1989
FINAL FIELD REPORT

WESTERN ARCTIC SURVEYS
PACIFIC REGION

CSS JOHN P TULLY

SURVEYS IN THE BEAUFORT SEA

JULY TO SEPTEMBER

G.H. EATON
HYDROGRAPHER-IN-CHARGE

CANADIAN HYDROGRAPHIC SERVICE
DEPARTMENT OF FISHERIES AND OCEANS
INSTITUTE OF OCEAN SCIENCES
SIDNEY, B.C.

Canadä

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George H. Eaton
Hydrographer-in-Charge

Department of Fisheries and Oceans
Canadian Hydrographic Service
Institute of Ocean Sciences
Sidney, B.C.

LIST of FIGURES

1.0 STAFF LIST

Hydrographic Field Staff and Electronics

George Eaton	Hydrographer in Charge
12 July to 28 Sept.	TULLY
Kalman Czotter	Second in Charge
31 July to 28 Aug.	TULLY
28 Aug. to 9 Sept.	NAHIDIK
9 Sept. to 29 Sept.	TULLY
Alex Raymond	Processor
10 July to 29 July	PCSP Tuktoyaktuk
31 July to 13 Sept.	TULLY
Ernest Sargent	Hydrographer
12 July to 30 July	TULLY (Second-in-Charge)
30 July to 11 Sept.	TULLY
George Schlagintweit	Hydrographer
10 July to 29 July	PCSP Tuktoyaktuk
29 July to 13 Sept.	TULLY
Graeme Richardson	Hydrographer
31 July to 11 Sept.	TULLY
David Thornhill	Hydrographer
12 July to 11 Sept.	TULLY
Olen Vanderleeden	Hydrographer
12 July to 29 Sept.	TULLY
Ian Hourston	Hydrographer
12 July to 1 Sept.	TULLY
Neil Denby	Hydrographer
12 July to 1 Sept.	TULLY
Lance McNichol	Hydrographer
12 July to 1 Sept.	TULLY
Ken Halcro	Hydrographer
1 Sept. to 29 Sept.	TULLY
Carol Nowak	Hydrographer
1 Sept. to 29 Sept.	TULLY

Ralph Loschiavo — Electronics Technologist
10 July to 29 July — PCSP Tuktoyaktuk
29 July to 1 Sept. — TULLY

Alan Thomson — Electronics Technologist
12 July to 12 Aug. — TULLY

Dave Gartley — Electronics Technologist
16 Aug. to 29 Sept. — TULLY

Valerie Forsland — Oceanographic Technologist
12 July to 29 July — TULLY
9 Sept. to 29 Sept. — TULLY

Earle Neil — Helicopter Pilot
10 Sept. to 12 Sept. — TULLY

Ship's Officers and Crew

John Anderson	Captain	12 July to 29 Sept.
Kay Gimbel	Chief Officer	12 July to 29 Sept.
Jonathon Purdie	2nd Officer	12 July to 29 Sept.
Rod Mason	3rd Officer	12 July to 29 Sept.
Khan Tran	Chief Engineer	12 July to 29 Sept.
Dave Stanway	2nd Engineer	12 July to 29 Sept.
Brian Heesterman	3rd Engineer	12 July to 29 Sept.
Steve Law	Boatswain	12 July to 29 Sept.
Dan Graham	Seaman	12 July to 29 Sept.
Randy Smith	Seaman	12 July to 29 Sept.
Graham Judd	Seaman	12 July to 29 Sept.
Al Keene	Seaman	12 July to 29 Sept.
Gerry Garneau	Seaman	12 July to 29 Sept.
Glen McKechnie	Seaman	31 July to 11 Sept.
Bruce Laforest	Seaman	31 July to 11 Sept.
Wayne Contois	Seaman	3 July to 11 Sept.
Miles Fidler	Seaman	31 July to 12 Aug.
Ray Sanderson	Seaman	17 Aug. to 11 Sept.
Terry Ryder	Seaman	12 July to 2 Aug.
Greg Wallingford	Oiler	12 July to 29 Sept.
Bob Noren	Launch Mechanic	31 July to 11 Sept.
Don Boughton	Chief Cook	12 July to 29 Sept.
Johannes Brens	2nd Cook	12 July to 29 Sept.
Colin Bell	3rd Cook	1 Aug. to 29 Sept.
Tom Smart	Steward	12 July to 29 Sept.
Stephen Desmond	Steward	12 July to 29 Sept.
Jim Napier	Steward	12 July to 29 July

2.0 LIST of MAJOR CRAFT and EQUIPMENT

1. Ship:
   CSS JOHN P. TULLY; Steel hulled, 69 metre hydrographic survey vessel ice strengthened.

2. Launches:

TEMPEST	10m.	NOAA design, diesel
TORONADO	10m.	NOAA design, diesel
SURGE	10m.	NOAA design, diesel
STORM	10m.	NOAA design, diesel, equipped with radar

   Launches have aluminum semi-displacement hulls.

3. Helicopters:
   C-GNNK,C-GBSP and C-GUCX Canadian Helicopters, Bell 206-B Jet Rangers on charter to Polar Continental Shelf Project.

   C-FOKV Canadian Helicopters, Sikorsky S-61 on charter to Beaudril in Tuktoyaktuk.

4. Positioning Systems:
   Cubic Western ARGO medium frequency (1702 kHz) electronic positioning system with four shore stations operating with either Texas towers which varied in length from 70 to 100 feet or guyless 75 foot fibreglass whips. The stations were powered by propane thermal electric generators or in the case of the station in Tuk, by standard 110VAC from a nearby building. The equipment was configured for one range/range receiver and five hyperbolic receivers.

   Trisponder 542 microwave positioning system with one master and three remote shore transponder beacons, plus three short range beacons for ARGO launch calibration.

   Ashtech XII-L 12 channel GPS satellite receiver rented from Ashtech Inc. of Sunnyvale California.

5. Echo Sounding Equipment:
   One Raytheon DSF-6000, 24/100 kHz sounder complete with a built in digitizer and operated with a TSS heave compensator; used for ship sounding in the survey area.

   One Raytheon PTR, 12.5 kHz sounder along with a PDD digitizer and LSR recorder, used for GEBCO lines.

   Five Simrad Skipper 50 kHz sounders, operated in conjunction with Meyers Systems Digitizers (Model G-1097); used in launches.

   One Nusonics Velocimeter operated in conjunction with a Hewlett Packard Preset counter.

6. Data Loggers:
    Five HAL data loggers operating with Targa 1Mb RAM cartridges.

    One ISAH (68020 processor on trial for the field season also operating with TARGA RAM cartridges.

7. Processing Systems:
    One Digital MicroVAX II computer with 370Mb storage
    Two Targa RAM cartridge readers
    One Calcomp 1044 series plotter
    One VT100 terminal
    One VT220 terminal
    One Tektronics 4211 graphics terminal
    One Tektronics 4109 graphics terminal
    One LA120 printer
    One LA210 printer
    Two IBM PC computers

8. Launch Radios:
    Five Robertson VHF radios with Sel-Call headphones and intercom. Four Icom handheld portables.

9. Tidal Equipment
    One Low powered tide gauge complete with 30MHz radio link

10. Horizontal Control Equipment:
    Two Microfix 100 CX's
    Two Wild T-2s

3.0 LIST OF PROJECTS

Hydrographic Survey, Beaufort Sea
Project Number 7710-89
Percentage Complete 100%

4.0 CHRONOLOGY OF EVENTS

10 July	Shore Party including Raymond, Schlagintweit and Loschiavo depart for PCSP, Tuktoyaktuk. TULLY sailing date delayed to 1530 Wednesday due to tardy launch mechanical work. Controversy surrounding shipboard captive time for EG-ESS employee category continues. A decision is made to dispatch the ship despite the issue being unresolved.
12 July	TULLY sails at 1620. There is a short delay due to a hydraulic line bursting when attempting to lift the port forward launch. Clear skies and warm weather prevail.
13 July	GEBCO line begins. Magnetometer streamed at 1155 after ship's direction finding equipment is calibrated and emergency steering gear tested. Evening barbeque on the stern of the TULLY under ideal conditions.
16 July	Weather reverts to the usual north Pacific regime of low pressure systems with accompanying gray skies and moderate seas. The 12 kHz sounder transducers are badly affected by air under the hull. The hydraulic ram is tried, however the results are less than satisfactory.
19 July	Birds sighted, indicating TULLY is approaching land. Loran-C and the other navigation aids working satisfactorily.
20 July	TULLY alongside Dutch Harbour fueling wharf at 0300. Departed at 1300 and streamed the magnetometer after Pilot disembarks.
24 July	Crossed arctic circle. Lloyd Clarke's ashes cast into sea by Randy Smith.
25 July	King Neptune aboard after lunch; 13 Tadpoles become certified as Shellbacks. The first ice is sighted. Magnetometer is brought aboard and Gebco line terminated.

26 July	Three to four tenths ice encountered at Pt. Barrow. Easy sailing in better conditions to the east.
28 July	TULLY anchored off North Peak.
29 July	Shore party from Tuk joins TULLY and Argo calibration begins.
31 July	Coxswains and hydrographers arrive from IOS to join TULLY.
1 Aug.	First day of launch sounding. Herschel Island Argo station giving unstable signals.
2 Aug.	Neil Denby and Seaman Terry Ryder to Tuk by helicopter. Denby on to Inuvik for x-rays of suspected cracked ribs. Some Argo problems but survey production continues.
3 Aug.	Heave compensator on chartroom DSF 6000 not functioning correctly. Technical service literature not available to effect repairs. Denby from Inuvik and Wayne Contois from IOS meet at PCSP before joining TULLY by helicopter.
4 Aug.	TEMPEST loses data from one shift due to flat battery in RAM cartridge. Ice clearing out of survey area.
5 Aug.	Argo-GPS comparison made. Selective availability does not appear to be deployed since ageement is within 15 metres most of the time.
6 Aug.	First sounding plots show 0.3 metre discrepancies between soundings obtained by TULLY on check lines and launches. TULLY draft determined by various methods and adjusted.
9 Aug.	10 km. square area left by TULLY last year around Kulluck drill site surveyed.
10 Aug.	Argo unstable. Launches unable to maintain lane count. Ship sounds using range/range positioning for remainder of day with launches aboard.
11 Aug.	Launches sounding again in morning. Argo problems force launches to be recovered at noon. Launch sounding resumes on the last shift at 2000.

12 Aug. Seamen Fidler and Graham visit nurse and shut down Tuk Argo station. Thomson and McNichol travel to Herschel Island to add additional ground plane and tune the antenna. Loschiavo and Schlagintweit get Pelly Island Argo station on the air, check Pullen Island Argo and level the tide gauge. Thomson returns to Victoria.

13 Aug. Herschel Island Argo station even more unstable after retuning.

14 Aug. Raymond and Loschiavo return to Herschel Island to extend antenna 30 feet, change all electronics and retune. More stable positioning is immediately apparent.

15 Aug. Launches resume sounding with good positioning for the first time this season. Sandilands arrives in Tuk but is unable to join ship because of the TULLY's distance offshore.

16 Aug. Gartley and Sandilands arrive by helicopter. 1300 km. of sounding acquired today.

17 Aug. Launch problems at 0800. Tempest will not start and Surge has leak in lubrication system. Both launches are quickly repaired and obtain soundings during first shift. Seaman Ray Sanderson arrives. Wind rising during day and launches are recovered at 2000.

18 Aug. 25 to 30 knot winds continue, ship sounding only.

19 Aug. Winds decrease sufficiently to have launches in the water by the last shift. Sounder replaced in Surge.

20 Aug. Three launch shifts completed before freshening winds force launches to be recovered at 2000. Large, steep swell overnight causes TULLY's Raytheon sounder to lose bottom frequently.

21 Aug. Wind and rough seas keep the launches aboard in AM. Crowther joins TULLY by helicopter. Last two launch shifts worked.

