

FRANKLIN

National Facility
Oceanographic Research Vessel

CRUISE SUMMARY

R/V FRANKLIN

FR 12/98

**Late Quaternary Reefal Sedimentation
at the Southernmost Reefs:
Elizabeth and Middleton Reefs and Lord Howe Island**

Departed Sydney 1100 hrs, Tuesday 6 October, 1998
Arrived Sydney 0930 hrs, Friday 16 October, 1998

Principal Investigators

Associate Professor Colin Woodroffe
School of Geosciences
University of Wollongong

Associate Professor Brian Jones
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SUMMARY O.R.V FRANKLIN CRUISE

FR 12/98

ITINERARY

Depart Sydney 1058hrs, 6 October 1998
Arrive Sydney 0930hrs, 16 October 1998

PRINCIPAL INVESTIGATORS

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PROJECT

The scientific objectives of the project were to examine reef sedimentation and erosional development of volcanic islands at the southernmost occurrence of reefs in the southwest Pacific Ocean. Balls Pyramid, Lord Howe Island, and the atolls of Elizabeth and Middleton Reefs lie along a linear chain of seamounts/islands in the Tasman Sea at the latitudinal limit to reef growth.

SAMPLING AREA

Sampling on O.R.V. Franklin Cruise 12/98 was centred around two areas: Lord Howe Island and Ball's Pyramid (31°25'-31°47'S, 159°00'-159°22'E) and Middleton Reef (29°20'-29°32'S, 159°00'-159°10'E) in the Tasman Sea. The proposed sampling around Elizabeth Reef (29°56'S, 159°04'E) could not be carried out because of bad weather.

RESULTS

1. Data and samples obtained

A total of 90 grab sea-floor sediment samples were obtained from around Lord Howe Island, Ball's Pyramid and Middleton Reef (see Tables 1-3). Three piston cores (total 3.6 m) were obtained from the northern flank of Middleton Reef. Three of the five piston cores around Lord Howe Island were successful and resulted in 5.10 m of core. Seismic equipment was deployed from the OVR Franklin for 115 km and resulted in

variable quality data from both boomer and sparker methods. None of the five dredge sampling attempts at Middleton Reef and Lord Howe Island yielded samples.

In addition the deployment of three dinghies at Middleton Reef resulted in obtaining 8 km of seismic data, four vibrocores (total 4.84m), nine sediment samples and an assessment plus video coverage of coral populations from in and near the lagoon. Two of the dinghies were also used for coral studies and rotary coring at Lord Howe Island yielded 7.97 m of core and retrieval of 8 previously tagged corals.

Bathymetric and current velocity data were obtained throughout the voyage to provide geomorphological information and to relate to the sediment distribution.

Details of the cruise tracks are provided in Figures 1 and 2.

2. Cruise Objectives

Middleton Reef

Bathymetric data from around Middleton Reef shows a clearly defined gently shelving platform down to a depth of 120 m. Below this level the flanks slope steeply down to about 2000 m where the slope begins to decrease again. A series of north-trending ridges and valleys were observed on the northern flank of the reef where more detailed bathymetric surveys were conducted (Fig. 3).

A grab sampling program was conducted on the northern flank of Middleton Reef (Fig. 4) and indicated the dominance of coarse carbonate sands. Rhodoliths and *Halimeda* were common in these shallow water sites. Three piston cores from this same area also consisted entirely of carbonate sediment but only penetrated to a maximum depth of 1.9 m. Coarse carbonate sand and rhodoliths were also common on the western and southern flanks of the reef. No volcanic detritus was observed in any of these shallow water samples.

An attempted grab sample on the steeper part of the northern flank of Middleton Reef at 700 m depth was unsuccessful, whereas a muddy fine carbonate sand sample was obtained from a flatter plateau between 1200-1300 m. Planned deep water sampling on the northwestern flank of Middleton Reef, in the area between 2200-2300 m, was prevented by high winds.

Dredge sampling was attempted on the southwestern flank of Middleton Reef in an attempt to retrieve basement samples. Wind directions restrained the location of dredge sample sites, and the ship could not be stopped for sample retrieval because of proximity to the reef. These conditions resulted in the loss of two dredges near the top of the steep incline below the 120 m b.s.l. plateau.

Because of wind and wave conditions no underwater photography was attempted.

Successful deployment of the dinghies for shallow water sampling and observation around Middleton Reef was only possible on one day instead of two because of weather conditions. This severely curtailed the planned data acquisition from within the reef since even on the first day the heavy swell produced strong currents and

deeper water within the lagoon. Observations and video coverage of corals near the entrance to the lagoon showed very little recovery of the coral fauna following the 1985 outbreak of crown-of-thorns starfish. The two longer vibrocores from within the lagoon (as yet unopened) should yield useful information for determining the sedimentation style and rate in this area.

Elizabeth Reef

Storm conditions curtailed all activities at Elizabeth Reef and none of the objectives were achieved.

Lord Howe Island

Bathymetric data clearly indicated the nature of a raised rim around the outer margins of the Lord Howe platform. This rim has an irregular moderately steep outer slope and frequently shows a very steep drop of up to 20 m along its inner margin. A bathymetric map produced from the Franklin data is provided in Figure 5.

Seismic traverses on the eastern side of Lord Howe Island did not produce good records and failed to delineate the internal structure of the 20 m-high geomorphic feature around the rim of the Lord Howe platform. Later seismic runs in the northeastern, eastern and southwestern parts of the platform yielded good seismic records but also failed to define the nature of the rim.

A successful grab sampling program was conducted around the Lord Howe platform (Fig. 6) which, when combined with the previous nearshore sampling program, will yield a good understanding of the nature and distribution of sediments in this region. The outer flank of the platform was characterised by the presence of coarse carbonate sands, abraded skeletal material and rhodoliths. The rim around the platform generally lay between 25-35 m and consisted of a predominantly hard substrate dominated by coralline algae and attached epifauna. This assemblage is consistent with the high wave and current activity over this raised structure. An attempted piston core on this structure gave essentially no penetration and only yielded a few fragments of dense platy carbonate of probable algal origin. The inner portion of the platform at water depths of >40 m consisted of fine- to medium-grained carbonate sand. Piston cores from this deeper portion gave variable recovery but one unopened core 2.25 m long should yield interesting results. No evidence of volcanic detritus was observed in any of the grab samples, which contrasts with the common volcanic detritus in the nearshore sands around the southern part of the island.

