RV *Franklin* Cruise 01/-02, January-February, 2002

(Geoscience Australia Cruise 234)

Cross-shelf sediment transport in the Torres Strait - Gulf of Papua Region.

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Executive Summary

The RV *Franklin* sailed from Cairnscross Shipyard, Brisbane on 17-1-02 and returned to Cairns on 9-2-02. The cruise discovered that a zone of strong tidal currents at the northern end of the Great Barrier Reef prevents the southward advance of sediment derived from Papua New Guinea's rivers that would otherwise bury the coral reefs. The Fly River, located in close proximity to the northern end of the Great Barrier Reef, discharges about 120 million tonnes/yr of sediment, equal to more than that all of Australia's rivers combined. This sediment does not penetrate as far south into the reef area as might be expected, because southward prograding deposits are eroded by tidal currents.

Swath sonar mapping and underwater video equipment aboard the research vessel RV Franklin, was used to map a series of channels up to 220 m deep that extend for more than 80km from eastern Torres Strait across the northern end of the Great Barrier Reef. It appears that there are two sorts of channels - those in the north are clearly relict fluvial channels, exhibiting lateral accretion surfaces and incised channels that intersect and truncate underlying strata. Over-deepened channels in the south, however, appear to have formed by tidal current scour. They exhibit closed bathymetric contours at both ends and are floored with well sorted carbonate gravely sand. Oceanographic observations indicate that the channels provide a conduit onto the shelf for cool and saline (and nutrient-rich?) upwelled Coral Sea water. The deepest channels form isolated depressions, and possibly were the sites of lakes during the last ice age, when Torres Strait formed a land-bridge between Australia and Papua New Guinea.

Introduction

On a global scale, surprisingly little sediment is transported across continental shelves to the shelf break under modern (high sea level) environmental conditions. Rather, most terrigenous sediment is trapped in coastal environments (beaches, estuaries and embayments). Autochthonous shelf sediments that are mobilised by storm events tend to be transported short distances along isobath-parallel pathways (eg. Gagan et al., 1990). Current energy drops off dramatically away from the shoreface on most wave-dominated shelves, and even on tide-dominated shelves the tidal current transport paths generally do not extend to the shelf break (eg. Stride, 1982). The result is that cross-shelf sediment transport occurs mainly during sea level low stands, when rivers erode and transport material to the shelf break (Nittrouer and Wright, 1994). Exceptions to this pattern occur where large river systems have built deltas across the shelf to the shelf break (eg. the Mississippi and Amazon Rivers), on some high-energy shelves and in some locations where the shelf width is very narrow (eg. where the Sepic River empties directly into an ocean basin in northern Papua New Guinea).

In the Gulf of Papua, two separate processes appear to give rise to cross-shelf sediment transport in different locations. The first of these is the transport of fine-grained terrigenous muds delivered by the Fly, Aird and Puari Rivers to the inner shelf area of the Gulf (Fig. 1). This mud is thought to be advected eastwards by combined tidal currents, wind-driven currents and swell waves until it reaches the most narrow part of the shelf at around 146°E. The mud may then descend to the Coral Sea basin via the Moresby Canyon (Brunskill et al., 1995). Recent shelf current modeling work has demonstrated that these processes do indeed result in eastward advection of tracers introduced at specific locations (see also Brunskill et al., 2000). Cores and geophysical data collected by the RV Franklin during TROPICS cruises have formed the basis of detailed studies of this cross-shelf terrigenous sediment transport path.

The available evidence also identifies a second location of potential cross-shelf sediment transport path located adjacent to the northern end of the Great Barrier Reef. Numerical modelling predicts that this zone experiences elevated tidal current bottom stress (Hemer et al., in press), which corroborates sidescan sonar images of subtidal dunes comprised of coarse sand and gravel-sized sediments shown by Harris et al (1996). Hence, energy is apparently available to mobilse and transport sediment grains, but whether the residual current regime results in any cross-shelf transport is not known. The key questions are: (1) Are modern oceanographic processes transporting calcareous and terrigenous sediments from NE Torres Strait to the outer shelf of the Gulf of Papua? (2) Do the sediments deposited at the receiving end-point of this transport path contain a record of variability through the Holocene? Through the late Quaternary?