22 Aug. Four launch shifts completed despite rough sea conditions. Kal Czotter has a new son today. Coast Guard Ship FRANKLIN takes possession of Rob MacDonald's equipment transported north by TULLY.

24 Aug. Ship anchors off Tuk. Eight hours of rest and recreation ashore for the majority of the TULLY's complement. Crowther departs for IOS.

28 Aug. Launches start splits and exams. NAHIDIK takes possession of launch ALFIE. Kal Czotter accompanies ALFIE.

29 Aug. Heavy fog. Splits and exams

30 Aug. More fog.

31 Aug. Last shift for students before they depart TULLY Sept.1st.

1 Sept. TULLY anchored off North Peak. Launch STORM transports Denby, McNichol, Hourston and Loschiavo to Tuk for flights south. Hydrographic locker at PCSP cleaned out and the majority of gear transported to the TULLY. Groceries are picked up at the Hudson,s Bay and Halcro joins the party at this time. Arrangements are made with PCSP for demobilization and helicopter. Nowak joins TULLY later in the day by helicopter off Pullen Island.

2 Sept. Sounding resumes. Launches on board again during last shift due to rough seas. Fred Stephenson at PCSP disassembles and stores the Argo tower after it was lowered the previous day.

3 Sept. Ship sounding; rough seas.

4 Sept. A good day for launch production despite heavy fog. Launch nearly collides with Canmar supply vessel. The Coast Guard Vessel Sir John Franklin returns Rob MacDonald's oceanographic gear for transport south.

5 Sept. Fog continues, as does production.

6 Sept. Splits are run to prove non existence of shoals. All shoal indications appear to result from ice scouring.

7 Sept. Mechanical problems with Launch STORM at 0800, solved before 0900. Trisponder master beacon on TULLY fails and is replaced.

8 Sept. Checklines and splits

9 Sept.	Final soundings for the survey collected at 0800. Shore parties dismantle positioning gear and tide gauge at Pullen and Hooper Islands. Landings made by launch and whaler.
10 Sept.	Helicopter C-GBSP joins TULLY at Relief Islet and remains on board until the 12th. Argo gear and propane bottles transported to the ship. Fiberglass whip antenna and ground mat remain. Argo and Trisponder gear recovered from Pullen and Hooper Islands. Fiberglass whip and ground mat remain at Pullen Island.
11 Sept.	Richardson, Sargent and Thornhill along with Seamen Contois, McKechnie, Sanderson, Laforest and Noren depart the TULLY by helicopter for flights south. Launch ALFIE returned from the Coast Guard Ship NAHIDIK off Pullen Island. Positioning gear recovered from Pelly Island by helicopter. Texas tower and ground mat is brought out to TULLY.
12 Sept.	TULLY anchored in Pauline Cove south of Herschel Island. Argo station dismantled in the morning. 100 feet of Texas tower along with all ground mat is stored aboard the TULLY. Raymond and Schlagintweit return to Tuktoyaktuk with helicopter to secure remaining CHS gear at PCSP which includes sufficient Texas tower for 1 Argo station. TULLY commences her southern voyage.
13 Sept.	Raymond and Schlagintweit fly south from Tuk. TULLY passes Prudhoe Bay and streams magnetometer in ice free waters.
14 Sept.	Pt. Barrow abeam at 0800. One of the easiest passages along the north slope in recent memory. Magnetometer brought in near Wainwright to avoid loose ice; redeployed near Icy Cape.
20 Sept.	TULLY in Dutch Harbor for fuel at 0400.
21 Sept.	Running GEBCO line at 0030. Mag aboard at 0700 due to auto steering problems. Return to GEBCO line at 1300 on a lumpy day.
27 Sept.	TULLY arrives Esquimalt.

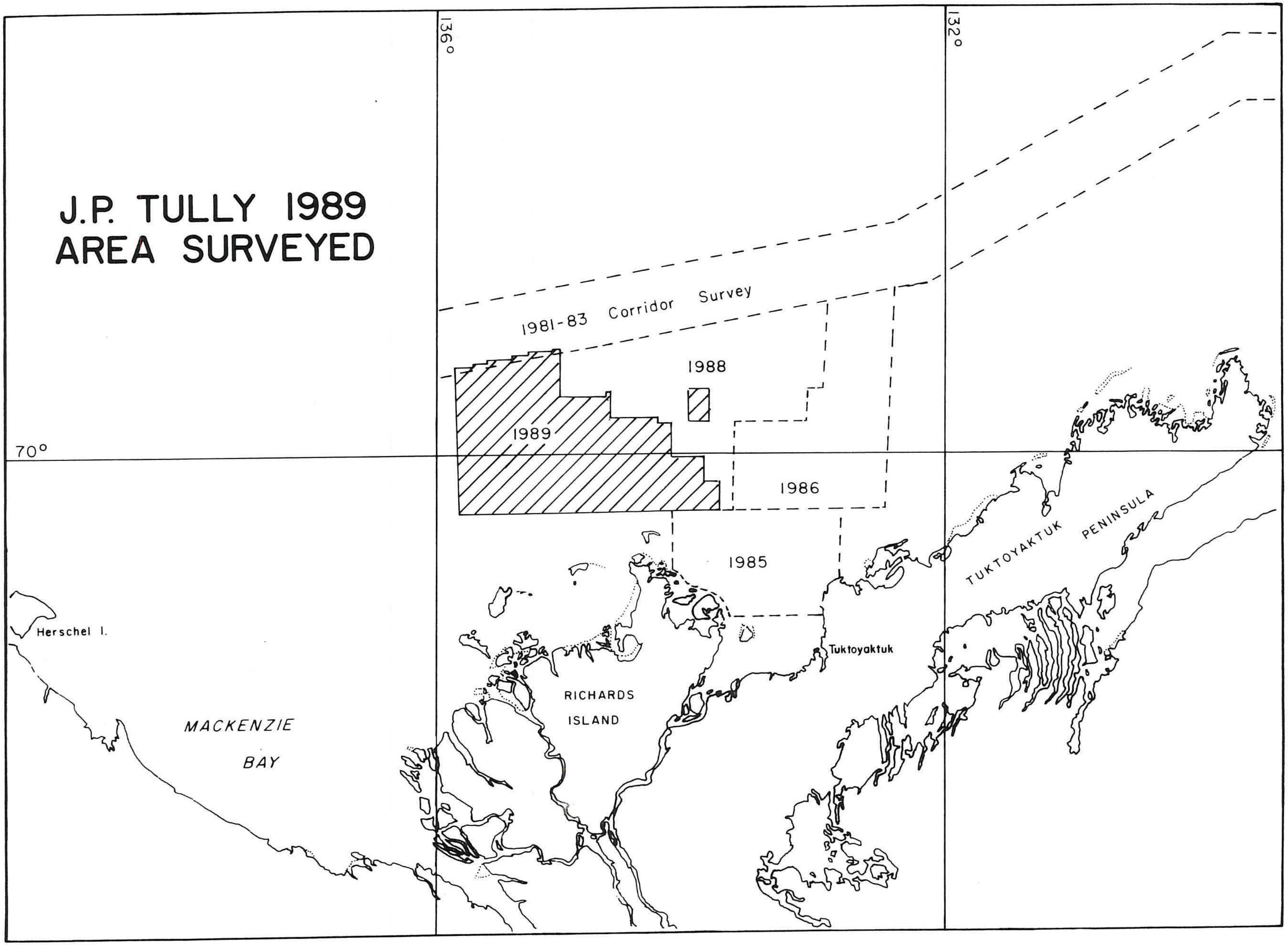
5.0 SURVEY AREA

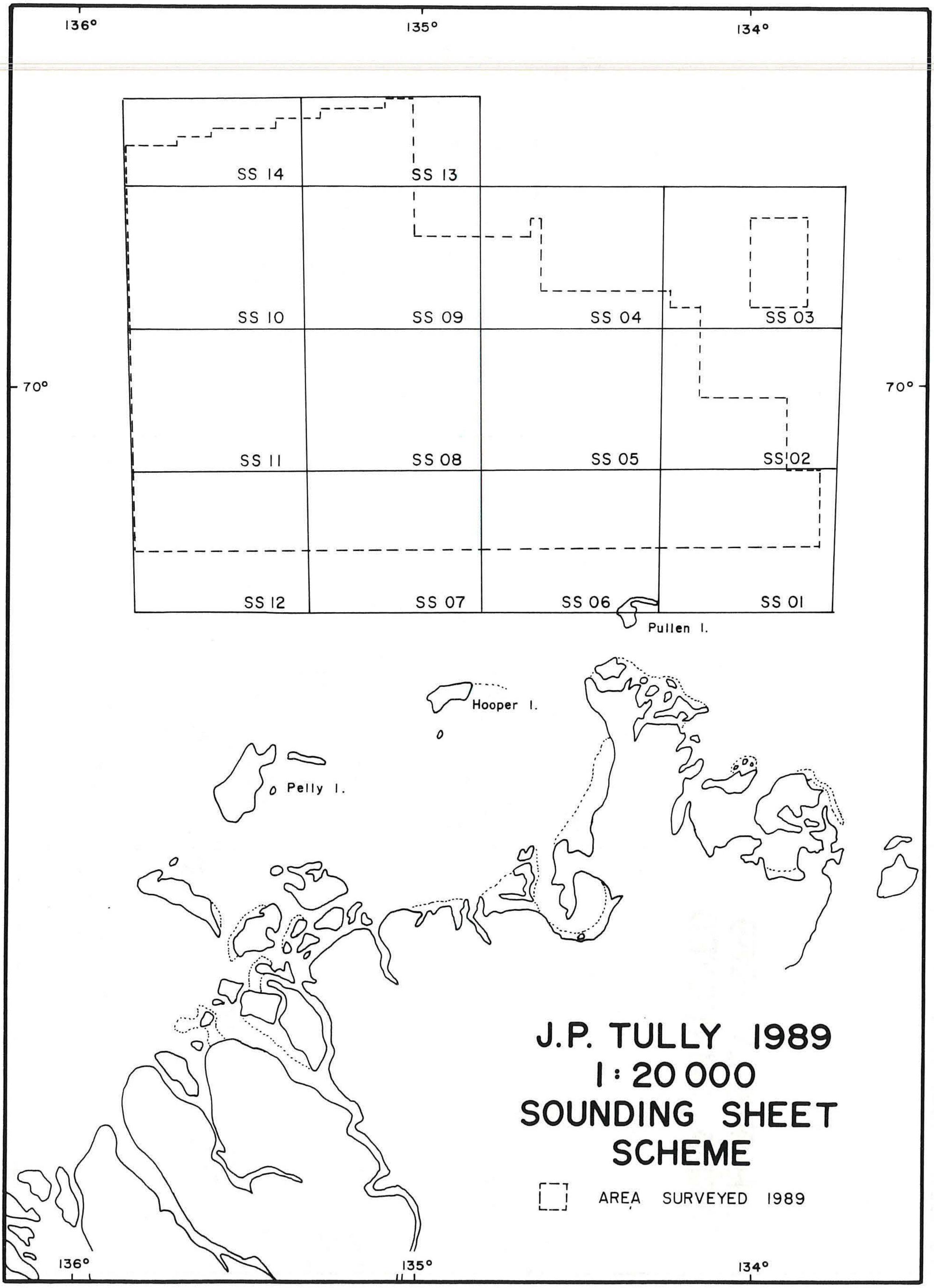
This years work was a continuation of the 1:100,000 surveys started in 1985 on the J.P. TULLY'S inaugural voyage. These surveys, divided into three 25,000 linear mile sections, adjoin the southerly limits of the previously sounded shipping corridor. As usual, the objective of this work was to detect shoals that would pose a hazard to navigation and as 1:100,000 surveys, they are somewhat anomalous because 100 metre line spacing is used. Originally, completion of one 25,000 mile block per season was anticipated, but due to weather, ice and limited ship time, 13,500 nm. annual mileages have been more typical.

