RV *Investigator* Voyage Scientific Highlights and Summary

Voyage #:	IN2019_V04
Voyage title:	Hotspot dynamics in the Coral Sea: connections between the Australian plate and deep Earth
Mobilisation:	Cairns, 6th August, 2019
Depart:	Cairns 0700 7th August, 2019
Return:	Brisbane 0800 3rd September, 2019
Demobilisation:	Brisbane 3rd September, 2019
Voyage Manager:	J Hooper
Chief Scientist:	J Whittaker
Affiliation:	University of Tasmania
Principal Investigators:	E Woehler
Project name:	Spatial and temporal variability in the distribution and abundance of seabirds
Affiliation:	Birdlife Australia
Principal Investigators:	V Lucieer
Project name:	Understanding the spatial links between geomorphology and biodiversity in the Coral Sea Australian Marine Park
Affiliation:	University of Tasmania

PART B -VOYAGE SUMMARY

Voyage Summary

Objectives and brief narrative of voyage

One of the world's most extensive intraplate volcanic regions is located in Eastern Australia, including the world's longest continental hotspot trail and two parallel trails offshore (Tasmantid and Lord Howe Seamount chains). Hotspot trails are thought to arise from deep mantle plumes, whose episodic eruptions affect the world's atmosphere (release of gas and aerosols), biosphere (mass extinctions) and hydrosphere (altering ocean circulation and chemistry).

During Voyage IN2019_V04, 7th August, 2019 to 3rd Sept, 2019 we collected continuous swath data and dredged rock and/or sediment samples data from 51 sites along the Tasmantid seamount chain, Louisiade Plateau, Lord Howe seamount chain, and adjacent seafloor features. These data will enable us to understand the timing of the seamount formation, the nature and timing of the plume – plate boundary interactions, test whether the Tasmantid and/or Lord Howe plumes played a significant role in the formation of the Louisiade Plateau and/or plate tectonic breakup between Queensland and the Louisiade Plateau, and also investigate the plume's influence on the bathymetric evolution of Coral Sea region.

We were able to dredge at all our planned dredge site, due to favourable sea states throughout the voyage. We undertook 56 dredges with material recovered from 51 of these. We had some trouble obtaining basement samples from some seamounts, notably Lexington Seamount, where 5 dredges recovered almost exclusively fine-grained sediment. We are confident that we will be able to date, and geologically, geophysically, and geochemically categorise almost all of the targeted seafloor features.

Scientific objectives

We will use this offshore region as a natural laboratory to test competing hypotheses for how deep mantle plumes have influenced the evolution of the Australian plate. Using a combination of geophysical characterisation and geological sampling, we will determine the spatial and temporal extent of mantle plume activity in the Tasman and Coral Seas to test the following hypotheses:

1. The Louisiade Plateau is the birthplace of Eastern Australian intraplate volcanism and predominantly composed of volcanic material.
2. This volcanism formed within a short (1-2 Ma) timeframe shortly before the oldest Tasmantid seamounts.
3. The initiation of plume activity predates a major plate-mantle reorganisation affecting the southwest Pacific, and plume products provide a detailed record of Australian plate motion before, during, and after this reorganisation.
4. Fragments of rifted continental crust underlie the volcanic carapace.

Identifying the sites of mantle plume eruptions allows us to make connections between the surface and deep Earth with global scientific significance for understanding our planet's geodynamic and climatic history and biotic evolution. The results from this project will help inform government and industry on the effect of magmatism on distal continental margins and basins, and help constrain the extent of Australian continental crust into the Coral Sea.

Voyage objectives

The key to answering these questions lies in the rocks of the Louisiade Plateau, Tasmantid seamount chain and Lord Howe Rise seamount chain that both run roughly parallel with the East coast of Australia.

Objective 1. Collect seafloor and subseafloor geophysical data. This data will be used:

a. To identify seafloor fabric, which will help refine plate reconstructions in areas difficult to constrain from magnetic anomaly lineations alone.

b. To collect magnetic anomaly profiles, which will help understand the seafloor spreading history of the area and be combined with other geophysical datasets particularly gravity and bathymetry to understand the subseafloor nature of the crust.

c. To obtain comprehensive multibeam and backscatter coverage of the Louisiade plateau and seamounts and their morphology to understand tectonic setting, eruptive style, palaeo-water-depth and sedimentation patterns;

d. To assist in dredge site targeting by identifying sediment-free scarps and slopes;

e. Sub-bottom profile data will be collected to provide additional context for the nature of the near-surface sediment and geological structure.

Objective 2. Dredge volcanic samples from seamounts from the Louisiade Plateau, Tasmantid seamount chain and Lord Howe Rise seamount chain. Ashore, samples will be:

a. Ar/Ar Dated to determine the age and duration of seamount formation;

b. Volcanic coherent rocks will be described macroscopically, petrographically and mineralogically to classify and characterise the type volcanism on the seamounts. Comparing the nature and origin of volcanism at different sites may reveal multiple episodes of volcanism or variations in volcanic activity in time and space.

c. Volcaniclastic rocks will be described macroscopically, petrographically, mineralogically and include ash morphology descriptions. This work will constrain submarine/subaerial eruption/emplacement and style of transport

d. Sedimentary rocks will be described macroscopically, microscopically and petrographically. Additional U-Pb geochronology will be undertaken as will micro- and macro-fossil palaeontology. These analyses can constrain depth, environment, and time of deposition, important for constraining the timing and rate of subsidence.

The objectives are linked and so have equal priority. If time is lost to weather etc we will dredge fewer locations. Swath mapping was be prioritised when weather conditions were too poor to dredge.

Results

Objective 1. Collect seafloor and subseafloor geophysical data.

Bathymetric mapping was ongoing throughout the voyage. We mapped numerous seamounts, plateaus, troughs, and an extinct mid-ocean ridge. Gravity data was also collected continuously, while magnetic data was collected during all transits between sampling sites. Together, these data will be used in conjunction with the results from rock analyses to determine the nature and formation evolution of the Louisiade Plateau.

Objective 2. Dredge volcanic samples from seamounts from the Louisiade Plateau, Tasmantid seamount chain and Lord Howe Rise seamount chain.

The collection of samples with the dredge was highly successful. We undertook dredging at 55 sites, and were able to collect samples from all of our target seamounts and plateaus. A key aim is to date these underwater features and we obtained datable samples from the majority of sites. We also collected other volcanic and sedimentary rocks that will enable us to investigate the evolution of the seamounts and plateaus through time, including their paleo-environments. Early examination of samples has demonstrated a wide variety of eruption and sedimentation regimes.

Supplementary Projects

1. Understanding the spatial links between geomorphology and biodiversity in the Coral Sea Australian Marine Park.
Principal Investigator: Dr Vanessa Lucieer

This project focussed on how deep-water benthic habitats are related to geomorphic features on the seafloor. The aim of this project was to use advance marine sonar to examine how different habitats are distributed across a variety of geomorphic structures within the Coral Sea Marine Park. A summary is presented here, but a detailed report can be found in Appendix E.

Voyage IN2019_V04 has contributed an additional 29,000 kms2 of seafloor survey data to this knowledge base. This new bathymetric data has been assimilated into the 2010 bathymetric grid (Beaman 2010) to create a new 100m grid resolution bathymetric data product.

The new data collected during IN2019_V04 pertain to ongoing research to examine spatial patterns in deep-water seafloor biodiversity, in particular how organisms are related to geomorphic features within the Coral Sea Australian Marine Park (AMP). The seafloor biodiversity and associated geomorphic habitats in the Coral Sea AMP are poorly understood, and given the recent release of the AMP rezoning, it is particularly important to understand the spatial variability of seafloor biodiversity and associated habitats to better quantify the biological assets within the AMP.