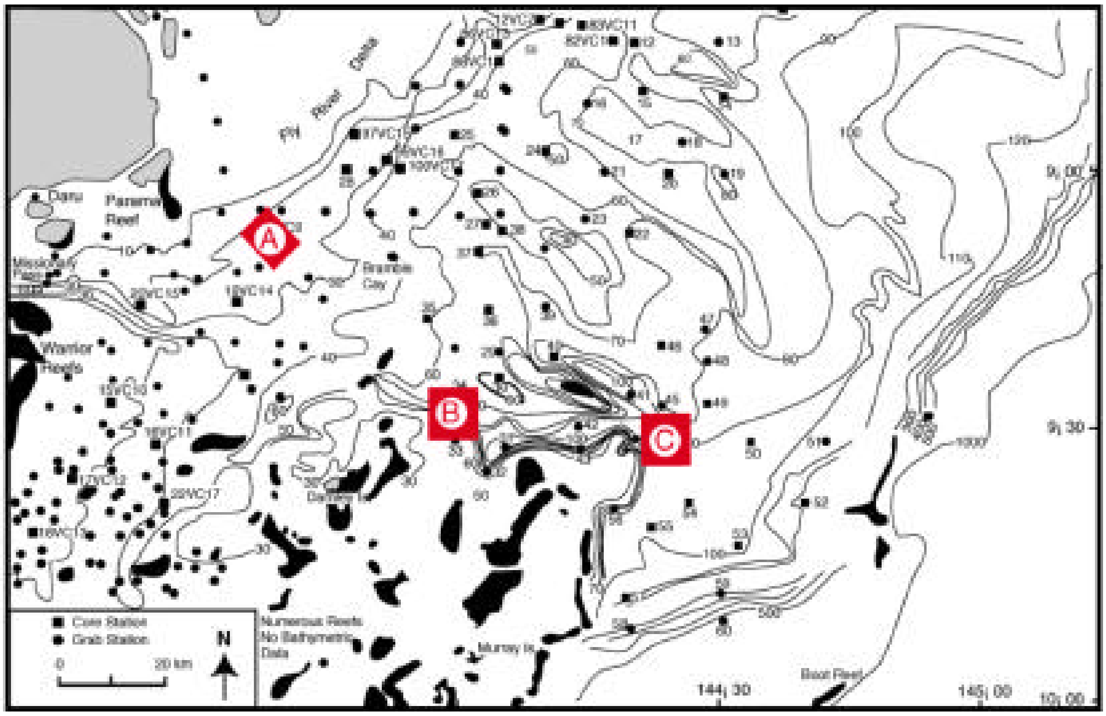

Figure 1. Location of the three study areas in the northern Great Barrier Reef region.

The cruise aims were to verify and quantify modelling results predicting the occurrence of a potential sediment transport path across the northern end of the Great Barrier Reef and into the Gulf of Papua. The objectives were, therefore, to map the seabed bathymetry, bedforms and Holocene sediment deposits and to measure currents and near-bed suspended sediment concentrations in a transect across the shelf from northeastern Torres Strait (in the vicinity of the southern Fly River Delta) to the shelf break. Seabed photography and surface grab sampling provided information on seabed character, evidence of sediment mobility such as small-scale bedforms, as well as benthic habitats and communities. A second research goal was to establish linkages between benthic communities and sedimentary environments and facies.

Methods

A Reson 240 kHz swath system model no. 8101 was provided by James Cook University. The system recorded data using Reson 6042 Ver 7.2 format software. The total amount of data recoreded was 70 GB. A Datasonics 3.5 kHz Chirp Sub-bottom profiler, recorder model no. DSP 661/66 and tow fish model TTV170S was also used. The trigger interval was 0.5 to 0.25 seconds (0.25 to 180 metres, 0.5 below 180 M) and the total amount of Chirp data recorded was 30 GB. An Applied Microsystems Ltd SV PLUS acoustic velocity profiler was used to measure the acoustic velocity range, which was from 1542 - 1546 m/s in the study area.

The ships Seabird SBE911 CTD was deployed along with a Seatech transmissometer, calibrated to measure suspended sediment concentration using surface and near-bed water samples. Two-litre water samples were filtered through pre-weighed 0.45 µm filter papers using a vacuum system to obtain mass concentration values. On return from the voyage, the filter papers were oven dried @ 60°C and re-weighed in the lab to the nearest ±0.0001 g.

Seabed sediment samples were collected using a Smith Macintyre grab and the AGSO 1-tonne gravity corer, also rigged to work as a piston corer. Sub-samples of sediment grabs were taken for laboratory analyses, including mini-cores of the top 10 to 20 cm where possible, and the remainder was sieved and any living material was bagged and recorded. An underwater video camera was also deployed at each station to record a minimum of 3 minutes of seafloor imagery, in order to characterise the seabed type and associated benthic biota.

Current, temperature, salinity and turbidity measurements were also made using a newly constructed benthic frame designed for deployment in shelf water depths up to 300 m. The *Benthic Research for Underwater sediment ConcEntrations* probe (BRUCE) comprised a Sequoia LIST-100 transmissometer- laser particle sizer-Seabird CTD (located at 30 cm above the bed) NORTEK acoustic current meter and Benthos optical backscatter sensor (located at 100 cm above the bed). Instruments were wired together and programmed for synchronised 20-minute burst sampling using software prepared by IMBROS Scientific Equipment Pty Ltd., Hobart. The Nortek acoustic current meter also logged the Benthos optical backscatter sensor data at 10 Hz whereas the Sequoia LIST-100 transmissometer-laser particle sizer logged the Seabird CTD data (one record for each instrument every 20 minutes). Lastly, two 20 cm lengths of 9 cm diameter plastic pipe were placed in the frame at 30 cm and 100 cm height above the bed, to serve as sediment traps for the deployment.

Results

A narrative of the cruise progress is given in Appendix 1. Our instrument mooring BRUCE was successfully recovered and, after inspection, was found to have logged all data as per the program. Further results will be available once the data have been more thoroughly analysed.

Swath mapping and Chirp sub-bottom profile data were collected along evenly spaced track lines as shown in Figures 2, 4 and 6. A total of 75 stations were occupied spread more or less evenly between the three survey areas. Station locations are listed in Appendix 2 and shown in relation to bathymetric maps in Figures 3, 5 and 7. In summary, the following samples were recovered:

64	Surface Grab Samples
64	CTD's
125	Filterpapers (from surface and 2m above the seabed)
10	Piston Cores
24	Gravity Cores
65	Underwater Video Stations
2	Sediment traps

None of the sample data have been analysed to date (25-3-02), but results will be published in a Geoscience Australia record, that is scheduled for draft completion in June 2002.