Sounding coverage has advanced north and westward since 1985, through much of the area being actively investigated by the oil companies. This area includes "Amauligak", quoted in Doig's Digest as "the most prolific well drilled in Canada" with its 35,000 barrel per day flow rate. The remains of several abandoned artificial islands and drill sites are situated throughout the area. This year, sounding coverage terminated in the north at the shipping corridor, in the south at 69-55 and in the west at 135-55.

The 1989 survey area was divided into fourteen, 1:20,000 sounding sheets which aided the efficient management of the copious data. These fourteen sheets were assembled into one 1:100,000 Field Sheet at the conclusion of the field work.

J.P. TULLY 1989
AREA SURVEYED




136°
135°
134°
70°
70°
SS 14
SS 13
SS 10
SS 09
SS 04
SS 03
SS 11
SS 08
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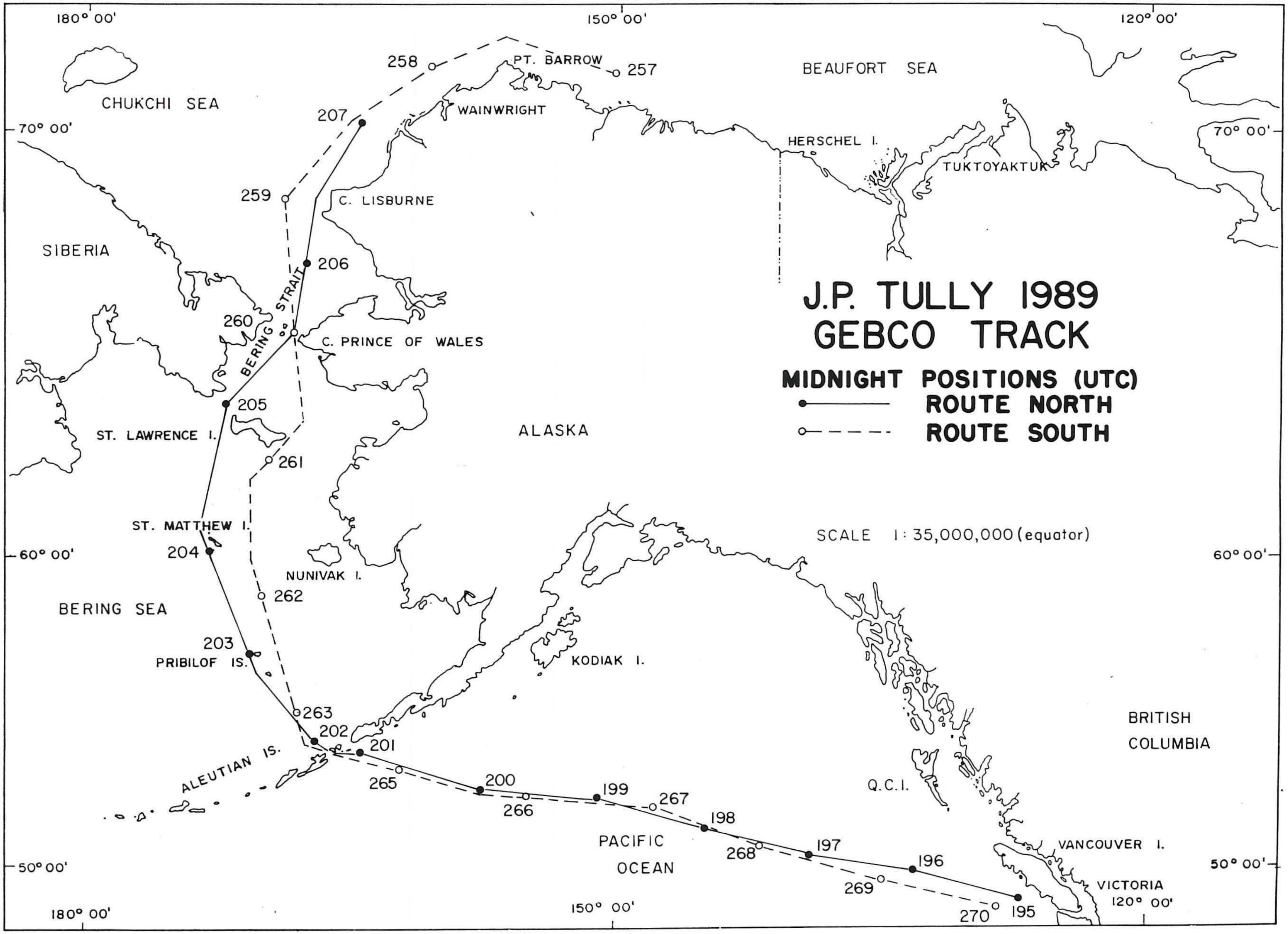
SS 02
SS 12
SS 07
SS 06
SS 01
Pullen I.
Hooper I.
Pelly I.
J.P. TULLY 1989
1 : 20 000
SOUNDING SHEET
SCHEME
AREA SURVEYED 1989
136°
135°
134°


J.P. TULLY 1989
GEBCO TRACK
MIDNIGHT POSITIONS (UTC)
ROUTE NORTH
ROUTE SOUTH
SCALE 1: 35,000,000 (equator)
180° 00'
150° 00'
120° 00'
70° 00'
60° 00'
50° 00'
CHUKCHI SEA
BEAUFORT SEA
PT. BARROW
WAINWRIGHT
HERSCHEL I.
TUKTOYAKTUK
C. LISBURNE
SIBERIA
BERING STRAIT
C. PRINCE OF WALES
ST. LAWRENCE I.
ALASKA
ST. MATTHEW I.
NUNIVAK I.
BERING SEA
PRIBILOF IS.
KODIAK I.
ALEUTIAN IS.
PACIFIC
OCEAN
Q.C.I.
BRITISH
COLUMBIA
VANCOUVER I.
VICTORIA
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6.0 PREPARATIONS

The planning and preparations for the 1989 Beaufort Sea survey was a relatively straightforward process. The area, personnel, methodology and equipment have been much the same since 1981 when the first part of the Shipping Corridor survey was undertaken by the CSS HUDSON.

6.1 Survey Approvals:

One exception to the routine planning was the necessary involvement with the Inuit People. Every company and government agency engaged in surveys must have permission and approval from various groups before working in the Beaufort Sea and surrounding area. There are at least four bodies that have interests in the environment and resouces. They are:

P. Savoie
Government of Yukon
Box 2703 Whitehorse
Yukon Y1A 2C6

R.A. Cockney
DIAND
Box 2100 Inuvik
NWT XOE OTO

G. Wagner
Joint Secretariate
Box 2120 Inuvik
NWT XOE OTO

J. Bicknell
Inuvialuit Land Admin.
Box 2120 Inuvik
NWT XOE OTO

Lengthy applications and project explanations were required and the reviewing process took more than four months.

There may be fees, deposits, site inspections and limited access to some locations. The onus lies with the surveyor to contact the above organizations prior to any work ashore or at sea. Fortunately only a paper exercise was required this year.

6.2 Launches:

Many other preparations began early in the new year. These preparations included establishing a schedule that would permit the necessary launch mechanical maintenance work to be carried out, the survey launch electronics to be installed, tested and calibrated and four new launch hydrographers to be trained. Due to Marine Division's other commitments this schedule was not kept and the TULLY was held up two days while the required mechanical work was completed. Moreover, the consequences of this schedule slippage were more far reaching. The electronics installations became hectic and virtually no testing including draft vs. speed tests could be done. The training was presented to our new employees on an opportunity basis, that is when a launch was available, when the electronics were installed and when a coxswain could be freed from his other duties. The correct meshing of the work from the three involved groups is crucial to the overall success of the survey.

6.3 Positioning:

The Argo chain configuration used last year was no longer adequate for this year's area, consequently some new shore installations were required. After examining accuracy contours for both range/range and hyperbolic configurations, station locations were chosen at Relief Islet, Pelly, Pullen and Herschel Islands and at Tuktoyaktuk.

On July 10th a shore party travelled to Tuk to deploy the Argo chain and Trisponder gear used for Argo calibration. Some minor horizontal control work was required, but the bulk of the work involved wrestling forty 200 lb. bottles of propane onto the tundra, raising some towers and connecting propane generators to the Argo gear. A Sikorsky S-61, on charter to Beaudril facilitated this work by carrying one complete station per flight. All the gear was set onto the tundra in one day, however another visit by Bell 206 was needed to get the equipment assembled and operational.

6.4 New Hardware:

New equipment this year included a Microvax II computer and UPS. A 12 channel GPS receiver was rented to assist with the Ship's positioning. Similarly, a heave compensator was connected to the Raytheon DSF-6000 for a field evaluation and a new ISAH with the latest software was installed in the Chart Room for examination. Some additions to the launch electrical systems were also undertaken including isolation transformers, auxillary recepticles and permanent wiring for block heaters, cabin heaters and battery charging.

6.5 Software:

A significant effort was required in the spring to ready the software as well.

A contract was let to Quester Tangent to cure a number of HAL logging problems that were identified in previous seasons and write some minor additions. The major problem was to build a read after write mechanism to ensure the Targa bubbles were recording data and thus avoid the situation encountered last year of launches returning without data. Other changes were made to the HAL software to ensure that the 97th block was not lost and incorrect negative times did not appear in the record. Finally, a module was written to decode the Ashtech GPS data for navigating and logging.

In-house work included rewriting the SENSOR program to permit the processing of Argo data and to employ the information derived from velocity vs. squat tests. Kal Czotter obtained a contouring package from Universal Systems to experiment with on this years bathymetric data. Anne Ballantyne from Tides and Currents worked on Vax programs to manipulate and plot tidal data transmitted over radio and satellite links. Her programs will eliminate much of the tedious plotting and calculation needed to obtain and check tidal reduction figures, as well as provide fast access to predicted and observed tides throughout the season.

Modifications to the SAIL shipboard logging system were made to improve its performance. Modifications included a new ASCII buffer and software changes which allowed more convenient parameter inputs as well as a streamlined routing through the program. Two versions of the SAIL software now exist; SAIL B written in Basic and SAIL C written in the "C" language. SAIL C was to be tested over the course of the summer and if successful used on the southward voyage for recording GEBCO data. Kal Czotter wrote programs to take the SAIL data logged on the Ship's PC, transfer it to the Microvax computer and then decode it into Caris edit format which permits plots of soundings and magnetometer readings.

6.6 Tides:

Two tide gauges were proposed for the survey. One was to be installed at Pullen Island and the other was the permanent gauge in Tuk Harbor. The Pullen gauge would provide more accurate data for the sounding area than the Tuk gauge used in previous surveys.

The gauge at Tuk. would send data to IOS via land line, then to the TULLY by Inmarsat. For the Pullen Island gauge, Institute Electronics designed and built a new three element horizontally polarized yagi antenna to operate with the 30.46 MHz transmitter which was expected to provide data directly to the Microvax on the TULLY at distances in excess of 30 km. thus avoiding regular boat or helicopter visits. The new low powered tide gauge close to the survey area combined with a reliable data link marked a very real improvement over the technology used until recently.

7.0 OPERATIONS

7.1 Voyage North:

The TULLY severed her ties to shore on Wednesday afternoon, the 12th of July, and sailed out Juan de Fuca Strait. People quickly fell into the shipboard routine and by noon the next day the magnetometer was streamed, GEBCO data was being logged and Val Forsland from Ocean Chemistry started her seawater and atmospheric sampling. The trip across the Pacific was uneventful with predominant gray skies, fog and moderate seas. The 12 kHz sounder did not operate well in these conditions. Fifteen degrees of rolling or pitching would introduce air to the transducer face, resulting in a loss of bottom. The ram-mounted transducer was tried but it produced even less pleasing results than the hull-mounted equipment.

Fuel was taken at Dutch Harbour in the Aleutian Islands on the morning of July 20th. The Arctic Circle was crossed four days later and the ashes of a long time shipmate Lloyd Clarke were cast into the Bering Sea. King Neptune and his entourage arrived the following day, July 25th, and awarded 13 new certificates. The TULLY then enjoyed an effortless passage along the north slope, not once stopping for ice and arrived off Tuktoyaktuk late in the evening of July 28th.

