUMMARY OF DREDGES, SS2012_V07 CONTINUED

Latitude, longitude, and depth values in square brackets [ ] are for the end of the dredge

DREDGE NO.	LOCATION	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	RECOVERY (KG)	SHIPBOARD SUMMARY OF MATERIAL RECOVERED
TMD-16	NE rift zone of South Moreton Seamount	25°59.4' [25°59.4']	154°58.0' [154°58.2']	1940 [1760]	10	**Igneous:** iddingsite and plagioclase phyric vesicular mafic rock. **Sedimentary:** Mn crusts. **Biota:** large siliceous sponges, scleractinian coral, a single Desmophyllum(?) corallite, and an alcyonarian. **Ooze:** contains abundant foraminifers but no pteropods, also piece of waterlogged pumice.
TMD-17	SW flank of North Moreton Seamount	25°45.4' [25°45.4']	155°04.3' [155°04.5']	2340 [2220]	20	**Igneous:** small boulder of iddingsite-phyric mafic rock. **Sedimentary:** bioeroded and Mn-crust-stained foraminifer packstone. Mn crusts. **Biota:** barnacle shells, sponges, ophiuroid. **Ooze:** contains abundant foraminifers.
TMD-18	Summit of North Moreton Seamount.	25°42.4' [25°42.2'	155°05.2' [155°05.5']	1750 [1560]	400	**Igneous:** various hyaloclastites. **Sedimentary:** friable volcaniclastic-rich foraminifer packstone, finer-grained limestone in matrix between pebbles, in some cases overlying foraminifer packstone. Mn crusts. **Biota:** barnacles, alcyonarians, molluscs and sponges. **Ooze:** contains abundant foraminifers.
TMD-19	SW flank of North Moreton Seamount	25°44.1' [25°44.1']	155°04.6' [155°04.9']	2080 [1820]	50	**Igneous:** iddingsite-phyric vesicular mafic rock, volcanic breccia, some fresh volcanic glass. **Sedimentary:** heavily bioeroded, Mn crust stained foraminifer packstone. Mn crusts. **Biota:** large siliceous sponges, alcyonarians and one attached scleractinian coral. **Ooze:** contains abundant foraminifers.
TMD-20	SW flank of South Recorder Guyot	25°17.7' [25°17.9']	154°47.5' [154°47.8']	2210 [1940]	30	**Igneous:** iddingsite-phyric vesicular mafic rocks. **Sedimentary:** heavily bioeroded recrystallised bioclastic limestone. Mn crusts. **Biota:** large number of large barnacle plates along with siliceous sponge, deep-water coral. **Ooze:** small amount, contains abundant foraminifers and waterlogged pumice.
TMD-21	Canyon on W flank of South Recorder Guyot	25°12.5' [25°12.3']	154°48.7' [154°48.9']	2750 [2390]	20	**Igneous:** volcaniclastic breccias with aphanitic or iddingsite-phyric clasts. **Sedimentary:** Mn crusts. **Ooze:** contains abundant foraminifers.
TMD-22	Ridge near summit of South Recorder Guyot	25°07.8' [25°07.6']	154°59.9' [155°00.1']	1100 [880]	70	**Sedimentary:** two major types of limestone: a recrystallised coralliferous, bioclastic grainstone to floatstone and floatstone consisting of recrystallised limestone clasts in finer grained foraminiferal packstone. Mn crusts. **Biota:** variety of corals (Lophelia, Desmophyllum and various solitary scleractinian corals, alcyonarians and hydrozoans), molluscs, brachiopods, and crinoids. **Ooze:** contains abundant foraminifers, including some reworked older benthic foraminifers from limestone.
TMD-23	Canyon on S flank of North Recorder Guyot	24°59.2' [24°59.0']	155°00.6' [155°00.9']	2250 [1990]	20	**Sedimentary:** poorly indurated, bioturbated and Mn oxide-stained yellow foraminifer packstone. **Biota:** some intact siliceous sponges on holdfasts as well as a trochoid solitary scleractinian coral. **Ooze:** contains abundant foraminifers.