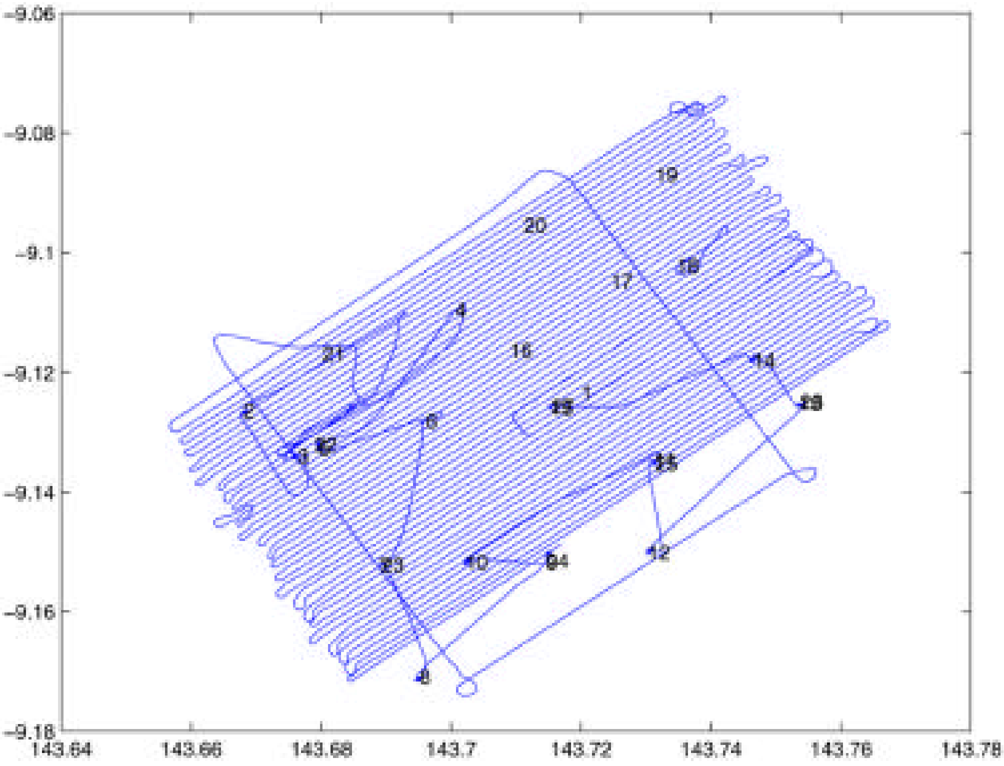

Figure 2. Survey track lines completed in Area "A", adjacent to the Fly River Delta.

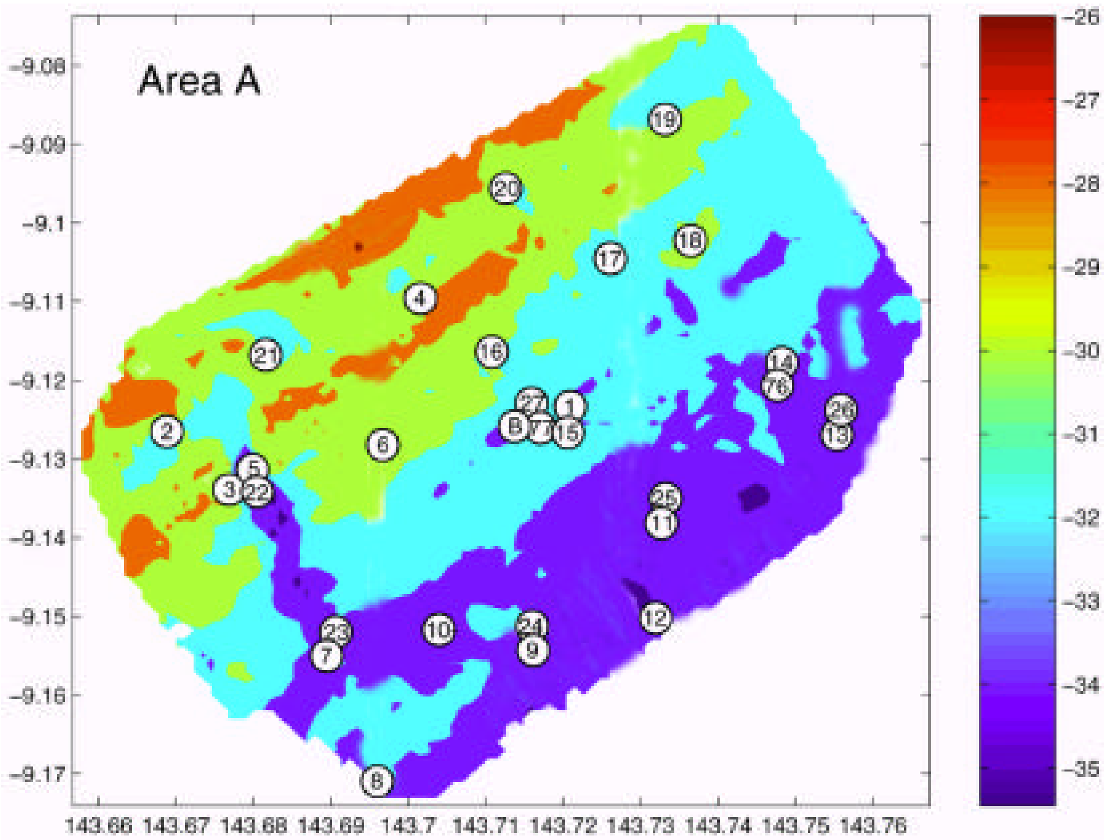

Figure 3. Location of stations occupied in Area "A" in relation to regional bathymetry.