7.2 Survey:

More coxswains and hydrogaphers as well as the shore party from Tuk joined the TULLY at the end of July and the next two days were spent getting the Argo system operational and calibrated in the survey area. Although the instability of the signal from Herschel Island immediately became apparent, the positioning was thought to be sufficient for the launches.

The launches began sounding on August 1st and although good progress was made, the boats frequently had to return to the ship to re-acquire the correct lane count. By August 12th the work had progressed to the point where the Argo chain configuration had to be modified to permit further sounding. The station at Tuk was taken off the air and the one on Pelly Island commissioned. On the same day, the station at Herschel Island was visited by Al Thomson and Lance McNichol to see if improvements could be made. Extra ground mat was added and the antenna retuned. The result of this visit was even poorer performance and consequently the launches were unable to sound.

Several theories, solutions and scenarios were discussed aboard before phone calls were made to IOS and Cubic Western in the U.S. to seek advice. A helicopter was arranged for August 14th and Herschel Island was revisited. This time 30 feet of antenna were added, bringing the total to 100 feet. All electronics were replaced with the gear from the decommissioned station at Tuk and the antenna was once again retuned. No further difficulties were experienced for the remainder of the season.

For the next weeks the work became very routine. Launches worked 16 hours per day from eight in the morning until midnight. Over the course of the season, four days were spent on splits and exams and only portions of seven days were lost when the seas were too rough for the launches to sound.

The area sounded now extends the coverage from the shipping corridor in the north to latitude 69-55 in the south and as far west as longitude 135-55. Sounding concluded on the morning of September 9th with a total of 29,039 line kilometres for the season.

Kal Czotter was assigned to the NAHIDIK from August 28th to September 9th, to help investigate the potential navigation hazards of abandoned artificial islands and drill sites north of Kugmallit Bay. The objective was to determine the location, size, shape, least depth, erosion rates and protruding hazard characteristics of these artificial islands. The project was jointly carried out by Coast Guard, EMR and the CHS. Please refer to excerpts from the Canadian Seabed Research Ltd.

report contained in Appendix A. If the CHS takes a more active role in the survey of these artificial islands, the recommendations of this report will be important.

Once again the problems involved with the deployment and recovery of the Argo and Trisponder chains came sharply into focus at the end of the season. Due to fuel limitations, the TULLY was required to leave the survey area no later than September 13th, regardless of whether or not the shore station gear was on board. If fog, which restricts the necessary helicopter support, persisted during the demobilization and the TULLY could not be used to transport this gear south an additional expenditure of 30,000 dollars to gather up and ship all the gear to Tuk by helicopter then southwards by air freight would have been required. The dilemma of deciding when to shut the survey down and start the demobilization is not an easy one. Fortunately, good weather prevailed and all the gear including 40 empty propane bottles was on board one day ahead of schedule.

7.3 Voyage South:

The southward voyage began on Sept. 12th after the Herschel Island station was loaded on the ship. Valerie Forsland from Ocean Chemistry rejoined the ship several days earlier to make the southern passage. The TULLY headed west along Alaska's north slope in all but ice free waters and the magnetomneter was streamed just west of Prudhoe Bay. The magnetometer was lifted once near Icy Cape to traverse a few miles of ice-infested water but otherwise the voyage to Dutch Harbor was routine. Fuel was taken at the Crowley Marine wharf near Unalaska on September 20th, and the TULLY was again underway by the afternoon on the final leg of her homeward trek. The ship's auto steering gear failed early the next morning so part of the Gebco line was aborted while the manual gear was tested. The TULLY arrived at Victoria on the morning of Sept. 27th after 78 days at sea. Here she would go into drydock for routine maintenance. Although a good and successful voyage, all aboard were looking forward to some time at home.

8.0 POSITIONING

The Argo positioning system, which provides navigational capability for the TULLY and her launches, required some relocation of sites for adequate coverage throughout the 1989 survey area. The new locations were at the Polar Shelf camp yard in Tuktoyaktuk and on Herschel Island in the Yukon. The other stations remained at Relief Islet near McKinley Bay, and on Pullen and Pelly Islands. The coastline configuration along the south shore of the Beaufort Sea does not permit the optimal deployment of the Argo system. Even with five shore stations covering a relatively small area, overall accuracy lobes were sometimes inconsistent with conventional 100 metre line spacing.

The station on Herschel Island was particularly erratic. Signal from this station passed over Mackenzie Bay which was either filled with a tongue of sea ice or fresh water from the Mackenzie River, both of which have an effect on the velocity of propagation. Rain, fog and low cloud also affected the velocity. The calibration of the distant stations Relief and Herschel was observed to change as much as 0.3 lanes (25 m.). This may not seem to be significant at first glance, but combined with the less than ideal chain geometry, adequate positioning accuracy was hard to achieve in some parts of the survey area.

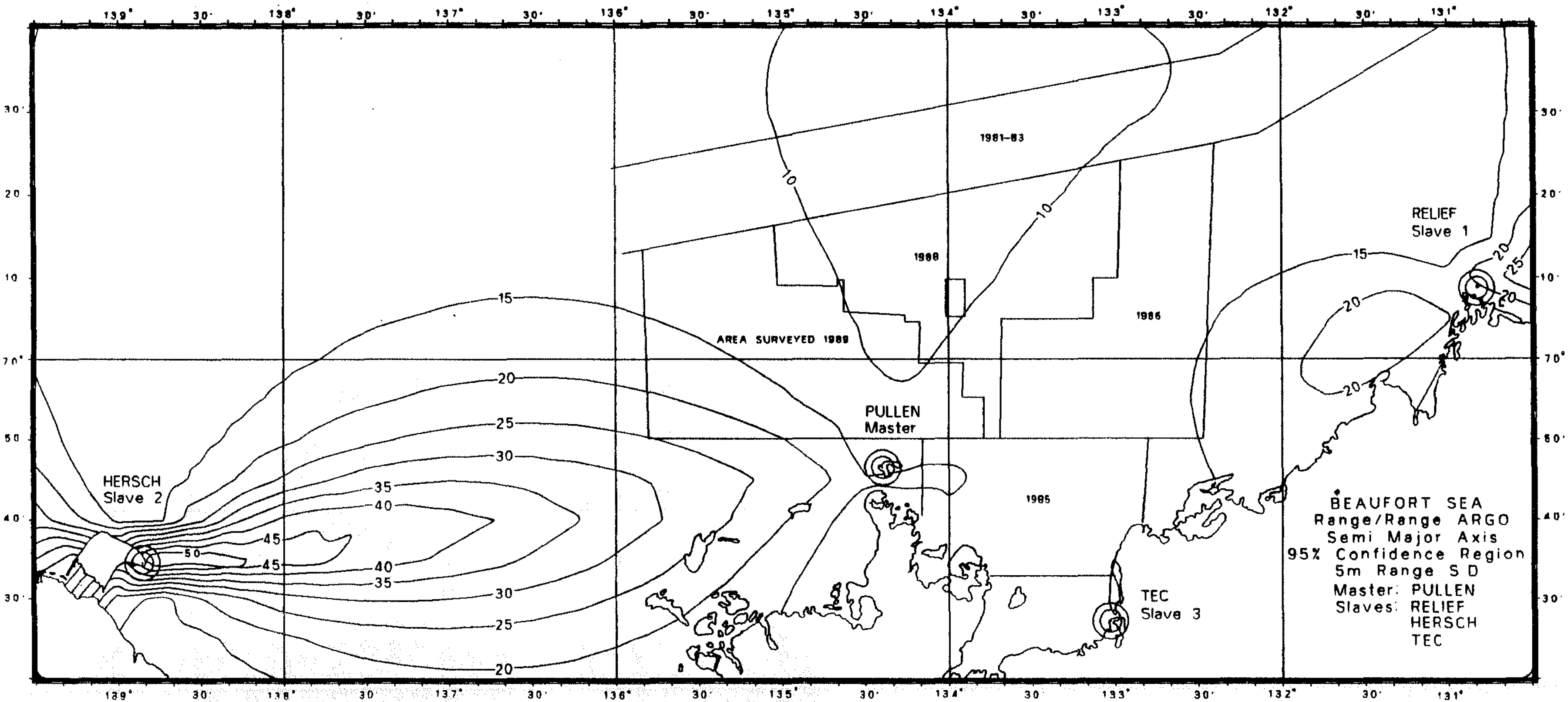
During the first half of August the stations in use were Relief, Tuk, Pullen and Herschel Island. Station Tuk was needed to provide acceptable accuracies in the southeast corner of the survey area, but as soon as the sounding progressed 10 km. westwards the signals became obstructed by land, forcing Tuk to be shut down and Pelly to be commissioned. The station on Herschel Island continued to cause problems and was visited twice. More ground mat and thirty feet of antenna were added. Finally all the electronics were changed and the antenna retuned before good, stable, strong signals were available.

Calibration was achieved by making the Range/Range Argo receiver agree with positions derived from a three range Trisponder chain in the southern part of the survey area. Next, the hyperbolic receivers on the TULLY and her launches were adjusted to agree with the Range/Range positions. These comparisons were made with well tested software running on our aging but reliable HP-85. A new ISAH (68020 processor/2.05 software) was also used for this task. The results from the ISAH and HP-85 were identical but the ISAH was faster and more convenient once the the operator became familiar with the software.

Monitoring of the Argo system calibration by Trisponder was possible throughout much of the summer since the Trisponder beacon locations were of such elevation to provide coverage over the southern 30% of the survey area and ranges of 70 km. were observed on occasion. The IOS anti-null antenna with its enhanced performance proved to be a real asset at these long ranges. Other than one master beacon failure the Trisponder system worked flawlessly. Solar panels provided enough charging capacity to keep the shore beacons operating for weeks on end.

When the TULLY was out of the Trisponder coverage, calibration checking was done by analysis of the fix residuals and comparison to GPS positions. The new ISAH was very convenient for gathering and analysing the available data from GPS, one or more ranges from Trisponder and both hyperbolic and range/range Argo. Although the new ISAH software is powerful and flexible a greater degree of complexity has resulted. Most operators seeing the ISAH for the first time had difficulty finding their way through the many screens and documentation. A new version of the software is being developed which will assemble the most commonly used screens near the top of the directory trees so that novices can operate the instrument easily and quickly.

The Ashtech GPS receiver worked well and was used on an ongoing basis for approximately 6 hours per day to monitor the Argo lane count when the TULLY was outside of Trisponder range. This receiver is simple to use but is limited in versatility, at least in its present configuration. A short report concerning this instrument appears in Appendix C. Twenty-four hour per day differential GPS looks extremely attractive in light of the expenses involved with the Argo deployment and recovery as well as the limited and variable accuracy throughout the survey area.


