MULTIBEAM BATHYMETRY
MONEO LAGOON, NORTHERN PROVINCE
NEW CALEDONIA

Robert Smith
SOPAC Secretariat

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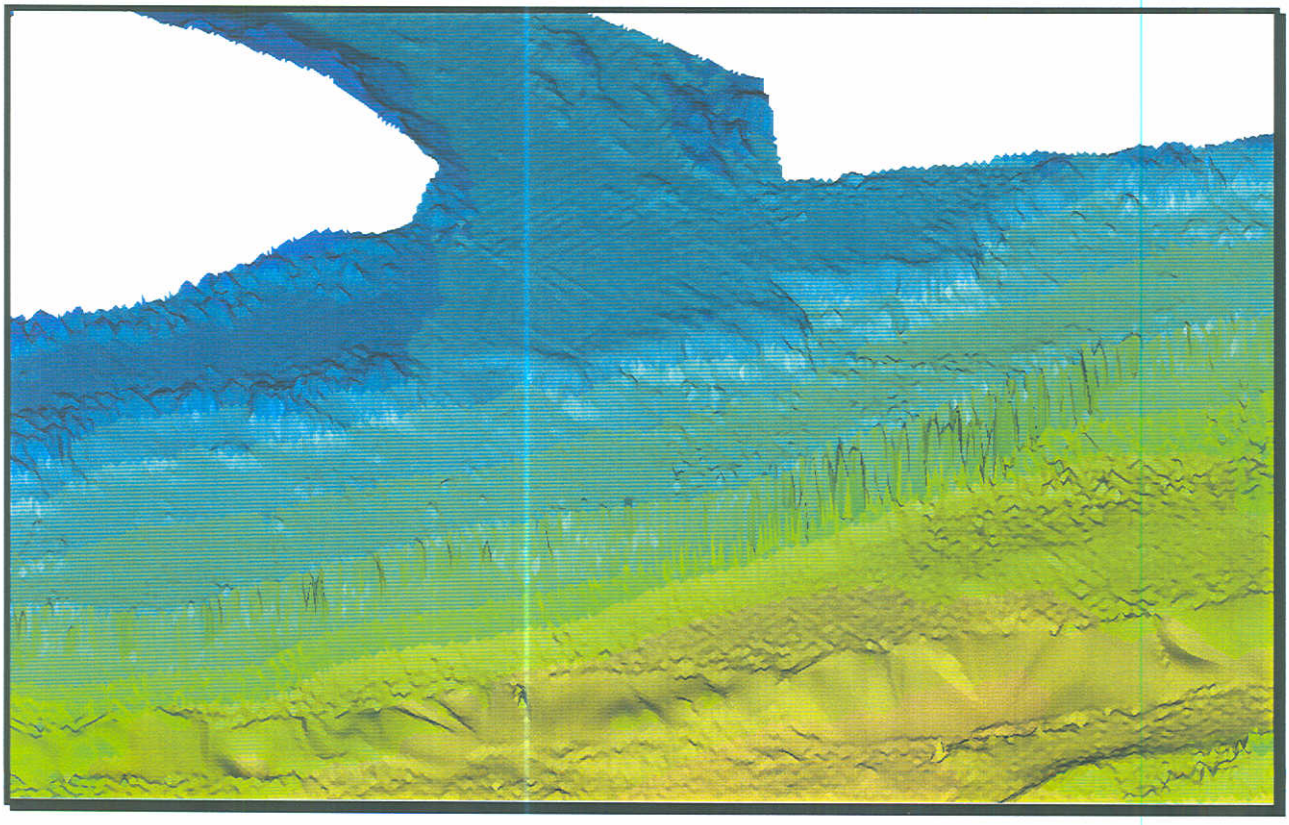

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SUMMARY

This report details the multibeam bathymetry results for the proposed pipeline route as of 7 March 2001. Preliminary survey results were detailed in the SOPAC preliminary report 130 of the lagoon and fore-reef slope for site selection of a deep-sea tailings pipeline (DSTP) route. The area surveyed included the lagoon and fore-reef slope to the east of Cape Bocage. The survey involved the acquisition of multibeam bathymetric data and CTD profiling data. A total of 523 line kilometres of data was collected by the South Pacific Applied Geoscience Commission (SOPAC) during the period 29th November to 6th December 2000.

Six sheets have been compiled of the bathymetry along the tentative pipeline route, at a scale of 1:5000, with map co-ordinates in metres based on UTM Zone 58, IGN 1972 datum.

General conclusions are:

- The dataset has delineated a narrow ridge, scarp, plateau sequence that dominates the centre of the lagoon and extends for considerable distance along a northwest-southeast axis.
- The plateau is interpreted to be drowned reef that has been structurally controlled by faulting.
- A number of deep depressions delineated south of the ridge in the lagoon are interpreted to reflect the underlying sub-surface, sink holes in a buried reef horizon rather than scoured features caused by currents.
- The fore-reef slope adjacent to Pass de Ugue shows two prominent scarps at 34 m and 70 m separated by a terrace between 60- and 70-m isobaths.
- Offshore the fore-reef morphology is complex, reflecting significant structural control through faulting.

INTRODUCTION AND OBJECTIVE

The primary objective of the swath mapping survey was to provide bathymetric data to define a suitable Deep-Sea Tailings Pipeline (DSTP) route for the two proposed alignments shown in Figure 1. The survey area is to the east of Cape Bocage on the east coast of the Northern Province. Based on the initial bathymetric results provided in Smith 2000 for the multibeam survey of the lagoon and fore-reef slope, a tentative route has now been defined Figure 1. This information was conveyed in a fax of 7th March which further requested "high-resolution data set along the proposed alignment broken down to a manageable size."

This report details the production of this data set and maps. The field survey was undertaken during the period 29th November to 6th December 2000.

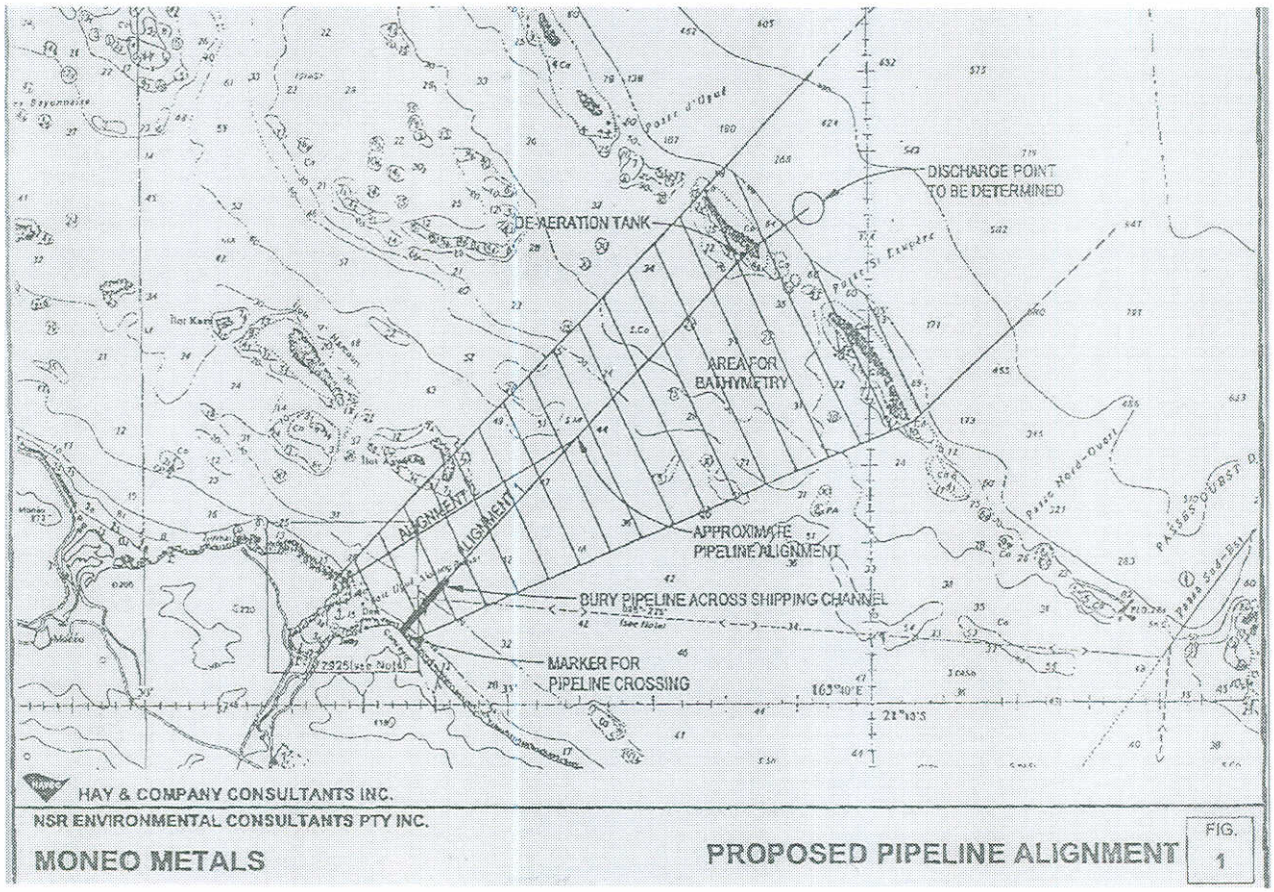


Figure 1. Plan of area to survey with proposed pipeline alignments.

However, following modelling studies (pers. comm., NSR) the proposed pipeline route was amended. The new proposed alignment was to move the pipe to the northwest of the survey area and pass offshore through the southern arm of the passage "Pass de Ugue" (Figure 2). Fortunately the survey was extended further north and was to capture

sufficient data to generate a series of maps for route-planning purposes. This report details the compilation and interpretation of these maps based on the new alignment.

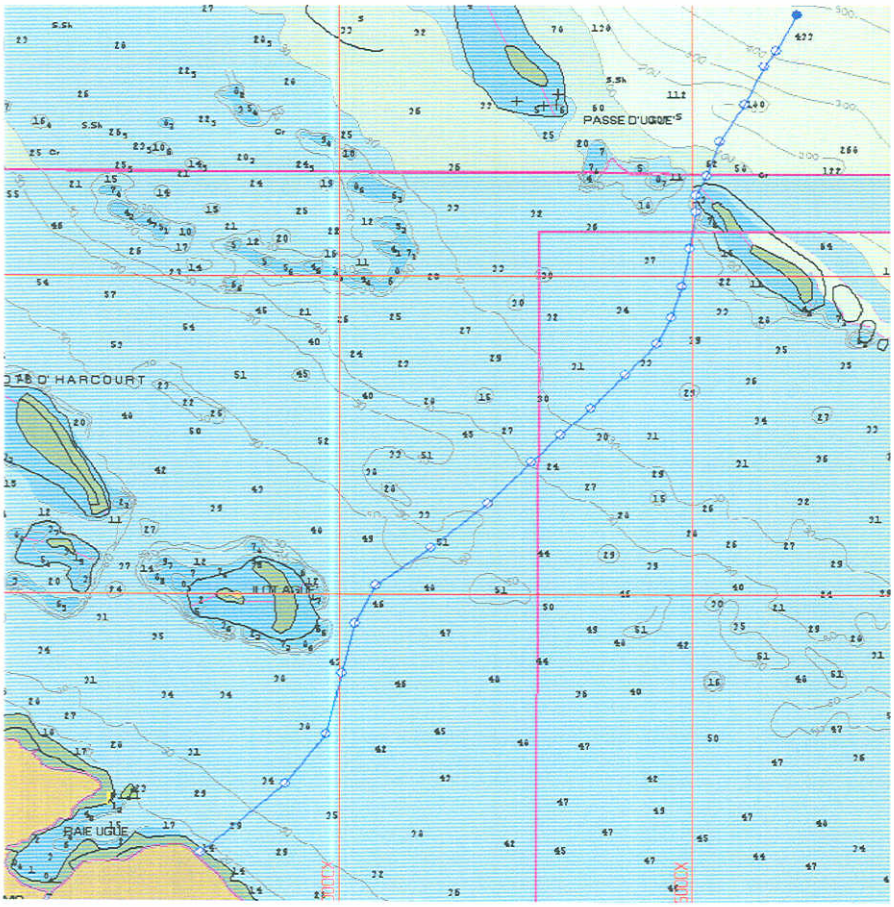


Figure 2. Location map illustrating new alignment of DSTP pipeline route (Base map file C-Map 02060496e).

EQUIPMENT & METHODS

Navigation Control

Navigation control was accomplished with a Trimble OMS12 RS and a OMS 121 mobile real-time differentially-corrected GPS system. Map coordinates are based on WGS 1984 spheroid, UTM zone 58 projection. The reference station for real-time OGPS was set on an established position located at Modiou. Station reference information was provided in the document describing site "*17-0B-Presquile Lebris*". The reference station was sited on location "0", a bronze marker set in a rectangular slab of concrete with the station geographical co-ordinates (in WGS84) as longitude 165033' 357024" east, latitude 21010' 05.2428" south; and with an elevation of 481.609 m. Station details and locations are provided in Appendix 1.

Survey base map

The survey base map was based on the hydrographic chart FR, SHOM (French Hydrographique Service), graph, 6529. Hydrographic navigation software used to control survey planning and execution was HYPACK from Coastal Oceanographics. Backdrop survey maps were electronic charts from C-Map.

Multibeam Bathymetry

Background

High-resolution swath mapping, using multibeam echosounders, is able to map a complete underwater landscape in a fraction of the time that is currently required by a single-beam echosounder, and with greater accuracy. Computer-processing of swath mapping data can produce data visualisations that render complex three-dimensional concepts into simple, informative, colour diagrams for the lay observer.

Swath mapping of the sea floor is carried out using sophisticated multi beam echosounders fitted to a ship or towed at depth. A computer is used to co-ordinate the large amounts of imaging information with the ship's position and attitude at very close time intervals. With further processing, an image can be created that represents, in fine detail, the morphology of the sea floor as well as objects on the sea floor.

Multibeam configuration

The system used is a Reason 8101 multibeam system. Details of the system configuration are given in Appendix 2.

RESULTS

Data processing

Based on the new pipeline alignment, a map series consisting of six sheets was compiled for the proposed route. Each sheet is based on a matrix with a cell size of 2 m for data extraction from the multibeam data set. Each sheet was drawn to incorporate a 500-m overlap. Additional information on data processing can be found in Appendix 2.

