VOYAGE SUMMARY SS03/2003

Title
A New Mechanism for Supply of Sand to Deep Water: The Eastern Australian Longshore Transport System

Itinerary
Depart Brisbane 0800hrs, Saturday 12 April 2003
Arrive Cairns 1200hrs, Saturday, 26 April 2003

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Scientific Objectives
The objective of this voyage was to evaluate the ability and capacity of the Eastern Australian longshore sediment dispersal system to supply sand to deep water at the Fraser Island (northern) end of the system. An associated aim was to determine the suitability of this mechanism as a model for deepwater hydrocarbon exploration in the ancient stratigraphic record. Subordinate objectives included determining the bed-load sediment dispersal system around Breaksea Spit and Shoal by surveying the bed-forms by swath mapping, seismic and bottom sampling, and investigating the presence of submarine canyon systems that penetrate to less than 50 m water depth on the upper continental shelf. It was hoped to establish a linked sediment dispersal system from the shoreline, across the shelf and down the slope. Deeper surface sediment sampling was planned to determine the extent of the system down the slope and onto any potential submarine fans.

Voyage Objectives
The voyage attempted to satisfy the scientific objectives by:

1. Collecting a grid of sediment samples that characterise the sand on Breaksea Spit and Breaksea Shoal and adjacent continental shelf through grain-size analysis and grain composition (e.g. by establishing sediment tracers through distinctive mineralogy). This characterisation builds on earlier shoreline sampling on Fraser Island and in shallow water (< 20 m) on an earlier small boat voyage.
2. By collecting an associated grid of sediment samples from the upper continental slope and any deep water submarine canyon systems and comparing the sediment texture and composition to the shallow water samples collected in #1.

3. By collecting a detailed grid of ADCP current measurements to indicate the strength and direction of the currents in the study area and to infer the direction of bed-load sediment transport from the current measurements.
4. By collecting a grid of swath mapping transects in the area between Breaksea Spit and Shoal and the upper continental shelf to map the distribution of bedforms, their scale and migration and the presence and character of any canyons on the upper slope.
5. To collect a grid of seismic profiles to detail the thickness of the sediment bodies in the area and their internal character to indicate sediment transport capability.

Voyage Track

The area of operation was located north of Fraser Island in SE Queensland and extended from Hervey Bay to the Tasman Abyssal Plain (see Figures 1,2).

Results

1. Grab samples showed that there is clastic sand distributed continuously from shallow water of <5 m on Breaksea Spit to over 3900 m on the Tasman Abyssal Plain. This result indicates that the process of longshore sediment supply to the deep ocean is actually operating in the area north of Fraser Island.
2. Dredge samples and seismic profiles indicate that the clastic sand sourced from Fraser Island is migrating across an older carbonate province made up of at least two vertically stacked carbonate platforms composed of consolidated limestone.
3. ADCP current data indicates strong shallow tidal flows from east to west on the flood tide and west to east on the ebb, extending up to 9 km seaward of the shelf break. North to south flow seaward of the shelf break is attributed to the East Australia Current. Currents are variable in strength and direction at greater depths.
4. Preliminary CTD results indicate a stratified water column over the outer shelf with a complex and variable vertical structure.
5. Swath mapping results show a region of sand prograding over an older carbonate platform and local reef mounds. The sand is moulded into bedforms at a range of scales from small ripples of centimeter scale up to 6 m high and 500 m long tidal dunes. The majority of the seaward dunes are ebb asymmetric, indicating eastward flow towards the shelf break. Seaward of Breaksea Spit, Channel and Shoal are a series of retrogressive slides and slumps indicating gravity failure of shelf sediments and transport downslope onto the top of a lower carbonate platform at 150-250 m water depth. On this lower platform, there are a series of around 15-20 gullies oriented downslope that are transporting the sediment supplied by gravity processes from the continental shelf across the top of the platform and into water depths of 500-600 m at the base of the platform. North of Breaksea Shoal near the entrance to Curtis Channel, there is a channel incised up to 50 m across the outer shelf. This channel has its southwestern margin flooded with clastic sand sourced from the south. The lack of sand in other parts of this channel and its burial of only the SW channel margin indicates that this location is the approximate limit of significant northward clastic sand transport at the present time.
6. Seismic results show the presence of two stacked carbonate platforms that make up the superstructure of the shelf north of Fraser Island. On top of the upper platform the Breaksea Spit and Shoal sandbodies are up to 55 m thick. The outer margins of both carbonate platforms are essentially bare of sediment cover, while a landward thickening wedge of either coastal clastic sediments or forereef slope sediments sits on top of the lower carbonate platform.

Taken together these results indicate a highly successful research voyage on which the majority of the scientific objectives were achieved and the overall concept of highstand sea level sand supply from the coastal zone to the deep ocean in the area north of Fraser Island was established.

Voyage Narrative

Day 1: Saturday, April 12, 2003

Ship departed Forgacs Shipyard Brisbane at 08:00 hours and proceeded to Caloundra where the pilot departed at 13:00 hrs. Two Geoscience Australia personnel were on board to assist in deploying the acoustic target and conducting the patch test. To complete this, many connections were required between the swath mapping system and the ship such as GPS feed and motion detectors. It took until 19:00 to complete these feeds. Being after dark and after the departure of the GA personnel on a pilot boat, the patch tests were not conducted.

In addition, the swath data appeared to be subject to a random vibration which was at first thought to be due to movement in the transducer pole. After winching up the pole with a block and tackle system, placing wedges in the top of the sleeve, and levering the top of the pole sideways with a second block and tackle system, no improvement was evident in the swath data, which unfortunately became progressively worse with the passage of time.