139°
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AREA SURVEYED 1989
1981-83
1988
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HERSCH
Slave 2
PULLEN
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RELIEF
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BEAUFORT SEA
Range/Range ARGO
Semi Major Axis
95% Confidence Region
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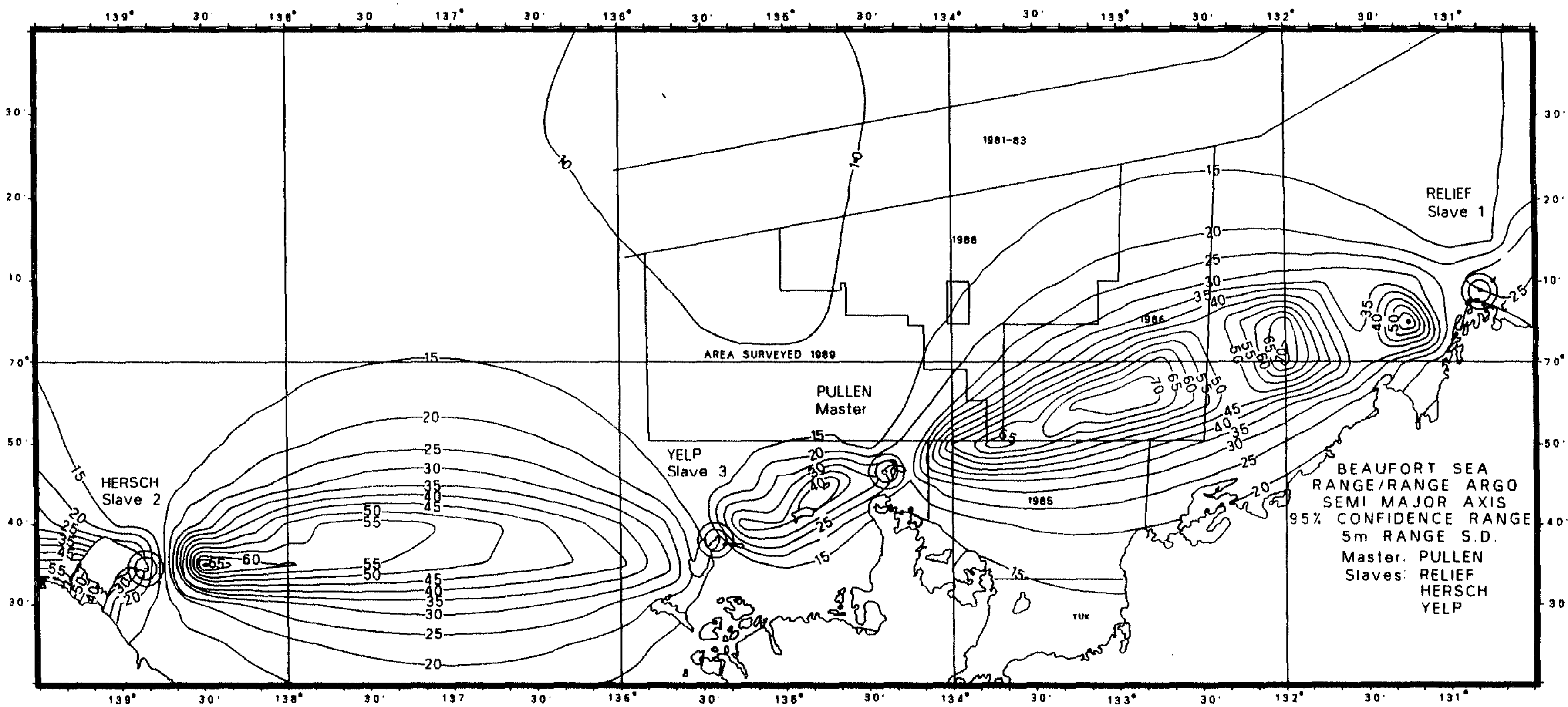

BEAUFORT SEA
RANGE/RANGE ARGO
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Slaves: RELIEF
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RELIEF
Slave 1
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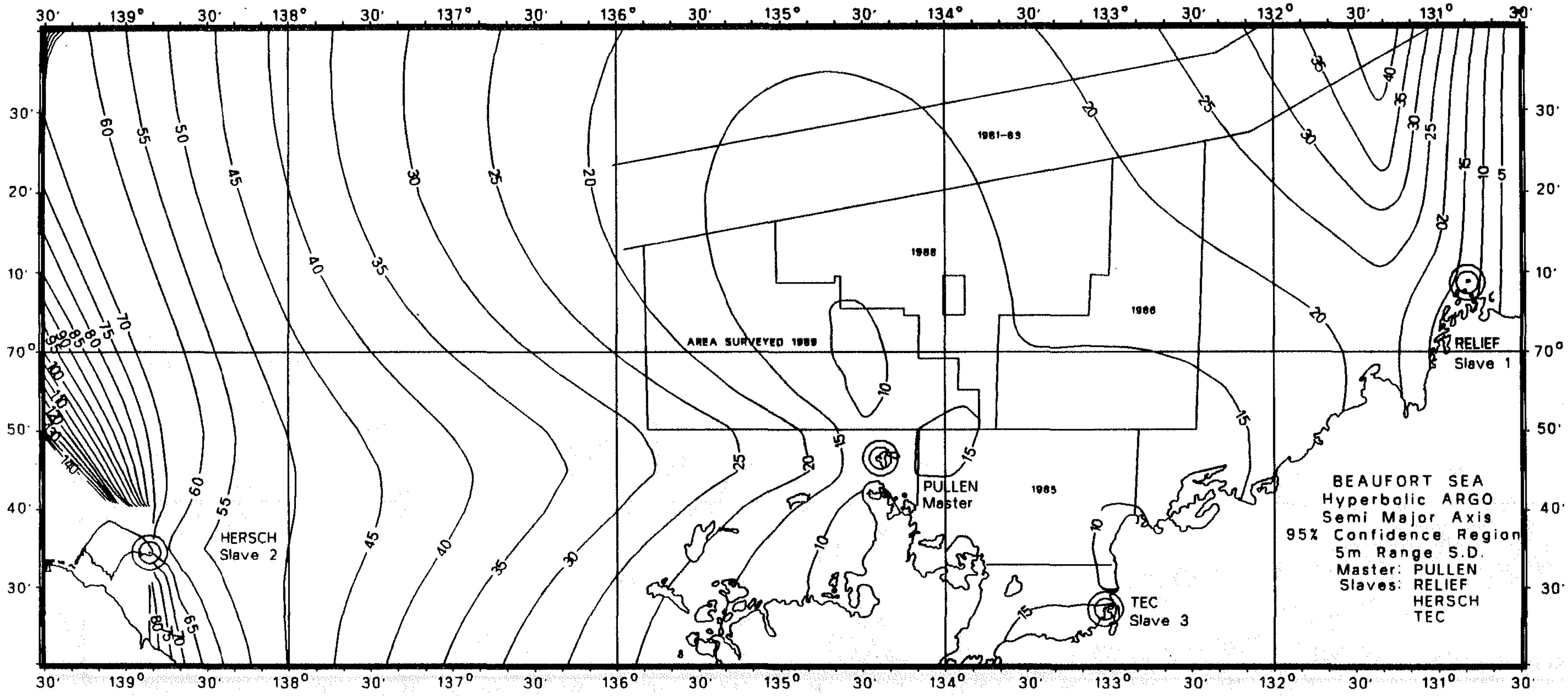
AREA SURVEYED 1989
1981-83
1988
1986
1985
TUK


BEAUFORT SEA
Hyperbolic ARGO
Semi Major Axis
95% Confidence Region
5m Range S.D.
Master: PULLEN
Slaves: RELIEF
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1981-89
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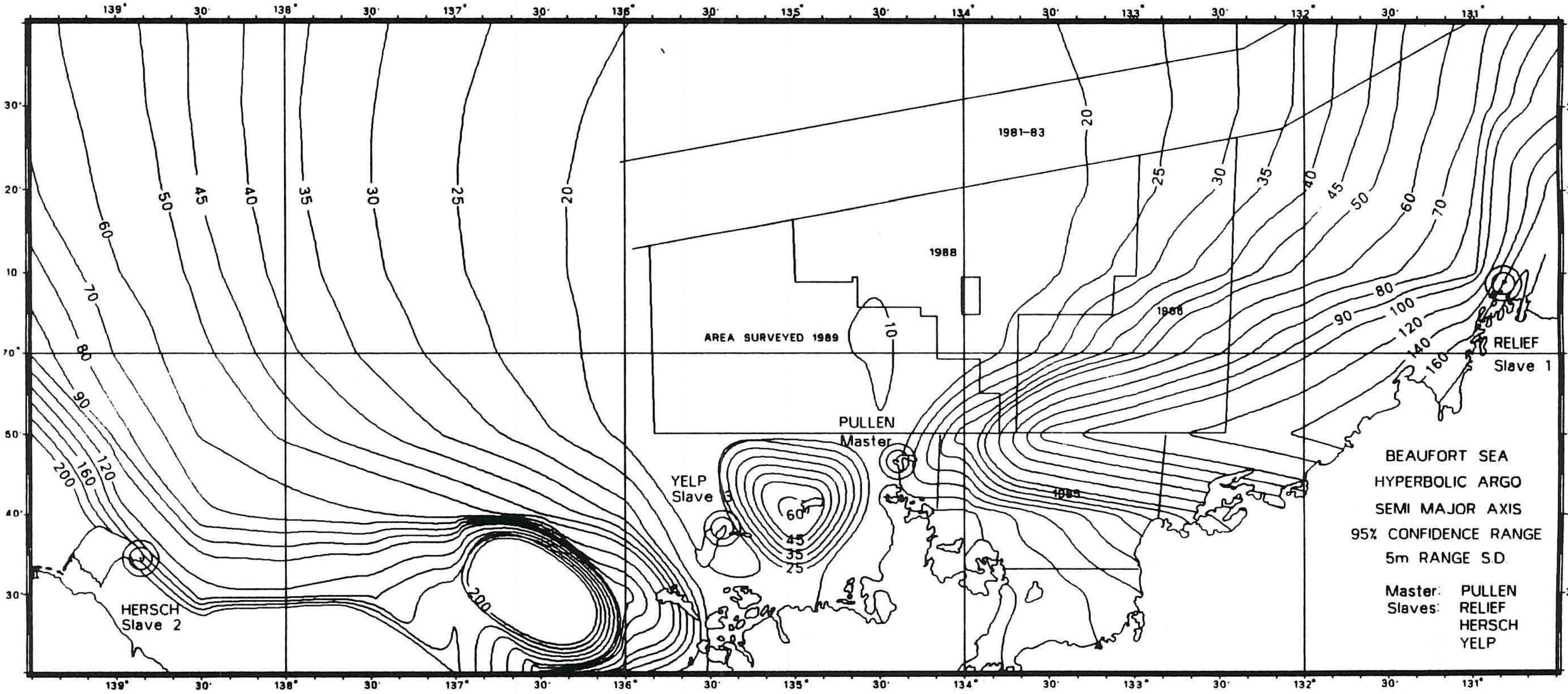

BEAUFORT SEA
HYPERBOLIC ARGO
SEMI MAJOR AXIS
95% CONFIDENCE RANGE
5m RANGE S.D.
Master: PULLEN
Slaves: RELIEF
HERSCH
YELP
PULLEN
Master
YELP
Slave 3
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Slave 2
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Slave 1
AREA SURVEYED 1989
1981-83
1988
1986
1985

9.0 SOUNDINGS and TIDES

The bottom throughout the survey area is exceedingly flat in a general sense. The depth often varies less than one metre over the extent of a kilometre or more. Locally, the ice scoured bottom is rough and ragged. Beside each trough there is a corresponding ridge or mound from the ice burrowing. Five metre depths are encountered near the southern survey boundary while fifty metres of water are found along the corridor boundary some fifty kilometres to the north.

The flat bottom emphasizes sounding errors that would never be apparent on the steeper shores of the Pacific Coast. Soundings did not always agree with adjacent hydrography and the magnitude of these discrepancies was often about 0.3 metres.

Checking the calibration of the TULLY Chartroom DSF 6000 was problematical. There was insufficient depth to do a bar check in the southern part of the survey area and the bottom was too rough to compare leadlines or launch sounders to the ship's sounder, although several attempts were made. A Furuno sounder on the bridge with its transducer close to the Raytheon's, indicates a 0.2 metre difference in draft which is physically not the case. The draft of the ship's transducer was levelled from inside to the waterline and was consistent with the draft marks on the hull, however checklines run with the TULLY indicated that the ship's transducer draft should be increased two to three decimetres to agree with the launch data. Electronic or mechanical reasons explaining this necessary two decimetre offset are difficult to find.

Disagreement of the soundings from the various vessels and resulting convoluted contours could result from the following:

1. Transducer draft vs. vessel speed not accurately known. The launches were not available for these tests prior to the TULLY sailing this season. Squat figures for the TULLY are unknown. These discrepancies can account for two decimetres in the launches and perhaps three for the ship.