Tide analysis

To correct for tides and reduce the data to Chart Datum, computed data and field data were compared. Real-time data for the tides covering the survey period were kindly provided by NSR who had a tide gauge in the survey area since early October. However, at the time of processing the gauge had not been leveled to a specific datum. Using the tidal constituents for Baie de Poro, Table 2, from the British Admiralty Tide Tables for year 2000, a tide level with a time step of 10 minutes (to match the field data) were compared.

Table 1. Harmonic constituents for Baie De Poro.

M.L.	Harmonic Constants zone - 1100								S.W. corrections	
Z	M2		S2		K1		O1		¼ diurnal	
m.	g°	H.m.	g°	H.m.	g°	H.m.	g°	H.m.	f_4	F_4
0.8	175	0.32	185	0.07	200	0.20	158	0.09	na	na

In Figure 3 the graphed tides for Moneo are illustrated. The blue curve represents realtime data from 4th October through to 10th December. The dark curve shows the predicted tides. Using a MSL value of 0.8 m both, datasets were reduced to chart datum. Good agreement was seen in both phase and amplitude. Amplitude variations in tide levels between the predicted and actual tides were noted on occasions (meteorological

influences); the final tide curve used for the processing was based on the real-time data. Tide files have been included on the data-CD.

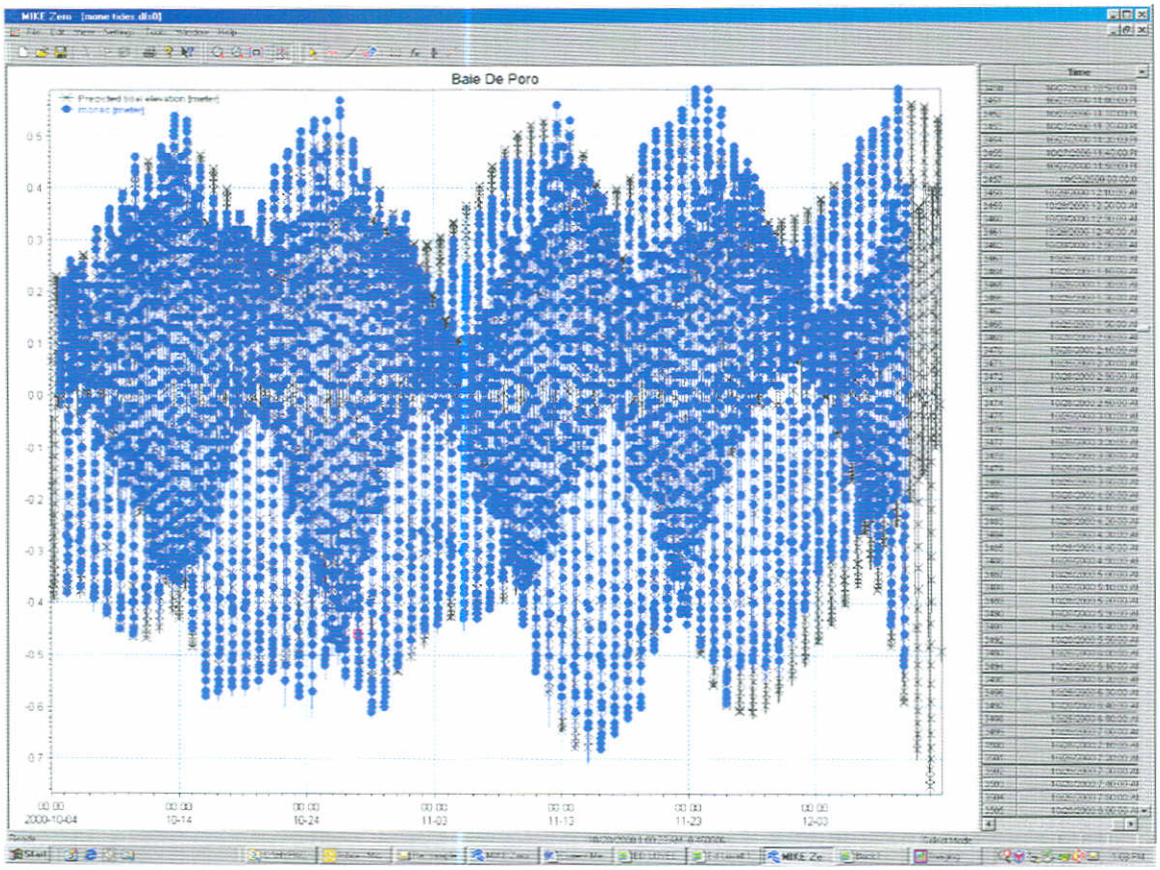


Figure 3. Moneo tides; blue is field data, black predicted curve from harmonic constituents for Baie De Poro.

Bathymetry of proposed pipeline alignment (sheets 6 through 1)

Based on the amended alignment of the DTSP shown in Figure 2, a six-sheet series at 1:5000 scale was generated. Figure 4 is an index map for the layout of the six maps. The large-scale plots can be found as Appendix 5.

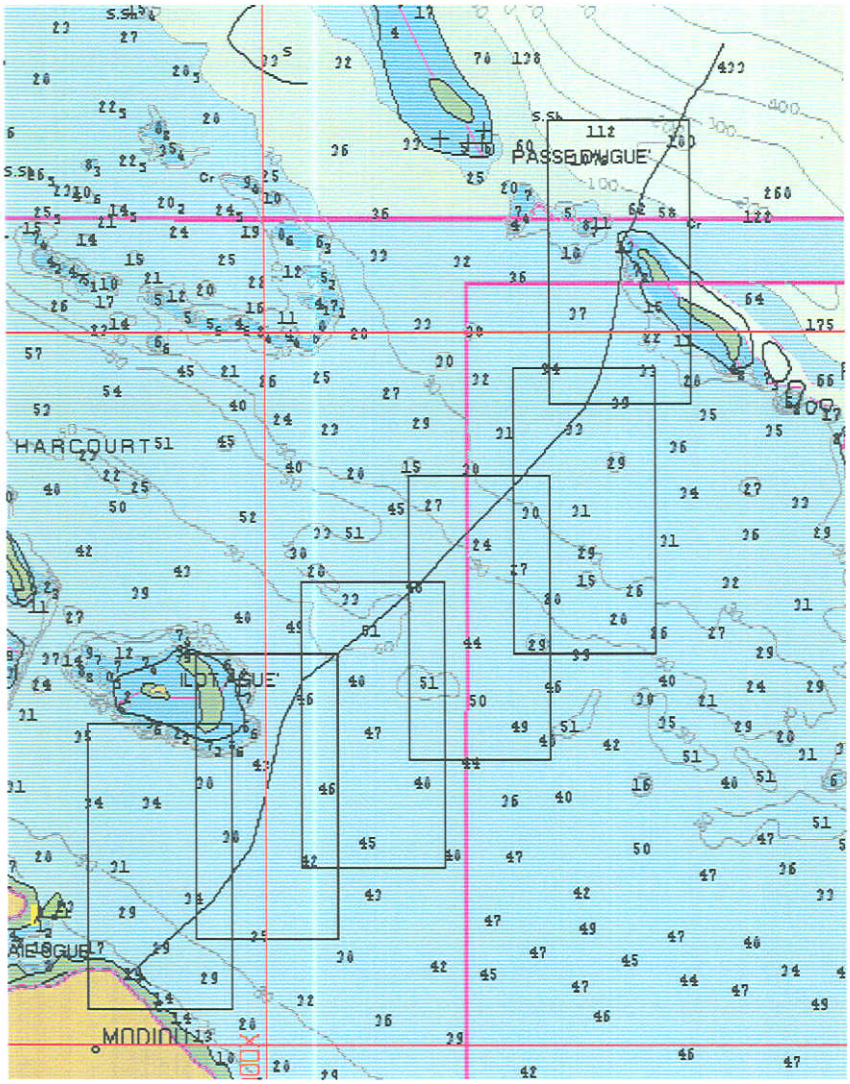


Figure 4. Index map for 1:5000 sheet series for amended DSTP route.

Sheet 6

Sheet 6 represents the data for start or the shore end of the pipe route and Sheet 1 the end of the DTSP offshore. Large-scale plots of the sixsheets are contained separately in folder pockets this report. Contouring of the large datasets was done with QuickSURF, and final maps compiled within the AutoCAD R14. For each map in the series the legend contains details of the file used to compile the sheet. The files include the ASCII xyz file based on a 2-m matrix with the file extension ".qs", a surface file used with Quicksurf , file extension".qsb", which contains the gridded data and the dwg AutoCAD file representing the final contour plots. All files are provided on the CD-Rom in Appendix 6.

From the fringing reef of Cape Socage the sea bed drops rapidly to an average depth of 16 m, the isobath considered best to define the base of the reef platform. Gradually descending, the sea floor reaches an average depth of 50 m about 3.5 km offshore. The

sea floor is quite featureless throughout this sheet except for the scarp of the fringing reef platform of 1I0t Ague captured at the northern edge of Sheet 6.

Sheet 5

The sea floor again is quite featureless with little relief, and a gradual decent to the northeast. The reef platform of 1I0t Ague is captured in the dataset lying to the northwest of the route.

Sheet 4

The deepest portions of the lagoon occur in this sheet. A number of broad depressions delineated by the 52-m isobath are evident. These depressions are interpreted to be partially infilled sinkholes or lagoon pools in a subsurface that may be an extension of the reef ridge described in Sheet 3. The nature of this substrate would best be confirmed with seismic-reflection data. Apart from those features, sea floor relief approximates a gentle undulating plain.

Sheet 3

The most significant bathymetric feature in this sheet is a ridge, bounded by a scarp to the southwest and a plateau extending to the northeast. This bathymetric feature is located midway across the lagoon. With a northwest-southeast axis, the ridge has a prominent scarp on its southern side rising from 49 m to a depth of 34 m over a horizontal distance of approximately 250 m. The scarp approximates a slope of 3.5 degrees. The 49-m isobath best delineates the base of the scarp, with the 34-m isobath defining the top of the scarp. From the 34-m isobath the sea floor extends towards the northeast as a plateau across the lagoon for a distance of about 2660 m. Although scattered coral heads or patches are evident on the plateau, they are not numerous. The morphology of the plateau suggests that this may have been an extensive reef platform that developed during an earlier sea-level stand, but failed to further develop with sea-level rise. The linear nature of the feature also suggests that this feature may be a surface expression of a northwest-southeast fault block or margin.

Sheet 2

Sheet 2 is a continuation of the plateau seen in Sheet 3. At the northern edge of the plateau, the sea floor then dips gently to forrn a broad rnoat 43 rn deep at the northern edge of the sheet. A nurnber of coral heads are evident on the plateau. A srnall rnound with sorne 2-3 m of relief can be seen on the inner slope of the moat. The existence of this rnoat suggests that sorne scouring due to current flow does occur.

Sheet 1

Sheet 1 covers the barrier reef, the southern arm of the passage Pass De Ugue and the fore-reef slope to depths greater than 200 m.
The barrier-reef slope on the lagoon side is steep with slopes as high as 40 degrees. The southern passage captured in the data set is narrow and is best defined by the 34-rn and 35-m isobaths, and is narrow at depth with an average width of 100 m. On the western side of the passage a number of large reef patches dominate. Beyond the passage the morphology of the fore-reef slopes reveals two very distinct scarps that are considered to be fault induced. The shallower of the two scarps is delineated well by the 35-m isobath and the second, deeper scarp by the 75-m isobath. A prominent reef terrace between the 50-m and 70-m isobaths separates the two scarps. This terrace varies in width from 5070 m, widening considerably to well over 150 m at the juncture of Pass de Ugue proper and the fore-reef slope. To the west both scarp features terminate at this same juncture. The head of a small canyon defined by the 115-m isobath parallels the base of the lower scarp, running in an easterly direction before turning northwards. Further to the northwest the head of a larger canyon, best defined by the 180-m isobath, also shows an initial subtle easterly trend before turning northwards.

An unusual feature that was seen in the upper scarp is a small break occurring adjacent to the southern passage, suggesting this to be an erosion feature. Overall the fore-reef morphology in this area appears quite complex, reflecting significant structural or tectonic influence.

CONCLUSIONS

- The dataset has delineated a narrow ridge, scarp, plateau sequence that dominates the centre of the lagoon and extends for considerable distance on a northwest-southeast axis.
- The plateau is interpreted to be drowned reef that has been structurally controlled by faulting.
- A number of deep depressions delineated south of the ridge in the lagoon floor are interpreted to reflect the underlying sub-surface, either in filled sink holes, or small inner lagoons in a buried reef horizon rather than scoured features caused by currents.
- The fore-reef slope adjacent to Pass de Ugue shows two prominent scarps at 34 m and 70 m separated by a terrace between 60- and 70-m isobaths
- Offshore the fore-reef morphology is complex, reflecting significant structural control through faulting.

REFERENCES

Admiralty tides tables.