The remainder of the day was taken up with setup of various ship systems such as networking the computers, connecting up the boomer/sparker seismic systems, conducting a ship scientific crew meeting, and arranging navigation locations and future lines. A raw swath feed was collected and fed to the UN computer to test processing with OMG software. No specific voyage data was collected on day 1. After the GA personnel were offloaded, the ship proceeded north towards GR 8 grab sample station (approximately due NE of Sandy Cape in 50 m water) to conduct a CTD station and collect a grab sample. These activities were planned to test both systems and to provide data for the scientific personnel working on these data. For the remainder of the voyage, standard meteorological data, GPS location and echo sounding data were collected.

Day 2: Sunday, April 13, 2003

The ship arrived off the north end of Fraser Island around 7 am and proceeded to take a grab sample at location GR8. Weather conditions were ideal with minimal wind and sea and low swell. Due to a misunderstanding, the sample was taken in the same area but in 50 m water depth closer inshore. The sample contained temperate carbonate material with rhodolith and bryozoan fragments. A CTD was taken at the same spot (CTD 1). All data collected on the voyage such as CTD stations, grab samples, seismic lines etc. are summarised in Table 1.

The boomer was then deployed on Line 1 at WPA and we ran all of line 1 and 1A, finishing at Line 1A, WPA. Boomer data was poor with little return in deeper water and a lot of noise on the record. Part way along the line the sparker was deployed and later the Chirp Sonar. Along this line towards the northern end of Breaksea Spit and across Breaksea Shoal, a number of gullies were encountered approximately 5-25 m deep and up to 500 m wide. We then circled around and picked up Line 2 at WPA, and continued to run Line 2 to completion at WPE. A transit was then commenced to start Line 3 at WPB. Approximately half way along this line the ship slowed and the boomer was retrieved (it had not operated since early on line 1). The sparker was checked and redeployed and seismic data with sparker and Chirp Sonar was collected along Line 3 starting at WPB for the remainder of Day 2. The swath mapper head mounting had broken over the previous 24 hours and attempts were made to contact industrial divers in Maryborough, Urangan and Bundaberg. These attempts were unsuccessful and it was determined to continue the seismic program, running at a constant speed and with minimal stops until a diver could be located.

Day 3: Monday, April 14, 2003
This day began by completing Line 3 running parallel to Breaksea Spit in approximately 50 m water depth. Data and weather quality were both good. We encountered several reefs on the line early, and then the two big sand bodies extending seaward from the end of Breaksea Spit and Shoal. In between we saw the deep channel between the spit and the shoal and the bedforms in it. On the northern side of Breaksea Shoal there were a field of large 3-5 m high bedforms.

For the rest of the early morning of Day 3 we ended line 3 at WPK and then transited NE to pick up the beginning of Line 12 at WPA. Carbonate mounds and platforms were encountered in this area and we then completed Line 12 landward up the Curtis Channel to Line 12 WPB. Then followed a transit to Line 10 WPA and we completed Line 10 to WPB. At this point, no divers could be located so we steamed east, completing Line 9 from WPA to WPB. This was a high quality line with numerous bedforms in the base of the channel, a steep, sand covered reef front, a terrace, then another reef front to a gently sloping plain on the upper slope. The ebb tide raced out to the position of the first reef front and made a line of breakers in 50 m of water. A thick wedge of sediment was evident on the first terrace with progradational clinoforms dipping seaward. The second terrace appeared to be completely covered with sediment. After completing Line 9 we returned to 650 m water depth and took a grab sample GR 91 around 11.30 am. This turned out to be fine quartz sand with dark rock fragments (coal/charcoal or pumice) and what appeared to be heavy minerals as well as minor mud. This sample suggests fine quartz sand is making its way from Breaksea Spit to the platform at 650 m depth.

After the sand sample, CTD 2 was conducted at the same site as the grab sample. We then transited to the eastern end of Line 9 and ran seismic data with sparker and Chirp Sonar in towards Breaksea Spit N end. The data again showed a flat sediment covered platform, a steep reef front, a second platform covered by a wedge of sediment, and a second reef front. Through the afternoon and early evening we continued to run a grid pattern of seismic lines until approximately 19:30, covering Line 8 running W, Line 7 running E and a tie line called Line 4A running SE. At that point we changed voyage plan to travel north in order to be in a position to rendezvous with a diver at 07:30 on Day 4 in Platypus Bay inside Fraser Island. We turned at a location suitable to transit the canyon head on the way south, then again on the way north, running Line 4B until linking up with Line 4 at WPC and continuing to WPA at its northern end. On this line at the southern end there was considerable relief of up to 50-100 m and extensive hyperbolic Chirp reflections from the wide beam. This style of bottom continued for the majority of Line 4B up to the sandy platform samples earlier in the day at site GR91.We then turned west running Line 11 on the northern side of Breaksea Shoal across the bedform field from WPB. This line was completed to Line 11 WPA and then a new line (Line 18) was run from Line 11 WPA south to Platypus Bay ending around 07:00.

Day 4: Tuesday, April 15, 2003
The ship rendezvoused with the divers at 07:30 and the swath head was recovered from the pole while at anchor in Platypus Bay. It was found that both attachment bolts had sheared off, leaving the swath head only attached by the safety line and essentially floating free. The pole and extension had been retracted and hence the swath head and extension were wedged in the moon pool when under way. This prevented the loss of the swath head. When recovered, the extension was found to have metal fatigue cracks across the upper join. It was decided to abandon deployment of the swath head on the pole and instead deploy it from the moon pool trolley. In order to accomplish this, the ADCP was withdrawn from the trolley and could not be used further on the voyage. After departure of the divers, the ship pulled up anchor and departed NW to grab sample site GR83. The sample here was a grey, fine, well sorted quartz sand with abundant shell debris and organic matter. The ship then moved in order to sites GR 84, 82, 80 and 81 with the final site also being CTD Site 3. Sediments at all these locations were clastic sands with GR 81 being relatively coarse grained and containing

abundant carbonate gravel in a flood tidal delta position. A trial swath mapping line was run underway at 10 knots to test the new installation in the moon pool trolley and was found to be satisfactory.