Dredging was attempted across the southern portion of the rim around the Lord Howe platform but was unsuccessful. This was partly due to the combination of wind and currents that prevented accurate passage over the selected rim crest area.

Because of wind and wave conditions no underwater photography was attempted. Also the planned deep water (>2500 m) sampling program on the southwestern flank of the Lord Howe platform was prevented by adverse weather.

Scuba diving on the Lord Howe reef from a dinghy was possible on the morning of 13 October and the previously tagged coral samples were successfully retrieved. A

second dinghy was deployed for rotary coring but was unable to approach the planned sites on the reef crest. A secondary objective of drilling within the lagoon was successful.

Ball's Pyramid

Seismic data from the Ball's Pyramid platform indicated a predominantly hard bottom with no significant sediment accumulations. No consistent geomorphic evidence for former reef growth was apparent from the limited bathymetric data available or collected on this trip (Fig. 5). Two grab sample traverses were conducted across the Ball's Pyramid platform (Fig. 6) and all the samples consisted of carbonate sediment with no obvious evidence of volcanic detritus. The sediment mainly consisted of coarse carbonate sand with rhodoliths, coralline algae, bivalves, bryozoans, sponges, regular echinoids, brachiopods and possible coral fragments. Carbonate sand was thicker with better sample returns on the south side of Ball's Pyramid compared to the north side. Two further grab sample traverses and dredging on the margin of the platform were planned, but were curtailed because of weather and time constraints. The data collected have indicated the presence of significant carbonate production on the platform but probable strong current and wave activity have resulted in a predominance of coarse abraded carbonate debris and encrusting coralline algae.

CRUISE NARRATIVE

- 6 October departed Sydney at 10.58 a.m., transit to Lord Howe Island.
- 7 October transit to Lord Howe Island.
- 8 October arrived Lord Howe Island, proceeded to Neds Beach pickup point and embarked Dean Hiscox and dingy, completed sequence of grab samples with Smith-MacIntyre grab, commenced seismic boomer traverses across Lord Howe shelf and undertook two piston cores east of Lord Howe Island. Sailed overnight to Middleton Reef.
- 9 October arrived Middleton Reef and deployed 3 dinghies. Dinghy 1 undertook 2 seismic traverses across lagoon of Middleton Reef and through passage. Dinghy 2 visited a series of coral sites, undertaking two scuba dives and snorkel tows in backreef and deep lagoon, taking underwater video of degraded coral and collecting 3 surface sediment samples. Dinghy 3 attempted vibrocoring of lagoon sediments but was unable to core during the high tide, returning to successfully vibrocore 2 cores in the afternoon at low tide. Disruption of the dinghy program occurred in the middle of the day when a heavy squall caused a recall request for the dinghies. The Franklin took a series of grab samples across the northern flank of Middleton Reef. Overnight further grab sampling was undertaken on the northern flank of Middleton Reef down to a depth of 1310 m followed by bathymetric traverses across the deeper northern margin of the submerged reef basement.

- 10 October Deployed Dinghy 3 at first light and successfully vibrocored a further three cores in the lagoon and inspected wreck of Frontier Monray. Undertook a series of piston cores along the northern flank of Middleton Reef. As the weather deteriorated were unable to deploy further dinghies to carry out further planned shallow water investigations. Undertook grab sampling along western and southern flanks of Middleton Reef. Two unsuccessful dredges attempted on southwestern flank. Strong winds forced abandonment of further planned sampling program at Middleton Reef, and cancellation of planned program at Elizabeth Reef. Sailed for Lord Howe Island.
- 11 October Strong winds and swell, Franklin hove to on transit to Lord Howe Island.
- 12 October Arrived Lord Howe Island, took grab samples on northeastern shelf, disembarked Dean Hiscox and dinghy 3. Completed a series of seismic traverses along the east shelf of Lord Howe and across Ball's Pyramid shelf. Overnight completed grab-sampling program along seismic track across Ball's Pyramid shelf and along southwest flank of Lord Howe Island.
- 13 October Deployed diamond-drill team in dinghy 3 for work in Lord Howe lagoon and took two short (up to 4.5 m) diamond-drill cores. Dinghy 2 deployed and scuba dive completed in Erscott's Blind Passage, stained corals retrieved. Piston cores and grab-samples collected from the Franklin across both Lord Howe shelf and Ball's Pyramid platform. A pipe dredge was deployed three times on the southern flank of Lord Howe shelf.
- 14 October Grab sampling completed on Lord Howe shelf by 5.45 a.m. Left Lord Howe Island for Sydney.
- 15 October Transit to Sydney.
- 16 October Arrived Sydney.

SUMMARY

Cruise 12/98 on the ORV Franklin provided sufficient scientific data to achieve most of the planned objectives for the Middleton Reef and Lord Howe areas, however Elizabeth Reef could not be visited. The ship and equipment functioned very well and the major difficulties were all attributed to the weather conditions. However, more reliable radio contact with the dinghies would have been an advantage. Of the six days at the sampling locations, only two were suitable for the safe deployment of the dinghies. This severely restricted the acquisition of the planned shallow water samples and data on the coral distributions on the reefs. One day was lost to storm conditions, one day was only suitable for seismic surveying and the remaining two days were suitable for grab sampling. The weather conditions also resulted in an apparently non-systematic sampling pattern dictated by wind and swell conditions. The weather

conditions were also marginal for dredging operations, resulting in the loss of two dredges and lack of dredge sample recovery.

PERSONNEL

The scientific party would like to express their sincere thanks to the master and crew of the Franklin for their assistance during this cruise – the food, accommodation and cooperation were all excellent.