Smith, R.B., 2000, Preliminary multibeam survey report for Moneo, Northern Province, New Caledonia. *SOPAC Preliminary Report 130.*

APPENDIX 1
Reference Station Location Map and Details

17-08 - Presqu'île LEBRIS

9880801

Île : Grande Terre
Territoire d'outre-mer : NOUVELLE CALEDONIE Commune(s) : Houaïlou
Feuille à 1/50 000 : 48-17 BAIE LEBRIS

Nature des repères

(a) Borne en fonte cimentée : Station GPS 1991 : point IGN 1953
(b) Repère en bronze G.M. scellé sur rocher : point IGN 1953
(c) Repère en bronze G.M. scellé dans un massif de béton. : point ST 1980
(d) Borne en fonte cimentée centrée sur un repère en bronze G.M. souterrain à -0.637 m du sommet borne, ~~(e) Antenne : paratonnerre : à 5 au sommet : point ST 1983~~ détruit (destroyed)

Coordonnées planes et altitudes

Système géodésique : IGN 1972 NOUVELLE CALEDONIE
Ellipsoïde : INTERNATIONAL-HAYFORD 1909
Projection : UTM SUD FUSEAU 58
Système altimétrique : NIVELLEMENT GENERAL DE NOUVELLE-CALEDONIE GRANDE TERRE

repère	E	N	CP	H	CH
(a)	557781,50	7658811,98	27	419,08	03
(b)	557783,64	7658813,61	27	419,37	03
(c)	557793,17	7658830,61	27	417,65	03
(e)	557805,96	7658824,54	27	non coté	08
(d)	557787,268	7658808,078		418,95	

CP : 27 : DETERMINATION TERRESTRE : PRECISION > 10 PPM
CH : 03 : NIVELLEMENT TRIGONOMETRIQUE
CH : 08 : POINT NON COTE

Système géodésique : ITRF90
Ellipsoïde : IAG GRS 1980
Projection : LAMBERT NOUVELLE CALEDONIE
Système altimétrique : NIVELLEMENT GENERAL DE NOUVELLE-CALEDONIE GRANDE TERRE

repère	E	N	CP	H	CH
(a)	354294.195	336681.790	22	419,08	03
(b)	354296,335	336683,432	22	419,37	06
(c)	354305.762	336700.504	22	417,65	06
(d)	354299,963	336677,900	22	418,95	06
(e)	354318,497	336694,534	28	non coté	08

CP : 22 : DETERMINATION GPS GEODESIQUE : PRECISION < 5 PPM
CP : 28 : COORDONNEES ABAQUES
CH : 03 : NIVELLEMENT TRIGONOMETRIQUE
CH : 01 : POINT NON COTE
CH : 06 : MESURE GPS DIFFERENTIELLE ET CORRECTION DE GEOIDE

copyright DITTMANN 1994

17-08 - Presqu'île LEBRIS

9880801

Coordonnées tridimensionnelles géographiques

Système géodésique : ITRF90
Ellipsoïde : IAG GRS 1980

repère	longitude	latitude	he	CX
(a)	165°33'35"5028	-21°10'05"1158	481.736	12
(b)	165°33'35"5772	-21°10'05"0626	482.042	12
(c)	165°33'35"9057	-21°10'04"5083	480.303	12
(d)	165°33'35"7024	-21°10'05"2428	481.609	12
(e)	165°33'36"3465	-21°10'04"7036	-	18

CX : 12 : DETERMINATION GPS GEODESIQUE ; PRECISION < 5 PPM
CX : 18 : COORDONNEES ADAQUES

copyright DITTT/S GN 1998

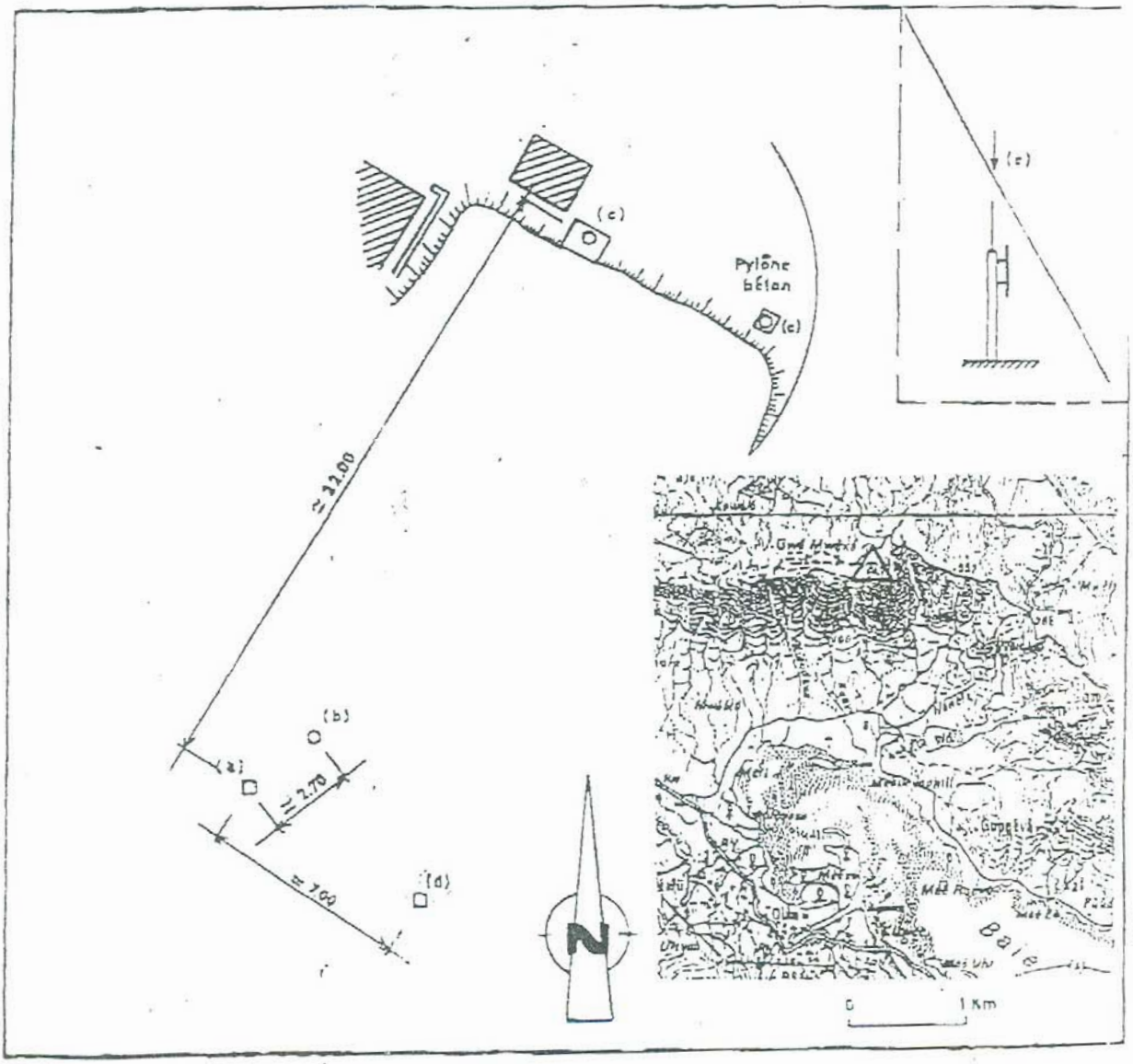
Réseau Géodésique de Nouvelle-Calédonie Page 1/1

17 - 08 - Presqu'île de LIBRIS 9880801

Orientement au sol à partir de la Imrne: Repère (d).

Situation Imm: 14 kms au Nord Ouest du village de HOUAILOU.

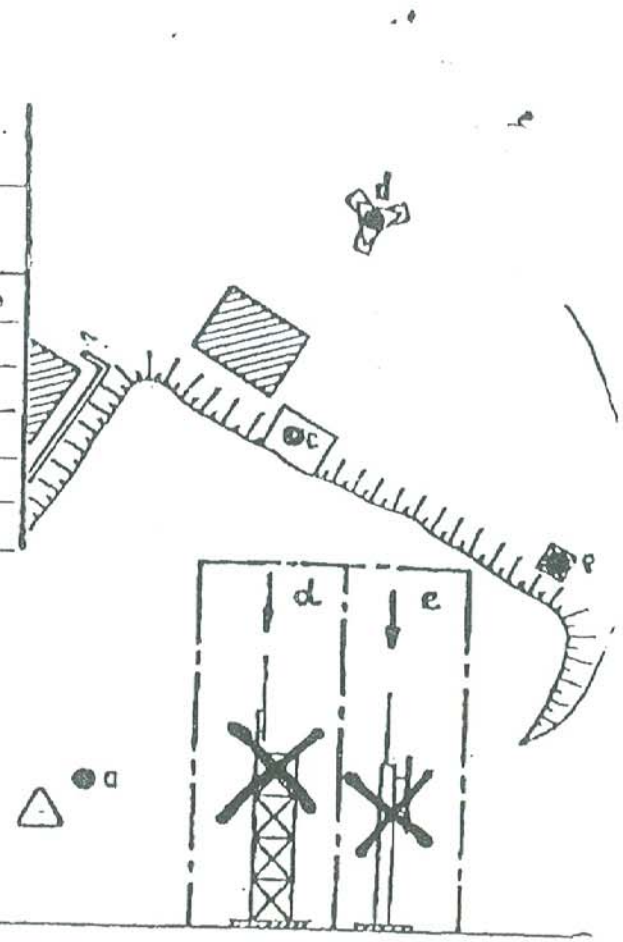
Accès: Véhicules 4/4.



Feuille au 50.000e : 17 - BAIE LEBRIS

Nom du point :	17 - 8 (B5)	Ordre : 1 (1953) Date : 05/83	
LONG :	LAT :		Zone
X: (.) 557 781,50	Y: 7 658 811,98	ALT: 419,08	
X: (a) 557 783,64	Y: 7 658 813,61	ALT: 419,37	
X: (c) 557 793,17	Y: 7 658 830,61	ALT: 417,65	
X: ~~(d) [illegible]~~	~~Y: [illegible]~~	~~ALT:~~	
X: ~~(e) [illegible]~~	~~Y: [illegible]~~	~~ALT:~~	

. BORNE en fonte cimentée
Repère en bronze g.m. scellé sur rocher
Repère en bronze g.m. scellé dans un massif de béton.
Pylône RFO : paratonnerre : axe au sommet
Antenne : paratonnerre : axe au sommet



[ac]cessible en voiture.

:-/a/Alti:mission IGN (1970) :IGN
:b/c/mission ST (1990) :ST (p. 222)
:d/e/CRT (1983) :CRT (manuel)
:b/détruit(ER:CT.13:02/83)

Feuille au 50.000e : 17-Baie Lebris

Nom du point : 17-11 Ordre : 3
Date : 1986

LONG :	LAT :		Zone
X : ( ) 560 533,80	Y : 7 656 874,62	ALT : 368,57	
X : (a) 560 532,64	Y : 7 656 875,38	ALT : 368,55	
X : (b) 560 562,16	Y : 7 656 954,81	ALT :	
X : (c) 560 528,78	Y : 7 656 869,71	ALT :	

./BORNE en fonte cimentée
a/Repère en bronze cimenté
b/Tas de pierres (point local)
c/Tas de pierres (point local)

Sur la R.T.3, 2 km au nord-ouest de BA, prendre la piste du Cap Bocage, fermée par une barrière, qui conduit au plateau. Continuer à pied en suivant une piste de prospection ravinée, puis se frayer un passage à travers la végétation pour atteindre le point en 15 minutes.

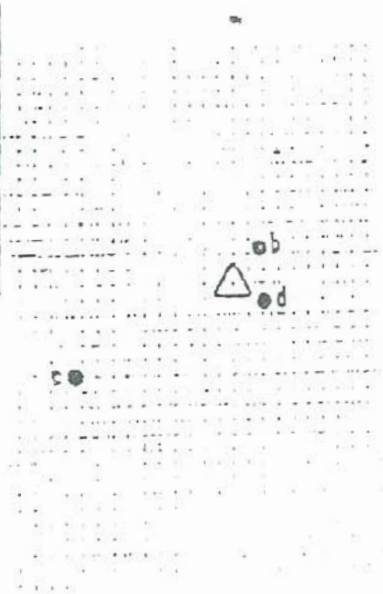
Feuille au 50.000e : 17-BAIE LEBRIS

Nom du point : 17-13 Ordre : 3 (1970)
Date : 1986

LONG :	LAT :		Zone
X (.) 561 850,52	Y : 7 656 494,26	ALT : 356,89	
X (b) 561 855,19	Y : 7 656 500,20	ALT : 356,72	
X (c) 561 824,23	Y : 7 656 479,00	ALT :	
X (d) 561 855,85	Y : 7 656 491,68	ALT :	

./BORNE en fonte cimentée
b/Repère bronze g.m. scellé sur rocher
c/Tas de pierres (point local)
d/Tas de pierres (point local)

Accessible en voiture.



Stations CAP BOCAGE: Septembre 2000

Ancien Surveyor

Nom	Concession	Zone	Y	X	Z	Nom	Topo	Type
1301	Aerolithe	B.piste	7657210.28	561190.35	325.79		JB	bois
15	Aerolithe	bas	7657459.84	561193.25	311.40	13 N	RS	jalon
31	Aerolithe	bas	7657433.84	561177.30	313.00	st31	JB	tube
24054	Aerolithe	bas	7657356.67	561211.29	310.01		JB	bois point
126	Aerolithe	haut	7657290.25	561072.92	335.60	st126	JB	tube
1409	Aerolithe	Haut	7657048.03	561116.11	369.35		JB	Jalon
1300	Aerolithe	Nord	7657439.91	561184.43	312.90	13Nexe	JB	tube
1000	Amoa	Est	7662095.57	555718.83	173.90	N°93	MOP	Tubejalon
7	AURORE	bas	7656973.69	562485.20	244.00	st AU 2	JB	tube
116	AURORE	bas	7657079.39	562390.45	247.40	st116	JB	fer
76	AURORE	haut	7656844.43	562275.19	294.70	st76	JB	fer
761	AURORE	Haut	7656824.32	562290.60	292.63	St761	JB	Tube
24032	BdM	conv lat	7661071.21	557464.72	5.83		JB	croix
2128	BdM	dragon	7661042.96	557516.94	12.74		JB	boisrouge
2	BdM	ducdn'be	7661236.79	557500.13	1.50	croix	JB	grave
4	BdM	PIE	7661199.31	557521.93	4.97	St4	JB	croix
8071	Bdm barrage	Bdmer	7660555.64	558317.33	9.67		JB	bois
8074	Bdm barrage	Bdmer	7660290.65	558528.68	8.58		JB	bois
25051	CAP BOCAGE	b13 Bd route	7656462.80	561732.29	324.70		JB	bois point
110	CAP BOCAGE	b13centre	7656341.67	561798.01	331.50	110	JB	ferauge
2032	CAP BOCAGE	B13haut	7656577.76	561608.02	337.77		JB	bois
6061	CAP BOCAGE	B56	7656205.51	562493.68	314.78		JB	bois
522	CAP BOCAGE	bal 13	7656619.40	561957.40	330.72		JB	bois
17131	CAP BOCAGE	bal 13	7656500.20	561855.19	356.72		IGN	douille
30032	CAP BOCAGE	bal 13	7656510.46	561637.88	323.30		JB	bois
26012	CAP BOCAGE	bal 13haut	7656615.84	561597.22	343.83		JB	boispoint
30092	CAP BOCAGE	bal 56	7656279.60	562443.90	310.52		JB	bois
30093	CAP BOCAGE	bal 56	7656164.29	562424.82	308.78		JB	bois
523	CAP BOCAGE	bal13 bas	7656496.53	561400.03	309.05		JB	bois
125	CAP BOCAGE	Bd Piste	7656999.87	561018.88	367.30	St 125	JB	Fer beton
29034	CAP BOCAGE	bd route	7656822.95	561443.40	351.14		JB	bois
242	CAP BOCAGE	Bdm	7661143.76	557359.36	3.75		JB	bois
29033	CAP BOCAGE	butte pist	7656775.22	561449.60	356.15	123	JB	bois
13	CAP BOCAGE	cb	7656494.26	561850.52	356.89	17-13	IGN	borne
95	CAP BOCAGE	CB A	7656179.73	562122.03	307.39	st95	JB	bois
129	CAP BOCAGE	CB A	7656376.58	562129.96	314.91		JB	bois
131	CAP BOCAGE	CB B	7656279.65	562238.36	320.40		JB	bois
20121	CAP BOCAGE	CBJ	7656655.50	561991.45	320.90		JB	boisrouge
961	CAP BOCAGE	cbc	7656157.41	562249.50	311.81	st961	JB	bois
14	CAP BOCAGE	Doline	7656976.09	561821.11	338.55	14N	JB	tube 1/2
1231	CAP BOCAGE	doline	7656831.36	561485.98	353.62		JB	tube1/2
133	CAP BOCAGE	Grille	7656059.54	561769.12	279.65		JB	bois
211	CAP BOCAGE	Grille	7656142.60	562294.84	307.44		JB	bois
606	CAP BOCAGE	Grille	7656163.26	561777.18	300.39		JB	Tube
27022	CHANA	bd route	7660779.07	557845.92	147.70		JB	tubejalon
111	Coqueue	bal 13	7656812.85	560467.11	351.20	St111	JB	tube 1/4
135	Coquette	Centre	7657133.34	560323.97	343.65		JB	tube
1111	Coquette	Dech ORO	7657389.03	560077.45	333.47		JB	cornier
134	Coquette	Ouest	7657946.77	559821.53	301.69		JB	tube
1711	Coquette		7656874.62	560533.80	368.57	36847	IGN	borne
99	KINOU	centre	7656393.71	562567.75	292.94	St99	JB	boispoint

Système Géodésique : IGN72
Ellipsoide International - Hayford 1909
Projection UTM Fuseau 58
N.G.N.C.

bois = Tube = Fer = Cornière =

APPENDIX 2

Multibeam Configuration, Calibration and Processing

Multibeam Configuration, Calibration and Processing

The system used is a Reson 8101 multibeam system with the following configuration of sensors:

Multibeam Echosounder: The 8101 multibeam system has 101 beams operating at a frequency of 240 kHz and has a swath width at 150 degrees of x 7.4 the water depth for depths 0-70 m. Depth capability of the system is limited to 300 m. The range resolution of the system is 5 cm. The transducer head can be installed on a vessel of opportunity as an over-the-side mount on a rigged pole and plate assembly. The acoustic centre, that is X, Y, Z of the subsurface unit, is used as the reference position for the survey.