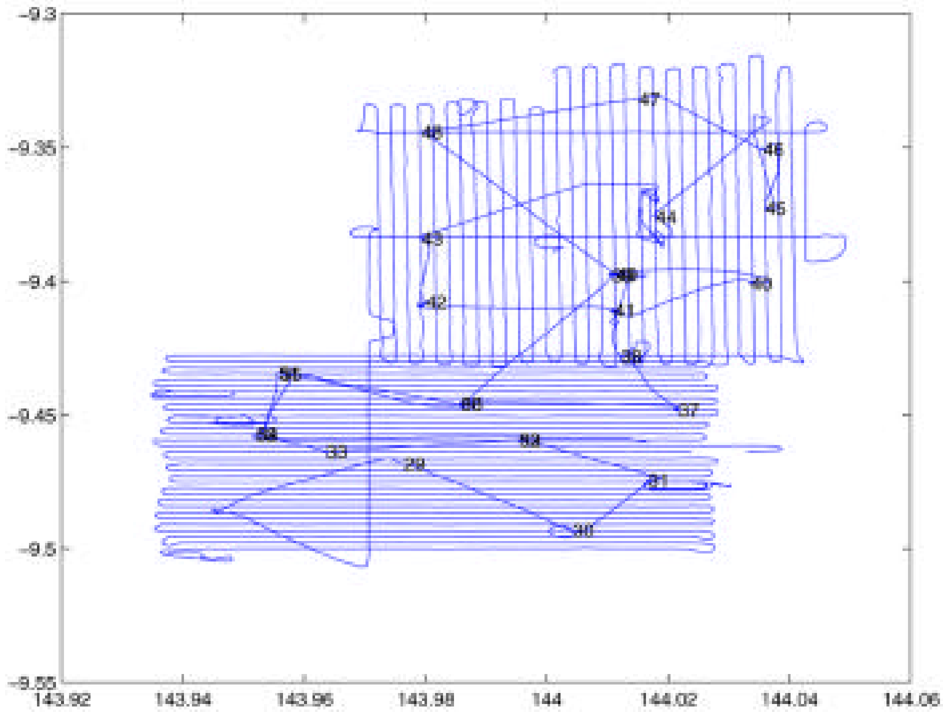

Figure 4. Survey track lines completed in Area "B", on the middle part of the Torres Strait shelf, north of Darnley Island.

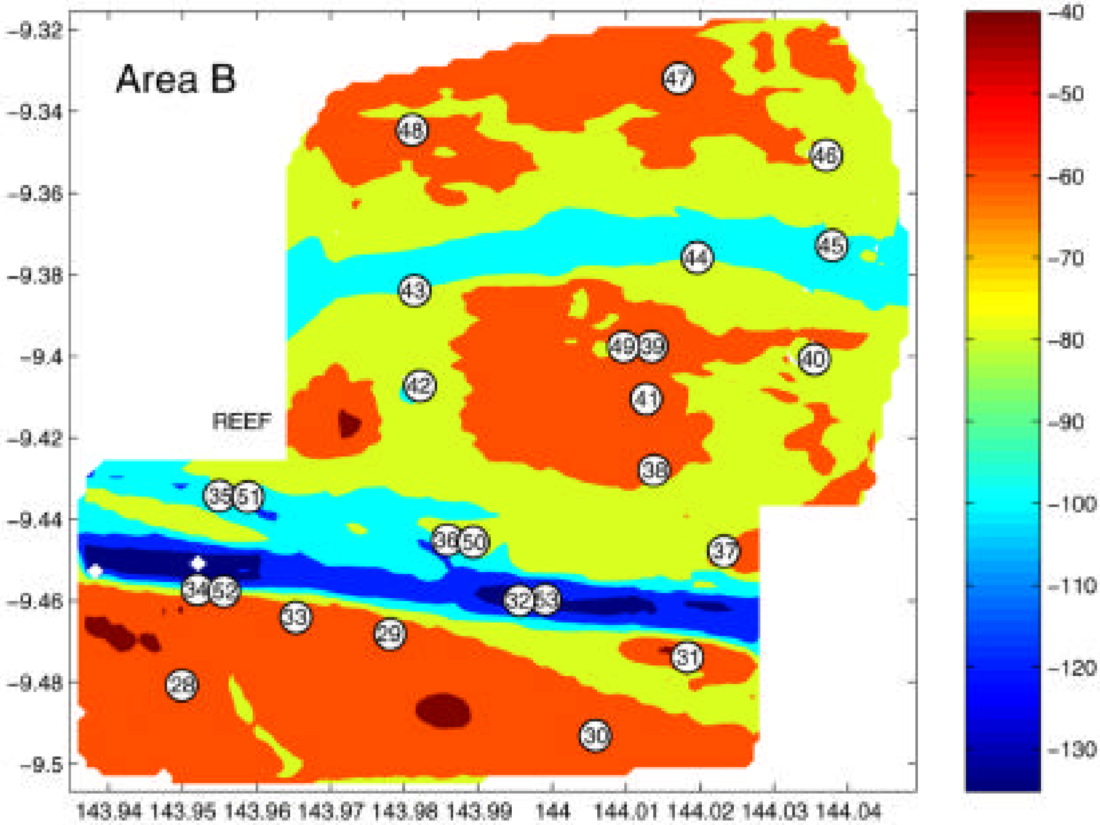

Figure 5. Location of stations occupied in Area "B" in relation to regional bathymetry.

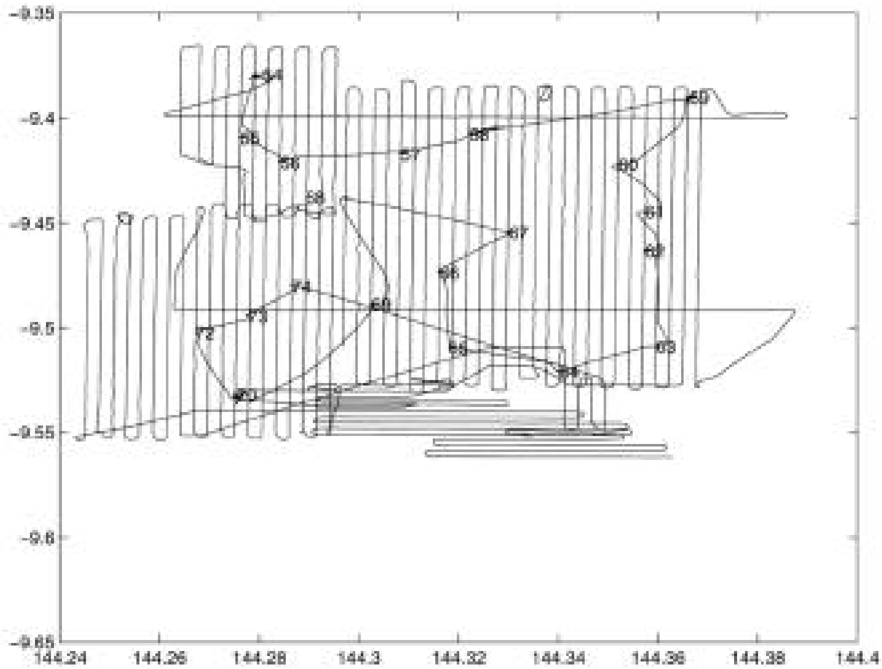

Figure 6. Survey track lines completed in Area "C", outer shelf of the Gulf of Papua, adjacent to East Cay.