Scientific Investigators

Colin Woodroffe	Chief Scientist, University of Wollongong
Brian Jones	Chief Scientist, University of Wollongong
John Marshall	Scientist, RSES, Australian National University
Stuart Fallon	Scientist, RSES, Australian National University
Vicki Harriott	Scientist, Southern Cross University
David Mitchell	Senior Technical Officer, University of Sydney
Eugene Wallensky	Operations Manager, RSBS, Australian National University
David Kennedy	Ph.D. Student, University of Wollongong
Mark Dickson	Ph.D. Student, University of Wollongong
Dean Hiscox	Lord Howe Island Board

CSIRO (Hobart)

David Terhell	CMR Cruise Manager / Computer Systems
Phillip Adams	CMR Electronics technician

ORV Franklin

Dick Dougall	Master
Arthur Staron	First Mate
John Lynch	Second Mate
John Morton	Chief Engineer
Greg Pearce	First Engineer
Andrew McLagan	Electrical Engineer
Jannick Hansen	Bosun
Norm Marsh	AB
Bill Hughes	AB
Peter Genge	AB
Wayne Browning	Greaser
Ron Culliney	Chief Steward
Gary Hall	Chief Cook
Tom Condon	Second Cook

TABLE 1. SAMPLES FROM MIDDLETON REEF

(G = grab sample, PC = piston core, MDS = surface sample, MV = vibrocore)

SAMPLE	DEPTH	LATITUDE/LONGITUDE	NOTES
G20	43.0m	29°26.472'S, 159°04.225'E	Coarse sand
G21	53.5m	29°25.483'S, 159°04.066'E	Sand
G22	51.5m	29°25.928'S, 159°03.374'E	Sand and rhodoliths
G23	61.5m	29°26.260'S, 159°02.760'E	Sand, live <i>Halimeda</i> & rhodoliths
G24	42.5m	29°25.024'S, 159°04.972'E	Sand
G25	33.5m	29°25.063'S, 159°05.063'E	Sand
G26	32.0m	29°26.033'S, 159°05.063'E	Sand
G27	66.5m	29°25.007'S, 159°03.993'E	Sand, rhodoliths and forams
G28	298.0m	29°25.199'S, 159°02.837'E	Coarse sand
G29	273.5m	29°24.046'S, 159°04.372'E	Sand
G30	167.0m	29°24.001'S, 159°05.174'E	Sand
G31	121.0m	29°24.031'S, 159°06.201'E	Sand
G32	367.5m	29°23.940'S, 159°06.710'E	Fine sand
G33	1312.0m	29°21.768'S, 159°03.878'E	Muddy sand
G34	90.5m	29°27.453'S, 159°01.706'E	Hard substrate, sponges & minor sand
G35	139.0m	29°28.715'S, 159°01.845'E	Very small sample of sand
G36	254.0m	29°29.998'S, 159°03.434'E	Sand
G37	117.5m	29°29.953'S, 159°05.238'E	Sand
G38	295.0m	29°30.167'S, 159°07.414'E	Sand
PC3	49.0m	29°25.839'S, 159°03.920'E	1m core, but may be surface sediment
PC4	54.0m	29°25.645'S, 159°03.495'E	1.9m core
PC5	87.0m	29°24.160'S, 159°05.750'E	0.7m core, rhodoliths at base
MDS1	2.0m	29°29.000'S, 159°06.200'E	Sand
MDS2	2.5m	29°28.453'S, 159°04.107'E	Sand
MDS3	2.0m	29°28.453'S, 159°04.305'E	Sand
MDS4	2.0m	29°27.466'S, 159°05.754'E	Sand
MDS5	2.0m	29°27.533'S, 159°05.904'E	Sand
MDS6	1.5m	29°27.757'S, 159°05.592'E	Sand
MDS7	11.0m	29°27.800'S, 159°05.100'E	Sand
MDS8	10.5m	29°27.400'S, 159°05.900'E	Sand
MDS9	1.0m	29°27.150'S, 159°07.900'E	Sand
MV1	2.5m	29°28.347'S, 159°04.107'E	Penetration 1.12m, core length 0.66m
MV2	2.0m	29°28.453'S, 159°04.305'E	Penetration 3.08m, core length 2.00m
MV3	1.0m	29°27.833'S, 159°05.502'E	Penetration 1.0m, sediment loss, therefore effectively a surface sample
MV4	2.0m	29°27.838'S, 159°05.464'E	Penetration 3.47m, core length 2.18m

TABLE 2. SAMPLES FROM LORD HOWE ISLAND

(G = grab sample, PC = piston core, LH = rotary drill core)