Multibeam Bathymetry Collection System, the SeaBat 6042: Essentially a computer with 8 serial ports, this is a dedicated data-collection system that combines the data from the onboard sensors for vessel heave, roll, pitch, heading and position, time tagging them for post processing. The 6042 records the raw data in its own format with the file extension *.svy.* For post processing, raw data files can be exported in a number of different formats depending on the type of multibeam software used for editing the data.

Multibeam Side Scan: From the multibeam data, sidescan imagery can be recorded and is available in an XTF format. This removes the need for a separate piece of equipment, which is usually towed behind the vessel.

Navigation system: This is required to provide real-time information to the vessel helmsman for navigating along the planned track lines of the survey. This is accomplished using Hypack Hydrographic software. With HYPACK TM, of the NMEA output from the mobile GPS receiver is translated into a graphical plot of the vessel movements.

Heading Sensor: A heading sensor is required to measure the orientation of the vessel. The system used is a Scan 2000 gyrocompass. This provides heading data to 0.01 of a degree which are logged by the SeaBat 6042. The heading is output from the 6042 to the motion sensor. The gyro sensor on installation is aligned with the centre line of the survey vessel.

Motion Sensor: This is essential to correct the swath data for vessel movement, namely heave, pitch and roll. The unit used is a VRU1 0 motion reference unit. The sensor, once installed, requires that the offsets of its reference frame of origin are measured with respect to the survey origin, in this case, the acoustic centre of the multibeam system, and inserted in the 6042 program set-up system offsets.

Water Velocity Profiler: Sound velocity measurements in the water column are required to correct for beam refraction as the sound passes through the water column. Sound velocity profiles in the survey area are measured using a Seabird CTD, computed for every 0.5 m and applied during the processing and editing phase. During data collection a constant velocity of 1540 msec-1 was set in the Sea Bat processor

Multibeam Bathymetry Data Editor: multibeam data, once collected, require editing and cleaning before presentation of data can be considered. This is accomplished using HYSWEEP software from Coastal Oceanographics Inc.

Tidal reductions: All bathymetric data acquired during the survey are reduced to chart datum based on tidal corrections provided by the Nautical Almanac for Vuda Point. These corrections are applied during the editing and cleaning of the data.

Multibeam Data Presentation software: Commercially available software that accepts X, Y, Z points can be used. Once the datasets have been cleaned and reduced, presentation of the data can be accomplished in software package is such as AutoCAD using QuickSURF, MaplNFO using Vertical Mapper, or Surfer for that matter.

Patch Test Calibration

The patch test is a multibeam calibration procedure that is completed after installation and set-up to calculate sonar roll, pitch, and yaw and GPS latency errors in the multibeam data. Data for the patch test are collected over specific bottom terrain in a specific order. The roll angle test is done in an area where the bottom terrain is smooth and flat, running the same line in different directions at survey speed. Latency test follows, running a line twice in the same direction up a slope once at survey speed and once as slowly as possible. The pitch test is done running reciprocal lines with a slope at normal survey speed. Lastly, the yaw test is done by running offset lines in the same direction, approximately 2 to 4 times water depth apart. The roll test is by far the most important, because it is misalignment in the roll direction that leads to the greatest survey errors.

The data collected for the patch test are converted from the Reson 6042 *.svy* file format to a *.hyp* format used in the HYSWEEP patch-test program. Having completed the processing for the patch test, the computed angles and latency times are then configured in the set-up system offsets for the multibeam data-collection system. An interesting and important feature of the 6042 is that multibeam data can be collected immediately, or prior to running the patch test, as the raw survey data can be reprocessed and exported in a different format, leaving the raw data unchanged.

Multibeam data processing

Patch Test calibration

Processing the patch files the following files were used in the final analysis.

Patch test	Files	Results
ROLL	Roll000	+0.5 degrees
	Roll001	
LATENCY	Roll003	-0.2 second
	LAT001	
PITCH	Roll002	+1.0 degrees
	Roll003	
YAW	Roll002	+4.0 degrees
	Roll000	

Results of the patch test used for reprocessing the data using the Win6042 program are shown in the above table.

Multibeam data files

A log of all the files for the multi beam data is provided in Appendix 4. The original data files have the file extension *.**svy** and are archived on CD ROM. For processing, the raw Mon* .svy files will be reprocessed with the 6042 program using the patch-test parameters and output as Mon*.hyp files. This file format is then imported into HYSWEEP, the multibeam editing software. The *.hyp files will also be archived on CD-ROM.

Once the processed *.hyp files have been generated, editing and cleaning of the multibeam data was completed, using HYSWEEP. Each file is first imported into the sweep editor along with a tidal correction file and sound velocity file. Tidal and soundvelocity-profile correction files have been archived along with the .swp files in a directory called \datum. The graphical representation of all collected data, position, heave, heading and soundings, makes it easier to separate good points from bad.

Once satisfied with the graphs, the Sweep Editor will convert the raw survey data into X, Y, Z depth points and redisplay them, again in a graphical format. In multibeam surveys, data spikes in the dataset occur due to fish, bubbles, hull turbulence, etc. The application of an automatic filter removes the spikes quickly but is best for flat bottom topography.

Sounding reductions

Multibeam surveys produce a lot more data than are actually required, particularly for presentation. Sounding reductions of a multibeam data set are done using the Mapped program in HYSWEEP. This program will load an entire survey and reduce the data to the desired density. This data reduction is accomplished through gridding. A grid is created from a matrix with rectangular cells of any size; the soundings are loaded and reduced to one per cell.

APPENDIX 3

Survey Log

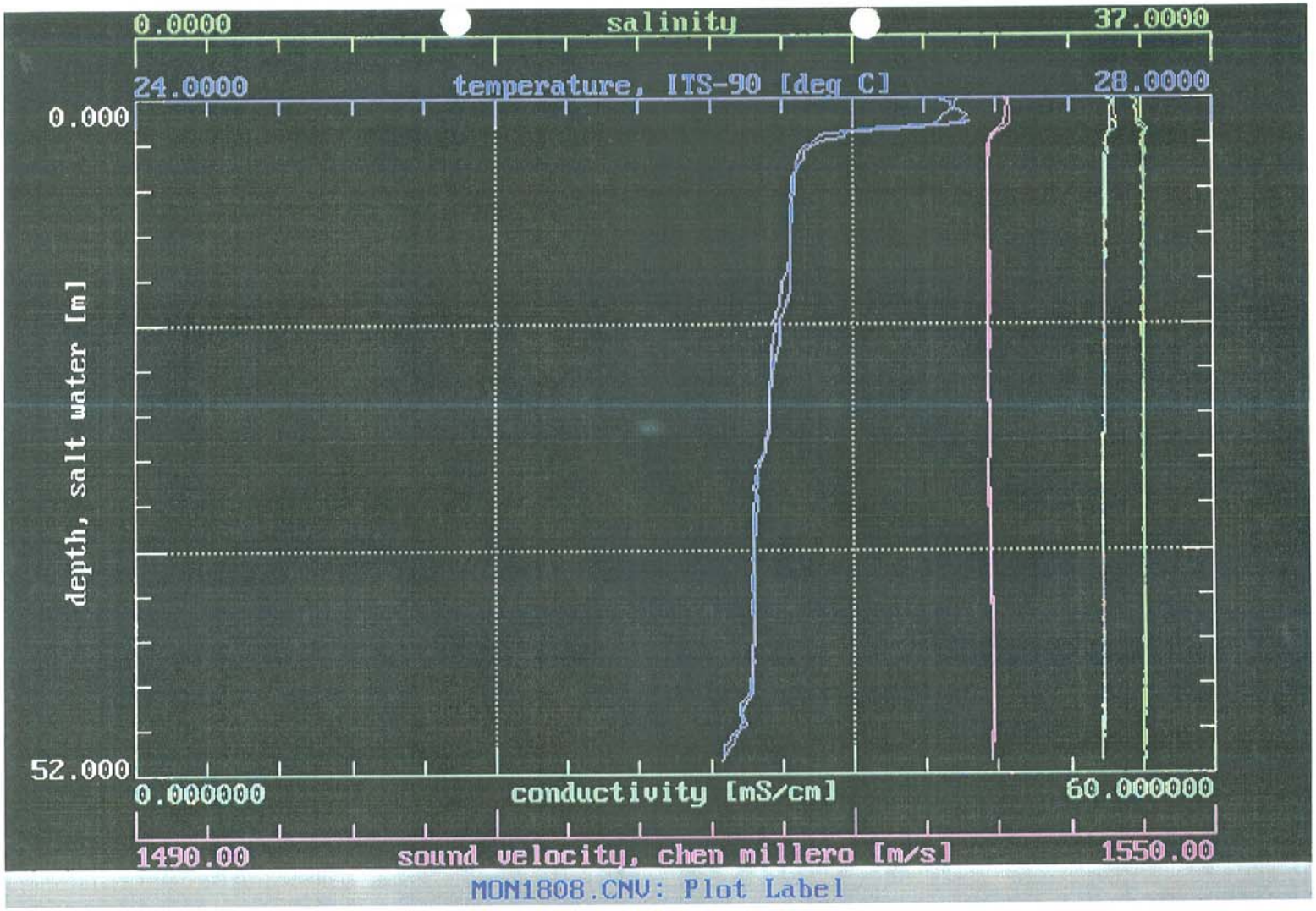
Moneo - multibeam survey											
Date	01-12-000										
6042-file	Line -Az	Heading	Speed	Log-on	Log-off	SOL#	EOL#	Line#	Hy-Inw-file	Hy-log-file	Comments
Mon000	236	240	6	16:46	16:49	241	249	3	roll-yaw	003_1646.raw	Patch test files
Rol000	236	64	6	16:53	16:58	250	260	3	roll-yaw	003_1653.raw	Patch test files
Rol001	236	236	6	17:01	17:05	261	269	4	roll-yaw	004_1701.raw	Patch test files
Rol002	236	64	6	17:09	17:14	270	280	4	roll-yaw	004_1709.raw	Patch test files
Rol003	236	230	6	17:16	17:21	281	289	5	roll-yaw	005_1716.raw	Patch test files
Rol004	236	64	6	17:24	17:28	290	300	5	roll-yaw	005_1724.raw	Patch test files
Date	02-12-000										
Measure dry height pole =0.81cm Draft=1.86m											
CTD profile M-1- at start of line 6 in pipe-route.lnw 30m											
Mom001	46.9	46	6	8:01	9:13	1	142	6	pipe-route	006_0801.raw	line based on pipe alignment
Mon002	na	338	5.3	9:16	9:53	143	218	na	forereef	011_0916.raw	following line llol inside line11
Mon003	142	116	5	9:56	10:40	219	311	9	forereef	009_0956.raw	heading into large swell
Mon004	145	160	5	10:46	11:08	317	362	9	forereef	009_1046.raw	with swell
Mon005	144	328	5.3	11:09	12:16	363	495	8	forereef	008_1109.raw	at sol deep
Mon006	142	140	5.3	12:21	13:03	496	577	7	forereef	007_1221.raw	at sol deep
Mon007	324	340	5.5	13:04	13:38	578	646	10	forereef	010_1304.raw	some target at sp 582
Mon008	na	na	5	13:39	14:01	647	693	1	pipe-zone	001_1339.raw	thru passage to line 1- dangerous reefs
Mon009	na	na	5	14:02	na	694	696	na	na	001_1402.raw	transit to passage to pickup line 11 forereef
Mon010	130	316	5	14:11	na	697	767	11	forereef	011_1404.raw	following line llel reef as best as possible wrt to line11
CTD cast for deep water corrections 300m at 14:45pm											
Mon011	136	123	5	15:18	16:06	768	802	3	pipe-zone	003_15.18raw	lines start in passage then onto sol of 3 sp852 patches
Date	03-12-000										
Measure dry height pole =0.84cm Draft=1.83m											
Mon012	46.9	45	6	7:34	8:45	863	997	7	pipe-route	007_0734.raw	
Pich000	49	233	6	8:47	8:51	998	1006	3	Lat-pich	003_0847.raw	pitch line
Pich001	49	49	6	8:54	8:58	1007	1016	3	Lat-pich	003_854.raw	pitch line
Lat000	49	233	3	9:02	9:08	1017	1030	3	Lat-pich	003_0902.raw	latency line
Lat001	49	49	3	9:11	9:18	1031	1046	3	Lat-pich	003_0911.raw	latency line
Mon013	129	131	6	9:33	9:53	1047	1086	1	pass-exu	001_0933.raw	into swell
Mon014	309	318	6.4	9:54	10:18	1087	1131	2	pass-exu	002_0954.5aw	with swell
Mon015	129	128	6.4	10:17	10:37	1132	1172	3	pass-exu	003_1017.raw	into swell
Mon016	309	313	6.4	10:38	11:00	1173	1214	4	pass-exu	004_1038.raw	with swell
Mon017	129	132	6.4	11:02	11:22	1215	1254	5	pass-exu	005_1102.raw	as close as we dare to reef edge many patches
Mon018	309	308	6.4	11:24	11:38	1255	1283	6	pass-exu	006_1124.raw	very shallow atsol of 6 reef to port
Mon019	129	124	6.4	11:40	11:52	1284	1307	7	pass-exu	007_1140.raw	end line at poit of reef walu caught
Mon020	309	320	6.4	11:53	12:03	1308	1329	8	pass-exu	008_1153.raw	