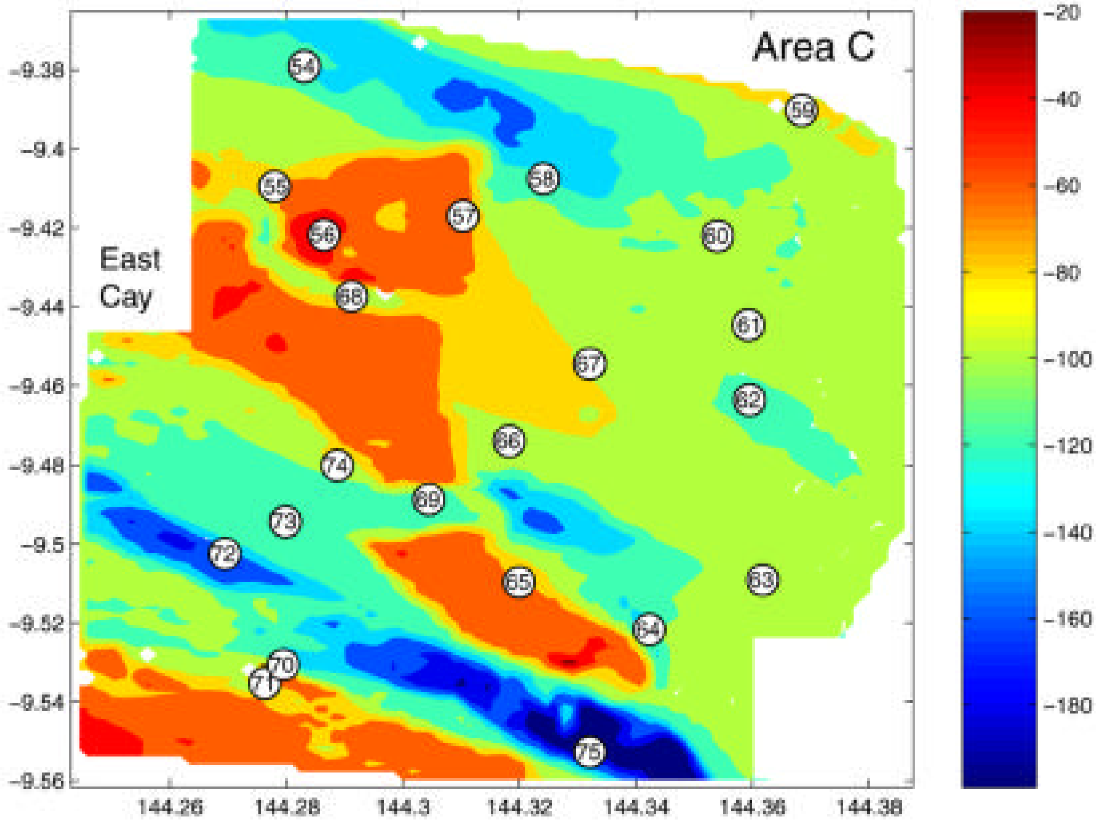

Figure 7. Location of stations occupied in Area "C" in relation to regional bathymetry.

Acknowledgements

Thanks to the National Facility Steering Committee for making the ship time available and to Geoscience Australia for logistical and financial support.

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Appendix 1

Cruise Narrative – RV *Franklin* Cruise 01/-02
(Geoscience Australia Cruise 234)
Fly River Delta, Torres Strait and Gulf of Papua, Jan-Feb., 2002

Thursday 17-01-02 The RV *Franklin* sailed from Cairnscross Shipyard, Brisbane, @ 1000 hrs local time. Pilot dropped at Caloundra @ 1500 hrs and ship headed north with a brisk following (southerly) breeze.

Friday 18-01-02 Transit

Saturday 19-01-02 The 2nd cook has injured his finger. We must detour to Cairns to take him for treatment.

Sunday 20-01-02 Anchored offshore Cairns @1100 hrs on while 2nd Cook was taken to hospital for treatment. Underway again by 1300 hrs.

Monday 21-01-02 Transit

Tuesday 22-01-02 Arrived in Torres Strait and commenced work at station 1 @1500 hrs. Deployment of CTD, bottom video camera and grab sample were successful and the current meter frame was launched @1720 hrs. The probe has been named BRUCE (for Benthic Research Underwater sediment Concentration Experiment). After two sound velocity profiles were completed we commenced the swath survey @ 1900 hrs.

Wednesday, 23-01-02 By 1200 hrs we had completed 13 10km survey lines. The sea conditions were excellent, quiet and calm, and the Seabat system was operating at its optimum swath width (7 times water depth). Thus we decided to increase the line spacing from 100 to 125 m. This should save us a few hours of survey time.

Thursday, 24-0-02 Continue swath survey of Area “A”.

Friday, 25-01-02 Swath survey for Area “A” completed @1630 hrs. Proceeded to conduct a “Patch Test” (swath system calibration) before start of sampling @1900 hrs. Sea conditions remain calm.

Saturday, 26-01-02 After completion of 3 stations including one piston core, an incident occurred @0015hrs when the piston core appeared to slide down the wire mid-way through deployment and come to jolting stop. Inspection of the damaged piston-core, trigger-arm assembly indicated the clamp had failed, although suspected that the winch may have spontaneously paid out wire. Coring was therefore postponed until daylight.

Sunday, 27-01-02 Completed all cores and stations in Area “A” @0145 hrs. Transit to Area “B”, arriving @0730 hrs. Delay to start of survey @ 1300 hrs caused by failure of air conditioning system and attendant shut-down of all computing systems.