SAMPLE	DEPTH	LATITUDE/LONGITUDE	NOTES
G1	47.0m	31°30.800'S, 159°05.300'E	Sand
G2	48.0m	31°30.620'S, 159°05.900'E	Sand and bryozoan
G3	31.5m	31°29.810'S, 159°08.270'E	Sand, coral, coralline algae
G4	53.5m	31°29.400'S, 159°09.190'E	Sand and coral
G5	33.5m	31°32.130'S, 159°06.187'E	Sand
G6	25.0m	31°32.810'S, 159°06.299'E	Coarse sand, branching coral, gravel
G7	37.0m	31°33.905'S, 159°07.049'E	Carbonate gravel and bryozoans
G8	53.0m	31°32.184'S, 159°11.349'E	Sand and shell
G9	34.0m	31°32.199'S, 159°10.293'E	Coralline algal rubble
G10	50.0m	31°33.028'S, 159°09.019'E	Fine sand
G11	42.0m	31°33.384'S, 159°08.017'E	Sand, <i>Halimeda</i> and <i>Fungia</i>
G12	41.0m	31°34.491'S, 159°06.928'E	Medium-fine sand
G13	50.0m	31°35.603'S, 159°08.560'E	Sand, shell, rhodoliths & scallop
G14	35.0m	31°36.365'S, 159°09.946'E	Very coarse well rounded rubble
G15	42.0m	31°36.785'S, 159°10.421'E	Hard bottom, algae
G16	110.0m	31°37.983'S, 159°09.578'E	Fine sand, mud, small molluscs
G17	44.0m	31°37.349'S, 159°08.564'E	Coarse sand/gravel, 2 echinoids
G18	30.5m	31°36.985'S, 159°08.099'E	Sand
G19	36.0m	31°36.629'S, 159°07.067'E	Coarse sand, branching coral gravel
G39	64.0m	31°25.470'S, 159°03.207'E	Coarse sand and rhodoliths
G40	96.0m	31°26.610'S, 159°07.611'E	Sand
G41	34.0m	31°28.758'S, 159°05.059'E	Sand and coral
G48	118.0m	31°44.209'S, 159°04.336'E	Large rhodoliths
G48A	117.5m	31°44.266'S, 159°04.439'E	Shelly sand, few rhodoliths, bryozoan
G49	98.0m	31°43.038S, 159°04.430'E	Coarse sand, rhodoliths and shell
G50	65.5m	31°41.995'S, 159°04.307'E	Sand and echinoderm (spines kept)
G51	57.0m	31°40.963'S, 159°04.300'E	Sand, coral, echinoderms, rhodoliths
G52	54.0m	31°40.216'S, 159°04.366'E	Sand, very small sample
G53	47.5m	31°39.037'S, 159°03.800'E	Medium-coarse sand, shell fragments
G54	35.0m	31°37.960'S, 159°03.820'E	Hard substrate, rhodoliths, trace sand
G55	26.5m	31°36.810'S, 159°03.440'E	Hard substrate, sponges, bryozoans
G56	37.0m	31°36.277'S, 159°03.541'E	Fine-medium sand
G57	35.5m	31°35.797'S, 159°03.414'E	Coarse sand with rhodoliths
G58	32.5m	31°34.528'S, 159°03.468'E	Calcareous algae and rhodoliths
G59	26.0m	31°34.187'S, 159°03.514'E	Hard, calcarenite, coral, bryozoans
G60	41.5m	31°33.887'S, 159°02.882'E	Medium sand

TABLE 2 (continued)

SAMPLE	DEPTH	LATITUDE/LONGITUDE	NOTES
G61	30.5m	31°33.858'S, 159°01.388'E	Hard base, bryozoan, coral, calc algae
G61A	34.5m	31°33.841'S, 159°01.424'E	Hard base, bryozoan, coral, calc algae
G62	31.0m	31°31.934'S, 159°02.329'E	Sand
G63	32.5m	31°32.418'S, 159°01.355'E	Sand
G64	34.0m	31°32.767'S, 159°00.732'E	Sand, common shell, few corals
G65	32.5m	31°33.129'S, 159°00.265'E	Small sample, sand, some coral
G66	33.5m	31°33.834'S, 159°00.617'E	Sand
G73	32.0m	31°35.129'S, 159°02.020'E	Coarse sand
G74	30.0m	31°36.002'S, 159°02.070'E	Coarse sand and gastropod fragment
G75	36.0m	31°36.588'S, 159°06.729'E	Sand and encrusted massive coral
G76	58.5m	31°25.888'S, 159°02.376'E	Medium sand and scallop
G77	57.0m	31°27.683'S, 159°02.711'E	Medium sand and rhodoliths
G78	40.5m	31°28.818'S, 159°03.093'E	Fine sand and coralline algae
G79	32.5m	31°30.005'S, 159°02.788'E	Fine-medium sand, sea pen
G80	35.0m	31°29.902'S, 159°01.848'E	Hard bottom, calcareous algae, bryozoans, coarse shell sand (2 nd grab)
G81	41.0m	31°29.528'S, 159°01.244'E	Hard bottom, minor fine sand
G82	57.5m	31°27.658'S, 159°08.291'E	Coarse sand, bivalves, few rhodoliths
G83	35.0m	31°28.357'S, 159°07.720'E	Coarse sand, common rhodoliths
G84	35.0m	31°28.901'S, 159°06.940'E	Hard bottom, small sample coarse sand
G85	51.5m	31°31.045'S, 159°07.539'E	Medium sand
G86	38.5m	31°31.451'S, 159°09.635'E	Fine-medium sand
G87	49.0m	31°30.873'S, 159°10.034'E	Coarse sand, rhodoliths, scallop
G88	38.5m	31°33.904'S, 159°10.076'E	Coarse sand and rhodoliths
G89	45.0m	31°34.420'S, 159°12.033'E	Hard base, medium sand, calc algae
G90	31.5m	31°38.000'S, 159°06.105'E	Hard base, medium sand, calc algae
PC1	50.0m	31°35.603'S, 159°08.560'E	2.25m core
PC2	50.0m	31°33.040'S, 159°09.053'E	No core
PC6	42.0m	31°33.900'S, 159°02.843'E	No core
PC7	760.5m	31°44.379'S, 159°06.198'E	2.8m core, very fine muddy sand
PC8	34.5m	31°36.434'S, 159°09.765'E	Coralline algal fragments
LH23	Low tide	31°32.851'S, 159°04.738'E	Near steps in Lovers Bay, total depth 3.47m, all carbonate, may have hit basalt at base, good recovery
LH24	Close to high tide	31°32.905'S, 159°04.730'E	Around corner north of LH23, total depth 4.50m with basalt at base, 15-20cm clean coral above basalt, rest all carbonate

TABLE 3. SAMPLES FROM BALL'S PYRAMID

(G = grab sample)

SAMPLE	DEPTH	LATITUDE/LONGITUDE	NOTES
G42	59.0m	31°46.843'S, 159°20.498'E	Carbonate sand and red sponge
G43	48.5m	31°46.555'S, 159°19.067'E	Coarse sand and rhodoliths/coral
G44	49.5m	31°46.495'S, 159°17.104'E	Coarse sand, rhodoliths and scallops
G45	40.0m	31°46.501'S, 159°15.031'E	Coarse sand & coralline algae
G46	37.5m	31°46.553'S, 159°13.400'E	Coarse sand, platy algae and bivalves
G47	157.5m	31°46.584'S, 159°09.653'E	Muddy coarse sand, bivalves, bryozoan
G67	78.0m	31°44.041'S, 159°18.991'E	Fine-medium sand, brachiopod
G68	42.5m	31°44.071'S, 159°16.966'E	Sand
G69	48.0m	31°44.121'S, 159°15.854'E	Calcareous sand
G70	39.5m	31°44.203'S, 159°15.137'E	Sand
G71	53.5m	31°44.011'S, 159°11.913'E	Sand, rhodoliths and 'oyster'
G72	51.5m	31°44.041'S, 159°10.405'E	Rocks and echinoderm