After completing grab samples and CTD 3 the ship commenced a series of repeat seismic lines to better define the features identified so far. For these lines the swath mapper was running together with Chirp Sonar and sparker seismic source. The first line, Line 19, was run NE through Breaksea Channel slightly to the north of Line 9 to see the bedforms and the steep fronts to CP1 and CP2. Spectacular bedforms were present on this line (shark tooth and sawblade types) and they continued over the front of CP1 cascading down the front in a fishscale pattern of smaller 3D dunes. After completing Line 19 the ship completed a short tie line to the W to link to the beginning of Line 21 which was a long strike line parallel to Line 1 to locate the presence of gullies, the expected high dunes on the 200 m terrace and Vince's Canyon head. The line was run close to the base of the escarpment on the front of CP1 and showed few gullies, but a sharp V shaped notch was located at the canyon head.

Day 5: Wednesday April 16, 2003
At the completion of Line 21, a short tie line was run to the W to pick up Line 6 at WPA and this line was run NE to WPB, followed by a tie line to the S to Line 5 WPB and this line was run to the SW to Line 5 WPA. Line 5 was shifted slightly to the S to avoid the shallow ground near Sandy Cape Shoal, an element of the 25 m reef line. This completed the seismic survey in the southern area at 9:05 am.

The weather forecast was for deteriorating conditions so we began a program of grab samples, first along Line 5 where 4 samples were collected (GR 11a, 12a, 13a, and 14a), and then the ship headed east to recover the deepest samples. These were first GR 86, then GR 85 and GR 105 (no sample). The first sample failed at this site, and the winch was malfunctioning leading to a second sample being taken slightly south of the first at GR107a. GR 107a was the deepest sample in the program at around 3920 m depth and recovered a large quantity of fine quartz dominated sand with a very minor planktonic foram sand component. This would seem to prove the presence of Fraser Island type sand in deep water 70 km off shore from the island and 50 km seaward of the shelf break. After the grab sample was successfully recovered CTD 4 was also successfully completed in 3920 m water, providing water samples for ANU.

Day 6: Thursday April 17, 2003
The ship then headed north to collect the remainder of the deeper water grab samples seaward of Breaksea Spit, attempting GR 104, 102, 103, and 101 throughout the morning and the afternoon of Day 5. The weather was poor during this interval, with SE wind gusts to 33 knots and a 2-3 m sea opposing the current. Only grab samples were feasible in these conditions. GR 102 misfired and GR 103 was carbonate ooze, but GR 104 returned muddy clastic sand from 3600 m and GR 101 had fine clastic sand in 1780 m depth.

Having collected the deeper water samples, the ship moved to the NW to run a transect of samples parallel to the shelf break in around 1000m from GR 95 to 100. Of these GR 100 in the south was carbonate ooze, and GR 98 off the Breaksea Channel returned no sample. Samples GR 99 and 97 both returned either clastic sand or muddy sand.

Day 7: Friday April 18, 2003
The weather remained poor with SE winds 20-25 knots and seas to 3 m. The ship completed another N to S transect of grab samples overnight from GR 93 to GR 86 from 480 to over 800 m depth. Of these GR 87 was bypassed and GR 88 contained carbonate ooze in 802 m, as did GR 86. The remainder off the end of Breaksea Spit contained either sand or muddy sand, confirming that the area south of the spit is more typical deep sea sediments containing carbonate ooze, but those off the end of Breaksea Spit and further N are either outcropping bedrock or contain clastic sand.

The next sampling location was moved inshore to GR 20 in approximately 400 m water over the edge of the CP2 reef wall and in the axis of Vince's Canyon head. The sample was a silty carbonate rich clay. The ship then moved to a position in 50 m water to find a small reef pinnacle seen on an earlier seismic line in order to do a patch test which was commenced around 2:30 pm and was completed around 5.30 pm. As time was required to compute the results of the patch test, two more grab samples GR 28 and GR 31 were successfully recovered. The deeper sample GR 31 on the 200 m terrace returned a predominantly clastic sand lithology, as did the shallower sample on the presumed hardground surface at 43 m.

Around 8.30 pm the ship began the first swath survey parallel to the shoreline and shelf break, termed Shelf Survey. These lines were approximately 1 hour in duration with the centre line being surveyed first and then progressively moving into deeper water overnight. The lines were able to be downloaded and processed immediately after collection, and data quality was good considering the ongoing 2 m swell and 20 knot winds.

Day 8: Saturday April 19, 2003
The swath mapping continued overnight with lines moving progressively seaward from the centre line of the Shelf survey, reaching number 19. After this, a problem developed with the GPS positioning equipment with no navigation fixes being received after approximately 5 am. It was determined to stop swath mapping until the problem was fixed and a program of sediment samples was begun. These samples commenced with a traverse normal to the shelf break north of Breaksea Shoal from east to west from GR 62 to GR 59. The samples were uniformly clastic sand with shallower samples coarse grained. Then followed two more traverses normal to the shelf break. The first of these was off Breaksea Shoal from west to east and from GR 55 to GR 58. The second was off Breaksea Channel and was run from east to west from GR 46 to GR 43. All samples in these transects from 40 m to 220 m depth were clastic dominated sand with deeper samples outside gullies containing a minor component of mud. On the second transect, the sample locations were planned from the swath survey and previous seismic lines. The first sample GR 46 was taken on the outer 200 m terrace, the second sample (GR 45a) in a medium sized gully on this terrace, the third (GR 44) at the base of the CP1 forereef, and the fourth (GR 44a) half way up this forereef slope. The final sample (GR 43) was from the axis of Breaksea Channel in 42 m of water.