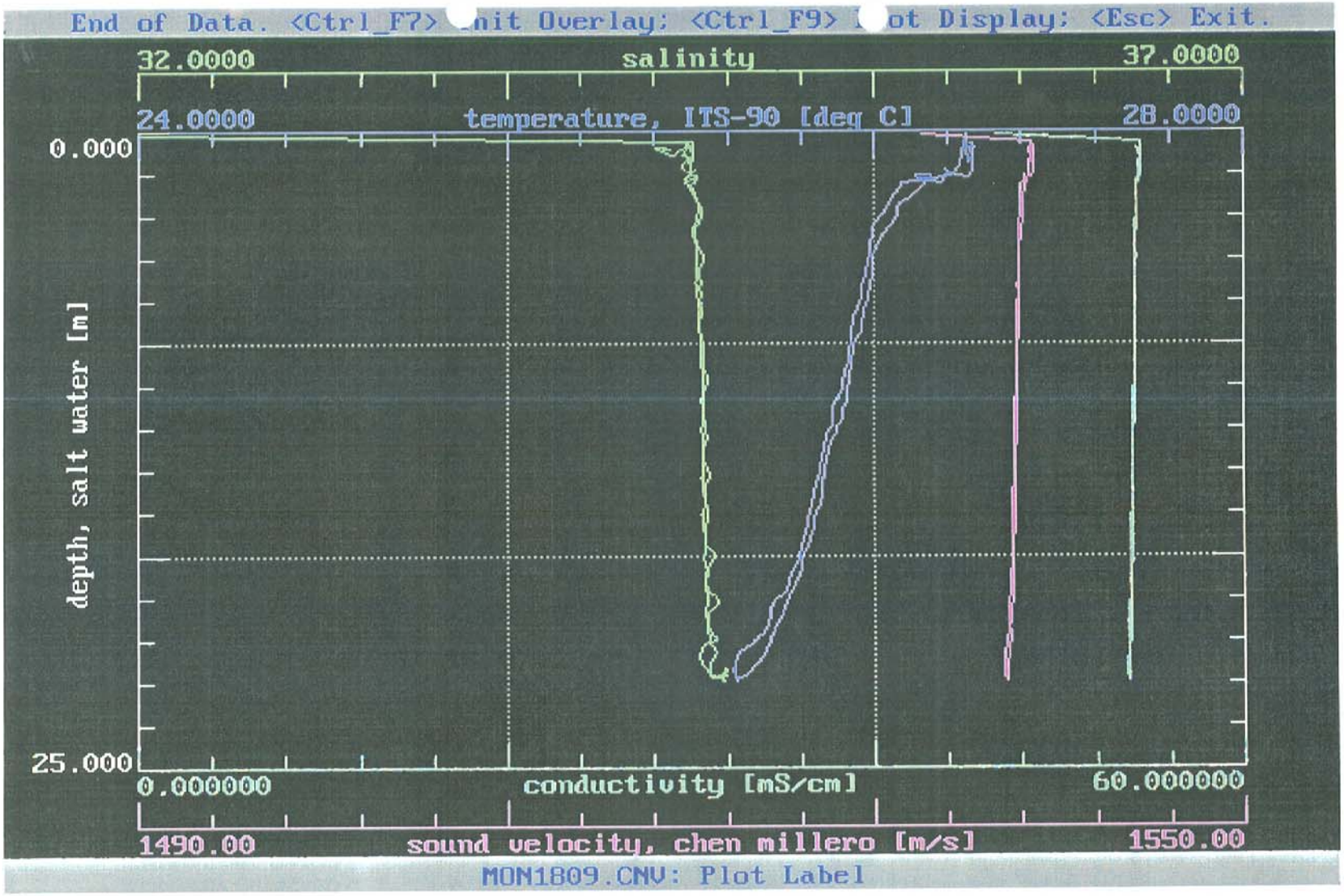
Mon021	129	134	6.4	12:05	12:15	1330	1350	9	pass-exu	009_1205.raw	swell building up
Mon022	309	308	6.4	12:16	12:25	1351	1370	10	pass-exu	010_1216.raw	sol was at tip of reef
Mon023	129	128	6.4	12:26	12:34	1352		11	pass-exu	011_1225.raw	eol at end of reef
Mon024	311	301	6.4	12:42	12:47	1389	1398	4	pass-infill	004_1242.raw	infill lines for the nw part of pass-de-exupere
Mon025	131	134	6.4	12:47	12:52	1399	1408	5	pass-infill	005_1247.raw	infill lines for the nw part of pass-de-exupere
Mon026	311	312	6.4	12:52	12:57	1409	1417	6	pass-infill	006_1252.raw	infill lines for the nw part of pass-de-exupere
Mon027	131	130	6.4	12:57	13:01	1418	1427	7	pass-infill	007.1257.raw	infill lines for the nw part of pass-de-exupere
Mon028	311	312	6.4	13:02	13:06	1428	1437	8	pass-infill	008_1302.raw	infill lines for the nw part of pass-de-exupere
Mon029	131	132	6.4	13:08	13:13	1438	1447	11	pass-infill	011_1308.raw	infill lines for the nw part of pass-de-exupere
Mon030	311	314	6.4	13:13	13:18	1448	1458	10	pass-infill	010_1313.raw	infill lines for the nw part of pass-de-exupere
Mon031	131	131	6.4	13:19	13:23	1459	1468	9	pass-infill	009_1319.raw	infill lines for the nw part of pass-de-exupere
Mon032	transit line to 4 of pipe zone sol 1469-eol 1476									004_1324.raw	
Mon033	316	318	6.4	13:28	13:45	1477	1513	4	pipe-zone	004_1328.raw	
Mon034	136	140	6.4	13:46	14:03	1514	1547	5	pipe-zone	005_1346.raw	
Mon035	316	322	6.4	14:04	14:21	1548	1581	6	pipe-zone	006_1404.raw	
Mon036	136	134	6.4	14:23	14:38	1582	1612	7	pipe-zone	007_1423.raw	
Mon037	316	318	6.4	14:39	14:56	1613	1646	8	pipe-zone	008_1439.raw	
Mon038	136	138	6.4	14:57	15:31	1647	1678	9	pipe-zone	009_1457.raw	
Mon039	316	316	6.4	15:14	15:30	1679	1712	10	pipe-zone	010_1514.raw	
Mon040	136	136	6.4	15:31	15:47	1713	1745	11	pipe-zone	011_1531.raw	
Mon041	316	318	6.4	15:48	16:04	1746	1778	12	pipe-zone	012_1548.raw	
Mon042	136	136	6.4	16:05	16:21	1779	1811	13	pipe-zone	013_1605.raw	
Mon043	316	315	6.4	16:22	16:38	1812	1844	14	pipe-zone	014_1622.raw	
Mon044	136	136	6.4	16:40	16:56	1845	1877	15	pipe-zone	015_1640.raw	
Mon045	316	316	6.4	16:57	17:03	1878	1889	16	pipe-zone	016_1657.raw	
CTD cast at m-3 at eol 16. Noteat intersection olpipe alinment dxf and line 16 . Cast 17:05. Saved in target file for 03-12-00											
Mon046	226	226	6.4	17:10	1800		1984	6	pipe-route	006_1710.raw	hummocky seabed around sp1909 this course more roll
Date	**4/12/00**										
Measured draft -dry height 0.87m draft =1.80cm.											
Mon047	136	147	6.2	7:14	7:26	1985	2010	80	pipe-zone	080_0714.raw	reef edge difficult to see very calm-but seen in stbd beams
Mono48	316	319	6.2	7:27	7:40	2011	2036	79	pipe-zone	079_0727.raw	
Mon049	136	140	6.3	7:41	7:54	2037	2063	78	pipe-zone	078_0741.raw	
Mon050	316	314	6.5	7:55	8:08	2064	2090	77	pipe-zone	077_0755.raw	beamsea occasional roll
Mon051	136	135	6.3	8:10	8:23	2091	2118	76	pipe-zone	076_0810.raw	sp1200 interesting "V"feature in sscn
Mono52	316	311	6.6	8:25	8:38	2119	2145	75	pipe-zone	075_0825.raw	lineation sp2133-2136-anchor scars
Mon053	136	138	6.3	8:39	8:54	2146	2175	74	pipe-zone	074_0839.raw	
Mono54	316	312	6.4	8:55	9:09	2176	2203	73	pipe-zone	073_0855.raw	
Mon055	136	136	6.4	9:10	9:25	2204	2233	72	pipe-zone	072_910.raw	
Mono56	316	316	6.6	9:26	9:40	2234	2262	71	pipe-zone	071_0926.raw	lineation sp2133-2136-anchor scars
Mon057	136	136	6	9:42	9:58	2263	2295	70	pipe-zone	071_0942.raw	
Mono58	316	318	6	9:59	10:14	2296	2326	69	pipe-zone	069_0959.raw	
Mon059	136	130	6	10:16	10:33	2327	2362	68	pipe-zone	068_1015.raw	
Mon060	316	314	6.4	10:34	10:50	2363	2394	67	pipe-zone	067_10.34.raw	
Mon061	136	136	6.4	10:51	11:08	2395	2428	66	pipe-zone	066_1051.raw	sscn off save memory space
Mon62	316	316	6.4	11:09	11:25	2429	2459	65	pipe-zone	065_1109.raw	

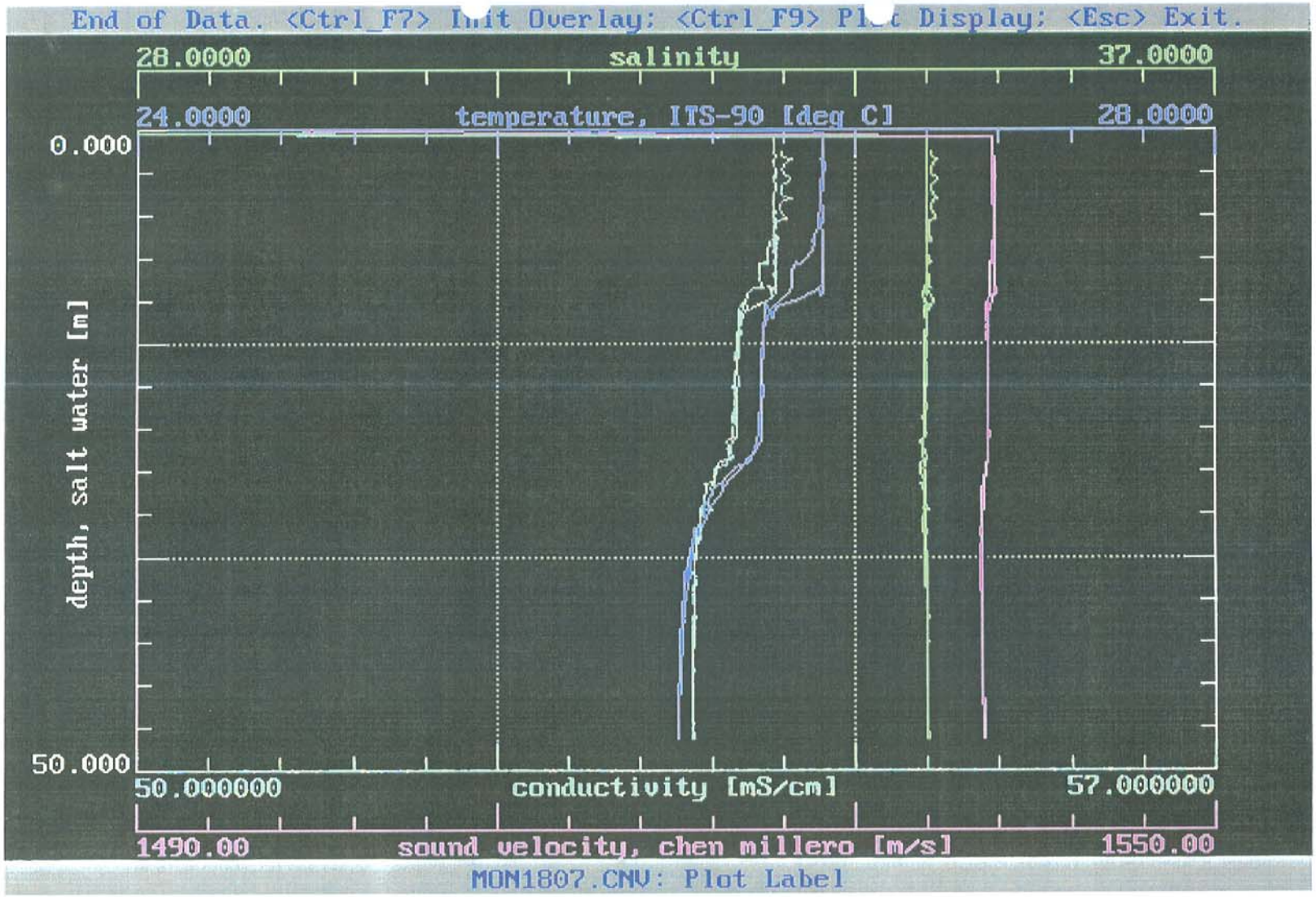
Mon063	136	136	6.8	11:27	11:45	2460	2495	64	pipe-zone	064_1127.raw	more rock and roll windup
Mon64	316	316	6.4	11:46	12:01	2496	2525	63	pipe-zone	063_1146.raw	wind up 15+
Mon65	136	136	5.6	12:02	12:19	2526	2559	62	pipe-zone	062_1202.raw	sol behind reef Ilot Agut
Mon66	316	316	6.4	12:20	12:34	2560	2586	61	pipe-zone	061_1220.raw	
Mon067	136	136	5.6	12:34	12:49	2587	2616	60	pipe-zone	060_1234.raw	Now bouncy wind and sea up
Mon068	316	316	6.3	12:50	13:03	2617	2643	59	pipe-zone	059_1250.raw	
Mon069	136	136	5.13	13:04	13:18	2644	2671	58	pipe-zone	058_1304.raw	
Mon070	316	316	6.4	13:19	13:33	2672	2699	57	pipe-zone	057_1319.raw	
Mon071	136	134	5.9	13:33	13:48	2700	2729	56	pipe-zone	056_1333.raw	
Mon072	316	316	6.1	14:20	14:32	2791	2807	53	pipe-zone	053_1420.raw	
Mon073	136	136	6.1	14:33	na	2808	2833	54	pipe-zone	054_1433.raw	
Mon074	316	316	5.8	14:47	na	2834	2853	52	pipe-zone	052 1447.raw	
Mon075	46	47	6.1	15:00	15:31	2854	2917	2	pipe-route	002_1459.raw	heading into big sea -on quarter
Mon076	226	228	6	15:32	16:01	2918	2974	3	pipe-route	003_1532.raw	fish noise in records - coral heads 2936 - 2937
Mon077	46	40	6	16:02	16:35	2975	3041	4	pipe-route	004_1602.raw	fish at northeast end of these lines patches 3062-3064
Mon078	226	226		16:36	17:06	3042	3102	5	pipe-route	005_1636.raw	
CTD cast moneo7.hex											
Mon079	46	40	6	17:22	17:57	3103	3172	8	pipe-route	008_1722.raw	
Mon080	226	226	6.5	17:58	18:29	3173	3233	9	pipe-route	009_1758.raw	
Date 05/12/2000											
Measured draft dry height pole=0.9m Draft 1.77m											
Mon081	136	140	6.5	7:27	7:39	3234			pipe-zone	081_0727.raw	marked bouy-sscn
mon082	46	42	6.5	7:43	8:35	3260	3259	81	pipe-route	011_0743.raw	sscn off
mon083	227	221	6.4	8:37	9:12	3366	3365	11	pipe-route	010_0836.raw	
mon084	316	319	6.2	9:21	9:40	3438	3437	10	pipe-route	055_0921.raw	
mon085	46	44	6.4	9:47	10:16	3475	3474	55	pipe-route	001_0947.raw	sscn over ridge
mon086	na	na	6	11:14	11:28		3560	1	na	002_1114.raw	lost diff -hill in way close to shore -fill inline wharf and mouth of Baie de Ugue
cast 10:38 moneo8.hex											
cast 111:27 moneo9.hex-near wharf											