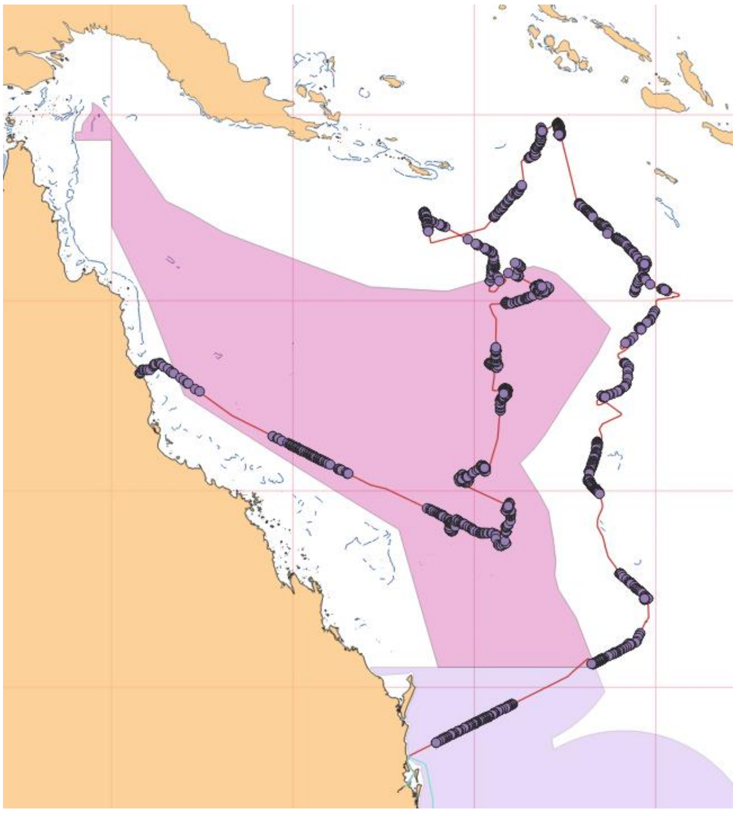
Ongoing research with this survey data will provide new insights into the detailed geomorphic shape and spatial relationships between adjacent seabed features. This information will be released in future publications to show the potential of how the scale of such seafloor data can be used for predictive habitat modelling, when analysed with the biological data overlays.

Future research outcomes and interpretations of the survey data reported here, will greatly improve our knowledge of the environmental assets within the Coral Sea Australian Marine Park, an area that is identified by Parks Australia as a priority for environmental asset inventories, baseline environmental data and monitoring.

2. Spatial and temporal variability in the distribution and abundance of seabirds.
Principal Investigator: Dr Eric Woehler

IN2019_v04 provided an opportunity to undertake quantitative and spatially explicit surveys of seabirds and marine mammals in remote areas of the Coral Sea for which there have been no previous surveys.

Observations were undertaken continuously from before sunrise to sunset daily. A team of 3 observers were present on board for the voyage. Observations were conducted from Deck 7, approximately 25m ASL. All seabirds within a 300m arc from the bow to the side of the ship with least glare were recorded, with details of species, behaviours and numbers recorded in real time on a dedicated data collection portal connected to the vessel's underway data system. All marine mammals with a 1km radius were recorded in a similar manner. All seabirds and marine mammals seen beyond these bounds were recorded in the system as 'out of zone' records. The vessel's underway data system recorded extensive additional details on location, water temperature and salinity, fluorometry and depth etc.



Map showing the northeast Australia and the Coral Sea. The locations of seabird and marine mammal observations collected during IN2019_v04 are shown in purple; the cruise track is also shown. Latitude and Longitude are shown at 5° increments.

More than 13,800 seabirds and 128 marine mammals were recorded during the voyage (for details see Appendix E). A total of 26 seabird taxa were identified to species, with several unidentified taxa observed that could not be identified with certainty. Three marine mammal taxa were identified to species, with an unidentified dolphin and unidentified whale also observed. A Minke Whale was seen briefly and we are awaiting confirmation as to whether it is a Dwarf Minke Whale. Very few marine mammals were observed. Four observations were made of Short-finned Pilot Whales associated with Bottle-nosed Dolphins. All observations were in the southern survey area early in the voyage. Three of the observations were made at Calder and Mellish Reefs.

More seabirds and a greater diversity of seabird species were observed than expected on the voyage, based on the limited data available. In contrast, fewer than expected marine mammals were observed. The expectations were based on previous surveys by Dr Woehler off the SE Queensland coast and on a transit from Sydney to Broome. The limited data available for the Coral Sea prevents an assessment as to whether the results from in 2019_v04 are representative of the area at the time of the survey or not.

The survey has provided a substantial data set for an area of the Coral Sea for which there were little or no previous data. Earlier surveys were typically closer to shore and often associated with the GBR. The survey collected spatially explicit quantitative data on the distributions and abundances of 26 seabird taxa and three marine mammal taxa.

The observations of seabirds and marine mammals collected during IN2019_v04 provide contemporary data on the distribution and abundance of species inside the Australian EEZ and over adjacent international waters. In many cases, the data are novel, with no previous survey data available for the area. The survey data provide spatially explicit quantitative data on resident and migratory species, many of which are listed under the EPBC Act 1999.

In many cases, the observations will also provide initial species lists for marine protected areas inside the Australian EEZ. These species' data are critical for agencies involved in, or responsible for the management of threatened and migratory species for example. Future surveys will provide further data on the spatial and temporal patterns of species in the Coral Sea, and around Australia more broadly.

Other Projects

1. Survey of Coral Sea deepwater shipwreck sites

Principle Investigator: Dr Robin Beaman

During 4-8 May 1942, United States, Australian and Japanese forces engaged in a major battle in the eastern Coral Sea region, called the Battle of the Coral Sea, which arguably prevented the invasion of Australian soil. The subsequent US-Australian alliance was a direct result of this World War II collaboration. During the battle, three US vessels were sunk within what is now the Australian marine jurisdiction: USS *Lexington*, USS *Neosho* and USS *Sims*. The focus of this survey are the reported sinking locations of the aircraft carrier USS *Lexington* and the fleet oiler USS *Neosho*, as these two vessels lie relatively close together on the Louisiade Plateau.

The reported sinking location of the fleet oiler USS *Neosho* comes from records by the US Naval History and Heritage Command and USS *Neosho* War Diary (Table below). The sinking position lies in 2997 m water depth, based upon the depth of that location in the gbr100 bathymetry grid. The USS *Neosho* (AO-23) sank on 11 May 1942 after multiple attacks by Japanese aircraft that severely damaged the *Neosho* and its destroyer escort, the USS *Sims*, which also sank. Neither the USS *Neosho* nor USS *Sims* have ever been found.

Wreck	Latitude	Longitude	Decimal Latitude	Decimal Longitude	Depth (m)
USS *Neosho*	15° 35.0'S	155° 36.0'E	-15.583333	155.600000	2997
USS *Lexington*	15° 14.12'S	155° 27.71'E	-15.235330	155.461830	2952

The location of the aircraft carrier USS *Lexington* (CV-2) comes from RV *Petrel*, which lowered a camera onto the vessel in March 2018. The location comes *Petrel's* position in Facebook screenshots, as no coordinates were provided to the Australian Government. The *Lexington* had been scuttled on 8 May 1942 to prevent capture following repeated Japanese aircraft attacks during the battle. The depth at this position is 2952 m. The camera confirmed the vessel was the *Lexington*, but no 3D mapping data were acquired as depths were too deep for the *Petrel's* multibeam.

No 3D mapping data exists over these two wrecks and their locations are approximate. Parks Australia have indicated that accurately locating and 3D mapping of these wrecks would assist in filling a significant piece of Australia's maritime history within this region, as this area has now been declared the Coral Sea Marine Park. The WWII maritime history of the Coral Sea, in particular the vessels sunk during the Battle of the Coral Sea, contributed to the heritage values underpinning the new Coral Sea Marine Park.

A deepwater multibeam survey over these sites aimed to provide accurate locations of the vessels and the preliminary archeological evidence to understand their current state of preservation, i.e. whether the vessels are intact or broken into large pieces.