Around 3 pm the GPS problem was fixed by repositioning the antenna. It was decided to recommence swath mapping and this was commenced on Line 20 of the Shelf survey run from S to N. Swath mapping then continued on this survey, first moving offshore and then onto the shallower parts of the grid.

Day 9: Sunday April 20, 2003
The Shelf swath survey was completed around 8 am with the shallowest lines on the shelf. The ship then moved to start the Boomerang (later renamed Stingray) Shoal swath survey. It was decided that the most southern line 117 was too shallow and the survey started with Line 115 run east to west, followed by Line 116 run west to east. The survey then continued after 12 noon moving progressively further north. The weather continued to be windy with gusts to over 30 knots and seas of 2-3 m. The survey was completed apart from the two northern lines by 8 am on Monday and the ship moved south to commence the Breaksea Channel survey around 9 am.

Day 10: Monday April 21, 2003
After the first line in the Breaksea Channel was run E to W in the middle of the southern grid, the next line was run W to E at the extreme southern end of the grid next to Breaksea Spit and only approximately 200-300 m to the north. After this, as the lines were still generating gaps on port to port traverses, it was decided to run the survey in a circular fashion with all line contacts being port to starboard to avoid gaps. The survey was then continued until dark, after which it was considered too dangerous to work in the channel and near shallow water. Hence a program of CTD cast and velocity survey was completed and then the ship moved north to clean up some earlier swath lines with gaps. CTD 5 was conducted on the flooding tide, with a second survey (CTD 6) to be conducted on the ebbing tide was planned for Tuesday. The velocity survey was unsuccessful. The swath mapping repaired some problems with the Shelf Survey and the Boomerang Shoal Survey until midnight.

Day 11: Tuesday April 22, 2003
The morning of Tuesday was reserved for collecting a final set of shore normal grab samples from south of Breaksea Channel. The rationale for these samples was to fill in the gap between the early line of samples collected in the south (GR 11a-GR 86) and the extensive set of samples on lines near the entrance to the Breaksea Channel (such as GR 43-46 and GR 51-54). The northern samples were all sand while the southern line had sand with carbonate hardground seaward and then reefs at the shelf break. As it was felt the carbonate hardground indicated a barrier to seaward transport of sand in the south, it was required to establish how far north this carbonate hardground extended.

The first line of samples was run along Seismic Line 7. GR 27a, GR 28a, GR 108, and GR 29b were collected on this line. Most were sand except for those close to the reefs on the shelf break. As there was still time before the dredges planned for 4 am, a line of samples to the south, GR 21 to 26 were also collected showing similar results.

At 4 am the dredges were commenced. The objective of these three dredges was to establish the composition and origin of the steep dropoffs on the upper continental shelf. The first dredge (SS03 DR 3) was targeted to sample from approximately 400 m to 275 m along Line 7 where the steep dropoff had been observed. The dredge soon hooked up and an excellent collection of cemented carbonate reef rock and encrusting corals and sponges were acquired, probably from around 350 m.

The second dredge (SS03 DR 1) was targeted at a topographic bump at around 85-100 m. This dredge was also successful, returning a small quantity of carbonate reef rock with extensive algal growth but few encrusting corals. The third dredge (SS03 DR 2) was moved to the top of the slope to sample the linear reefs at the shelf break around 40-55 m. The dredge hooked up at around 50-55 m and returned a moderate haul, again of encrusted carbonate reef rock. These three dredges proved that there are a series of old carbonate reef platforms underlying and seaward of Breaksea Spit and Shoal. The seaward platform is 200 - 300 m high and steep, covered with a rich coral community of solitary and colonial corals, bivalves and bryozoans. The inner platform is only around 100 m high

and more sediment covered with exposed reef on the slope and linear wall reefs around 15 m high on the shelf break.

After completing the three dredges around 7:30 am, the inner sand sample (GR 27a) on line 7 was taken and the ship moved to complete the Breaksea Channel survey. This was virtually ended by 3 pm when the ship returned to the site of GR45a and the previous day's CTD cast at around 196 m. CTD 6 was collected here, this time on the ebbing tide to locate the water mass at the seabed responsible for transporting sand offshore. A successful velocity survey was also conducted here for swath mapping calibration. After completion of CTD 6 the remainder of the Breaksea Channel survey and the seaward part of the L-shaped survey were completed after dark.

Day 12: Wednesday April 23, 2003
After additional patching of grid holes early in the night, the ship moved north to conduct the Ravine Swath Survey. This site was chosen as it was unsafe to conduct further work around Breaksea Shoal at night. The location was indicated by local fishermen as being a "ravine" with deep water of 91 m in a flat area of the seafloor averaging around 50 m. This smaller survey was run at 10-11 knots and data quality was acceptable in the rough sea conditions. Results were interesting and showed a sinuous channel up to 90 m deep meandering across the seabed to the shelf break. This was presumably a lowstand channel with a delta-like deposit at the margin. The front of CP1 was clearly delineated. The southern margin of the channel was infilled by northward migrating sand. Bare, slightly elevated seafloor covered much of the western part of the survey.

After completion of the Ravine Survey, the ship continued to complete additional grid patching before conducting a small survey termed Corner Swath Survey at the eastern margin of Breaksea Shoal. The objective of this survey was to map the connection between the shoal bedforms and the slumping at the shelf break. The survey imaged an excellent truncated bedform where a slump feature had undercut the advancing dune slip face, leading the slumped sediment off into deeper water. One small hole was left in the survey where the two grids did not meet up on the southern margin. This hole was later filled by ship's echo sounder data.