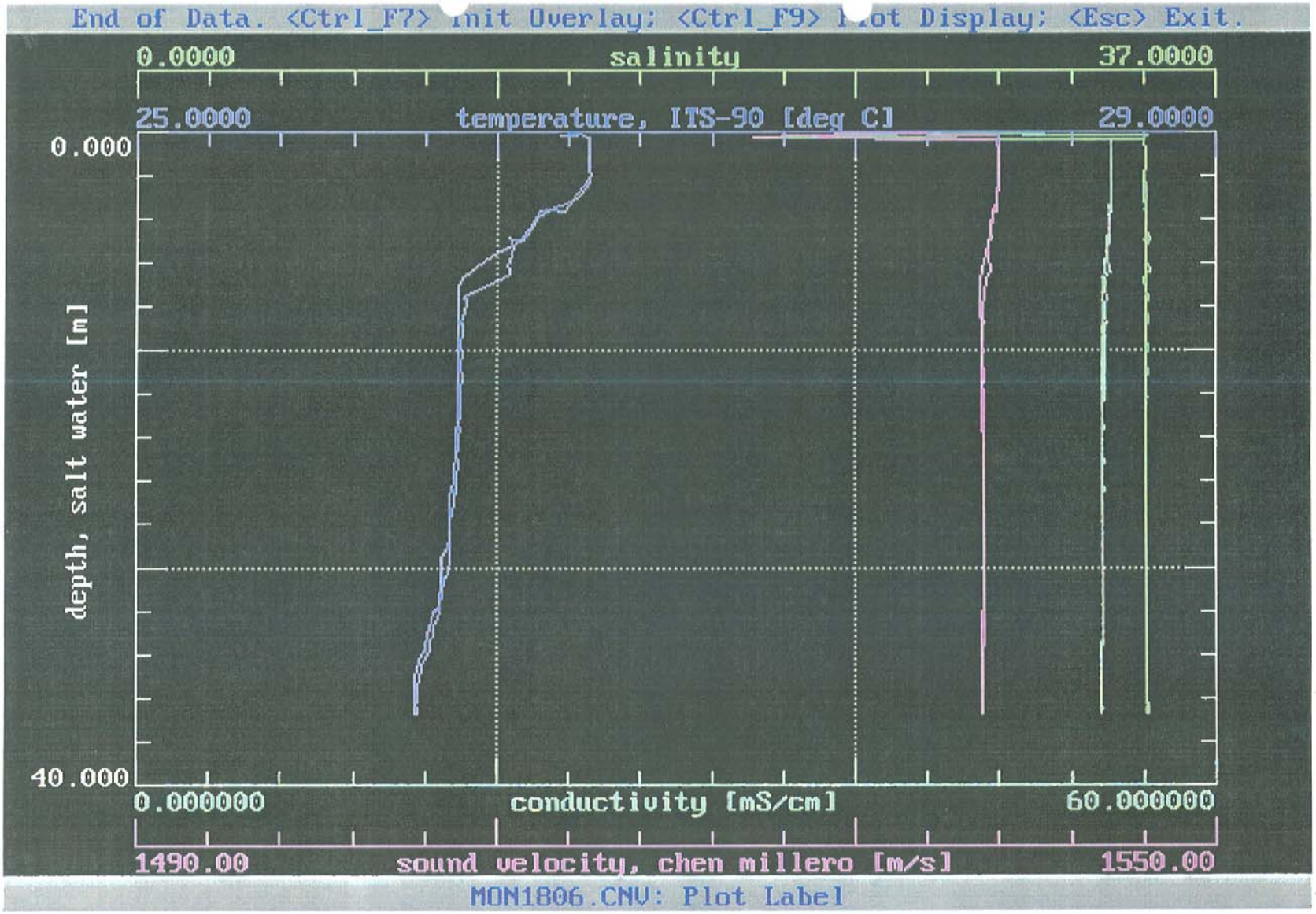
APPENDIX 4

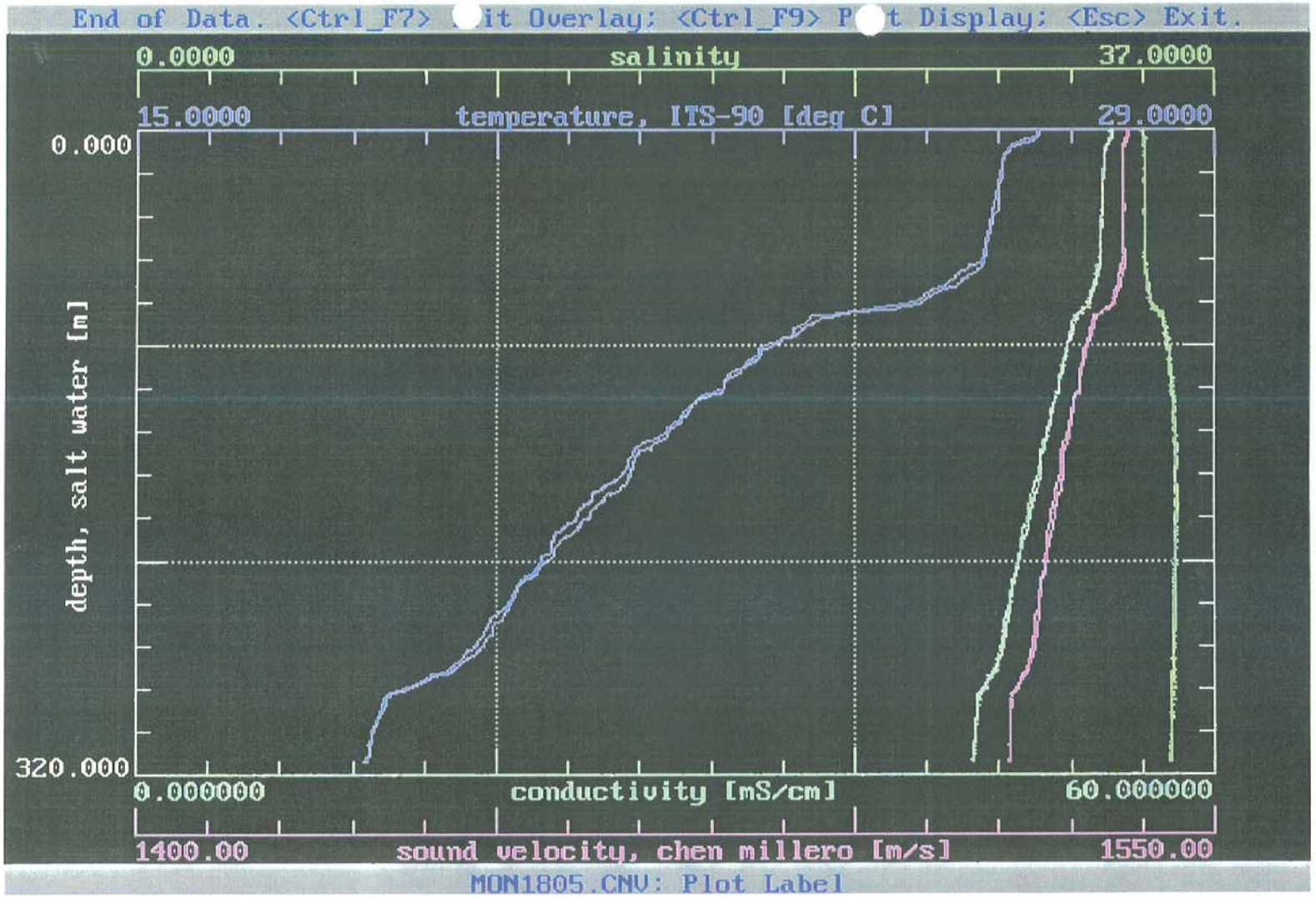
CTD Profiles

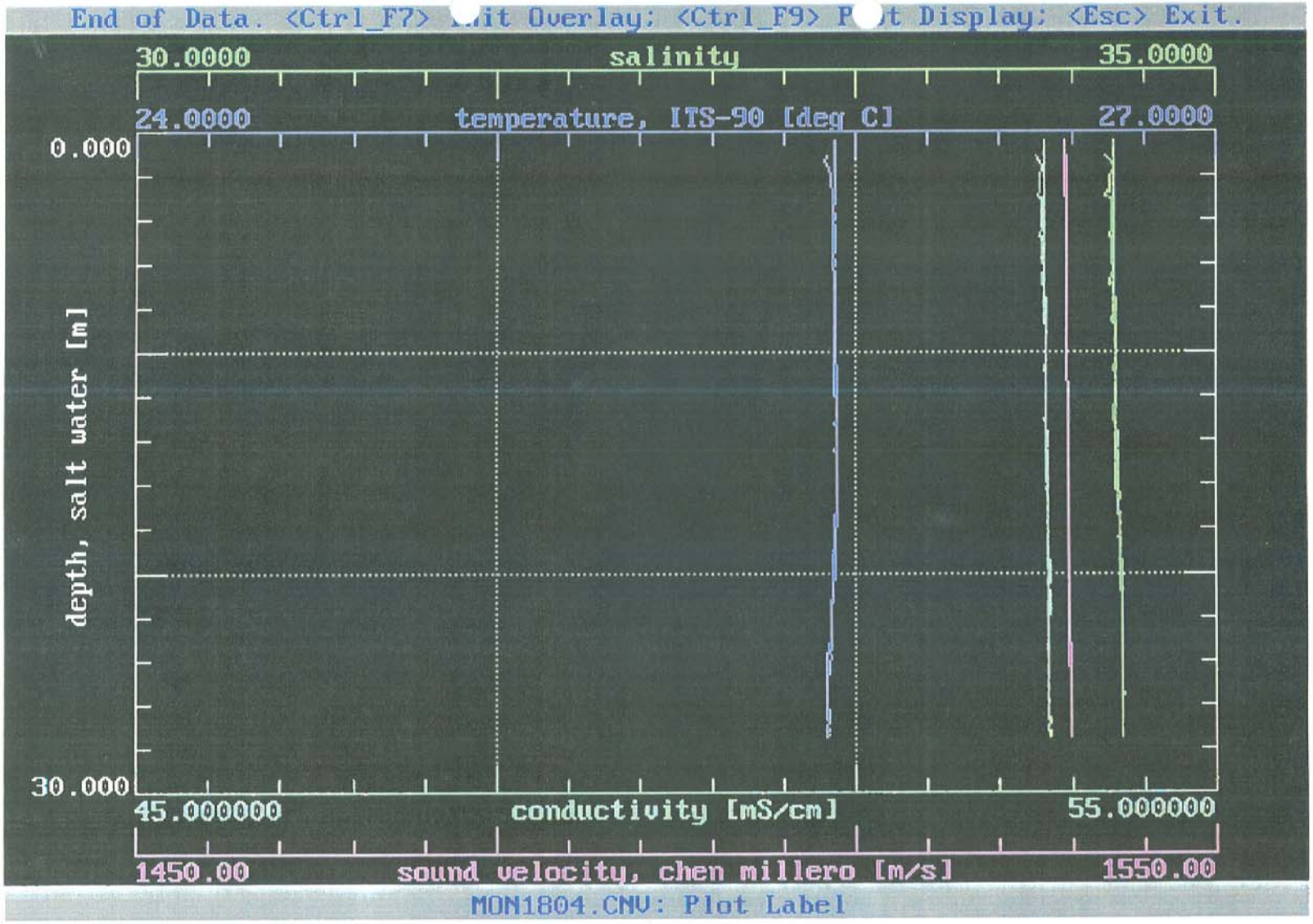

0.0000
salinity
37.0000
24.0000
temperature, ITS-90 [deg C]
28.0000
0.000
depth, salt water [m]
52.000
0.000000
conductivity [mS/cm]
60.000000
1490.00
sound velocity, chen millero [m/s]
1550.00
MON1808.CNV: Plot Label