2. Gain and Time Varied Gain settings in both the Skipper sounders in the launches and the Raytheon in the Chartroom can effectively move the bottom up or down one decimetre.

3. The speed of sound varied widely in the water column. Fresh warm water near the surface had a velocity of 1460 m/s and the cold saltier water found in depths greater than five metres was closer to 1430 m/s. The launch transducers are always within three decimetres of the surface while the

ship's is approximately 4.5 metres. The velocity being used to reduce the data was 1440 m/s.

4. The DEPPRO processing program has a number of input parameters so that the software best suits the bottom in question. A shoal biasing feature can account for a 1 decimetre variation.

5. The tide gauge is more than fifty kilometres from some parts of the the survey area and the recorded tides may not always be fully representative of the area being sounded.

If the comparison between the various launches and ship used this year was disturbing, comparisons of this year's soundings with previous adjacent and superceeding hydrography was even more so. Although each survey was reasonably consistent within itself,ie. agreement of checklines and different launch shifts, discrepancies of up to one metre were noticed on some field shhet boundaries. The flat bottom emphasizes the mismatch of contours. There are several reasons for this poor fit.

The Low Power Tide Gauge and radio link installed behind Pullen Island provided good data throughout the season. A well known fact is that there is no substitute for having a gauge in the survey area and the on site installation this year was an improvement over previous years in which 67% of the Tuk gauge observations were used. Consequently, tides more representative of the survey area were used this year and may be somewhat different to those used in previous years. Predicted tides varied widely in both height and time from the observed, indicating predominant local meteorological tidal effects. Wind in the survey area was often different than that found in Tuktoyaktuk.

As wind and sea conditions deteriorate sounding operations are carried out by the ship and not the launches. This year was the first time the TULLY was fitted with a heave compensator and the first time heave was measured in a realistic manner. The instrument could not have been used in more apprpriate conditions; rough seas and shallow bottoms where 1 dm. resolution is required. Corrections of one metre or more were found to be normal in seas generated by 20 knots of wind. In the past, in true CHS shoal biased fashion, the shoalest peaks were read no matter what the sea state, consequently areas of poor fit were generally areas that had been surveyed in rough seas. Further information regarding the heave compensator can be found in Appendix B.

Showing soundings to the closest decimeter is particularly hypocritical when soundings are not heave compensated in rough seas and tide gauges are far from the survey area.

The performance of the tide gauge and radio link at Pullen Island exceeded expectations, sometimes providing data at ranges in excess of 35 miles. Unfortunately, the broadcasts were scheduled for the most inopportune times during the day; when the launch shifts were changing and the TULLY was required to be near the area being actively surveyed. The most appropriate time would have been during the night when the ship was involved with running checklines and could have steamed within reception range. Better yet, duplex capability would have allowed the ship to poll the station at any convenient time.

10.0 LAUNCHES

With the exception of the TORONADO which sustained damage when overheated, Bob Noren our launch mechanic, kept the launches running with virtually no down time all season. These reliable boats however need improvements:

1. All the launches should run within a knot or two of each other. The fastest launch ran at close to 18 knots while the slowest ran near 12 knots. Oil coolers fitted to all the launches will solve the overheating problems and thus make the launch speeds more equal which in turn will make the launch scheduling easier and increase survey production.

2. Propellers should be repitched to allow the launches to run at higher engine speeds and lessen the rpm droop in fully loaded conditions.

3. All launches should be fitted with radar. The launches are required to work in foggy conditions every summer and this year was no exception. There was one incident this summer when a launch nearly collided with a Canmar supply boat.

4. The coxswain seats are inadequate. They should be replaced with good quality, fully adjustable seats with fold up arm rests similar to the hydrographer's seats. One coxswain is on extended sick leave due to back injuries attributed to these seats.

5. The wiper motors do not stand up to the service required of them. A better more robust design is necessary.

6. Run solenoids should be changed to stop solenoids.

7. Removable launch roof panels should be added so that engines can be hoisted and changed on board the TULLY.

8. The launches are required to work during dark hours when deployed for 16 hours per day. Therefore, launch navigation lights should be larger and fitted higher above the water. Roof lights above the coxswain and engine compartment would help with the necessary daily inspections and servicing.

11.0 INSTRUMENTS and EQUIPMENT

11.1 Electronics:

Other than the Argo problems discussed above, most of our equipment worked reliably.

The launch radios, Meyers digitizers and Skipper sounders continued to work well as did the HAL loggers and their RAM cartridges. There was always sufficient spares aboard when failures did occur and little time was lost to equipment problems. Further documentation is required for the recent changes in the HAL software. The Trisponder equipment caused no problems except for a master beacon failure towards the end of the survey.

The Raytheon DSF 6000 caused some difficulties early in the August. Two faults were diagnosed. A stylus, although appearing serviceable was not electrically conductive and the performance of a component in an interface board was found to be temperature dependent. Several days effort was required to make this complex sounder operate in a reliable manner.

The 12.5 kHz transducers used with the Raytheon sounder did not function well on the northward voyage. Moderate pitching motion would cause the sounder to frequently lose the bottom. The transducers are to be inspected and replaced if necessary when the TULLY is in drydock at the conclusion of the arctic voyage.

11.2 Processing Equipment:

The rented Microvax computer worked faultlessly. The keyboard for the 4205 terminal required some maintenance and the plotter's pen assembly needed new parts. Ralph Loschiavo reports the Calcomp plotter should receive a midlife refit and updated software.

Creating and storing back-up data was a lengthy and boring job in the field as was the archiving work at the conclusion of the season. An on board 9-track tape capability and worm drive optical disk located at IOS would offer gains in efficiency and productivity. A worm drive device would allow the data to be kept permamently as well as permitting easy access and updating. This four gigabyte capacity is not inexpensive, but the 30,000 dollar expenditure could be shared by other groups at IOS such as Ocean Physics and Remote Sensing, who are also interested in storing vast quantities of data.

11.3 SAIL:

On the trip north the B-SAIL system, which appeared to be working better than in previous years, was in fact not. Data polled every fifth minute was frequently null data, thus requiring extensive file editing of the Gebco and magnetometer data. The gyro interface does not work and the later C-SAIL, sent north for testing, exhibits problems as well. C-SAIL appears to log data correctly but the screen displays do not work. Documentation is inadequate. B-SAIL was used again on the southward voyage and this software continued to show uncooperative characteristics as it always has in the past. Through Dave Gartley's and Kal Czotter's efforts, the program was made to run and log the necessary data but the operation and start up procedure is anything but straightforward. Without Czotter and Gartley the SAIL data required by both the Ocean Chemistry Project and GEBCO would have been unavailable.

12.0 ARCTIC COASTLINE

The coastline on our arctic charts is hopelessly out of date. The coastline is derived from 1950s and 60s photography and is positioned in a control network that is at the least questionable. The coastline erodes quickly and can be substantially different from one year to the next. Features such as Pullen Island bare little resemblance to what is currently shown on Chart 7663. Since the coastline, along with the occasional Racon, is used for radar positioning, correct coastline delineation is of paramount importance. The single biggest improvement that could be made to our charts is to have more up to date shoreline mapping. Much of this data is probably available in digital and graphical form from work undertaken by EMR in the 1980s. Most western arctic traffic traverses the waters between the Alaska - Yukon border and Tuk so priority should be given to this area.

13.0 LIFE ON THE TULLY

Seventy-eight days were spent at sea on this trip and considering there was only one day off in Tuk most of the people dealt well with the shipboard confinement. Operationally, the ship is far more functional than it was in the first years. Most of the crew now have a few seasons hydrographic experience and the launches for the most part are well driven and conned. The deck crew raised, lowered and fueled the boats in an efficient manner. Small changes to the lifting blocks have helped immensly, however bits or staghorns on the rails would help with working the painters in rolling conditions. The positive, cooperative and productive atmosphere on board was in no small way due to Captain John Anderson.

14.0 CONCLUSIONS

If the traditional yardsticks are used the survey must be considered a success. A good quantity of first rate data was gathered and processed by the time the TULLY returned home. Overtime, helicopter time, mobilization costs and demobilization costs were kept to a minimum and no damage was sustained by the ship or her launches. Some new equipment was tested and evaluated. Exceptionally good relations were maintained between the ship's staff and hydrographers throughout the season. For these reasons and more the survey was successful.

However, if a wider view is taken, how much of a success was the survey really? The J.P.TULLY has now completed her 5th voyage to the arctic and she is a splendidly comfortable vessel from which to conduct a hydrographic survey. She is however, undoubtedly expensive and on each of these arctic sojourns, somewhere between 40 and 50 percent of the time is spent in transit; a comparatively non productive data gathering time. There are other alternatives for vessels in the Beaufort Sea and there may be other priorities such as more complete surveys of the Northwest Passage or more up to date coastline that would be of greater benefit to the arctic mariner than the recent surveys near Kugmallit Bay. The CHS western arctic priorities need a review.

15.0 RECOMMENDATIONS

1. All Launches should be serviced and fitted with electronics two weeks prior to sailing to permit testing and training. The launches should all run within 1.5 knots of each other. Other desireable improvements are mentioned in the section on launches.

2. The TULLY needs a test to determine her change in draft underway.

3. A storage room or shelves should be built forward of the electronics room on the hydrographic chart room deck. Spare electronics equipment has obstructed this area for all hydrographic cruises.

4. The tide gauge radio link should have duplex capability.

5. A competent data processor should accompany the TULLY while in transit to and from the survey area. Data is quickly and effectively processed on these passages.

6. The feasibilty of contracting a survey from a charter ship out of Tuk should be investigated. Beaufort Sea surveys are technically straightforward requiring minimal supervision. Stern tow or swath survey technology may be more effective than launches.

7. Side scan sonar or electronic sweeping over abandoned artificial island is required to determine the presence of hazardous petroleum industry debris such as protruding pipes or well heads. There is virtually no chance of discovering these hazards with conventional methods. The CHS with external funding and not the Coast Guard should assume the responsibility for surveying and charting these artificial islands.

APPENDIX A EXCERPTS FROM CDN. SEABED RESEARCH LTD. REPORT ON ABANDONED ARTIFICIAL ISLANDS SURVEY, BEAUFORT SEA

The following report discusses some aspects of the survey of abandoned artificial islands in the Beaufort Sea. Despite statements made in the report, the bathymetric data gathered on this project does not meet CHS specifications. The deficiencies stem from the lack of systematic sounding pattern being run over the entire extent of the submerged features, inadequate line keeping between fixes and questionable positioning for 1:1,000 surveys.

INTRODUCTION:

A pilot program to survey abandoned artificial islands in the Beaufort Sea was undertaken during the period Sept. 1st to 10th 1989. This program was funded by the Canadian Coast Guard (Pacific Region) and administered by the Atlantic Geoscience Centre of the Geological Survey of Canada. The Canadian Coast Guard provided the CCGS NAHIDIK as an operations vessel for the duration of the survey.

Canadian Seabed Research Ltd. (CSR) of Halifax was contracted by the Coast Guard to act as prime contractor for the survey, providing the geophysical personnel and equipment required for the job. A commercial navigation package, SYLEDIS was provided by Canadian Engineering Surveys (CES), under contract to CSR, with Gulf Canada Resources providing the navigation chain at no direct cost to the program.

The primary objective of the program was to collect side scan sonar, subbottom profiler and bathymetric data over representative artificial island sites in the coastal regions, in order to assess the impact of these features on navigable waterways in the Beaufort Sea. Specifically, information relating to the exact location, morphology, depth below sea level, erosion rate and protruding hazard characteristics of these abandoned islands was to be collected.

Despite logistical and weather constraints, this objective was realized through the collection of good quality geophysical data at four representative sites in the central Beaufort Coastal region. The following four islands were successfully profiled: Kaubvik I-43, Issungnak O-61, Itiyok I-27 and Arnak L-30 This survey has resulted in sufficient data for the Coast Guard to determine the exact location, morphology, depth below sea level, erosion rate and any protruding hazards present at the sites.