The remainder of the morning and the early afternoon was used to patch holes in the Boomerang Shoal Survey, before deploying the seismic gear around 2 pm when Line 14 was run northward to a reef on the northern side of Curtis Channel, and Line 13 run NE from the reef over the shelf break and into deep water. Following the seismic survey, a line of grab samples were recovered back along Line 13 using seismic data for positioning. These 7 samples were numbered GR 70, 69a, 68a, 67a, 66a, 71a, 72a from seaward to landward and from 350 m to 30 m water depth. The seaward samples had clastic and carbonate sand mixed with lithic pebbles, but the remainder were dominated by carbonate sand and gravel and abundant tropical coral debris.

Days 13 -15: Wednesday April 24 - Saturday April 26, 2003
These sediment samples concluded the scientific program for SS03, and at around 10 pm the ship headed for Cairns. The transit then took from 10 pm Wednesday to 8 am Saturday 26 April when a diving inspection of the ship was held and the ship then proceeded to Cairns Trinity Wharf at 12 noon.

Summary
The voyage was a major success in terms of the achievement of the scientific objectives and the performance of the ship and its installed systems as well as the added systems. Early problems with the swath mapping system installed on the moon pool pole were overcome by its transfer to the moon pool trolley. Thereafter the swath mapping operations were a highlight of the voyage. Grab sampling worked well throughout with a high (88%) success rate even in deep water. Dredging operations were another highlight of the voyage and highly successful. Underway systems (GPS, echo sounding, meteorology) performed well throughout the voyage. The CTD system experienced some problems, mainly due to teething issues. The ADCP worked well until removed to replace the swath mapper. Although the seismic reflection systems provided good quality data throughout the voyage, the user supplied system on this voyage had several shortcomings. Firstly the digital EPC 9800 recorder used on the voyage failed to function throughout. The other digital EPC recorder 9701 worked well but consistently printed a white line down the center of the record where the two channels joined, leading to quality problems with the final product. The substrate largely consisted of highly reflective materials with little internal detail (sand bodies and carbonate platforms) and hence the seismic records also did not provide much detail. The CHIRP sonar or boomer provided virtually no penetration in any locations of the voyage. The sparker system was more successful and was able to identify and map the distribution of the major stratigraphic units in the area and their thickness.

The only shortcomings of the ship on the voyage were related to the ability to hold effective meetings and to deploy seismic systems. These seismic systems require a boom arrangement in order to locate the acoustic source (e.g., sparker) and the receiver (hydrophone array) in clear water behind the ship but a distance outboard and away from the ship wake. The Southern Surveyor does not currently have this capability and will have problems functioning as a seismic survey vessel until it is provided. I suggest installation of at least two towing booms, one on either side of the vessel. Secondly, the ship currently does not have an adequate meeting room for the sizable crew to gather for pre, during and post voyage meetings. Although the lounge is large enough to accommodate most of the scientific crew, it has few facilities for a meeting with seating largely consisting of bean bags and armchairs and no audio visual materials. I suggest at least the provision of a white board/projection screen and a video projector and overhead projector. The video projector could double as a home movie theatre projection unit for entertainment.

Considerable time and effort would be saved if the scientific systems deployed on our voyage (in particular swath mapping and seismic reflection profiling) were permanent fixtures on the ship. Hopefully the provision of a deep water capable swath mapper and a CHIRP sonar system in 2003 will go a long way to solving these problems. Note that without a capability to survey to at least 4000 m water depth, it will be impossible to adequately map and document the exciting deep water sediment dispersal system we have discovered on SS03. Hence I recommend installation of such deep water capable systems. A remaining major shortcoming of the Southern Surveyor will be an adequate deeper water, higher penetration seismic system such as an airgun or water-gun. These types of systems are essential to penetrate sandy and carbonate reef substrates such as in the Fraser Island area, or to achieve penetration in water depths below 500 m. No suitable system is currently available for use in Australia due to the lack of an appropriate air compressor supplying both high pressure and high volume. I suggest the provision of a more powerful seismic profiling system be a high priority for acquisition in 2004.

Personnel
Scientific Crew

Ron Boyd	University of Newcastle	Chief Scientist
Kevin Ruming	University of Newcastle	Research Scientist
Jason Roberts	University of Newcastle	Research Student
Shannon Davies	University of Newcastle	Research Student
Tobi Payenberg	NCPGG	Research Scientist
Jonathon Beaudoin	OMG, University of New Brunswick	Research Student
Kevin Hooper	James Cook University	Technician
David Mitchell	University of Sydney	Technician
Ron Plaschke	CMR	Voyage Manager
Mark Underwood	CMR	Electronics
Bernadette Heaney	CMR	Computing
Gary Critchley	CMR	Hydrochemistry

Marine Crew
Neil Cheshire (Master)
Roger Pepper (First Mate)
John Boyes (Second Mate)
Evan Peters (Chief Engineer)
John Hinchliffe (First Engineer)
Rob Cave (Second Engineer)
David Willcox (Chief Steward)
Peter Graham (Chief Cook)
Mark Chambers (Second Cook)
Graham McDougall (Bosun)
Allan Browlie (IR)
Fred Germann (IR)
Rebecca Brown (IR)
Phil French (Eng. IR)

Acknowledgments
Financial support for the voyage was provided by the Australian Research Council and ConocoPhillips. Without this support, the range of technical data acquisition enjoyed on the voyage would not have been available. The scientific party of SS03 would like to acknowledge the professionalism and seamanship of the crew of Southern Surveyor. Fraser Island and Breaksea Spit are difficult areas to work in such a large research vessel. We were able to obtain virtually all the data we required, even when close to navigation hazards of shallow water. Dredge and grab sample data were obtained successfully under virtually all conditions. In addition we would like to acknowledge the dedicated and competent contribution of the CSIRO personnel, as evidenced by the continuing performance of all onboard equipment throughout the voyage and its speedy repair when required.