Monday, 28-01-02 Continue surveying Area “B”

Tuesday, 29-01-02 Continue surveying Area “B”

Wednesday, 30-01-02 Complete survey of Area “B” @ 1900 hrs and commenced sampling. After one successful gravity core was collected, the winch again spontaneously paid out wire with the gravity corer hanging just outside of the deployment cradle at the third station @2345 hrs. Coring work postponed until the winch can be made safe.

Thursday, 31-01-02 CTD, camera and grab operations continued at the remaining stations. Ship’s engineers and crew declared that the winch may be used again for gravity coring, but not piston coring, operations began @1100 hrs. Sea conditions calm to moderate, with morning nor-westerly winds up to about 15 knots.

Friday, 1-02-02 Final gravity cores collected and station work in Area “B” completed @0430. Transit from Area “B” to Area “C” arriving @ 0900 and commenced swath survey.

Saturday, 2-02-02 Swath survey of Area “C”

Sunday, 3-02-02 Swath survey of Area “C” Strong to moderate nor westerly wind and moderate seas. Chirp tow fish hitting side of ship in larger waves caused the loss of seismic data on about 3 lines.

Monday, 4-02-02 Complete swath survey of Area “C” and commence station work. Sampling sites chosen on the basis of the swath data recorded.

Tuesday, 5-02-02 Station work completed @1900 hrs and swath surveys of selected targets commenced. A deeply scoured channel up to 220 m in depth has been discovered on the outer shelf, in an area marked as shoal on the AUS chart.

Wednesday, 6-02-02 Swath survey and final station work completed @ 1700 hrs and transit to Area “A”. Final underwater video and CTD stations completed and current meter mooring BRUCE successfully recovered @2200 hrs. This marks the end of the scientific work for the cruise. Depart Torres Strait headed for Cairns.

Thursday, 7-02-02 Transit to Cairns. Scientific party packing up equipment, completing data entry work and down-loading of moored instrument (current meter) data.

Friday, 8-02-02 Transit to Cairns.

Saturday, 9-02-02 Divers inspect hull at Fitzroy Island, 0600 to 0800 hrs. Arrive Cairns @ 1100 hrs.

Appendix 2.

List of station locations and operations completed during cruise Fr 01/02. Operation codes are as follows: CM = current meter; CTD = conductivity, temperature depth profile; CAM = video camera pictures of seabed; GR = Smith Macintyre Grab Sample; PC = piston core; GC = gravity core. Station numbers in parentheses are repeat stations targeted at the same locations.

	StationNo	Latitude	Longitude	Water Depth	Operations
"Area A, Fly River Delta"					
	"1 (27, 77)"	-9º7.364	143º43.113	31.50	234/1CM1
		-9º7.616	143º43.1	31.50	234/1CTD1
		-9º7.4	143º43.2	31.50	234/1CAM1
		-9º7.3	143º43.1	31.50	234/1GR1
	2	-9º7.584	143º40.086	30.50	234/2CAM2
		-9º7.586	143º40.161	30.00	234/2CTD2
		-9º7.58	143º40.085	30.00	234/2GR2
	3	-9º8	143º40.518	29.00	234/3CTD3
		-9º8.048	143º40.559	29.00	234/3PC1
		-9º8.048	143º40.559	29.00	234/3GR3
		-9º8.037	143º40.584	29.50	234/3CAM3
	4	-9º6.564	143º42.054	23.00	234/4CTD4
		-9º6.576	143º42.038	24.50	234/4GR4
		-9º6.575	143º42.042	24.00	234/4CAM4
	5 (22)	-9º7.929	143º40.787	33.00	234/5CTD5
		-9º7.928	143º40.767	34.00	234/5CAM5
		-9º7.964	143º40.779	33.50	234/5GR5
	6	-9º7.691	143º41.769	28.00	234/6CAM6
		-9º7.025	143º41.745	25.50	234/6CTD6
		-9º7.69	143º41.754	28.50	234/6GR6
	7 (23)	-9º9.129	143º41.353	32.00	234/7CTD7
		-9º9.122	143º41.342	32.50	234/7GR7
		-9º9.135	143º41.334	32.50	234/7CAM7
	8	-9º10.291	143º41.677	31.50	234/8GR8
		-9º10.271	143º41.684	31.50	234/8CTD8
		-9º10.255	143º41.713	31.50	234/8CAM8
	9 (24)	-9º9.11	143º42.88	31.50	234/9CAM9
		-9º9.002	143º42.891	31.50	234/9CTD9
		-9º9.11	143º42.871	32.00	234/9GR9
	10	-9º9.087	143º42.158	32.50	234/10CTD10
		-9º9.114	143º42.153	33.00	234/10GR10
		-9º9.107	143º42.131	33.00	234/10CAM10
	11 (25)	-9º8.08	143º43.874	33.50	234/11CAM11
		-9º8.111	143º43.90	33.50	234/11CTD11
		-9º8.074	143º43.872	34.00	234/11GR11
	12	-9º9.01	143º43.817	35.00	234/12CAM12
		-9º8.98	143º43.829	34.50	234/12GR12
		-9º9.016	143º43.827	35.00	234/12CTD12
	13 (26)	-9º7.527	143º45.209	33.50	234/13GR13
		-9º7.537	143º45.194	33.50	234/13CTD13
		-9º7.511	143º45.215	33.50	234/13CAM13
	14 (76)	-9º7.08	143º44.787	33.00	234/14GR14
		-9º7.08	143º44.796	32.50	234/14CTD14
	15	-9º7.552	143º42.917	32.50	234/15GR15
		-9º7.527	143º42.943	32.50	234/15PC2
		-9º7.554	143º42.918	33.00	234/15CAM15
		-9º7.526	143º42.902	32.50	234/15CTD15
	16	-9º7.022	143º42.561	30.00	234/16GR16
		-9º7.064	143º42.552	31.00	234/16CTD16
		-9º6.98	143º42.541	29.50	234/16CAM17
		-9º7.057	143º42.549	30.50	234/16CAM16