BACKGROUND

In excess of 80 exploration wellsites including artificial islands and drill ship locations have been abandoned by petroleum companies in the Beaufort Sea since the early 1970's. These artificial islands were used originally as drilling platforms and often were raised-relief granular structures upon abandonment. Very little information exists relating to the fate of these features upon abandonment in terms of their erosion rates, their present day positions and depths and the possible presence of petroleum related debris on the island's surface. Such information is important in assessing the degree of liability that may have to be undertaken by the Crown and/or the petroleum companies in the event that a major grounding and oil spill occurs on such hazards some time in the future.

A previous study, (Harper and Penland, 1987) documents changes in the island's sub-aerial morphology over time through the use of aerial photographs and interpretive line sketches. The study indicates that the islands undergo considerable morphological change before they become sub-aqueous features. A second study, (Gillie, 1988) presents shape and depth information on one island, Itiyok I-27, as well as one useful example of petroleum related debris left on the island's surface. A third study, (O'Connor and Gilbert, 1982), evaluates the feasibility of profiling the submerged islands using a float plane in the Beaufort Sea.

These studies, as well as shipping observations in the Beaufort Sea indicate that these artificial islands represent a present day hazard to navigable waterways in the Beaufort Sea. The significance of this hazard is exemplified by the fact that the 68 metre survey vessel *J.P.TULLY* with a 4.5 metre draft lay hard aground on Kaubvik I-43 for almost 4 hours during survey operations in September 1988.

In order to assess the impact of these sites on navigable waterways, the Coast Guard initiated a pilot study through Cdn. Seabed Research Ltd. to collect bathymetric, subbottom and side scan sonnar images over four submerged artificial islands to determine their present status.

SUMMARY AND RECOMMENDATIONS

The 1989 pilot study to profile the abandoned islands in the Beaufort Sea was highly successful and met all the intended objectives within the ship time allocated for the program. Despite logistical problems with the survey launch and the

Syledis navigation system, the CSR team managed to profile 4 artificial islands, collecting over 65km. of geophysical data along a total of 110 separate lines in the 5 days actually available for surveying. Although the typically poor September weather constrained the survey operations on a couple of occasions, moderate conditions generally prevailed and reasonably good data was collected throughout. It is recommended that future surveys be undertaken earlier in the season. Loss of production due to equipment downtime was minimized by having backup equipment for most of the major items.

From an operations standpoint, the program ran very smoothly: with all gear arriving on time, efficient shipboard mobilization and demobilization operations, minimal downtime due to equipment malfunction and an overall positive working relationship between all concerned onboard. Excellent support from the crew of the NAHIDIK was especially instrumental in achieving the overall objectives of the survey.

The data collected on the NAHIDIK 89 program has already yielded important results. The uncorrected shoal depths for each of the artificial islands would generally found to be between 3 and 5 metres, even despite differing years of abandonment. This depth is shallower (ie., more of a hazard) than what was generally thought to occur. Side scan sonar has also reveallled a number of raised relief targets of unknown origin protruding off the sea floor at the island sites. It is expected that these strong reflectors likely result from petroleum related debris left at the sites upon abandonment. Such debris is hazardous to the structural integrity of any ship grounding on these islands by mistake or incorrect charting. Side scan and subbottom profile data also indicate that sediment transport is presently taking place on the island's crest, whereas, grab samples have confirmed sand and occasional gravel at the profiled sites.

GENERAL RECOMMENDATIONS

The preliminary results of this study indicate that these artificial islands represent a present day hazard to navigable waterways in the Beaufort Sea. In order to reduce the degree of liability to the Crown and/or the petroleum companies, in the event of a major grounding and oil spill, all these islands (in excess of 80 sites) should be surveyed over the next 3 - 4 year period. It is recommended that an initial detailed survey be undertaken (during July/Aug.) at each location collecting bathymetric, side scan sonar and subbottom data with infrequent resurveys occurring inthe future.

In order to organize for a long term survey directive it is recommended that a data base and digital map (ideally in a GIS environment) be created that depicts the location, charting history, island construction details, general bathymetry and ownership of the island. Such a map would serve as a visual planning reference for the island sites to be surveyed. This map is felt important, as it was clear from this summer's program that inadequate positional and general information was available for these sites (ie., some islands had three different geographical positions). The digital map would serve as a base for survey planning and information storage relating to the interpreted hazards. For example, different hazard levels could be colour coded or symbolized uniquely. Also it will be important for pre-planning operations to plot out the accuracy lobes of the positioning system in relation to the island locations in order to organize a survey program that will not be constrained by navigation problems.

Selection of the main operations vessel should be made in consideration of the ability to safely stow, launch and recover at least three hydrographic style launches. The islands maybe split into a nearshore and offshore group due to navigational restraints. In consideration of such an approach it would be wise to utilize a shallow draft vessel for the nearshore work such that the vessel could be in close association with the launches at all times.

The survey launch must be seaworthy and have adequate cabin space to store all the geophysical equipment and four personnel. The launch should be self contained and weather tight and have VHF radio contact with the opperations vessel. A davit would be a useful addition for grab sampling operations. Consideration should be given to two personnel shifts and extended evening surveying for the launch operations.

APPENDIX B TSS HEAVE COMPENSATOR 320 B by Graeme Richardson

A TSS 320 B Heave Compensator was rented for the TULLY Beaufort Sea survey this past season. This device can be connected to virtually any sounder but in our case it was used in conjunction with a Raytheon DSF 6000. The following are some observations from a hydrogapher's perspective.

The User's Manual becomes generally quite clear, providing one repeatedly steps through the instructions on the instrument itself. Several of the instructions have either a different prompt than stated or have a missing step.

Figure 1 is a typical example of the analog record of a relatively flat bottom taken in moderate sea conditions (1-2 m. swell) with the Raytheon DSF-6000 aboard the TULLY. The dark line between 25 and 30 metres is the seabed as measured from the ships transducer. The upper wavy line is the heave centered around the default depth of 4 metres. The solid line above the seabed is the compensated seabed (seabed + or - heave), offset 5 metres above the seabed trace rather than the 2 metre default value. This offset keeps the compensated seabed from interfering with the digitizer verify line or the seabed trace. This depth + or - the offset is the depth sent to the data logger.

In this example, where both heave and seabed relief are moderate, the effect on the seabed trace is evident. The odds of a sharp peak or deep trough coinciding with the top or bottom of a heave is slim. A visual adjustment to manually read depths will give a reasonably accurate generalization of the shape of the seabed. Properly adjusting processing parameters will produce similar results with the digitized depths, although both will tend to be shoal biased throughout.

Figures 2 and 3 combine a rugged, irregular bottom with a large variation in heave (from 1 to 4.5 m.). Visually one could still approximate the shape of the seabed, however it is a nightmare to process the digital data regardless of the parameters used. Either way the result will generally be very shoal biased.

Because of the irregularity of the seabed a shoal being coincident with a heave top or bottom is quite possible. In Figure 3 the shoalest feature by over a metre and just past 15:19, occurs during and near the top of a large heave. Consequently; the uncompensated depth recorded may actually be deeper than succeeding shoals on this example. Note the peaks on the heave line are actually the troughs.

At 10:47 on Figure 2 there is a double-headed shoal. The first head, almost coincident with the trough of a 3 metre heave, appears to be the shoalest on the uncompensated seabed. This incorrectly results in about a 50 metre horizontal displacement of the shoalest peak.

In Figures 2 and 3 an occasional darkening of both the heave and compensated seabed lines can be noticed. This indicates that the instrument has momentarily lost confidence in the zero position of the heave which seems to primarily occur on a rapid recovery from a large heave or when heaves do not have equal ups and downs. A momentary loss of confidence seems to have only a minimal effect on the compensated depth. This also possibly occurs if the sensor is placed too far from the roll axis of the ship. On a heavy roll the horizontal acceleration may look like heave and has an unknown effect on soundings.

The heave and compensated seabed lines can be placed anywhere on the graph above the or below the actual seabed trace. No data logging can be done while making these changes. The heave line can be moved quickly (10 - 15 seconds) should the depths become so shallow that the various traces interfere with one another; which is unlikely to occur on a ship. When sounding in depths of 50 metres, if one chooses the second phase (40 - 90 metres), there should be a quick way to offset the compensated seabed below the seabed trace. Unfortunately, even if one remembers all the steps this is a lengthy and tedious process. First time operators are likely to require twice as much time as those with experience. Another solution is simply to change the the scale to 0 - 80 metres and accept the resulting loss of resolution on the analog trace.

One of the first pages of the User's Manual is a warning about the fragility of the sensor. " A drop of one-half metre is a possible cause of damage." This raises the question of the instrument's ability to survive in a launch environment.

Currently there is no method to test the calibration of the instrument. Virtually every other piece of survey gear is tested before or during the survey to ensure it is working within specifications and the heave compensator should not be an exception. Terry Curran has a number of ideas on how this may be accomplished.

Conclusion:

A heave compensator is an indispensible instrument when sounding in rough seas, particularly in depths of less than 30 metres where soundings are portrayed on our charts at decimetre resolution. The heave compensator should be purchased and permanently installed on the TULLY.