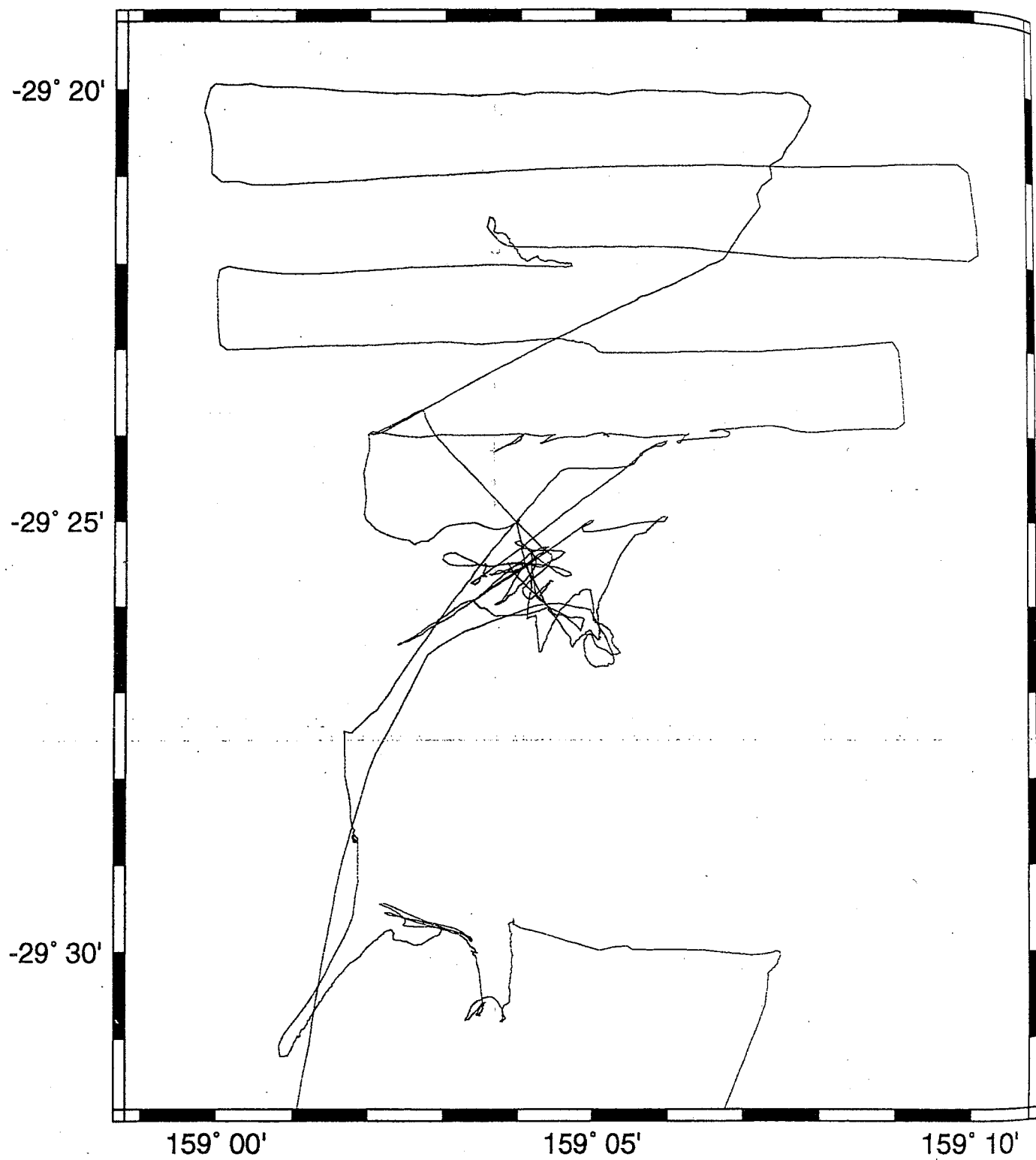


Figure 1. ORV Franklin cruise track around Middleton Reef.