	17	-9º6.222	143º43.513	30.00	234/17CTD17
		-9º6.287	143º43.469	30.00	234/17CAM18
		-9º6.178	143º43.495	30.50	234/17GR17
		-9º6.065	143º43.546	29.50	234/17PC3
	18	-9º6.135	143º44.082	29.00	234/18CAM19
		-9º6.15	143º44.081	29.50	234/18CTD18
		-9º6.131	143º44.082	29.00	234/18GR18
	19	-9º5.216	143º43.883	29.50	234/19CAM20
		-9º5.217	143º43.879	29.50	234/19CTD19
		-9º5.187	143º43.883	29.50	234/19PC4
		-9º5.206	143º43.876	29.00	234/19GR19
	20	-9º5.726	143º42.672	29.00	234/20CAM21
		-9º5.706	143º42.68	28.50	234/20CTD20
		-9º5.713	143º42.675	29.00	234/20GR20
	21	-9º7.019	143º40.816	29.50	234/21GR21
		-9º7.013	143º40.816	30.00	234/21PC5
		-9º7.014	143º40.814	29.50	234/21CAM22
		-9º7.014	143º40.817	29.50	234/21CTD21
	22 (5)	-9º7.924	143º40.738	34.50	234/22PC6
	23 (7)	-9º9.132	143º41.358	34.00	234/23PC7
	24 (9)	-9º9.093	143º42.88	32.50	234/24PC8
	25 (11)	-9º8.109	143º43.886	33.00	234/25PC9
	26 (13)	-9º7.49	143º45.224	31.00	234/26PC10
	"27 (1, 77)"	-9º7.537	143º42.927	30.50	234/27CTD22
	76 (14)	-9º7.086	143º44.781	31.00	234/76CAM66
	77 (1)	-9º7.359	143º43.234	31.00	234/77CTD65
"Area B, Torres Strait"					
	28	-9º29.196	143º56.749	56.00	234/28CAM23
		-9º29.13	143º56.704	51.50	234/28CTD23
		-9º29.176	145º56.733	55.00	234/28GR22
	29	-9º28.098	143º58.586	46.00	234/29CTD24
		-9º28.096	143º58.587	46.00	234/29GR23
		-9º28.104	143º58.587	47.40	234/29CAM24
	30	-9º29.551	144º0.264	54.00	234/30CTD25
		-9º29.586	144º0.258	54.00	234/30GR24
		-9º29.81	144º0.26	54.00	234/30CAM25
	31	-9º28.506	144º1.04	51.50	234/31CTD26
		-9º28.465	144º1.004	52.00	234/31GR25
		-9º28.483	144º1.017	52.00	234/31CAM26
	32 (53)	-9º27.565	143º59.729	131.50	234/32GR26
		-9º27.566	143º59.73	132.30	234/32CTD27
		-9º27.558	143º59.728	132.00	234/32CAM27
	33	-9º27.844	143º57.818	50.50	234/33CTD28
		-9º27.835	143º57.823	50.50	234/33CAM28
		-9º27.826	143º57.816	50.50	234/33GR27
	34 (52)	-9º27.431	143º57.134	90.00	234/34GR28
		-9º27.429	143º57.119	86.00	234/34CTD29
		-9º27.446	143º57.119	86.00	234/34CAM29
	35 (51)	-9º26.083	143º57.365	103.00	234/35GR29
		-9º26.081	143º57.361	103.00	234/35CAM30
		-9º26.071	143º57.369	103.00	234/35CTD30
	36 (50)	-9º26.776	143º59.182	84.00	234/36CAM31
		-9º26.748	143º59.153	85.50	234/36GR30
		-9º26.771	143º59.171	84.00	234/36CTD31
	37	-9º26.865	144º1.292	51.50	234/37CTD32
		-9º26.899	144º1.291	49.00	234/37CAM32
		-9º26.882	144º1.301	50.00	234/37GR31
	38	-9º25.68	144º0.731	55.50	234/38GR32
		-9º25.651	144º0.736	56.50	234/38CTD33
		-9º25.658	144º0.725	56.50	234/38CAM33