TABLE 1. SUMMARY OF DREDGES, SS2012_V07 CONTINUED

Latitude, longitude, and depth values in square brackets [ ] are for the end of the dredge

DREDGE NO.	LOCATION	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	RECOVERY (KG)	SHIPBOARD SUMMARY OF MATERIAL RECOVERED
TMD-24	NW rift zone of North Recorder Guyot	24°55.0' [24°54.8']	154°54.7' [154°54.9']	2330 [2030]	30	**Igneous:** volcanic breccia containing fresh glass, iddingsite-phyric vesicular mafic rock. **Sedimentary:** well-indurated fined-grained foraminifer packstone to wackestone with varying degrees of staining and Mn dendroid invasion. Mn crusts. **Biota:** one spiral alcyonarian. **Ooze:** contains abundant foraminifers.
TMD-25	NW flank of South Fraser Guyot	24°24.5' [24°24.5']	155°12.6' [155°12.8']	2330 [2130]	40	**Igneous:** iddingsite-phyric vesicular mafic rock. **Sedimentary:** well-preserved round rhodoliths within recrystallised bioclastic grainstone, recrystallised bioclastic grainstone with mouldic porosity, dense white micrite, several limestone pebbles. Waterlogged pumice. Mn crusts. **Biota:** diverse lag sample with alcyonarians, scleractinians, barnacles, and many pteropods, etc.
TMD-26	Bench on SW of South Fraser Guyot	24°28.2' [24°28.2']	155°14.5' [155°14.8']	1330 [1190]	100	**Sedimentary:** large collection of recrystallised coralliferous limestone including foraminiferal grainstone and coral rudstone to floatstone mostly with mouldic porosity. Mn crusts in places. **Biota:** Desmophyllum, various solitary corals, scaphopods, bivalves and gastropods with echinoid plates along with several reworked larger foraminifers from older limestone. **Ooze:** contains abundant foraminifers.
TMD-27	Block on S flank of South Fraser Guyot	24°29.7' [24°29.6']	155°17.1' [155°17.3']	1860 [1670]	30	**Igneous:** iddingsite and plagioclase-phyric mafic pillow lava with glassy quenched rim, volcaniclastic breccia. **Sedimentary:** Mn crusts. **Biota:** gastropods, siliceous sponges. **Ooze:** contains abundant foraminifers.
TMD-28	N rift flank of North Fraser Guyot	24°03.6' [24°03.6']	155°21.3' [155°21.7']	1980 [1670]	100	**Sedimentary:** large collection of foraminiferal packstone, cobbles and freshly broken blocks with heavy bioturbation. Some blocks show clear ichnofossils (which may help establish palaeodepth). Mn crusts. **Ooze:** contains abundant foraminifers.
TMD-29	S flank of North Fraser Guyot	24°07.4' [24°07.4']	155°20.7' [155°21.0']	NA	NA	Site aborted due to unfavourably high winds and seas.
TMD-30	Ridge at head of canyon on N flank of Wreck Volcano	22°05.7' [22°05.6']	155°23.35' [155°23.2']	1570 [1440]	20	**Igneous:** Conglomerate with igneous cobbles, volcaniclastic sandstone. **Sedimentary:** Sandstone to conglomerate with carbonate matrix, small reworked pebble of older recrystallised limestone. Mn crusts. **Biota:** small biota (gastropods, corals, alcyonarian fragments, small irregular echinoids, etc.). **Ooze:** contains abundant foraminifers.
TMD-31	Ridge on W flank of Wreck Volcano	22°11.2' [22°11.0']	155°04.5' [155°04.4']	2210 [2040]	40	**Igneous:** breccia with pillow fragments, fresh volcanic glass, and iddingsite-phyric vesicular mafic rocks. **Sedimentary:** small pebbles and cobbles of limestone. Mn crusts. **Biota:** Alcyonarians and barnacles. **Ooze:** contains abundant foraminifers.