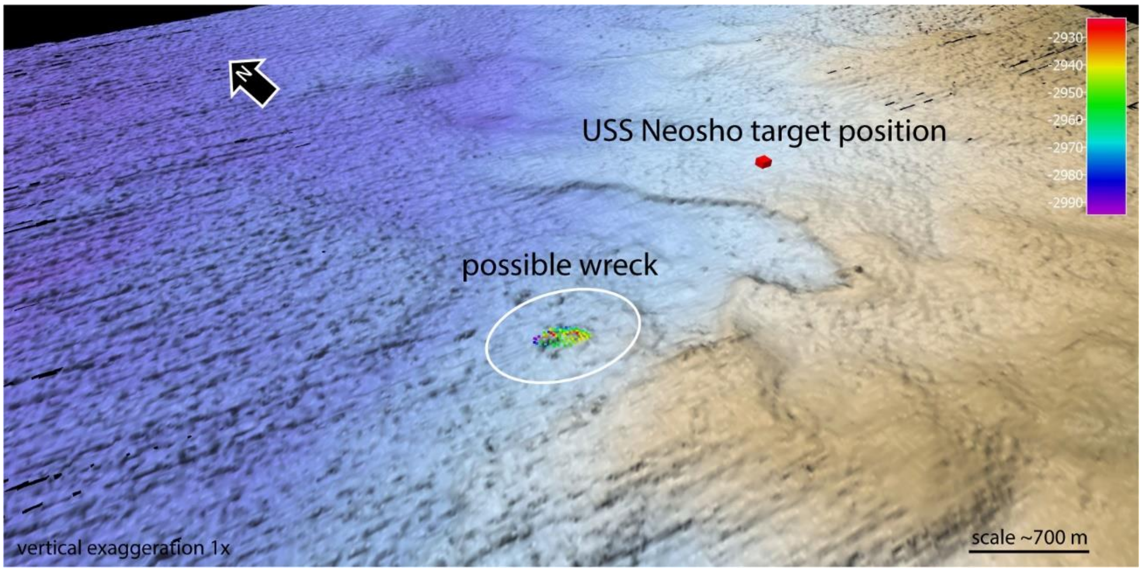
Between 2000 Thursday 15th and 0200 Friday 16th August, we conducted a deepwater shipwrecks survey using the *Investigator's* EM122 multibeam system over the reported sinking positions of the oiler USS *Neosho* and the aircraft carrier USS *Lexington*, sunk during the WWII Battle of the Coral Sea. The general geographic area the wrecks lie upon is a broad rise of about 3000 m depth that is a south-western extension of the Louisiade Plateau, between the deeper Coral Sea Basin to the west and the Louisiade Trough to the east.

We approached the *Neosho* position from the south, slowing down to around 6 kn and turning off all other sounders except the EM122 to keep the level of sound in the water to a minimum. Trigger synchonisation was also turned off to allow the EM122 multibeam to transmit as fast as possible given the ~3000 m water depth. The transmit cycle was around 14 seconds between pings. The SB120 sub-bottom profiler remained on to provide an indication of the sediment at the seafloor.

The lead up to the *Neosho* target position showed a seafloor with low relief and relatively homogenous with low reflectance backscatter imagery, thickly draped in sediment - ideal conditions for detecting wreck features. The outside weather conditions were also favourable with low winds and low swell. The swath width in ~3000 m was about 12 km wide, with individual point soundings about 15-20 m apart. So potentially, the *Neosho* ship length of 167 m (assuming intact) could obtain ~10 depth soundings across the length of the wreck.

Close to the reported sinking position, we viewed in the backscatter imagery scrolling down the monitors a cluster of four brighter pixels against the background darker seafloor. The bright pixels indicated higher reflectance returns of the sounding data. These brighter pixels lay about 2.7 km west of the reported sinking location. Once past the cluster of bright pixels or possible contacts, the seafloor then continued as generally low relief and homogenous with darker backscatter imagery.

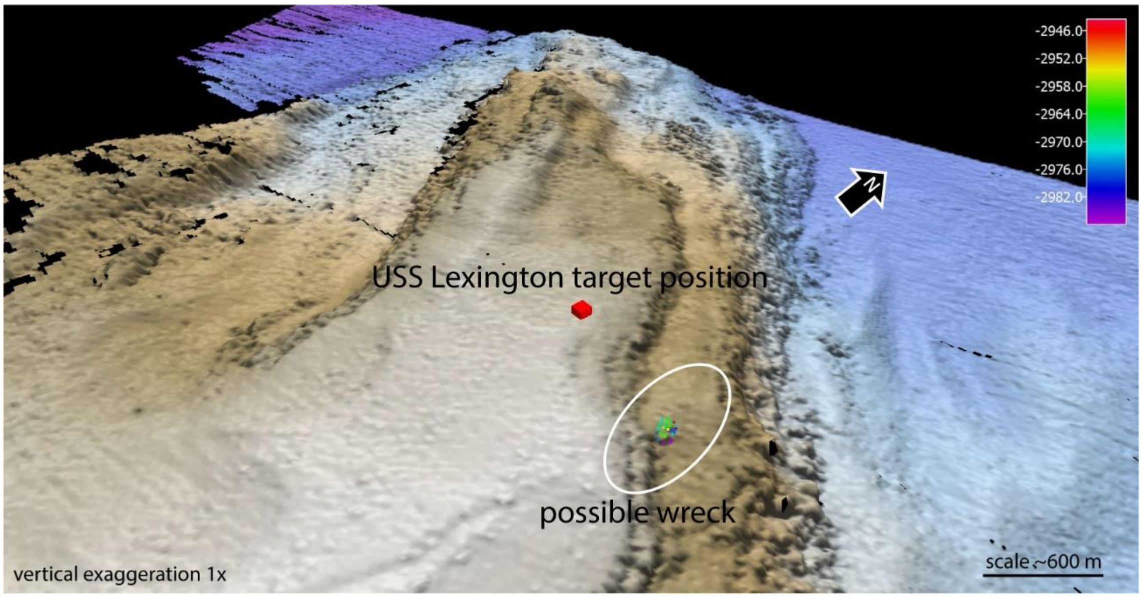
Later post-processing of the multibeam bathymetry data showed two of the bright pixels with soundings rising above the sounding flat seafloor, and one in particular has the rough dimensions of the *Neosho* at ~160 m in length. We are relatively confident we have located the possible wreck of the *Neosho*. However, the only way to be completely sure is for a camera groundtruthing survey over these seafloor contacts. The depth on the top of this prominent contact is 2920 m.



Following the *Neosho* survey, we increased speed transiting to the north-west direction to line up on the *Lexington* target position. Within 8 nm of the position we again slowed to 6 kn and maintained the same multibeam and sub-bottom profiler configuration settings. The seafloor became notably rougher with long streaks of high reflectance backscatter trending in a south-east to north-west direction, likely due to elongate rocky ridges about 100 m high exposed at the seafloor.

Sediment on the seafloor varied between small areas of thick sediment pinching out at these exposed ridges. Hence, the increasing seafloor complexity would prove to be a challenge to detect a ~270-200 m long wreck in such an environment. However, even without a definitive sinking location we were helped by a towed sidescan sonar image conducted by the RV *Petrel* in March 2018. The sidescan image revealed the relative positions of these ridges and the *Lexington* remains, now broken into several large pieces and straddling a ridge. The depths over the area are 3070-3160 m.

At the *Lexington* target position, we were not able to detect any bright pixels that definitively indicated wreck remains, but we are sure that we have multibeam surveyed over the same area, as indicated by the matching geography in the *Petrel* sidescan imagery. Later post-processing of the multibeam bathymetry data detected only a tentative contact for a wreck, known to be in pieces, within this targeted area. The difficulty in identifying wreck remains is due to the high relief (~100 m) changes in the variable ridge depths that dominate the wreck site.



The implications for the deepwater wrecks survey are numerous. At an operational level, we have shown that with a favourable seafloor environment (i.e. relatively low relief, homogenous sediment-draped seafloor), the *Investigator* can potentially detect large wrecks in depths ~3000 m where the sinking positions are roughly known. However, where the seafloor has localised high relief and/or highly varying relative backscatter, then detecting wrecks becomes far more challenging using the vessel's deepwater EM122 multibeam system.

On conclusion of the survey, we conducted a short Memorial Service from the back deck of the *Investigator* on Friday 16th August to commemorate the human cost of the Battle of the Coral Sea. Memorial wreaths for casting on the water over the wreck sites were provided by Mr Warren Entsch, MP - Federal Member for Leichardt, Returned & Services League of Australia - Qld Far Northern District, Australian Defence Force members and staff of HMAS Cairns, and the Australian American Association, Brisbane Chapter.

The search results have been provided to the Historic Heritage Section of the Department of the Environment and Energy, responsible for managing these historic shipwrecks through the Commonwealth *Underwater Cultural Heritage Act 2018*. In turn, they will liaise with the US Naval History and Heritage Command. The data will provide a more detailed description of the seafloor environment to Parks Australia, and a preliminary archaeological assessment conducted on the wreck remains by integrating both the *Petrel* and *Investigator* search results.

2. **Argo Floats**.