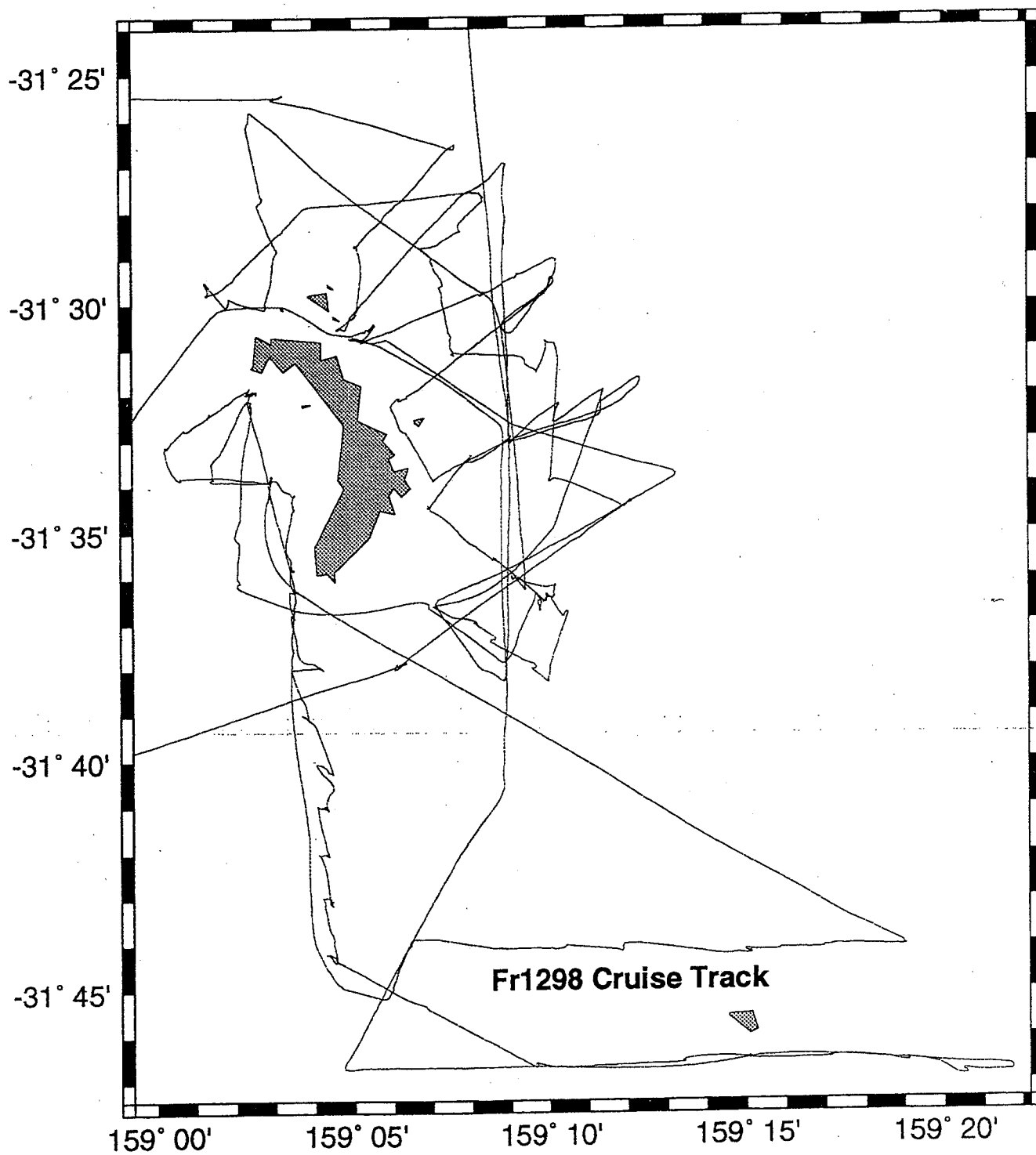


Figure 2. ORV Franklin cruise track around Lord Howe Island and Ball's Pyramid.

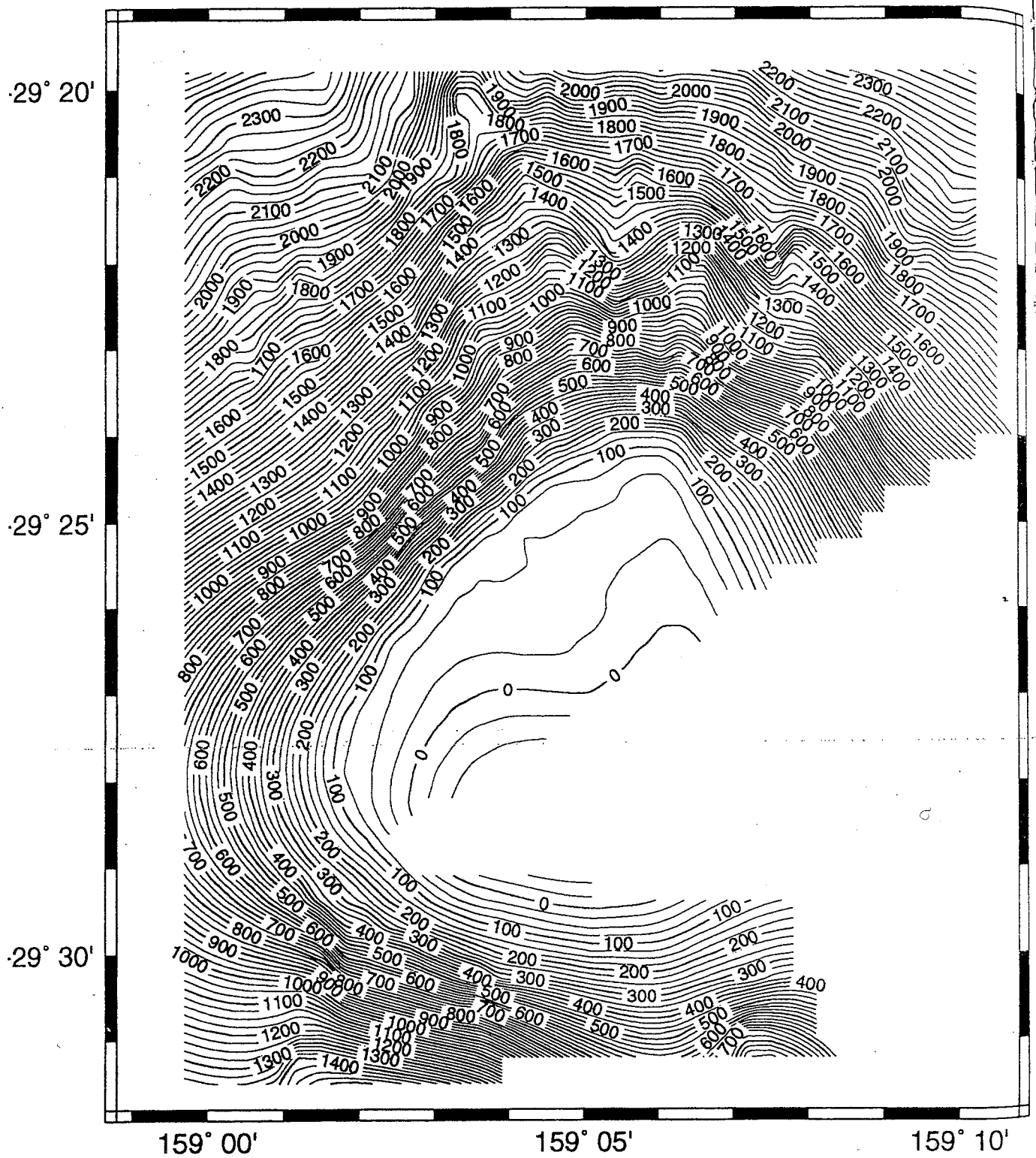


Figure 3. Bathymetry around Middleton Reef from ORV Franklin cruise data.