TABLE 1. SUMMARY OF DREDGES, SS2012_V07 CONTINUED

Latitude, longitude, and depth values in square brackets [ ] are for the end of the dredge

DREDGE NO.	LOCATION	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	RECOVERY (KG)	SHIPBOARD SUMMARY OF MATERIAL RECOVERED
TMD-32	Canyon on S flank of Wreck Volcano (Dredge in water for 8 hours)	22°16.3' [22°16.1']	155°18.0' [155°18.1']	2320 [2170]	40	**Igneous:** variably aphanitic or plagioclase- or iddingsite-phyric mafic rocks, either as carbonate-cemented volcanic breccia, or cobbles of non vesicular or vesicular mafic rock. **Sedimentary:** apparently some limestone among small rounded beach(?) pebbles. Some carbonate cements occur in igneous rocks. Thin Mn crusts. **Biota:** molluscs and some shallow material including coral and Halimeda flakes apparently washed down from modern reef. **Ooze:** contains abundant foraminifers.
TMD-33	Bench on the E flank of Wreck Volcano	22°12.9' [22°12.8']	155°33.5' [155°33.2']	1710 [1350]	30	**Biota:** small gastropods and bivalves in ooze. **Ooze:** contains abundant foraminifers.
TMD-34	Small cone to the north of Cato Reef	22°59.4' [22°58.9']	155°27.2' [155°27.5']	1380 [1050]	30	**Igneous:** clast-supported pebble conglomerate of scoria(?) fragments in carbonate cement. **Sedimentary:** Mn crusts. **Biota:** diverse larger fauna, including live stalked crinoid, alcyonarians, barnacles, and solitary and dendroid scleractinian corals. Some siliceous sponges on cobbles. **Ooze:** contains abundant foraminifers.
TMD-35	Small ridge to the north of Cato Reef	23°04.0' [23°03.6']	155°22.7' [155°23.1']	1900 [1570]	30	**Igneous:** olivine phyric vesicular mafic rock, possible pillow lava. **Sedimentary:** relatively well indurated, heavily bioeroded and Mn stained foraminifer packstones. Mn crusts. **Biota:** small bivalves and scaphopods. **Ooze:** contains abundant foraminifers.
TMD-36	S flank of satellite Guyot, W of Cato Reef	23°13.1' [23°12.7']	155°22.1' [155°22.4']	1210 [900]	10	**Sedimentary:** two major types of carbonate rocks showing stratigraphic contact – recrystallised bioclastic grainstone containing large benthic foraminifers with some pieces also containing crinoids and overlying with sharp contact foraminiferal wackestone to packstone. Both rock types are in places covered by Mn crusts and both were eroding at the sea floor. **Ooze:** contains abundant foraminifers.
TMD-37	Ridge to the WSW of Cato Reef	23°19.0' [23°18.8']	155°20.6' [155°20.5']	1560 [1320]	20	**Igneous:** plagioclase- and olivine-phyric vesicular mafic rock. Sedimentary: Mn crusts.
TMD-38	E Capricorn cone	23°48.9' [23°48.5']	153°38.9' [153°39.0']	1460 [1310]	5	**Igneous:** iddingsite-phyric vesicular mafic rock. **Sedimentary:** Mn crusts. **Biota:** a large collection of blue gorgonians and golden coral were recovered along with a live crinoid and several nudibranchs. Dead alcyonarians and siliceous sponges are abundant.
TMD-39	W Capricorn cone	23°50.4' [23°50.0']	153°35.0' [153°35.0']	1370 [1190]	100	**Igneous:** hyaloclastite dominated by carbonate matrix, multi-lithic volcaniclastic breccia. **Sedimentary:** abundant fine-grained dolomite(?) containing hyaloclastic fragments and rare foraminifers and larger fossils (gastropods, pteropods and coral) along with less abundant foraminiferal wackestone containing abundant Mn oxide-stained shelled fossils (pteropods?). Mn crusts. **Biota:** large starfish, some nudibranchs. **Ooze:** little recovered, but contains foraminifers.