Four ARGO floats were successfully activated and deployed during the voyage at sites within the CSAMP on behalf of Argo Australia operated by CSIRO Oceans and Atmosphere. Argo Australia is part of international ARGO program whose mission is to maintain a global ocean array of autonomous profiling floats. See Appendix D for further details.

3. Collection of dead Invertebrates dredged with geological samples (Jeremy Horowitz, Rob Beaman)

PhD student Jeremy Horowitz opportunistically collected and preserved dead coral skeleton and tissue retrieved as by-catch during dredging within the Australian EEZ. Specimens were photographed and preserved. See Appendix E for further details.

4. CSIRO Educator on Board

CSIRO Educator on Board is a professional development program for Australian STEM (science, technology, engineering and mathematics) school teachers which aims to support teacher professional development and provide students with a window on the real word application of STEM. Two STEM educators participated in the Educator on Board program, one from Jindabyne High, NSW and one from Edinburgh Museum, Scotland. Both educators assisted with scientific operations and shared their on-board experience with students across Australia and internationally through 19 live ship-to-shore video broadcasts to 27 schools, reaching 1000+ students. Teachers will also developed curriculum-linked resources based on the ship and underway science, including '*Deep Sea and Animal Adaptions'*, '*Swathing and Bathymetry'*, '*Using Sound to See'*, '*Mantle Mysteries*', and '*Ship Shape Science'*. The most common question asked by school students was "What PlayStation games do you have?".

Voyage Narrative

Wednesday 7th August

We departed Cairns at 0700. Ship safety induction was conducted. Transited through the Great Barrier Reef Protected Area, then continued transit through the Coral Sea Australian Marine Park (AMP). Deployed the magnetometer. The magnetometer was towed at all times during the voyage, except during dredging operations and during very short transits between dredge sites.

Thursday 8th August

We continued transiting through the Coral Sea AMP. Students were briefed about shifts, and lab inductions were conducted. We undertook the first RapidCast to collect temperature and salinity. Rapidcasts were used throughout the voyage instead of XBTs to collect temperature and salinity data to accurately calibrate the acoustic data.

Friday 9th August

After transiting across the Queensland Plateau, we reached Frederick Seamount. We circumnavigated Frederick Seamount obtaining acoustic data of the flanks. Ultimately, three dredges were undertaken on Frederick Seamount, using the bathymetric information to select target sites. We were unconstrained in the direction of dredging due to light winds <10 knots.

Dredge 1 – Northwest Frederick Seamount. A deeper water 'tail' extends from Frederick Seamount towards the northeast. We targeted the western slope of this feature at water depths of 1,800–2,100 m. There were 3-4 tension spikes towards the late stages of this dredge, between 6-8t. About 20 carbonate samples were recovered.

Dredge 2 – Eastern flank of Frederick Seamount. A deep step feature was targeted on the eastern flank of the Frederick Seamount at about 2,200–2700 m water depth. Dredge became stuck almost immediately after dredging began (tension topping out at ~12.5t) and the ship went backwards to retrieve the dredge. It is unlikely that anything upslope of ~2,700 mbsl on the target slope was sampled. The sacrificial cable was damaged. Carbonate, volcanic breccia, and vesicular basalt were recovered.

Saturday 10th August

Dredge 3 – ridge extending northwards from Frederick Seamount. The third site was a southeast facing slope on the farthest north section of the Frederick Seamount 'tail', in depths of 1,500–1,800 mbsl. Lots of tension spikes between 6-10t before becoming stuck, and slowly returning back to recover the dredge. 19 rocks were recovered including vesicular basalt, resedimented volcaniclastics and carbonates.

We transited from Frederick Seamount eastwards to Kenn Seamount, arriving at the western flank at approximately midway along the plateau. The southern and western flanks of Kenn Seamount were mapped in a counter-clockwise direction. Ultimately, four sites were dredged on the Kenn Seamount. Our initial target on the SW corner became unviable as a dredge target due to increasing wind speeds (need to dredge into the wind).

Dredge 4 – small volcanic cone southern flank of Kenn Seamount. Kenn Seamount has numerous small cones off its southern flank. We targeted one of these cones sitting 1,750–1,900 mbsl. Dredge became stuck immediately on dredge commencement, but was freed through ship movement, and 2-3 spikes at 9-11t followed. 24 samples of fresh olivine-phyric basalt and basalt breccia were recovered.

Sunday 11th August

Dredge 5 – eastern flank of Kenn Plateau. On the eastern flank of Kenn Plateau, at depths of 1600-1900 m we targeted a consistent slope with strongly reflective backscatter signal. Some small tension spikes before becoming hooked up with wire tension at 10-11t. No rock samples recovered, but cohesive sediment was returned.

Dredge 6 – eastern flank of Kenn Plateau. Since no igneous rocks were recovered in dredge 5 we tried again on the eastern flank of Kenn Plateau, focusing on a canyon at slightly deeper depths, 1800–2100mbsl. Four tension spikes up to 10.5t were recorded before becoming hooked up. We recovered rocks, sediment and biology. Three samples of olivine phyric basalt and basalt breccia with a calcite matrix were recovered.

Swath mapping resumed towards the north along the eastern flank of Kenn Plateau, until the northern extent of Kenn Plateau, where we turned southward, following the prominent scarp.

Dredge 7 – northwestern flank of Kenn Plateau. We chose an even deeper target (2,200 – 2,500 mbsl) on an even, relatively canyon-free section of slope with bright backscatter. Two-three tension spikes above 10t occurred before becoming hooked up. After freeing the dredge, another three spikes were observed above 10t. 17 samples of limestone, manganese oxide, and mafic volcanic breccias were sampled during this dredge.

Monday 12th August

We transited approximately 2 hours from Kenn Plateau northwest towards a previously unnamed seamount. We have chosen to unofficially refer to this seamount as Sula Seamount after the many Sula Boobies that have been observed in the region. On arrival we mapped the seamount with a clockwise track that and undertook three dredges. Winds around 10-15 knots, but we were still able to dredge in almost all directions.

Dredge 8 – northeast Sula Seamount. Bright backscatter was observed in a NNE-striking gully located on the northeast slope of Sula Seamount, and a target was selected on a steep section at 2,400–2,650 m water depth. There were numerous tension spikes between 8-10t and one short hookup towards the end of the dredge. 15 samples were kept including a trachyte(?), basalt breccia, and limestone.

Tuesday 13th August

Dredge 9 – top Sula Seamount. Mapped over the top of Sula Seamount, hunting for suitable dredge site on the crest of the seamount, as we were interested in discovering whether the seamount is topped with volcanics or carbonates. There were some technical difficulties with the winch used for dredging, which enabled some additional swath mapping to be undertaken. A site near the peak of Sula Seamount was selected, on a northward facing slope, water depths 850–700 mbsl. Six to seven tension spikes to ~10t occurred during the dredge, and two carbonates were recovered, one with a large coral piece and the other with large forams.

Dredge 10 – deep ridge NE Sula Seamount. This site was approximately 6 nautical miles to the northeast of dredge site 9. The site was selected on a deep ridge (targeting flank at depths of 2,200–2,600 mbsl) that extends away from the main Sula edifice, and appears to be a parasitic cone/ridge. A few winch difficulties towards the start of this dredge. Small tension spikes up to about 8t during the first half of this dredge, and five 10t spikes during the second half. Recovered altered basalt, volcaniclastics, and limestones.

Approximately 2-hour transit to the northwest an unnamed seamount that we are unofficially calling Cassowary Seamount. We approached the western end of this edifice and mapped counter-clockwise around the seamount. Cassowary seamount has a plateau top with distinctive rounded mounds. Winds had strengthened to 15-20 knots, constraining our options for dredging directions to roughly SE as the preference for ship operations is to dredge into the wind. Two sites were dredged on Cassowary Seamount.

Dredge 11 – north Cassowary Seamount. Site was selected in a broad canyon on the steep northern flank of Cassowary Seamount to try to sample the volcanic basement at this site. Target depths were 2,400–2,800 mbsl. A number of good tension spikes up to 10t before becoming stuck near the end of the dredge. Relatively fresh plagioclase-phyric basalt was recovered, as well as mafic volcanic breccia.