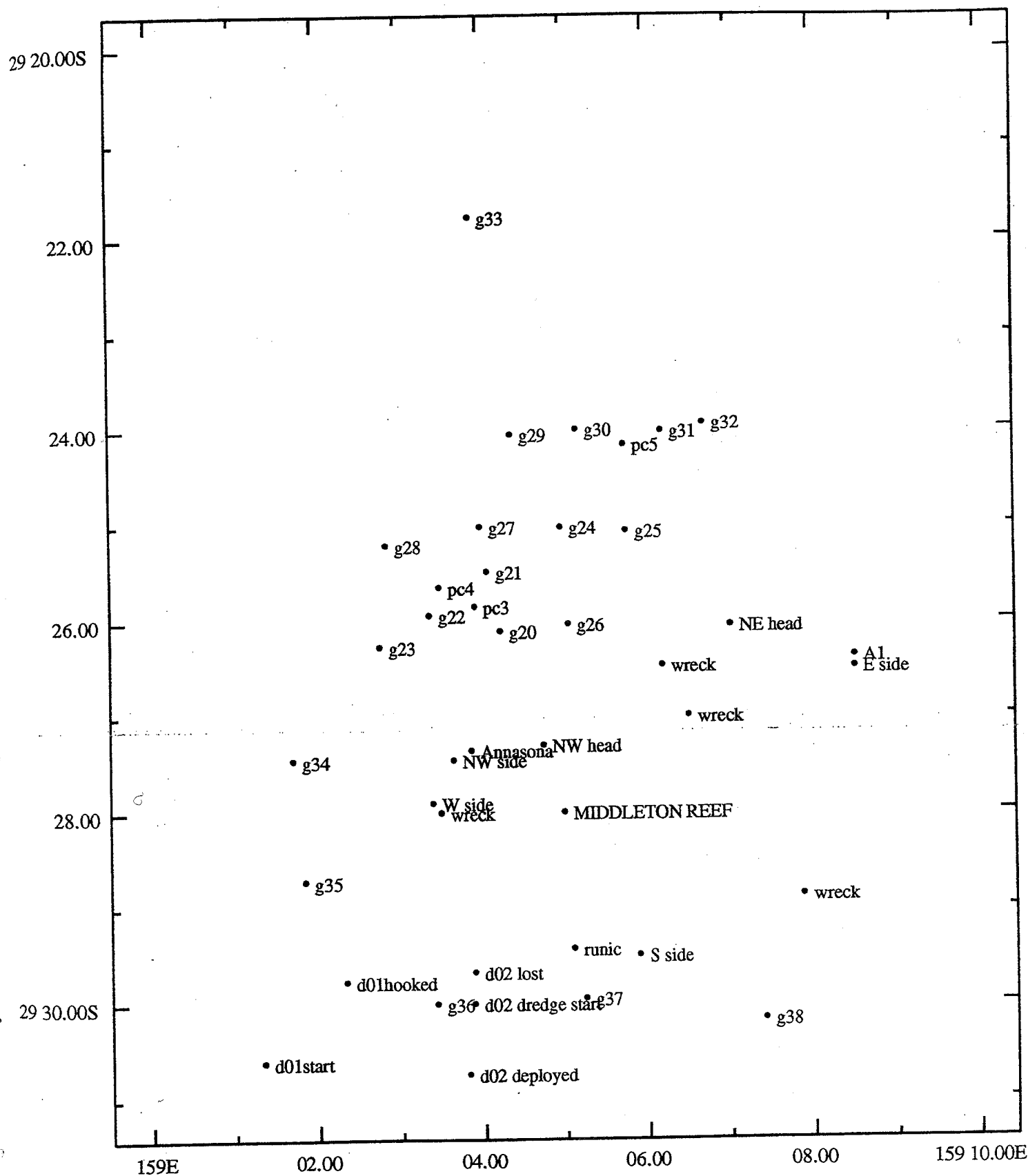


Figure 4. Sample locations around Middleton Reef from ORV Franklin cruise.