TABLE 2. SUMMARY OF SEDIMENT SMITH-MCINTYRE GRABS, SS2012_V07

SAMPLE	DATE (GMI)	LATITUDE (°S)	LONGITUDE (°E)	WATER DEPTH (M)	WIND (KNOTS/ DIRECTION)	SEA STATE	COMMENT
TMD-G-01	28/11/12	28º17.5'	155º4.0'	740	8/346	2	Summit of Britannia Guyot. Grab aborted due to winch problems.
TMD-G-02	09/12/12	25º06.6'	155º02.1'	1230	12/112	3	From a zone of low backscatter on the northern summit region of Recorder South Guyot. Approximately 20 ccs of foraminifer-rich mud.
TMD-G-03	16/12/12	22º35.1'	155º39.4'	2448	8/124	2	Deep-sea sediments from approximately midway between Wreck and Cato. Full bucket.

TABLE 3. SUMMARY OF SURFACE WATER SAMPLE LOCATIONS, SS2012_V07

SAMPLE	DATE (GMI)	LATITUDE (°S)	LONGITUDE (°E)	WIND (KNOTS/ DIRECTION)	SEA STATE	COMMENT
TMD-Water-01	28/11/12	28°40.3'	155°36.0'	14/008	2	At dredge TMD-04 (South Britannia Guyot).
TMD-Water-02	03/12/12	26º52.0'	154º12.2'	12/001	2	Approximately ½ way between Mooloolaba and Brisbane Seamount.
TMD-Water-03	11/12/12	24º03.6'	155º21.3'	27/346	6	At dredge TMD-28 (North Fraser Guyot).
TMD-Water-04	11/12/12	24º03.6'	155º21.3'	27/346	6	At dredge TMD-28 (North Fraser Guyot). Unfiltered
TMD-Water-05	16/12/12	22º12.9'	155º33.4'	11/193	2	At dredge TMD-33 (E flank of Wreck).
TMD-Water-06	16/12/12	22º12.9'	155º33.4'	11/193	2	At dredge TMD-33 (E flank of Wreck). Unfiltered.

Surface water collected in plastic bucket over the starboard side; 1 litre acidified with 2 ml of 70% HNO3.
Samples 01, 02, 03, and 05 are filtered to 22 µm; samples 04 and 06 are unfiltered.

TABLE 4. SUMMARY OF XBT LOCATIONS, SS2012_V07

All XBT's are Deep Blue

DROP NO.	DATE (GMT)	TIME (GMT)	LATITUDE (°S)	LONGITUDE (°E)	PROBE SERIAL NO.	XBT SST (°C)	SOUNDER DEPTH (M)	OK (Y/N)	COMMENTS
1	24/11/12	05:02	28°26.82'	154°49.75'	1089394	23.307	4572	Y	Britannia
2	24/11/12	12:22	28°57.42'	155°46.99'	1089398	24.037	3467	Y	Stradbroke
3	26/11/12	10:00	29°03.06'	156°06.94'	1089402	23.844	4423	N	To 500 m – Bad drop
4	26/11/12	18:20	28°26.82'	155°46.79'	1089395	24.680	3954	Y	Britannia
5	27/11/12	06:46	28°89.20'	155°22.75'	1089405	23.470	4023	Y	Britannia
6	27/11/12	12:59	28°18.23'	155°31.11'	1089401	23.577	1600	Y	Nth Britannia
7	29/11/12	08:58	28°09.63'	155°92.84'	1089403	25.481	1006	Y	Nth Britannia
8	30/11/12	07:42	27°56.18'	155°30.85'	1089339	26.180	823	Y	Queensland
9	01/12/12	05:50	27°29.92'	155°00.22'	1089397	24.530	1798	Y	Queensland – NW tip
10	05/12/12	09:50	26°18.92'	154°58.05'	1089396	26.173	4553	Y	Unnamed
11	07/12/12	10:28	25°16.90'	154°51.99'	1089404	24.890	1481	Y	South Recorder
12	09/12/12	03:05	25°02.28'	154°58.39'	1089400	25.793	2919	Y	North Recorder
13	12/12/12	06:21	23°00.71'	155°25.04'	1124170	26.192	1339	Y	Cato
14	14/12/12	00:05	22°10.56'	155°04.33'	1124171	25.850	2208	Y	Wreck – western side
15	17/12/12	17:05	23°48.06'	153°41.39'	1124177	26.824	1551	Y	Capricorn (note: XBT data is near edge of climate data)
16	17/12/12	17:14	23°48.58'	153°39.08'	1124176	26.870	1388	Y	Capricorn (this drop confirms that the data from drop #15 is valid)
17	18/12/12	05:28	24°48.36'	153°30.93'	1124178	25.731	123	Y	Gardner Bank.