Dredge 12 – top Cassowary Seamount. The second dredge site selected on Cassowary Seamount was one of the rounded mounds on the plateau top, to determine whether the mounds are igneous or carbonate features. This mound selected had bright backscatter and ~150 m of relief (2,000–2,150 mbsl) and was ~1.5 km in diameter. Two small tension spikes up to 8t and then a sustained spike while continuing to haul in at 10.5t. Recovered polymictic volcanic breccia, manganese oxide crust, and fossiliferous limestone.

Transit commenced towards the north to the western side of the Mellish Rise.

Wednesday 14th August

Continued the approximately 10-hour transit from Cassowary seamount to Mellish Rise. We passed a number of seamounts sampled during previous voyages. Winds strengthened to 25-30 knots, constraining possible dredge directions to around a SE-trending orientation.

Dredge 13 – southwest Mellish Rise. This dredge was conducted up a broad gully on the northwest facing flank of the southern Mellish Rise, at target depths of 1,400–1,900 mbsl. Upslope from the dredge line the slope plateaus out at ~1,000m to a small volcanic-looking feature. A series of small tension spikes occurred during this dredge, the strongest up to 8t. Around 20 samples of olivine-feldspar phyric basalt to altered basalt were recovered.

Dredge 14 – central Mellish Rise, south of Mellish Reefs. Progressed towards the northeast towards the Mellish Reefs. Just south of the Mellish Reef region we discovered some more small mound/cone features at 970–1,100 mbsl. As for dredge 12 we chose to dredge one of these features to determine whether it was predominantly igneous or carbonate in nature. A number of very strong spikes on this dredge, up to 10t from a baseline of 2.5t. Limestones were recovered, including grainstone and boundstone with coral fragments, plus some manganese crusts.

Dredge 15 – northwest Mellish Plateau. We circum-navigated the Mellish Reefs in an anticlockwise direction, then mapped back northwards along the western flank and undertook a dredge on the northwestern flank, 1,600–2,000 mbsl, where the steeper slope flattens out to the deeper ocean floor. No real spikes while hauling in the first couple of hundred meters of wire, but then stuck. Freed after moving astern, and a few very small spikes throughout the rest of the dredge. On retrieval, shearpin was broken on the dredge, which means that the dredge was pulled up upside-down and only some sediment and pebbles were recovered from the dredge pipe.

Thursday 15th August

Headed to the west to the eastern flank of the plateau we are unofficially referring to as Fregretta Plateau, after the Fregretta Petrels that have been observed in this region. We followed the eastern slope of Fregretta to the north as we were unable to dredge the eastern slope due to the prevailing southeasterly winds, sustained at ~25knots from the southeast.

Dredge 16 – northwest Fregretta Plateau. At the northern extent of Fregretta Plateau we headed to the northwest facing slope and found a target with bright backscatter signal in a broad gully striking towards the northwest. Target depths were 2,400-2,800mbsl. Four rapid spikes up to 11t and one gradually building tension spike to 11t on this dredge, all in the first half of the dredge.

Dredge 17 – northern Fregretta Plateau. This target was on the northwest side of an isolated block that appears to have become separated from the main Fregretta Plateau, at 2,000–2,300mbsl. One slowly rising tension spike to 10t and four more rapid spikes up to 11t were recorded during the middle of this dredge.

After dredge 17 we transited northwards looking for the wrecks of the Neosho and Lexington, which are US ships sunk during the WWII battle of the Coral Sea. Water depths in this region were >2,000-3,000 m so wreck hunting was difficult but two likely features were tentatively identified.

Friday 16th August

Transited eastwards away from the Lexington wreck search area towards a very prominent seamount located at the southern end of the Louisiade Trough. We are unofficially referring to this seamount as the Lexington Seamount.

Dredge 18 – southern end of the Louisiade tail. On the way to Lexington Seamount we passed over an approximately 300m high scarp facing to the north. We chose to dredge this feature as an earlier voyage led by Exon had recovered interesting rocks further north of this site. Target depths were 2,800–3,000mbsl. Four good tension spikes to ~11t during the last half of this dredge.

Following dredge 18, we continued to Lexington Seamount, and commenced mapping from the southwest corner counter-clockwise following the steep flanks of the seamount. Ultimately 5 sites were dredged on the Lexington Seamount. All dredges were towards the southeast, as constrained by the dominant wind and swell directions.

Dredge 19 – Lexington Seamount, northwest flank. A NW striking canyon on the NW facing flank of Lexington Seamount was selected in the hope that the canyon had exposed the volcanic rocks forming the core of the seamount. Target depths 2,000–2,500 m, constant slope and bright backscatter. Winds 20-25 knots from the southeast. One large spike to 10t with recoil to 0t shortly after we started hauling in, we were still moving 1knot ahead with the ship and hauling in at 15m/min. No spikes after this. Broken shear-pin and a very bent dredge plate were revealed on recovery. Sediments recovered from the closed dredge pipe – sandy with small pumice pieces.

Saturday 17th August

Dredge 20 – Lexington Seamount, northwest flank. This dredge was a repeat of dredge 19 but slightly further west. Target depths were 2,200–2,700m. One large tension spike to 10.5 t then hooked up roughly halfway through hauling in, ship moved backwards to release the dredge. No further spikes after coming loose. No rocks in dredge bag or pipes on recovery, only sandy sediments with small pieces of pumice.

Dredge 21 – Lexington Seamount, rise on plateau top. Moved to a target atop Lexington Seamount. The top of Lexington is a broad plateau with some smaller features rising an additional 200-300 m. From the sub-bottom profiler the plateau is covered in layered sediments. Target was the NW flank of one of these features – possible paleo-reef or lava flow? – at 1,100-1,400mbsl. Only a couple of small tension spikes and one larger spike during this dredge. Coral, manganese crust and sediments recovered.

Dredge 22 – Lexington Seamount, canyon on northern flank. Headed back north across the top of Lexington Seamount to a deep canyon on the northern flank, hoping for exposed basement rocks in the eroded canyon. Target was slightly deeper than the previous flank dredges, at 2,400–3,000mbsl. The dredge became stuck almost immediately after commencement of hauling in at 15m/min, and the ship reversed 100s of meters to free the dredge. A couple of rapid spikes up to 11t after freeing the dredge. Only sediments recovered in the dredge pipe.

Dredge 23 – Lexington Seamount, deep northwest flank. Following encouragement from onshore collaborators we decided to undertake one further attempt at dredging Lexington Seamount. A deep-water site was selected on the northwest flank. No tensions spikes were recorded at all. Sediments recovered only.

Transit away from Lexington Seamount back to the Louisiade Plateau 'tail', which appears to be the transition from the Louisiade Plateau and the Tasmantid Seamount trail.

Sunday 18th August

Dredge 24 – Louisiade Plateau 'tail' 1. Site was selected on a scarp identified in a pre-existing swath bathymetry profile. Dredge target at 2,400–2,800 mbsl with bright backscatter signal. Two tensions spikes during the dredge, on brief one to 8t and a more sustained spike to 11t. Altered trachyte, vesicular feldspar-phyric basalt, and basalt breccia with carbonate-zeolite matrix were recovered.

Dredge 25 – Louisiade Plateau 'tail' 2. This dredge was adjacent to dredge 24, approximately 2.5 km further east on the same scarp, as we liked the rocks we recovered in dredge 24 but wanted a few more. Target depths were slightly deeper at 2,650–3,000 mbsl. Only a couple of very small tension spikes during this dredge. Despite the lack of tension spikes a single altered vesicular basalt was recovered, as well as a piece of Mn-oxide crust.

Dredge 26 – Louisiade Plateau 'tail' 3. Another small scarp on the Louisiade tail, at slightly shallower depths than the previous dredges on the Louisiade tail, targeting 2,400–2,200 mbsl. This site was slightly further north and in PNG waters. Lots of abrupt spikes from 6-8t on this dredge, mostly in the second half of the haul in. Only one pebble of altered, vesicular basalt recovered.

Monday 19th August

Dredge 27 – Louisiade Plateau 'tail' 4. Back in Australian waters. A ~300 m high scarp on the Louisiade tail, facing towards the north, with high reflectance in backscatter, was identified for this dredge. Dredge target depths were 2,500–2750 mbsl. Winds were 10-15 knots from the southeast. Only one tension spike during the haul in, up to 11t and became stuck. Only one rock in the dredge basket, and another in the dredge pipe. Two altered trachyte/basalts recovered.