Ron Boyd
Chief Scientist.

Figures

Figure 1. Trackline plot for SS03. Squares indicate 00:00 hrs on the calendar date specified.

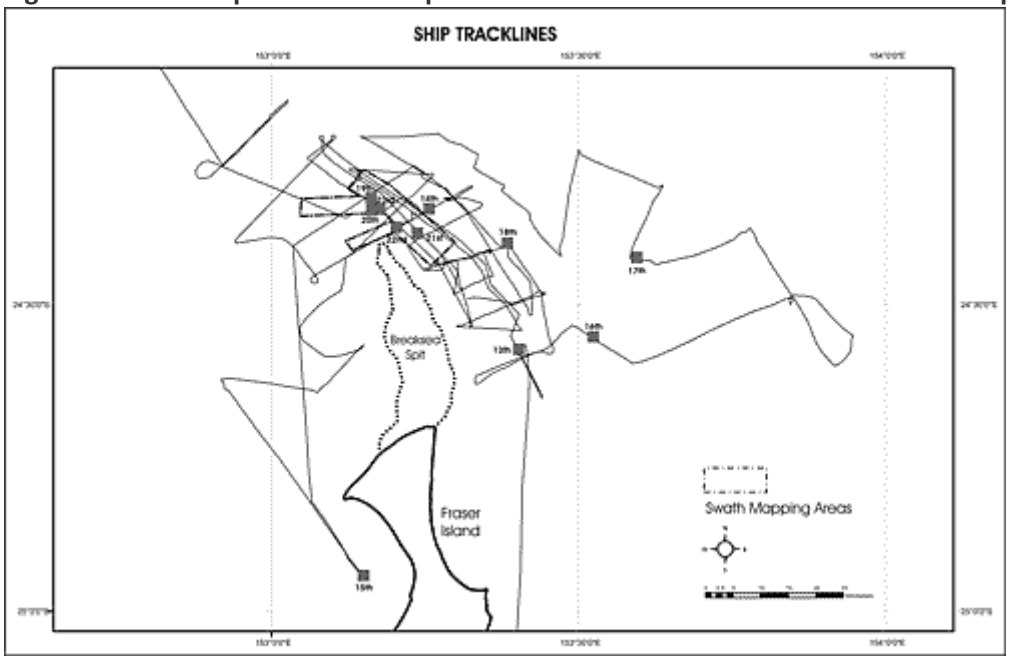

Figure 2. Detailed trackline plot for the swath mapping survey grids on SS03

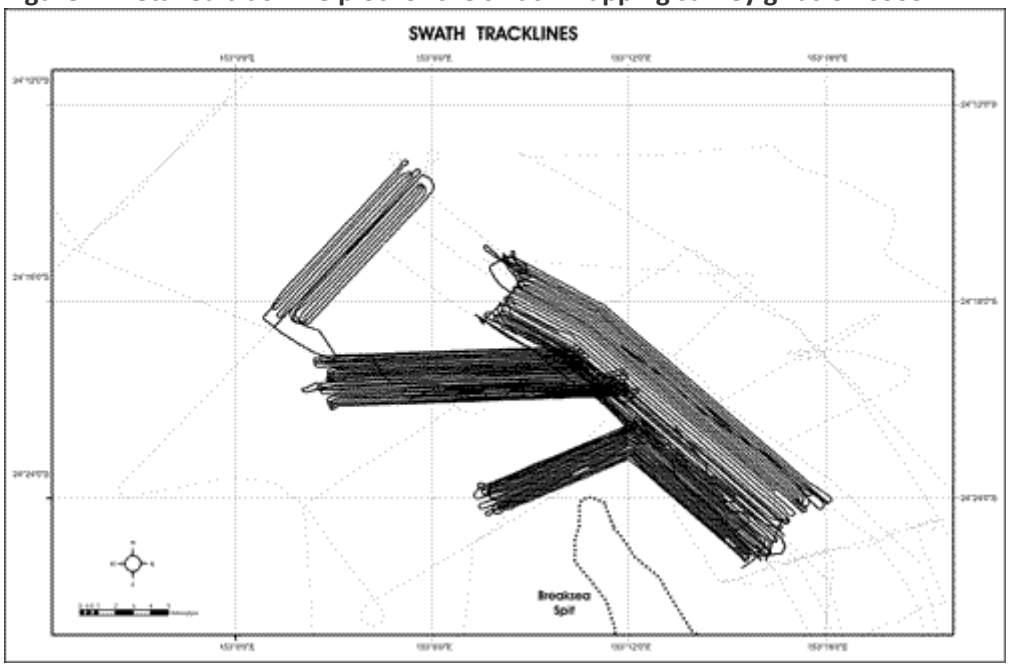

Table 1. Dredge and Grab Sample Summary

Sample number	Summary	Typ	Water depth (m)	Latitude wgs 84	Longitude wgs 84	Date (GMT)	Time (GMT)
DR1_start	sand (quartzose)	DR	160	-24.42750000	153.29583330	21-Apr-03	20:10:47
DR1_finish		DR	71	-24.42950000	153.28916670	21-Apr-03	20:21:40
DR2_start	sand (quartzose)	DR	56	-24.42983333	153.29066670	21-Apr-03	20:47:42
DR2_finish		DR	57	-24.43083333	153.28516670	21-Apr-03	21:17:13
DR3_start	muddy mixed quartz/ carbonate sand	DR	500	-24.41150000	153.35383330	21-Apr-03	18:48:14
DR3_finish		DR	250	-24.41483333	153.34350000	21-Apr-03	19:06:44
GR100	Carbonate ooze	GR	1275	-24.42016667	153.47216670	17-Apr-03	10:00:18
GR101	Quartz sand with very minor mud	GR	1780	-24.24650000	153.50033330	17-Apr-03	7:53:41
GR103	Sandy mud	GR	2600	-24.30416667	153.63800000	17-Apr-03	4:26:57
GR104	Silty mud	GR	3600	-24.38116667	153.77316670	16-Apr-03	20:48:09
GR107A	Quartz sand	GR	3920	-24.55766667	153.94383330	16-Apr-03	12:33:37
GR108	sand (quartzose)	GR	54	-24.43383333	153.27850000	21-Apr-03	15:14:16
GR11A	Quartz sand	GR	30	-24.62750000	153.33800000	16-Apr-03	0:03:13
GR12A	Quartz sand	GR	38	-24.61300000	153.35700000	16-Apr-03	0:56:58
GR13A	Hardground carbonate and bioclastic fine-sand to gravel	GR	56	-24.59866667	153.38733330	16-Apr-03	1:36:37
GR14A	Fine silty sand (carbonate)	GR	225	-24.57583333	153.43866670	16-Apr-03	2:28:02
GR20A	Sandy mud	GR	433	-24.49883333	153.38900000	18-Apr-03	3:05:42
GR22	mixed quartz/carbonate sand	GR	51	-24.48066667	153.29950000	21-Apr-03	16:40:47
GR24	Mixd quartz/ carbonnate sand	GR	50	-24.47533333	153.31050000	21-Apr-03	16:55:27

Sample number	Summary	Typ	Water depth (m)	Latitude wgs 84	Longitude wgs 84	Date (GMT)	Time (GMT)
	and carbonate gravel						
GR25	Sand (quartzose)	GR	137	-24.46366667	153.33600000	21-Apr-03	17:23:48
GR26	Sand (quartzose)	GR	221	-24.45400000	153.35550000	21-Apr-03	17:50:09
GR27A	Sand (quartzose)	GR	24	-24.44220000	153.24610000	21-Apr-03	22:01:55
GR28	Sand	GR	45	-24.43450000	153.27079000	18-Apr-03	8:50:00
GR28A	sand (quartzose)	GR	45	-24.43633333	153.26800000	21-Apr-03	14:49:57
GR29A	sand, mixed carbonate/ quartz and carbonate gravel	GR	56	-24.43066667	153.28716670	21-Apr-03	15:30:59