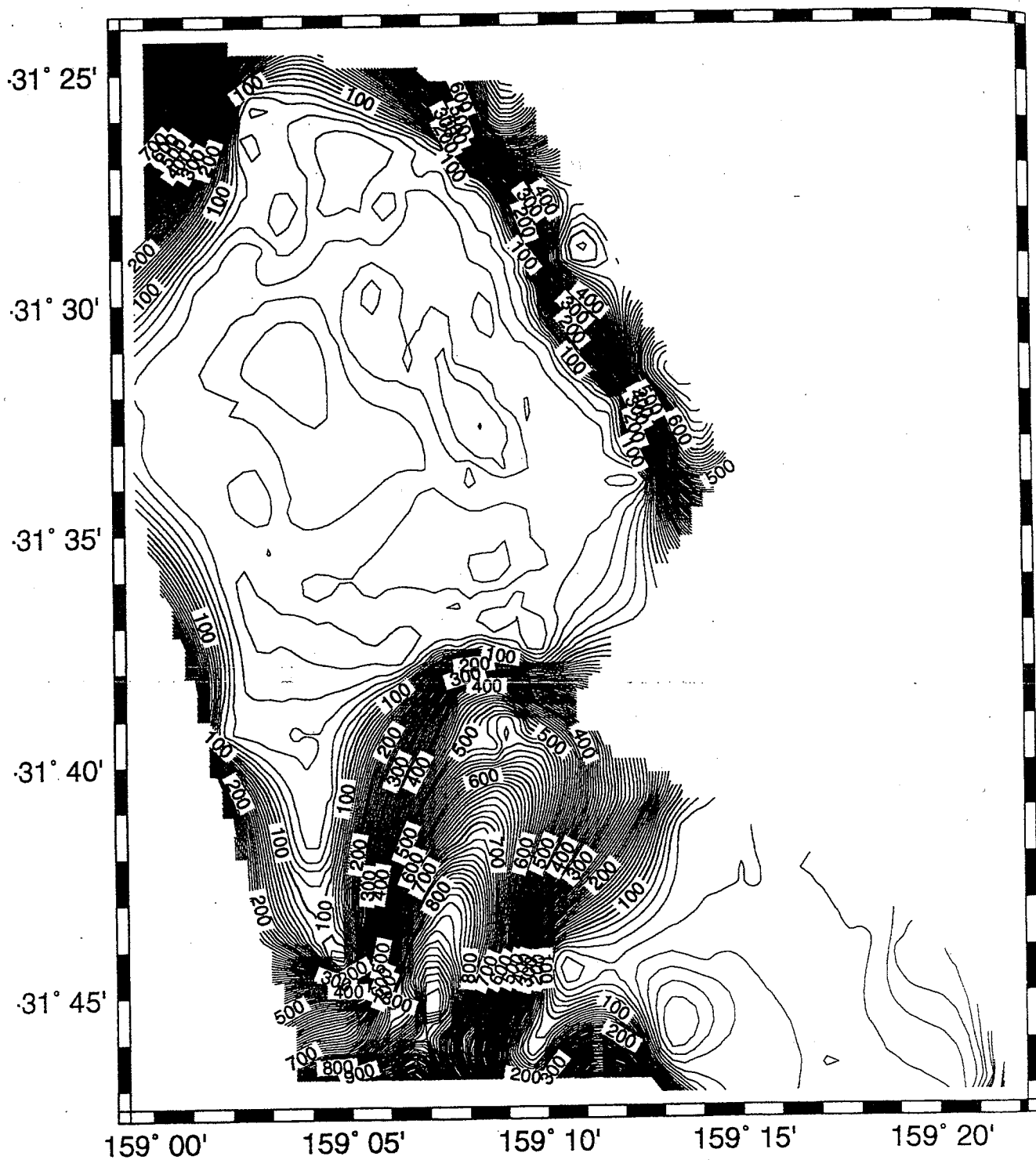


Figure 5. Bathymetry around Lord Howe Island and Ball's Pyramid from ORV Franklin cruise data.

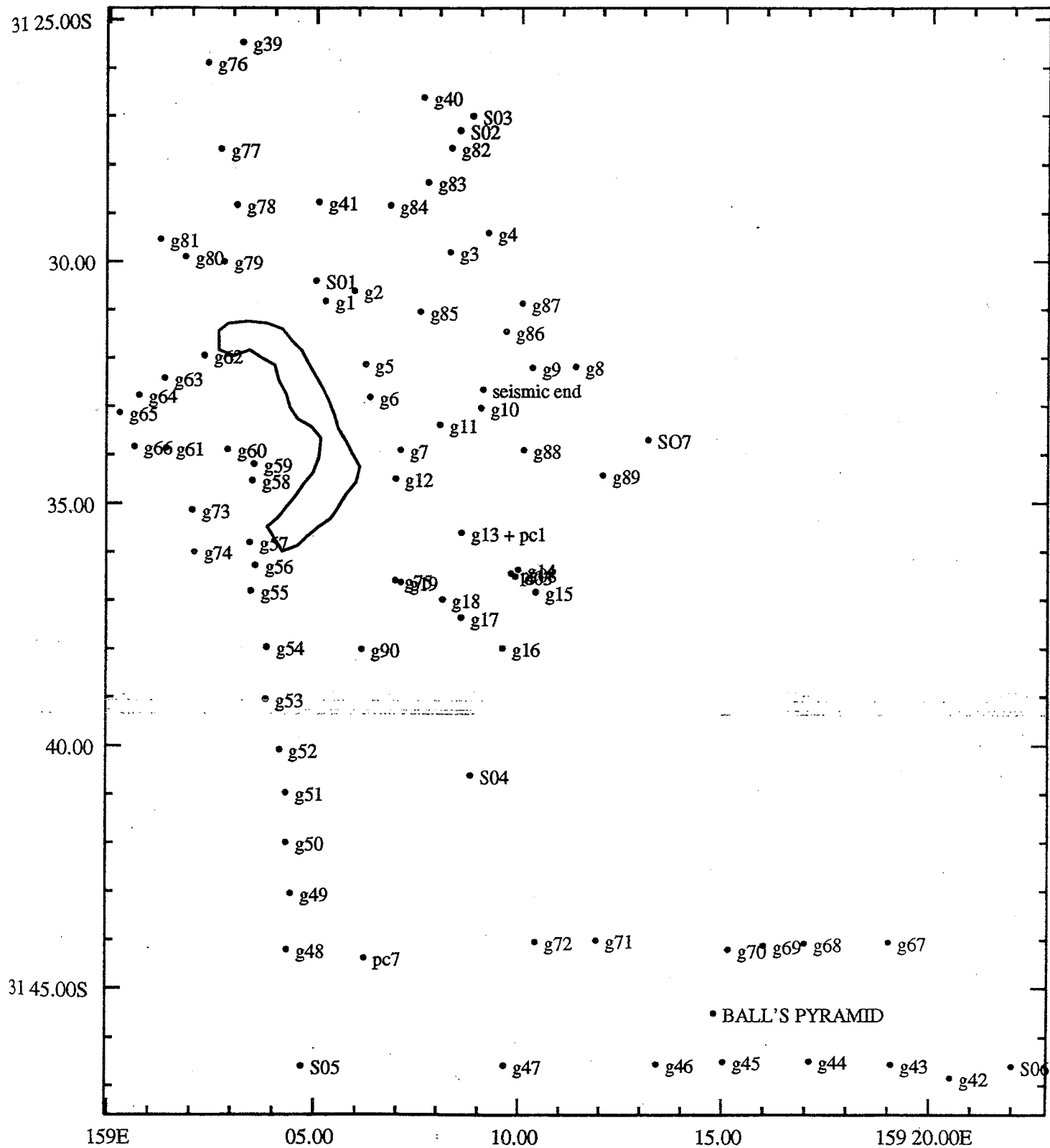


Figure 6. Sample locations around Lord Howe Island and Ball's Pyramid from ORV Franklin cruise.