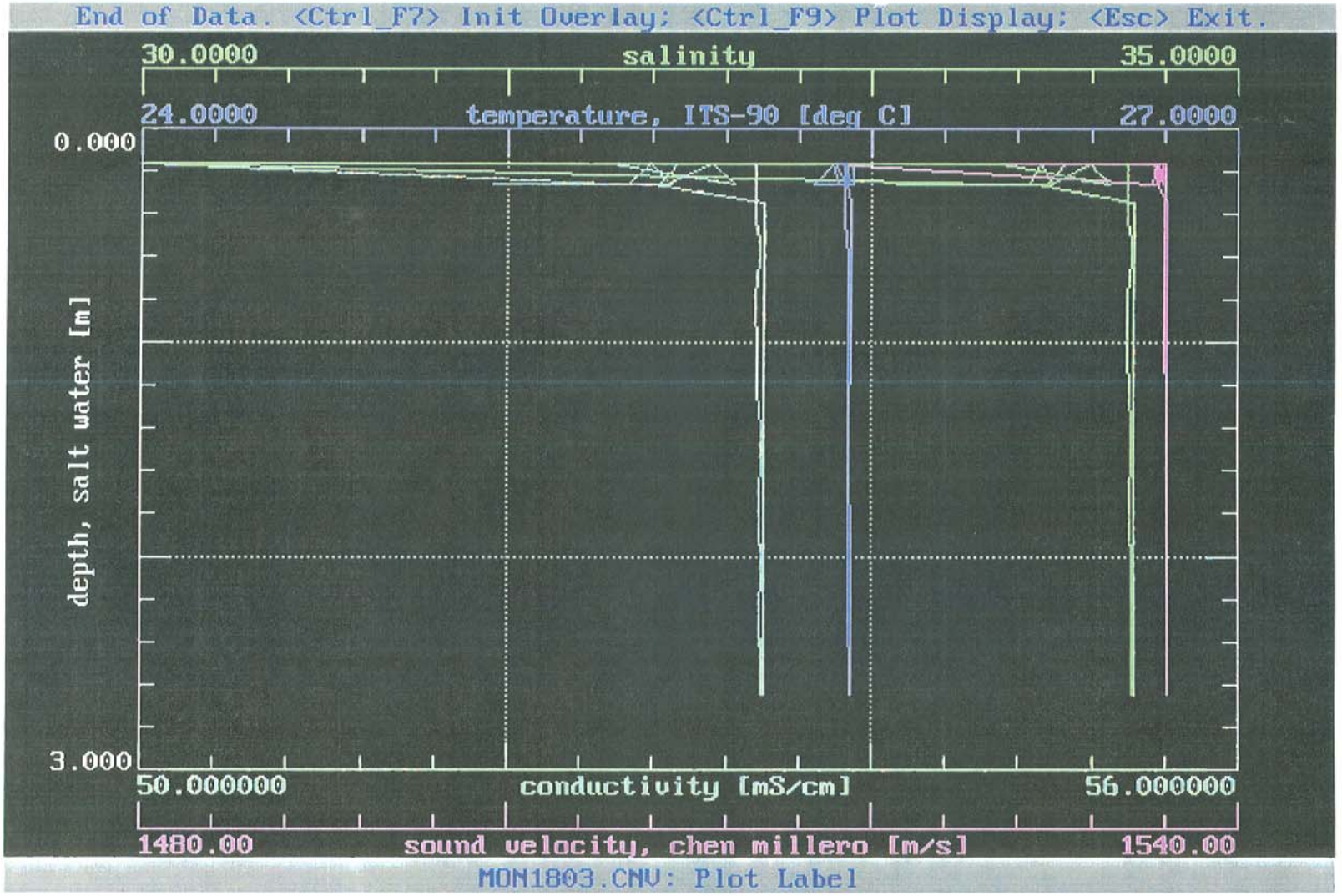

End of Data. <Ctrl_F7> nit Overlay: <Ctrl_F9> ot Display: <Esc> Exit.
32.0000
salinity
37.0000
24.0000
temperature, ITS-90 [deg C]
28.0000
0.000
depth, salt water [m]
25.000
0.000000
conductivity [mS/cm]
60.000000
1490.00
sound velocity, chen millero [m/s]
1550.00
MON1809.CNV: Plot Label


End of Data. <Ctrl_F7> Init Overlay: <Ctrl_F9> Plot Display: <Esc> Exit.
28.0000
salinity
37.0000
24.0000
temperature, ITS-90 [deg C]
28.0000
0.000
depth, salt water [m]
50.000
50.000000
conductivity [mS/cm]
57.000000
1490.00
sound velocity, chen millero [m/s]
1550.00
MON1807.CNV: Plot Label


End of Data. <Ctrl_F7> Init Overlay; <Ctrl_F9> Plot Display; <Esc> Exit.
0.0000
salinity
37.0000
25.0000
temperature, ITS-90 [deg C]
29.0000
0.000
depth, salt water [m]
40.000
0.000000
conductivity [mS/cm]
60.000000
1490.00
sound velocity, chen millero [m/s]
1550.00
MON1806.CNV: Plot Label


End of Data. <Ctrl_F7> it Overlay: <Ctrl_F9> P t Display: <Esc> Exit.
0.0000
salinity
37.0000
15.0000
temperature, ITS-90 [deg C]
29.0000
0.000
depth, salt water [m]
320.000
0.000000
conductivity [mS/cm]
60.000000
1400.00
sound velocity, chen millero [m/s]
1550.00
MON1805.CNV: Plot Label


End of Data. <Ctrl_F7> Exit Overlay; <Ctrl_F9> Plot Display; <Esc> Exit.
30.0000
salinity
35.0000
24.0000
temperature, ITS-90 [deg C]
27.0000
0.000
depth, salt water [m]
30.000
45.000000
conductivity [mS/cm]
55.000000
1450.00
sound velocity, chen millero [m/s]
1550.00
MON1804.CNV: Plot Label


End of Data. <Ctrl_F7> Init Overlay; <Ctrl_F9> Plot Display; <Esc> Exit.
30.0000
salinity
35.0000
24.0000
temperature, ITS-90 [deg C]
27.0000
0.000
depth, salt water [m]
3.000
50.000000
conductivity [mS/cm]
56.000000
1480.00
sound velocity, chen millero [m/s]
1540.00
MON1803.CNV: Plot Label

APPENDIX 5

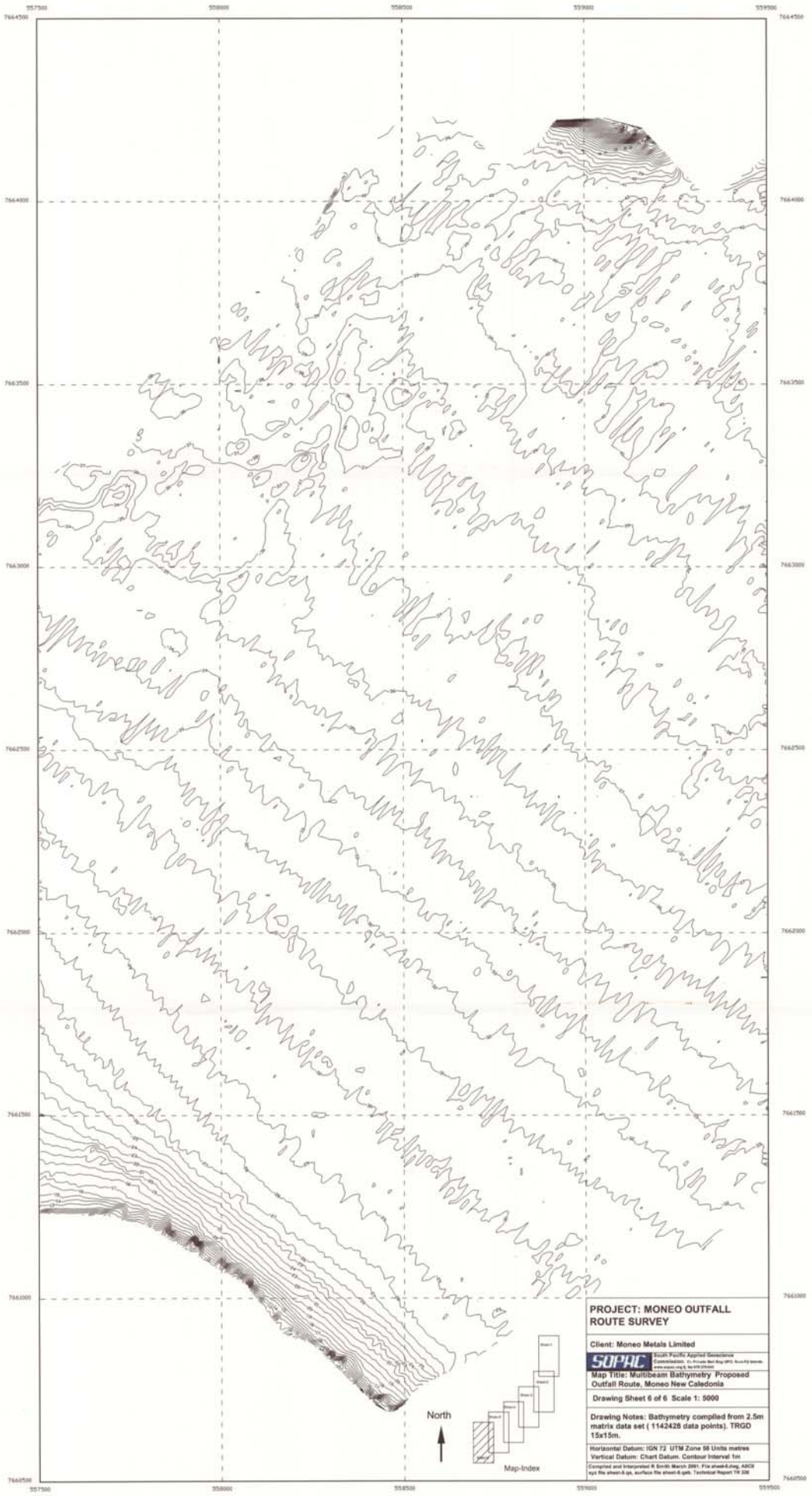
Bathymetric Map Sheets 1 through 6 (in pocket)

APPENDIX 6

CD-Rom Data Files

Table of CD-Rom Contents

File-name	File extension	Notes
Sheet-6 to Sheet-1	*.Dwg* – drawing files R14 AutoCAD	Contour maps of multibeam data
Sheet-6 to Sheet-1	*.xyz – ASCII xyz file*	Data points 2.0-m matrix
Sheet-6 to Sheet-1	*.qsb* Quicksurf surface files	Computed surface files used with Quicksurf
2795.con	.con	Configuration file for SBE19
Mon1804 to Mon1809	.cnv	ASCII text files for CTD data
Mon1804 to Mon1809	.hex	Hex file raw data SBE19
Moneo-tides	.xls	Excel spreadsheet of tide data
Moneo.dfso	dfso	Mike 21 file – time series tides
Poro.dfso	.dfso	Predicted tides Mike 21 time series
Moneo-tides.dfso	dfso	Predicted & Measured tides
Moneo-tides.doc	.doc	Word doc on tide workings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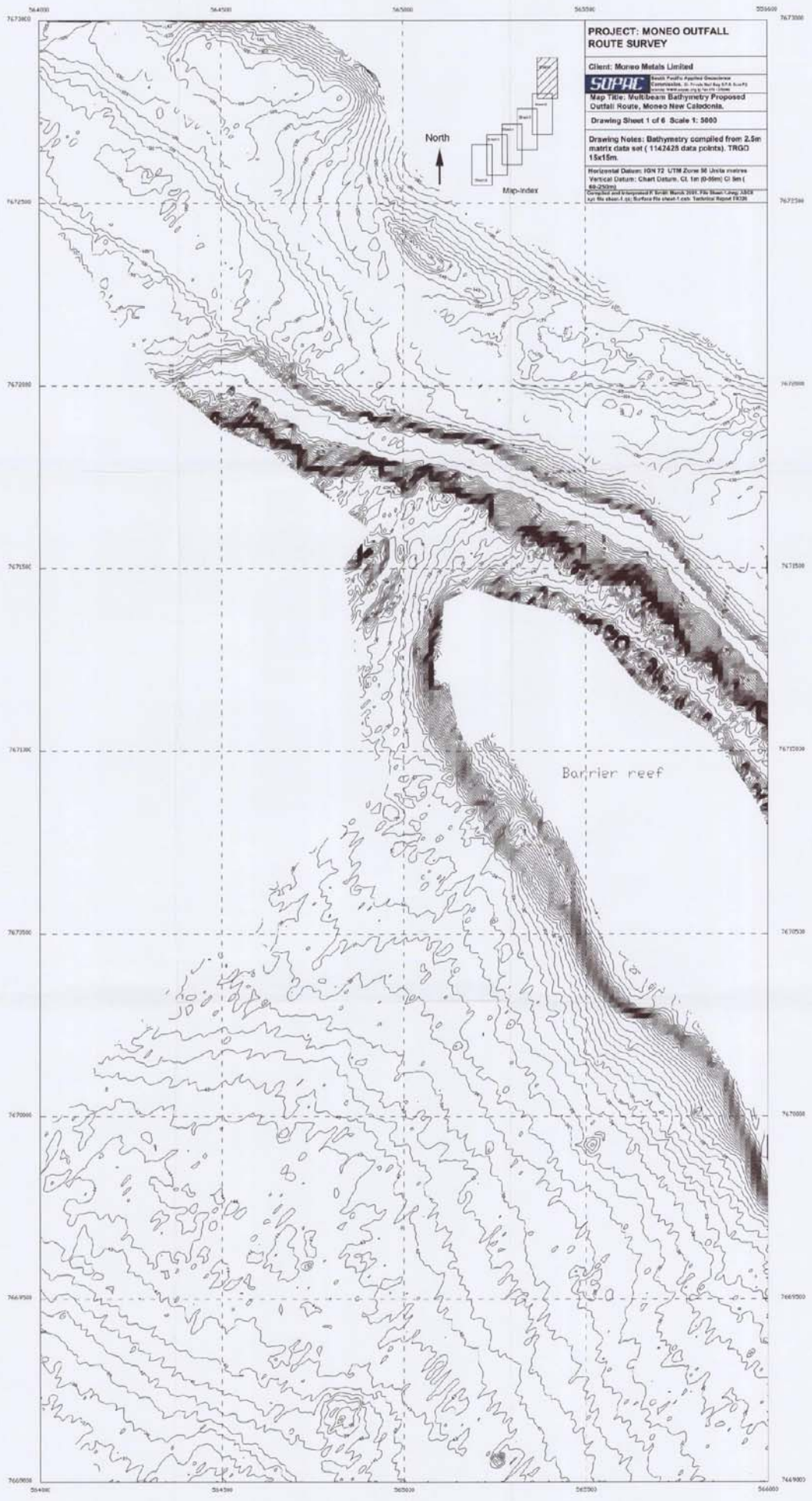
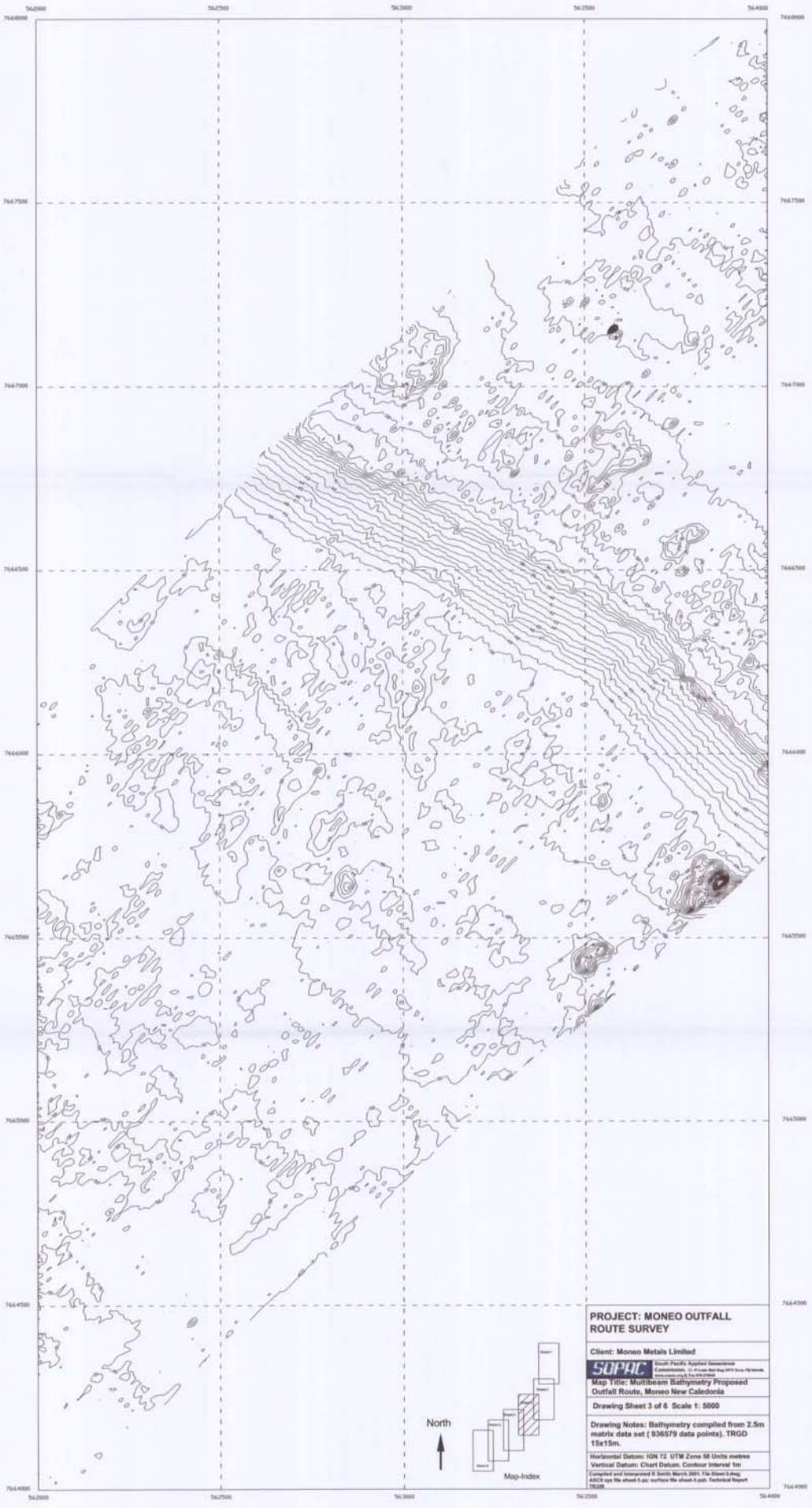
558500
559000
559500
7664500
7664000
7663500
7663000
7662500
7662000
7661500
7661000
7660500
North
Map-Index
PROJECT: MONEO OUTFALL ROUTE SURVEY
Client: Moneo Metals Limited
SOPAC
South Pacific Applied Geoscience Commission
Map Title: Multibeam Bathymetry Proposed Outfall Route, Moneo New Caledonia
Drawing Sheet 6 of 6 Scale 1: 5000
Drawing Notes: Bathymetry compiled from 2.5m matrix data set (1142428 data points). TRGD 15x15m.
Horizontal Datum: IGN 72 UTM Zone 58 Units metres
Vertical Datum: Chart Datum. Contour Interval 1m
Compiled and Interpreted R Smith March 2001. File sheet-6.dwg, ASCII xyz file sheet-6.xyz, surface file sheet-6.geb. Technical Report TR 326