GR29B	sand (quartzose)	GR	130	-24.42800000	153.30133330	21-Apr-03	15:52:50
GR31	Sand	GR	225	-24.41800000	153.33300000	18-Apr-03	8:20:00
GR43	sand (quartzose)	GR	42	-24.37583333	153.20566670	19-Apr-03	4:42:39
GR44	sand with minor mud	GR	159	-24.36200000	153.22850000	19-Apr-03	3:54:53
GR44A	sand with minor mud	GR	94	-24.36400000	153.22016670	19-Apr-03	4:19:16
GR45A	muddy sand	GR	198	-24.34916667	153.22816670	19-Apr-03	3:16:56
GR46	muddy sand	GR	219	-24.34983333	153.24783330	19-Apr-03	2:36:01
GR51	sand (quartzose)	GR	27	-24.34733333	153.17850000	19-Apr-03	0:21:32
GR52	sand (quartzose)	GR	155	-24.33583333	153.19816670	19-Apr-03	0:48:52
GR53	very muddy sand	GR	215	-24.33000000	153.20566670	19-Apr-03	1:08:17
GR54A	muddy sand	GR	227	-24.32583333	153.21300000	19-Apr-03	1:32:03
GR55	sand (quartzose)	GR	27	-24.32916667	153.15966670	18-Apr-03	23:54:44
GR59	Sand (quartzose)	GR	42	-24.31033333	153.12500000	18-Apr-03	23:13:23

Sample number	Summary	Typ	Water depth (m)	Latitude wgs 84	Longitude wgs 84	Date (GMT)	Time (GMT)
GR60	Sand (quartzose)	GR	90	-24.30100000	153.13483330	18-Apr-03	22:53:16
GR61	Sand (quartzose)	GR	179	-24.29283333	153.14483330	18-Apr-03	22:26:54
GR62A	Sand (quartzose)	GR	201	-24.27750000	153.13750000	18-Apr-03	21:58:09
GR66A	sand (carbonate)	GR	46	-24.25100000	152.94550000	23-Apr-03	11:27:00
GR67A	sand (carbonate)	GR	55	-24.22433333	152.96833330	23-Apr-03	11:03:04
GR68A	sandy carbonate gravel	GR	85	-24.19716667	152.99583330	23-Apr-03	10:35:01
GR69A	sand (carbonate)	GR	212	-24.18650000	153.00283330	23-Apr-03	10:12:02
GR70	sand (quartzose)	GR	365	-24.17416667	153.01683330	23-Apr-03	9:42:07
GR71A	mixed carbonate/ quartz sand	GR	50	-24.26133333	152.93166670	23-Apr-03	11:46:56
GR72A	sand (carbonate)	GR	33	-24.27266667	152.92133330	23-Apr-03	12:02:20
GR8	Carbonate hardground	GR	50	-24.58117000	153.40033000	12-Apr-03	21:01:09
GR80	Sand (quartz)	GR	31	-24.47666667	153.11250000	15-Apr-03	7:52:34
GR81	Sand quartz and bioclastic/ carbonate hardground gravel	GR	29	-24.42366667	153.12000000	15-Apr-03	8:23:27
GR82	Sand (quartz) some mud layers	GR	24	-24.56416667	153.15016670	15-Apr-03	6:12:31
GR83	Sand (quartz)	GR	32	-24.62133333	152.91766670	15-Apr-03	3:17:39
GR84	Sand (quartz)	GR	26	-24.63750000	153.07833330	15-Apr-03	5:17:11
GR85	Carbonate sand	GR	1500	-24.59516667	153.58750000	16-Apr-03	5:41:30
GR86	Sandy clay (carbonate sand)	GR	980	-24.53316667	153.49000000	16-Apr-03	4:08:46
GR87	Ooze	GR	960	-24.48050000	153.44300000	18-Apr-03	1:18:10
GR89	Ooze	GR	802	-24.40050000	153.38366670	18-Apr-03	0:04:13