Dredge 28 – Louisiade Plateau 'tail' 5. Headed further north up the Louisiade Plateau 'tail', back into PNG waters. Target was another ~300m high, northward facing scarp, at water depths of 2,400–2,100 m. Dredge became stuck not long after dredging commenced, then freed with backwards motion of the ship. After a couple of spikes up to 8t, the dredge became stuck again, and the ship had to reverse a few hundred meters to free the dredge. The top of the dredge was quite bent and the sacrificial wire badly damaged during this dredge. One small altered basalt was recovered.

Dredge 29 – Louisiade Plateau 'tail' 6. Returned southward to Australian waters again to dredge two sites spotted the previous day. The first was an unusual, circular/mound feature extending from the southwest end of a distinctive scarp. Winds were 10-15 knots from the southeast. Dredge target was at 2,250–2,700 mbsl on the north-western side of the mound. There were a few small tension spikes up to 8t followed by two larger spikes and hook-ups at 10.5t. Six rocks were recovered including feldspar-phyric basalt, and basalt hyaloclastite.

Dredge 30 – Louisiade Plateau 'tail' 7. The NE-SW trending scarp associated with the previous dredge was the target of this dredge, 1,950–2,800mbsl. Lots of tension spikes up to 11t, and became hooked up towards the middle of the dredge, which was released by paying out 30 m of wire. Sparsely feldspar-phyric basalt, trachyte, basalt breccia, carbonate matrix basalt-clast breccia, and Mn-oxide recovered.

Tuesday 20th August

Transit from the Louisiade Plateau 'tail' to the northwestern extent of the Louisiade Plateau. Targets on the northwestern extent of the Louisiade Plateau had been identified from seismic reflection profiles in REFS, and also suggested by prominent gravity anomalies.

Dredge 31 – Louisiade Plateau west 1. This dredge location was picked on a site with ~400m of relief on a west facing scarp, at target depths of 3,700–4,150mbsl. The top of the scarp looked sediment heavy but with barer looking slopes below. There were no tension spikes at all during this dredge, and no rocks or sediment recovered. Dredge may not have reached the seafloor, possibly due to the presence of strong currents.

Wednesday 21st August

Dredge 32 – Louisiade Plateau west 2. Repeat of dredge site 31, with more wire out (1.3 times the water depth of deepest of target range, compared with 1.1 times). This time there were a number of tension spikes up to ~11-13t from a base of ~10t. A wide range of volcanic and sedimentary rocks were recovered, including a possible dacite pebble, basalt, possible andesite(?), breccia (including possible ignimbrite), mudstone, and bedded siltstone.

Dredge 33 – Louisiade Plateau west 3. After a short transit north following the same scarp another location was selected at 3,400–3,800 mbsl. Numerous tension spikes up to 12t from a base of ~9.5t. This dredge recovered fine igneous rock (with and without veining), altered breccia with mafic volcanic clasts, bio-eroded mudstone, and Mn-Oxide.

Initially headed southwards to move onto unequivocal oceanic crust so that a full geophysical transect onto the Louisiade Plateau proper could be collected (bathymetry, gravity and magnetics). Then we undertook an ~20hour transit to the northeast of the Louisiade Plateau to the Pocklington Trough and Rise region.

Thursday 22nd August

Dredge 34 – small cone atop Louisiade Plateau. Transit to the Pocklington Trough/Ridge region continued. En route we discovered 4 small cones and elected to dredge the largest to discover whether they are volcanic or not. Cone rises from 2,200-1,800mbsl. Two tension spikes to above 5t, and a hookup at 10.5t. Recovered five rocks in total, olivine-phyric basalt (altered), feldspar-phyric clasts breccia, and Mn-oxide.

Northeasterly transit to the Pocklington Trough/Ridge region recommenced.

Friday 23rd August

Dredge 34a – Louisiade Plateau northeast 1. We tried to pick a target using pre-existing swath bathymetry data that mapped the northern flank of the Louisiade Plateau and flat deep region beyond, but it appears this data was collected to place a cable so we were unable to dredge that location. A revised location was selected away from the submarine cable at a northwest facing scarp. Target depths were 2,700-3,100mbsl. No tension spikes were recorded, and no rocks or sediment were recovered at all. Likely missed the bottom. Possibly due to low wire length and slightly elevated ship speed during laying out of cable (slightly above 2 knots). This dredge was 34a because of a labelling mix up for the rocks from the next few dredges.

Dredge 35 – Louisiade Plateau northeast 2. A second attempt, slightly further to the northwest, on the NW-facing scarp that marks the northern extent of the Louisiade Plateau. Target depths 2,000–2,800mbsl. Lots of tension spikes up to 10.5t from a base of around 7t. We recovered feldspar-phyric basalt, dolerite, gabbro(?),basalt-bearing breccia, bedded and non-bedded calcareous mudstone, limestone, and Mn-oxide.

Dredge 36 – Pocklington Trough. We moved to the northeast, where the deep Pocklington Trough (possible paleo-subduction zone) sits adjacent to the Louisiade Plateau. A site was selected on the steep scarp between these two features, at 3,200-3,800mbsl. Three tension spikes to 12t, from a base tension of about 9t. Rocks recovered from this dredge included feldspar phyric basalt, dolerite, veined altered basalt, vesicular volcanic-clast breccia, polymictic breccia, chert, and mudstone.

Saturday 24th August

Dredge 37 – Junction between Pockington Trough and Louisiade Plateau. Another site to the NE along the Pocklington Trough was selected, at 3,200-3,800 mbsl. Winds were 15-20 knots from the southeast, so dredging towards the southeast – into the wind. This was a difficult dredge with a number of hookups that required the ship to move astern. Due to the numerous hookups we chose to relay out wire and attempt the upper part of the dredge again (referred to as a teabag in the dredge log). We recovered a wide variety of rocks from this dredge including, limestone, carbonate mudstone, altered basalt, polymictic volcanic breccia, altered dolerite, serpentinite.

Dredge 38 – Pocklington Ridge 1. After leaving the Pocklington Trough and starting to transit southwards we progressed over the Pocklington Ridge. A suitable, prominent scarp with highly reflective backscatter, compared with the low reflectance surroundings, was identified at water depths of 800-1,200mbsl. Used stop and drop dredging technique. Became hooked up and lost the dredge due to breaking of the sacrificial wire. We had been using the same dredge, the only one with teeth, each time during the voyage up until this point.

Dredge 39 Pocklington Ridge 2. Same site as for dredge 38 – Pocklington Ridge at depths of 800–1,200mbsl. Used the 'fly-in' technique with a new dredge without any 'teeth'. Hooked up, lost dredge with a broken sacrificial wire.

Following the loss of two dredges at the same ridge, we gave up and headed towards the southeast Louisiade Plateau where we thought there should be likely targets based on legacy seismic data and prominent gravity anomalies. We planned the transit so to pass over a few gravity anomalies in the central Louisiade Plateau region but they did not reveal any good dredge targets – only small steps that appeared to be heavily sedimented.

Sunday 25th August

Dredge 40 – Louisiade Plateau southeast/NW Louisiade Trough. Winds 20-25knots from the southeast when we arrived at the southeast edge of the Louisiade Plateau (also the northwest edge of the Louisiade Trough), making it difficult to find a suitable dredge target, as we are restricted to dredging into the wind. Found a northwest facing scarp at 2,650-3050mbsl near the Louisiade Trough. No real tension spikes during this dredge, and no rocks recovered, only sediments.

Dredge 41 – Louisiade Trough east. Traversed southeast to the southeastern side of the Louisiade Trough where the northwest facing scarps made better targets in the dominant SE winds. This site is on the Mellish Rise, which appears to be connected to the Louisiade Plateau to the north. Target depth is 3,300-2,500 mbsl over distance of ~1.25 km. Five strong tension spikes to >10t, from a base of around 7.5t, and a number of smaller spikes occurred during this dredge. Over 40 samples were logged including, dolerite, gabbro(?), vesicular basalt, polymictic conglomerate, matrix supported conglomerate, bedded sandstone, laminated mudstone, and limestone.

Monday 26th August

Dredge 42 – Louisiade Trough Mellish Rise side 1. On the transit from the Louisiade Trough to the West La Perouse Rise we passed over a ~300m high, NW-facing scarp on the Mellish Rise and decided to dredge this nice target at target depths of 2,450-3,100mbsl. There were about eight tension spikes to about 8-9t from a baseline of 6-7t and one larger spike to 11t during this dredge. Rock recovered included altered and fresh feldspar-phyric basalt, carbonate mudstone, and limestone.