CSR/ROSCOP PARAMETER CODES

M01	Upper air observations
M02	Incident radiation
M05	Occasional standard measurements
M06	Routine standard measurements
M71	Atmospheric chemistry
M90	Other meteorological measurements

PHYSICAL OCEANOGRAPHY

H71	Surface measurements underway (T,S)
H13	Bathythermograph
H09	Water bottle stations
H10	CTD stations
H11	Subsurface measurements underway (T,S)
H72	Thermistor chain
H16	Transparency (eg transmissometer)
H17	Optics (eg underwater light levels)
H73	Geochemical tracers (eg freons)
D01	Current meters
D71	Current profiler (eg ADCP)
D03	Currents measured from ship drift
D04	GEK
D05	Surface drifters/drifting buoys
D06	Neutrally buoyant floats
D09	Sea level (incl. Bottom pressure & inverted echosounder)
D72	Instrumented wave measurements
D90	Other physical oceanographic measurements

CHEMICAL OCEANOGRAPHY

H21	Oxygen
H74	Carbon dioxide
H33	Other dissolved gases
H22	Phosphate
H23	Total - P
H24	Nitrate
H25	Nitrite
H75	Total - N
H76	Ammonia
H26	Silicate
H27	Alkalinity
H28	PH
H30	Trace elements
H31	Radioactivity
H32	Isotopes
H90	Other chemical oceanographic measurements

MARINE CONTAMINANTS/POLLUTION

P01	Suspended matter
P02	Trace metals
P03	Petroleum residues
P04	Chlorinated hydrocarbons
P05	Other dissolved substances
P12	Bottom deposits
P13	Contaminants in organisms
P90	Other contaminant measurements
B01	Primary productivity
B02	Phytoplankton pigments (eg chlorophyll, fluorescence)
B71	Particulate organic matter (inc POC, PON)
B06	Dissolved organic matter (inc DOC)
B72	Biochemical measurements (eg lipids, amino acids)
B73	Sediment traps
B08	Phytoplankton
B09	Zooplankton
B03	Seston
B10	Neuston
B11	Nekton
B13	Eggs & larvae
B07	Pelagic bacteria/micro-organisms
B16	Benthic bacteria/micro-organisms
B17	Phytobenthos
B18	Zoobenthos
B25	Birds
B26	Mammals & reptiles
B14	Pelagic fish
B19	Demersal fish
B20	Molluscs
B21	Crustaceans
B28	Acoustic reflection on marine organisms
B37	Taggings
B64	Gear research
B65	Exploratory fishing
B90	Other biological/fisheries measurements

MARINE GEOLOGY/GEOPHYSICS

G01	Dredge
G02	Grab
G03	Core - rock
G04	Core - soft bottom
G08	Bottom photography
G71	In-situ seafloor measurement/sampling
G72	Geophysical measurements made at depth
G73	Single-beam echosounding
G74	Multi-beam echosounding
G24	Long/short range side scan sonar
G75	Single channel seismic reflection
G76	Multichannel seismic reflection
G26	Seismic refraction
G27	Gravity measurements
G28	Magnetic measurements
G90	Other geological/geophysical measurements