Sample number	Summary	Typ	Water depth (m)	Latitude wgs 84	Longitude wgs 84	Date (GMT)	Time (GMT)
GR90A	Muddy sand	GR	644	-24.33733333	153.30783330	17-Apr-03	22:13:52
GR91	Muddy sand (quartz)	GR	650	-24.32566667	153.29116670	14-Apr-03	2:27:56
GR91A	Sand (quartzose)	GR	693	-24.33733333	153.30783330	17-Apr-03	22:13:52
GR92A	Muddy sand	GR	695	-24.28500000	153.24916670	17-Apr-03	19:39:50
GR93	Silty Sand	GR	482	-24.22450000	153.14383330	17-Apr-03	17:31:20
GR95	Silty mud with biogenic gravel	GR	768	-24.22033333	153.27200000	17-Apr-03	16:02:44
GR97	Muddy sand	GR	980	-24.26700000	153.33333330	17-Apr-03	14:23:15
GR99	Sand	GR	1127	-24.35250000	153.42116670	17-Apr-03	11:28:10

Table 2. CTD Summary Data for SS03

CTD Number	Latitude WGS84	Longitude WGS84	Date	Time
CTD1	-24.5712	153.3942	12-Apr-2003	19:54:37
CTD2	-24.3272	153.2857	14-Apr-2003	03:16:57
CTD3	-24.4188	153.1263	15-Apr-2003	08:48:47
CTD4	-24.5910	153.9323	16-Apr-2003	16:22:00
CTD5	-24.3472	153.2297	21-Apr-2003	09:02:57
CTD6	-24.3507	153.2282	22-Apr-2003	05:37:56

Table 3. Start and End of Line for Seismic Survey on SS03

Date Time	Latitude WGS84	Longitude WGS84	SOL EOL
12-Apr-2003 22:44:29	-24.636	153.4325	SOL1
13-Apr-2003 06:02:11	-24.2295	153.07883	EOL1
13-Apr-2003 07:10:51	-24.28033	153.11917	SOL 2
13-Apr-2003 10:08:58	-24.4415	153.301	EOL 2
13-Apr-2003 11:13:35	-24.5335	153.32683	SOL 3
13-Apr-2003 15:50:21	-24.26133	153.059	EOL 3
13-Apr-2003 16:49:40	-24.22817	153.10217	SOL 12
13-Apr-2003 19:38:35	-24.39433	152.9405	EOL 12
13-Apr-2003 20:47:41	-24.40267	153.0335	SOL 10
13-Apr-2003 21:34:16	-24.4525	153.0715	EOL 10
13-Apr-2003 21:59:43	-24.45167	153.07083	SOL 9
14-Apr-2003 00:50:15	-24.309	153.3193333	EOL 9

Date Time	Latitude WGS84	Longitude WGS84	SOL EOL
14-Apr-2003 04:37:48	-24.34366667	153.3343333	SOL 8
14-Apr-2003 06:02:23	-24.40466667	153.2221667	EOL 8
14-Apr-2003 06:05:49	-24.409	153.2245	SOL 7
14-Apr-2003 08:11:01	-24.4045	153.3858333	EOL 7
14-Apr-2003 08:13:05	-24.40633333	153.3871667	SOL 4
14-Apr-2003 09:41:07	-24.5165	153.4235	EOL4
14-Apr-2003 09:47:14	-24.514	153.4191667	SOL4B
14-Apr-2003 13:13:29	-24.27466667	153.2343333	EOL4B
14-Apr-2003 13:18:10	-24.2745	153.2285	SOL 11
14-Apr-2003 15:39:51	-24.40333333	153.0355	EOL 11
14-Apr-2003 15:44:45	-24.41116667	153.0353333	SOL18
14-Apr-2003 20:40:04	-24.90116667	153.1188333	EOL18
15-Apr-2003 09:02:08	-24.41483333	153.1315	SOL19
15-Apr-2003 11:14:01	-24.29	153.2621667	EOL19
15-Apr-2003 11:26:59	-24.28616667	153.2466667	SOL20
15-Apr-2003 13:00:30	-24.27766667	153.1285	EOL20
15-Apr-2003 13:03:03	-24.27983333	153.1283333	SOL21
15-Apr-2003 17:12:45	-24.53766667	153.4043333	EOL21
15-Apr-2003 17:15:12	-24.54116667	153.4038333	SOL22
15-Apr-2003 17:29:53	-24.5345	153.3067	EOL22
15-Apr-2003 18:34:25	-24.5355	153.3043333	SOL6
15-Apr-2003 19:49:44	-24.49383333	153.4023333	EOL6
15-Apr-2003 21:55:48	-24.5775	153.431	SOL5
15-Apr-2003 22:20:05	-24.6141	153.3374	EOL5
23-Apr-2003 04:20:06	-24.35766667	153.1211667	SOL14
23-Apr-2003 06:40:02	-24.2645	152.8966667	EOL14
23-Apr-2003 07:20:01	-24.29146	152.89922	SOL13
23-Apr-2003 08:53:34	-24.18983333	153.0038333	EOL13