Dredge 43 – West Laperouse Rise 1. We transited across the Mellish Rise to the northern end of the West Laperouse Rise, where we found a prominent ridge facing towards the NW. We dredged a target on this ridge at 1,300-1,750mbsl. We became immediately hooked up after we commenced hauling in the dredge and had to go astern to free the dredge. We decided to redeploy wire (teabag) to try to retrieve some rocks. After relaying out wire and recommencing hauling in there were a few large tension spikes up to 10t (from a base of around 4t). Rocks recovered included altered feldspar-phyric basalt, and Mn oxide some of which were associated with carbonate.

Tuesday 27th August

Dredge 44 – West Laperouse Rise 2. Transit roughly southward following a ridge of the Laperouse Ridge, looking for a dredge site on the western flank. Dredged a NW facing scarp at the far southern extent, at a target depth of 1600–1970m. There were a few small tensions spikes up to 8t. Very little sediment in this dredge, only a small amount of sandy sediment and a few small to medium sized rocks in the dredge pipe. Feldspar-phyric basalt clasts in a carbonate matrix breccia, limestone, and Mn oxide were all recovered.

After dredge 44, we returned northward to map the eastern side of the ridge we had just followed south, then turned towards the east to cross the deep South Rennell Trough to the East Laperouse Rise, again looking for a target. As there were existing good Ar/Ar dates from igneous rocks collected further north in the South Rennell Trough, we did not dredge as we crossed the trough.

Dredge 45 – East Laperouse Rise 1. After passing over the South Rennell Trough we found a suitable dredge location on a moderate slope at depths 2700–3150m. There were a few small tension spikes on this dredge, and one larger one to 11t. A few rocks were retrieved including one fresh feldspar phyric basalt, altered feldspar-phyric basalt, feldspar-phyric basalt clasts in a carbonate matrix breccia, and Mn-oxide.

Dredge 46 – East Laperouse Rise 2. Further to the east, but still on the East LaPerouse Rise we dredged a steep step at target depths of 2500–2850m. Dredge became stuck, then released. After becoming stuck again, the dredge was lost with only broken sacrificial wire returning.

We returned back to the South Rennell Trough, then followed the eastern wall southward.

Wednesday 28th August

Dredge 47 – South Rennell Trough 1. The broad South Rennell Trough started to contain a smaller ridge that looked like the beginning of a small, extinct seafloor spreading ridge. We decided to target this interesting feature on its western side at depths of 3,300–4,000m. Dredge became stuck with tension maxing out at 12.5t about halfway through the dredge, with no previous notable tension spikes. Dredge was released by moving astern, but then became hooked up again, and again had to be released by moving astern. No tension spikes after being released. Three rocks were recovered, two manganese crusts and a large piece of pumice.

Transit to the southwest along the apparent spreading centre inside the South Rennell Trough.

Dredge 48 – South Rennell Trough 2. We followed the extinct spreading centre feature towards the southwest and undertook a dredge on a section that looked particularly like spreading fabric. Dredge target was a slope 2,050-2,600mbsl extending over 1.1km, rising towards the southeast (into the wind). There were many small tension spikes to a maximum of 8t, from a baseline of 5-6t. Unusually, there were no clays/mud in the pipe dredge. Rocks recovered included very vesicular olivine-phyric basalt, including one with feldspar crystals. Most basalt clast are pebbles in matrix of clay or calcite. Most have thick Mn-oxide crusts; some are nodules.

Following dredge 48 we mapped the South Rennell Trough back and forth progressing southwards to try to get an idea of the seafloor fabric between the trough and the start of the seamounts of the Lord Howe Rise seamount chain to the south.

Thursday 29th August

Dredge 49 – Horsehead. Reaching Horsehead Seamount we mapped the northern flank and selected a dredge target in an eroded canyon (2,400-2,800mbsl), in order to try to sample the igneous basement of this seamount. Although an age has been published for this seamount (Ar/Ar from a very small basalt) the result was not high quality. The dredge became hooked up almost immediately on commencement of dredging and was released by heading astern. Additional wire was paid out (teabag) and hauling recommenced after which a number of tension spikes to a maximum of 11t were observed. Rocks recovered included feldspar-phyric basalt and feldspar-phyric basalt breccia.

Friday 30th August

Dredge 50 – East Chesterfield Plateau

Target depths 900-1,500mbsl over a length of 1.2km. Five strong tension spikes to >7.5-10t from a base of around 3t occurred in the first half of the dredge. Material recovered was calcareous mudstone, burrowed with fossil impressions.

Saturday 31st August

Dredge 51 – Northwest Nova Bank

Target depths were 1,800-2,100mbsl over a slope length of 700m. Tension base of 4-4.5t with all wire paid out, only two small tension spikes to 5t during this dredge. Rocks recovered included fine grained calcareous sandstone and siltstone that were heavily burrowed and bioturbated. Some had thin, discontinuous Mn oxide coatings and some coral.

Dredge 52 – East Nova Bank 1

Target depths were 1,400-1,800mbsl over a slope length of 750m. Only one large tension spike during this dredge, up to 7.5t from a base of 3.5t. One rock was recovered, a white friable foraminifera grainstone.

Dredge 53 – East Nova Bank 2

Target depths were 1,700-1,900mbsl over a slope length of 650m. Lots of tension spikes during this dredge, from a base of around 4t, up to about 10t. Became stuck towards the end of the dredge, released by moving astern, and one final tension spike before hauling back in clear of the seafloor. Rocks recovered were fossiliferous grainstone, altered basalt, and manganese nodules/crusts.

Sunday 1st September

Dredge 54 – Argo Seamount.

Target depths were 1,300-1,600mbsl over a horizontal distance of approximately 700m. An eventful dredge with three hookups at over 10t, all released by moving astern and paying out a little extra wire. There were two other spikes over 7.5t before and after the final hookup close to the end of the dredge. Sediment had no clays or mud, instead was sandy with abundant coral fragments. There were sponges and (deep water) coral bases on rocks. Rocks included altered olivine-phyric basalt with fresh feldspar phenocrysts, breccia with basalt clasts, clastic limestone with pebble to sand-sized fossil clasts, solidified coral-bearing limestone and some hardened carbonate (silica?).

Dredge 55 – Kelso Seamount

Target depths were 1,750-2,100mbsl over a horizontal distance of approximately 900m. Hooked up about a third of the way through the dredge, released by moving astern, followed by three small tension spikes up to about 6-7t from a base of 4t. Rocks included grainstone and feldspar phyric basalt conglomerate, fossiliferous limestone, Halimeda grainstone, coral pieces, and well-sorted carbonate mudstone.