39 (49)	-9º23.823	144º0.655	59.50	234/39CTD34
	-9º23.87	144º0.661	60.00	234/39CAM34
	-9º23.867	144º0.646	60.00	234/39GR33
40	-9º24.049	144º2.021	57.50	234/40GR34
	-9º24.032	144º2.017	58.50	234/40CAM35
	-9º24.017	144º2.046	54.00	234/40CTD35
41	-9º24.66	144º0.689	58.50	234/41CTD36
	-9º24.705	144º0.695	58.00	234/41CAM36
	-9º24.65	144º0.668	59.50	234/41GR35
	-9º24.653	144º0.71	59.00	234/41GC2
42	-9º24.456	143º58.807	80.50	234/42GR36
	-9º24.551	143º58.774	77.00	234/42GC3
	-9º24.524	143º58.736	80.50	234/42CTD37
	-9º24.522	143º58.752	78.50	234/42CAM37
43	-9º23.043	143º58.768	80.00	234/43GR37
	-9º23.032	143º58.778	81.00	234/43GC4
	-9º23.052	143º58.767	80.00	234/43CAM38
	-9º23.054	143º58.768	80.00	234/43CTD38
44	-9º22.546	144º1.073	90.00	234/44CAM39
	-9º22.557	144º1.078	85.00	234/44GC5
	-9º22.548	144º1.073	88.50	234/44CTD39
	-9º22.552	144º1.077	87.00	234/44GR38
45	-9º22.367	144º2.162	91.50	234/45CTD40
	-9º22.356	144º2.161	91.50	234/45GR39
	-9º22.357	144º2.16	91.50	234/45GC6
	-9º22.958	144º2.165	91.50	234/45CAM40
46	-9º21.029	144º2.137	62.00	234/46CTD41
	-9º21.036	144º2.138	63.00	234/46CAM41
	-9º21.038	144º2.139	63.50	234/46GR40
	-9º21.039	144º2.144	63.00	234/46GC7
47	-9º19.911	144º0.913	57.50	234/47GR41
	-9º19.909	144º0.912	57.50	234/47CTD42
	-9º19.91	144º0.114	57.50	234/47CAM42
	-9º19.908	144º0.908	57.50	234/47GC8
48	-9º20.655	143º58.77	57.00	234/48GC9
	-9º20.66	143º58.763	57.00	234/48GR42
	-9º20.654	143º58.768	57.00	234/48CAM43
	-9º20.649	143º58.76	57.00	234/48CTD43
49 (39)	-9º23.849	144º0.687	57.00	234/49GC10
50 (36)	-9º26.754	143º59.151	79.80	234/50GC11
51 (35)	-9º26.056	143º57.351	104.00	234/51GC12
52 (34)	-9º27.433	143º57.124	86.50	234/52GC13
53 (32)	-9º27.561	143º59.726	131.50	234/53GC14
"Area C, Gulf of Papua"				
54	-9º22.765	144º16.838	113.50	234/54GC15
	-9º22.865	144º16.72	114.50	234/54CAM44
	-9º22.816	144º16.718	119.00	234/54GR43
	-9º22.812	144º16.752	121.00	234/54CTD44
55	-9º24.591	144º16.578	66.00	234/55CTD45
	-9º24.589	144º16.582	65.50	234/55CAM45
	-9º24.581	144º16.57	64.50	234/55GR44
	-9º24.562	144º16.564	63.50	234/55GC16
56	-9º25.278	144º17.058	26.00	234/56CTD46
	-9º25.283	144º17.055	29.50	234/56CAM46
57	-9º25.029	144º18.503	49.50	234/57CTD47
	-9º25.041	144º18.508	50.00	234/57GR45
	-9º25.034	144º18.506	49.50	234/57CAM47
58	-9º24.481	144º19.325	103.50	234/58CAM48
	-9º24.48	144º19.334	104.50	234/58GR46
	-9º24.478	144º19.33	103.50	234/58GR47

	-9º24.491	144º19.342	103.00	234/58CTD48
59	-9º23.376	144º21.946	75.00	234/59CTD49
	-9º23.421	144º21.977	76.00	234/59GR48
	-9º23.464	144º21.975	78.50	234/59GC17
	-9º23.476	144º22.154	80.00	234/59CAM49
60	-9º25.348	144º21.127	95.50	234/60CTD50
	-9º25.335	144º21.124	96.00	234/60GR49
	-9º25.336	144º21.121	96.00	234/60CAM50
61	-9º26.671	144º21.444	90.00	234/61CAM51
	-9º26.683	144º21.445	92.00	234/61GC18
	-9º26.685	144º21.447	92.00	234/61GR50
	-9º26.664	144º21.439	89.00	234/61CTD51
62	-9º27.821	144º21.445	104.00	234/62GC19
	-9º27.818	144º21.445	103.50	234/62GR51
	-9º27.825	144º21.447	104.00	234/62CTD52
	-9º27.805	144º21.446	103.50	234/62CAM52
63	-9º30.542	144º21.57	91.00	234/63GC20
	-9º30.555	144º21.578	90.50	234/63GR52
	-9º30.534	144º21.582	90.00	234/63CAM53
	-9º30.526	144º21.58	90.00	234/63CTD53
64	-9º31.278	144º20.417	117.00	234/64GR53
	-9º31.255	144º20.42	119.00	234/64GC21
	-9º31.26	144º20.398	112.50	234/64CAM54
	-9º31.258	144º20.389	113.00	234/64CTD54
65	-9º30.584	144º19.08	52.50	234/65GR54
	-9º30.591	144º19.123	43.00	234/65CAM55
	-9º30.585	144º12.12	41.50	234/65CTD55
66	-9º28.433	144º18.971	82.50	234/66GR55
	-9º28.418	144º18.974	83.00	234/66GC22
	-9º28.388	144º18.97	82.50	234/66CAM56
	-9º28.395	144º18.974	82.50	234/66CTD56
67	-9º27.267	144º19.813	79.50	234/67CAM57
	-9º27.253	144º19.808	80.00	234/67CTD57
	-9º27.277	144º19.805	79.00	234/67GR56
68	-9º26.277	144º17.859	88.50	234/68CTD58
	-9º26.267	144º17.355	89.00	234/68GR57
	-9º26.319	144º17.855	88.50	234/68CAM58
69	-9º29.331	144º18.15	109.00	234/69GR58
	-9º29.335	144º18.15	109.50	234/69CAM59
70 (71)	-9º31.94	144º16.533	50.50	234/70GR59
	-9º32.045	144º16.526	48.50	234/70CTD60
	-9º31.988	144º16.541	50.00	234/70CAM60
71 (70)	-9º32.033	144º16.488	48.50	234/71CAM61
72	-9º30.144	144º16.031	171.50	234/72GR60
	-9º30.146	144º16.034	172.00	234/72CAM62
	-9º30.143	144º16.041	173.00	234/72CTD61
73	-9º26.682	144º16.673	117.00	234/73GC23
	-9º29.677	144º16.665	116.00	234/73GR61
	-9º29.659	144º16.677	117.00	234/73CAM63
	-9º29.66	144º16.667	116.50	234/73CTD62
74	-9º28.83	144º17.194	90.00	234/74GR62
	-9º28.828	144º17.196	90.00	234/74GC24
	-9º28.827	144º17.196	90.00	234/74CAM64
	-9º28.834	144º17.197	90.00	234/74CTD63
75	-9º33.59	144º20.018	219.50	234/75GR63
	-9º33.055	144º20.014	220.00	234/75GR64
	-9º33.058	144º20.006	220.50	234/75CTD64
	-9º33.058	144º20.016	221.00	234/75CAM65