PROJECT: MONEO OUTFALL ROUTE SURVEY
Client: Moneo Metals Limited
SOPAC
Map Title: Multibeam Bathymetry Proposed Outfall Route, Moneo New Caledonia.
Drawing Sheet 1 of 6 Scale 1: 5000
Drawing Notes: Bathymetry compiled from 2.5m matrix data set (1142425 data points). TRIG: 15x15m.
North
Map-Index
Barrier reef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563500
564000
7644000
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7645000
7645500
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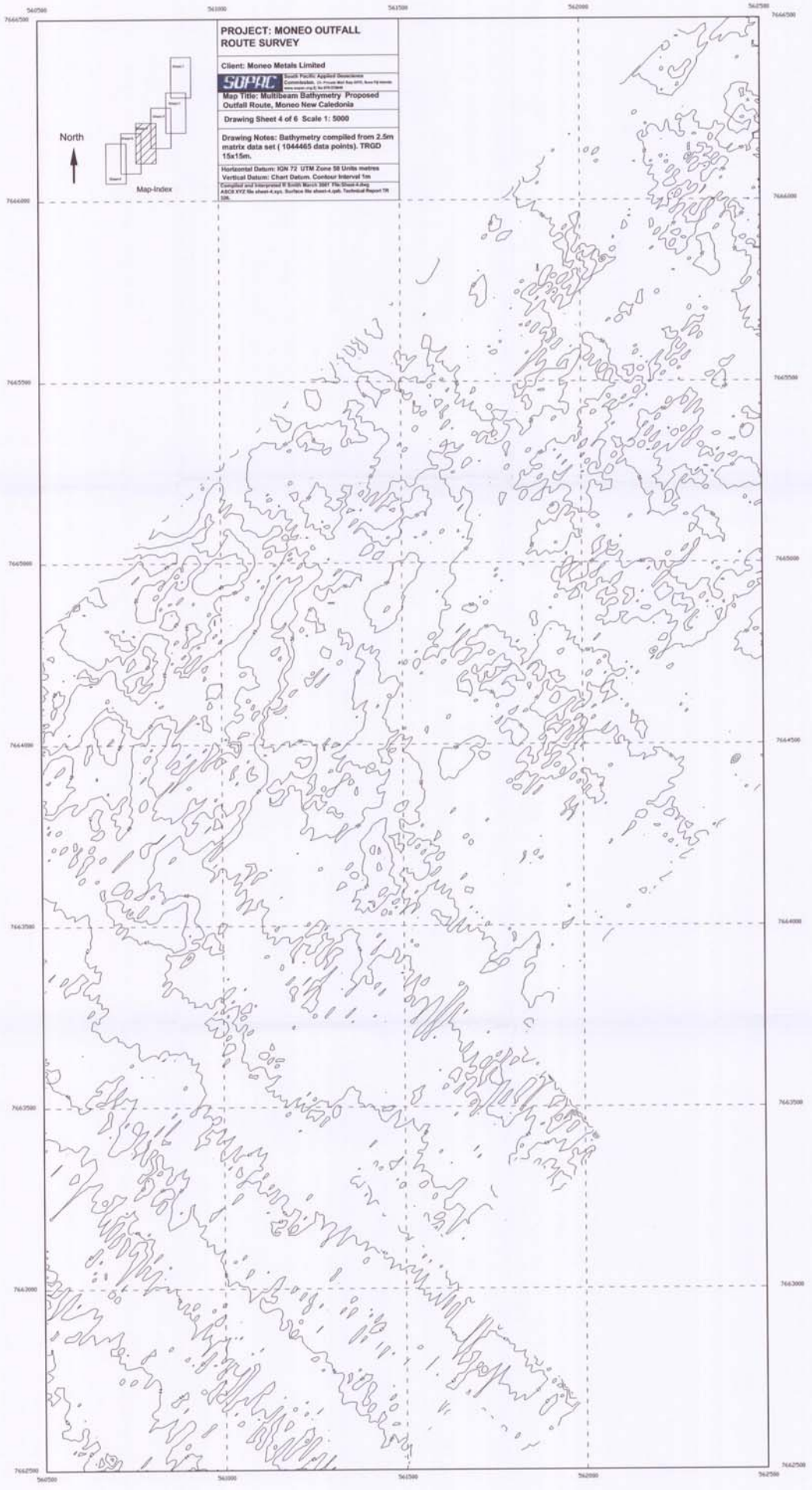
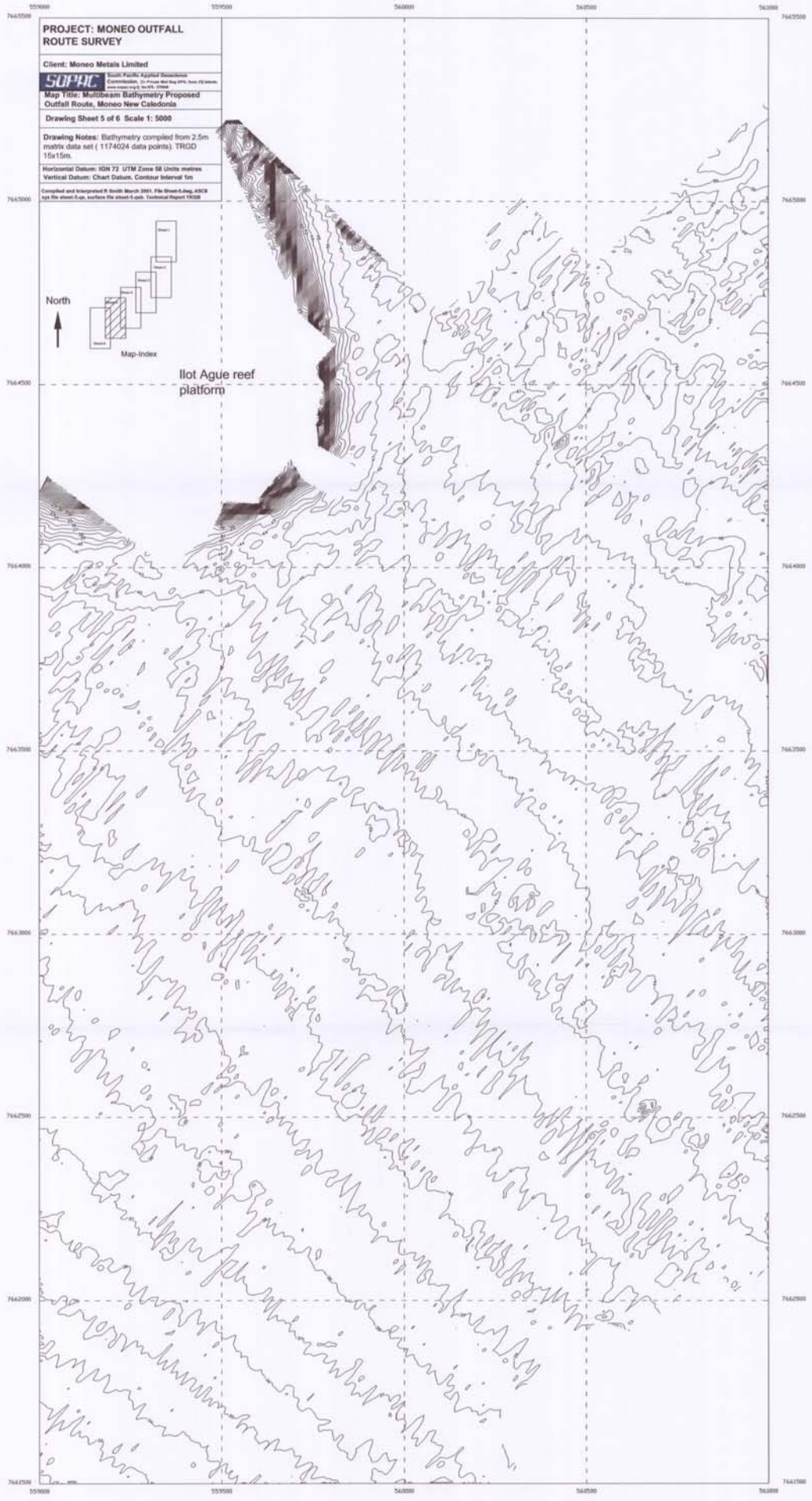
7646500
7647000
7647500
7648000
North
Map-Index
PROJECT: MONEO OUTFALL ROUTE SURVEY
Client: Moneo Metals Limited
SOPAC
Map Title: Multibeam Bathymetry Proposed Outfall Route, Moneo New Caledonia
Drawing Sheet 3 of 6 Scale 1: 5000
Drawing Notes: Bathymetry compiled from 2.5m matrix data set (936579 data points). TRGD 15x15m.
Horizontal Datum: IGN 72 UTM Zone 58 Units metres
Vertical Datum: Chart Datum. Contour Interval 1m
Compiled and Interpreted R Smith March 2003. File Sheet-3.dwg; ASCII xyz file sheet-3.xyz; surface file sheet-3.sph. Technical Report TR308


PROJECT: MONEO OUTFALL ROUTE SURVEY
Client: Moneo Metals Limited
SOPAC
Map Title: Multibeam Bathymetry Proposed Outfall Route, Moneo New Caledonia
Drawing Sheet 4 of 6 Scale 1: 5000
Drawing Notes: Bathymetry compiled from 2.5m matrix data set (1044465 data points). TRGD 15x15m.
Horizontal Datum: IGN 72 UTM Zone 58 Units metres
Vertical Datum: Chart Datum. Contour Interval 1m
North
Map-Index
560500
561000
561500
562000
562500
7644500
7644000
7643500
7643000
7642500


PROJECT: MONEO OUTFALL ROUTE SURVEY
Client: Moneo Metals Limited
SOPAC
Map Title: Multibeam Bathymetry Proposed Outfall Route, Moneo New Caledonia
Drawing Sheet 5 of 6 Scale 1: 5000
Drawing Notes: Bathymetry compiled from 2.5m matrix data set (1174024 data points). TRGD 15x15m.
Horizontal Datum: IGN 72 UTM Zone 58 Units metres
Vertical Datum: Chart Datum. Contour Interval 1m
North
Map-Index
Ilot Ague reef platform
559000
559500
560000
560500
561000
766500
766000
765500
765000
764500
764000
763500
763000
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