Commenced transit to Brisbane

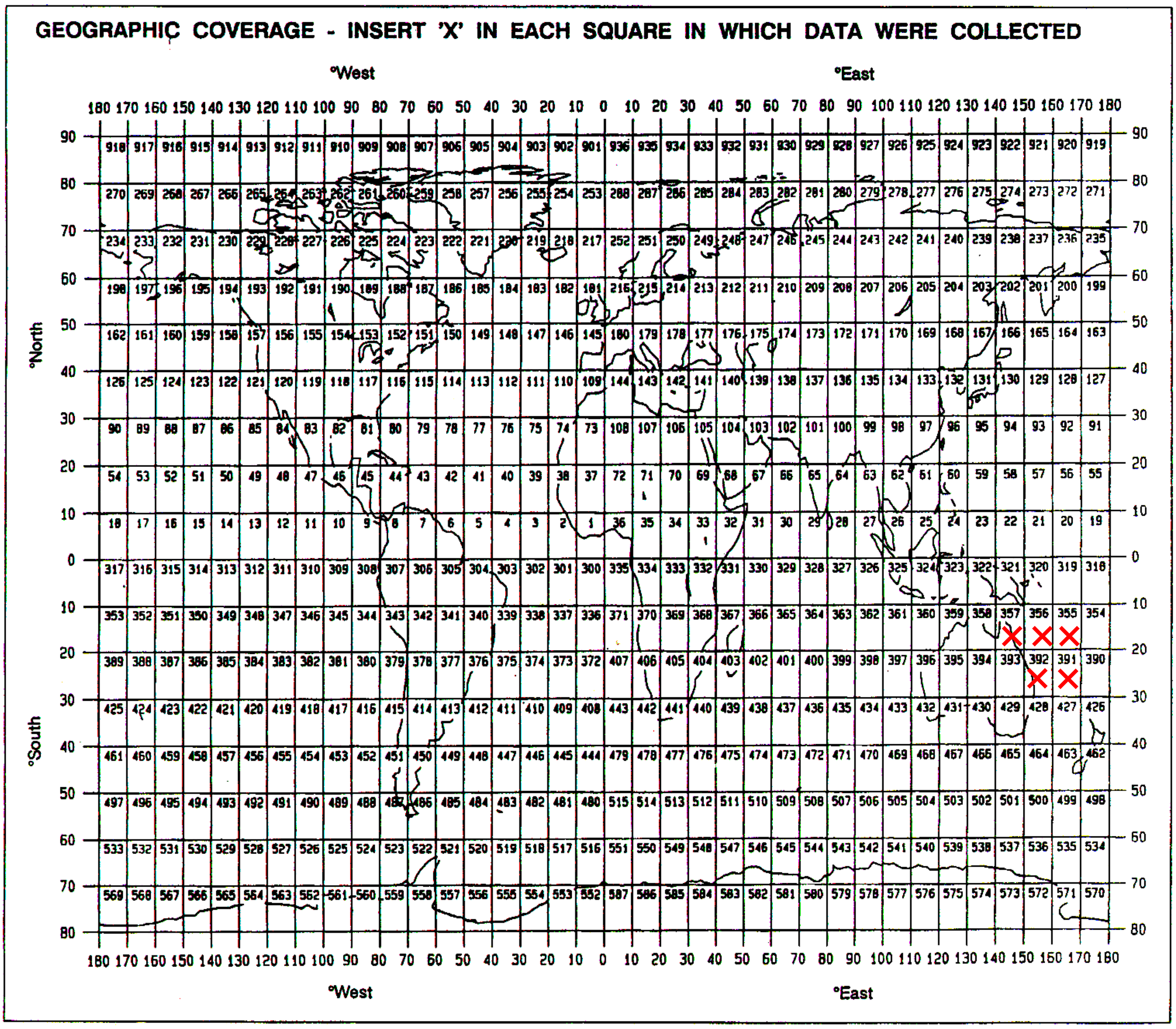
Tuesday 3rd September

Arrived Brisbane.

Summary

In summary, the outcomes of the voyage easily met the initial aims and objectives, and in many ways far surpassed what we could have hoped for based on previous voyages to the same region. We enjoyed predominantly favourable weather conditions during the voyage, and were able to conduct far more mapping and dredge operations than had been planned due to the speed and efficiency of all on board. Ultimately, we were able to undertake 55 dredges, 50 of which recovered seafloor material. A majority of sites returned material that we believe will be able to be used to address the main scientific questions motivating the voyage, to determine the nature and timing of volcanism that has shaped the seafloor northeast of Australia. Many sites also returned carbonate material that will enable us to constrain paleo-environments. The swath mapping was also very successful, with bathymetric data collected continuously, in particular mapping seamounts that were previously completely unmapped. Supplementary projects to map the birdlife and seafloor ecology of the survey area collected a wealth of new data. We are confident that we will be able to undertake our planned program of science with the data and samples collected.

Marsden Squares



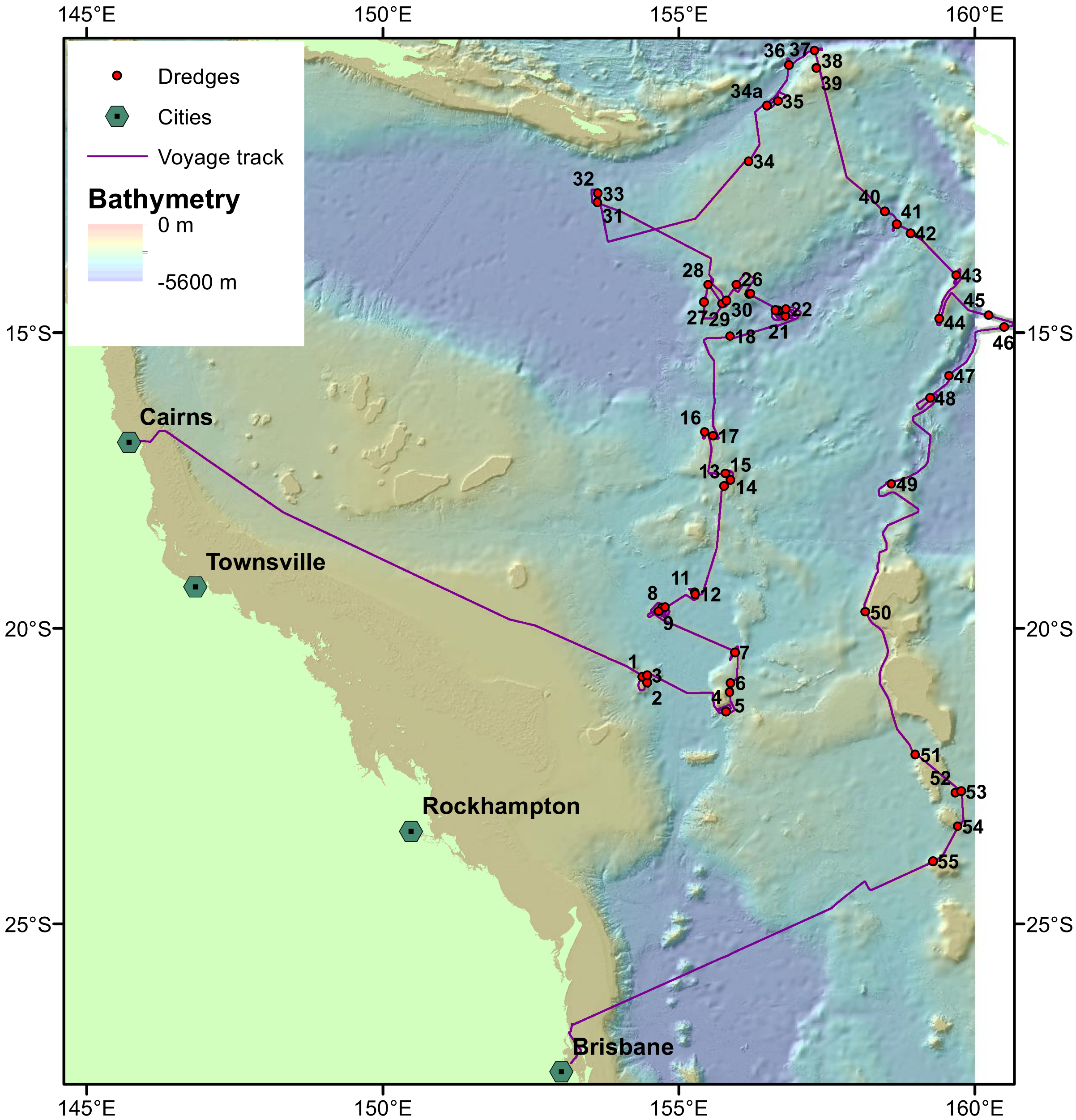
Summary of Measurements and samples taken

Item No.	PI	NO	UNITS	DATA TYPE	DESCRIPTION **Identify, as appropriate, the nature of the data and of the instrumentation/sampling gear and list the parameters measured. Include any supplementary information that may be appropriate, e. g. vertical or horizontal profiles, depth horizons, continuous recording or discrete samples, etc. For samples taken for later analysis on shore, an indication should be given of the type of analysis planned, i.e. the purpose for which the samples were taken.**
Dredges	JW, MS, RC, KO	56	rocks	G01	Dredged rocks and sediments using rock dredge with attached mesh and solid bottom sediment buckets. Planned onshore science: Hand samples descriptions, thin section analysis, geochemical analysis (major, minor and trace elements), Ar/Ar dating, biostratigraphy.

Curation Report

Item #	DESCRIPTION
1.	All rock samples are being archived at the University of Tasmania.
2.	Swath bathymetry, subottom profile data are curated and made publicly available by the Marine National Facility.

Track Chart



145°E
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160°E
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20°S
25°S
Dredges
Cities
Voyage track
Bathymetry
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-5600 m
Cairns
Townsville
Rockhampton
Brisbane
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List of additional figures and documents

Appendix A - CSR/ROSCOP Parameter Codes

	METEOROLOGY
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

	MARINE BIOLOGY/FISHERIES
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

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

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