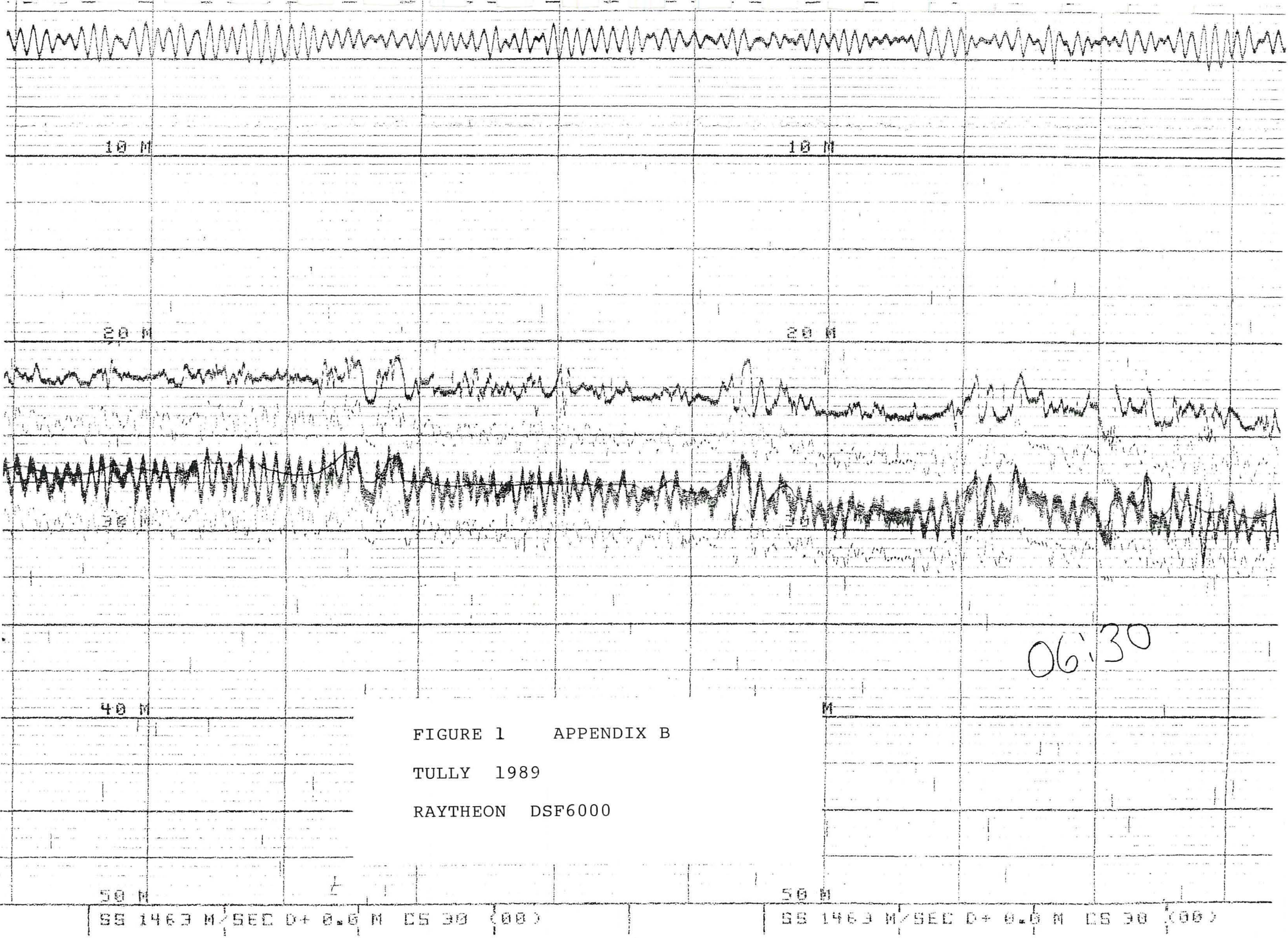


FIGURE 1 APPENDIX B

TULLY 1989

RAYTHEON DSF6000

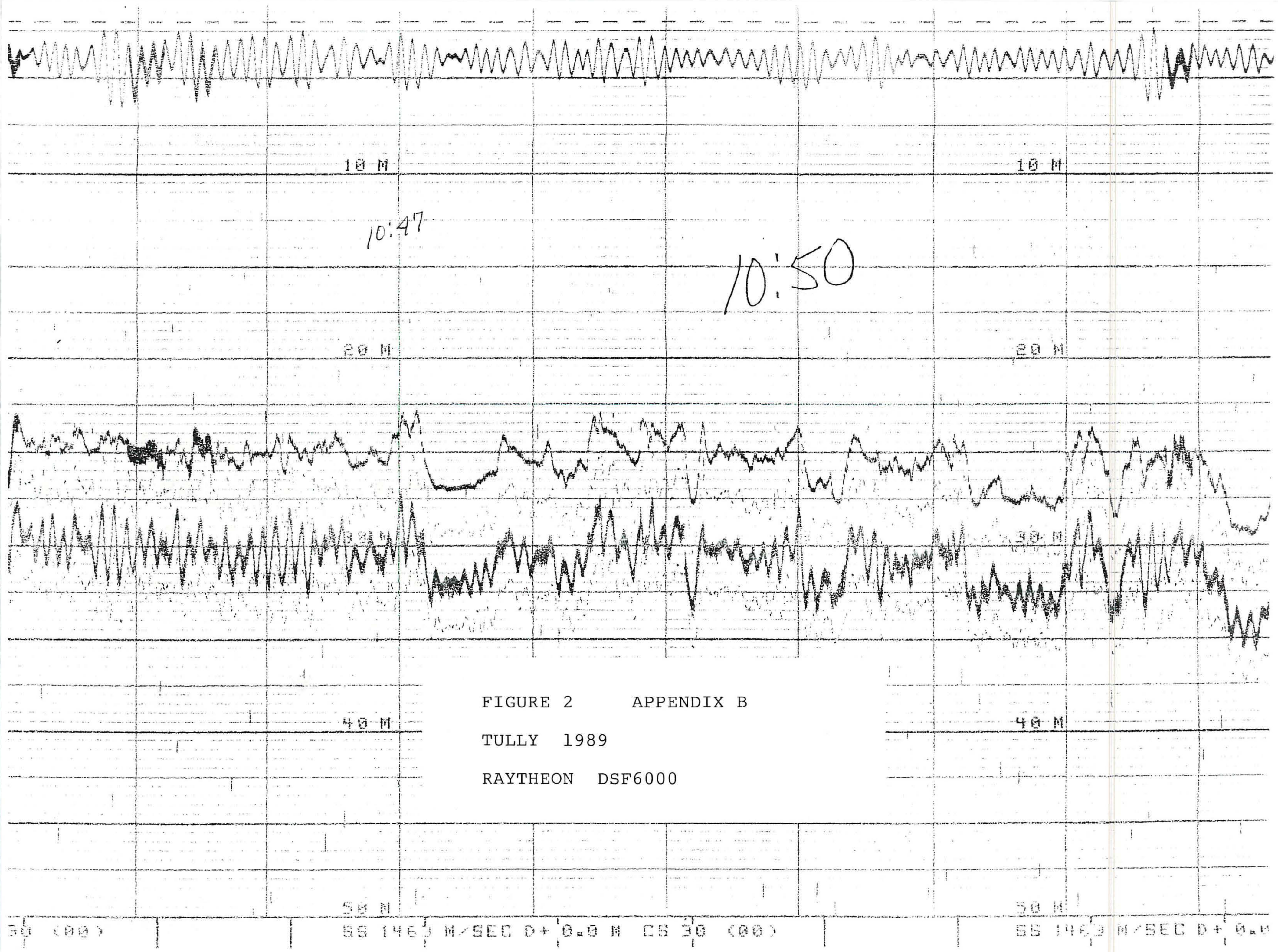


FIGURE 2 APPENDIX B

TULLY 1989

RAYTHEON DSF6000

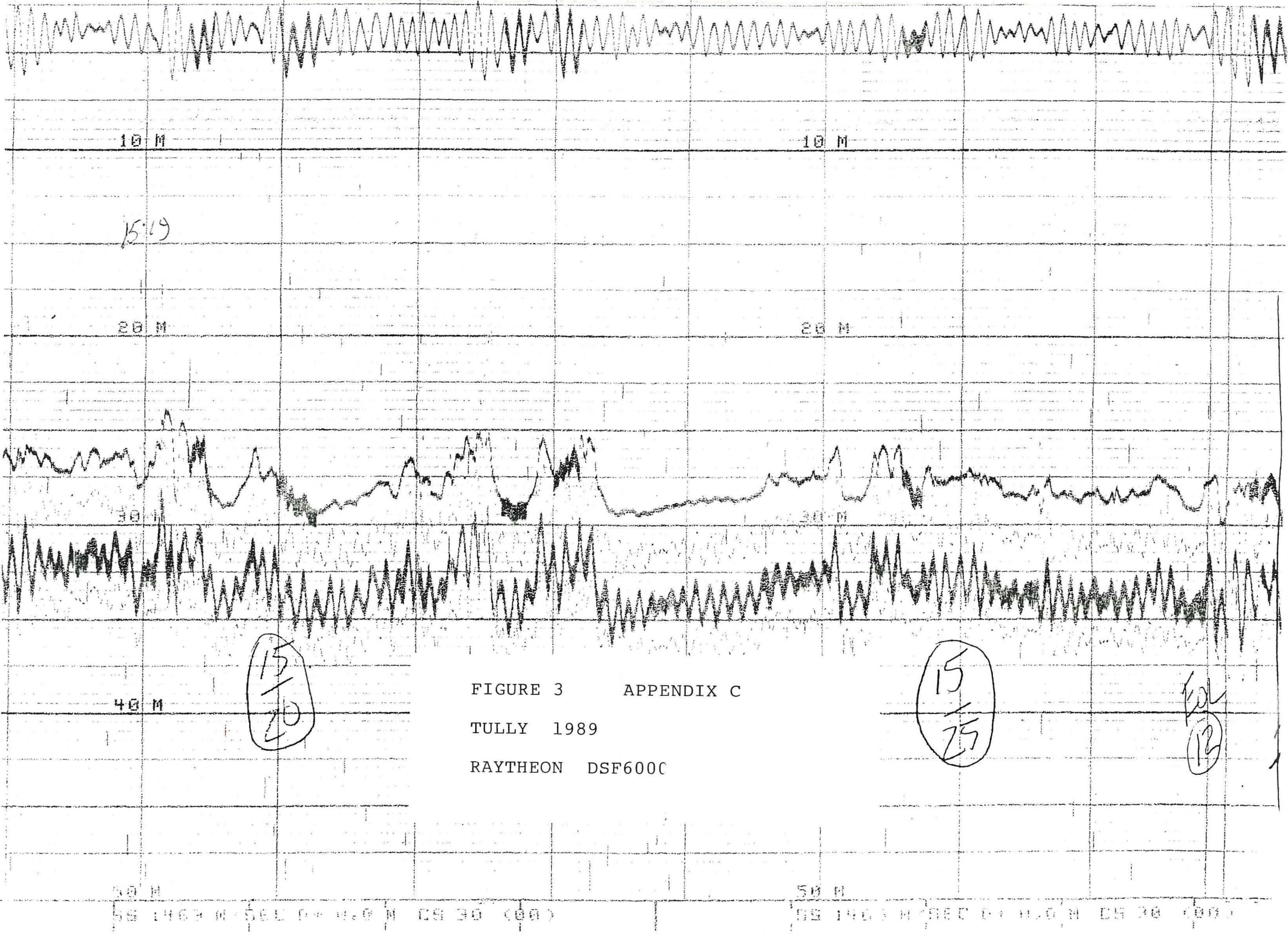


FIGURE 3 APPENDIX C

TULLY 1989

RAYTHEON DSF6000

APPENDIX C ASHTECH GPS RECEIVER by Dave Gartley

ASHTECH XII GPS RECEIVER EVALUATION
Mechanical Aspects:

The Ashtech receiver excelled mechanically. The unit is enclosed in a compact, watertight metal case that measures approximately 9 inches wide, 4 inches tall and 16 inches deep. The front of the unit is dominated by an 8 line by 40 character backlight liquid crystal display which is surrounded on three sides by a 16 key membraned keyboard. The power, antenna and interface connectors, all located on the rear panel, are of good quality and are equipped with covers for protection during transportation. The unit appears very rugged and could prove to be suitable for launch installations.

One of the connectors on the rear panel is a BNC type connector marked SCSI (small computer system interface), but the operator's manual indicates that the software does not currently support this type of data transfer. In fact, the SCSI protocol is a parallel data transfer technique operating at very high bit rates and is therefore impossible with this type of hardware implementation.

The antenna was mounted near the top of the main mast of the J.P.Tully and a cable was run to the hydrographic chartroom where the receiver was located. The antenna mounts in the same manner as the presently employed Trisponder hardware so there was no requirement for custom bracket fabrication as is usually the case with a new system. There was no evidence of any damage or deterioration due to salt water and/or vibration at the conclusion of the survey.

Documentation:

As is too often the case , the documentation, or lack of it, is a major drawback of the system. The operator's manual was almost useless. If there had not been a hand written note attached to the back cover of the processing manual or if the instrument required more than one switch for start up, chances are that I would not have got the system running at all.

The operator's manual briefly describes the appearance of the menus but fails to explain how to program the receiver. There is one menu, presumably for entering navigation way points, that is not mentioned.

There are two serial ports located on the rear panel of the receiver. One port is dedicated to the downloading of data while the other port allows real time logging of position data by an alternate device. The real time position was routed to ISAH and was logged every second whenever there were sufficient satellites to update our position. Amazingly enough, these positions were not time tagged by the Ashtech.

I was successful in downloading files from the receiver to the processing computer with the aid of the supplied HOSE.EXE program. I then attempted to run the data through the processing software. This exercise demonstrated that the software does not support track plotting with a single receiver. The manual verifies this fact and indicates that a geodetic differential set-up employing several satellite receivers is the only configuration supported.

Unfortunately, the processing software compressed the data which prevented me from obtaining any usable data for comparison with the Trisponder and Argo positioning systems. The accuracy of the receiver could therefore not be determined.

It should be noted that there is no facility to feed in a stable frequency reference such as a cesium or rubidium standard, nor is there a way of fixing the height component for work carried out strictly at sea level. Either of these options would decrease the number of space vehicles required for the generation of a position, thereby dramatically expanding the operating window of the receiver.

Conclusion:

The six-hour interrogation window available in the arctic during the summer of 1989 implied that GPS should not be used in this area until a significant number of additional satellites are introduced.

Although the Ashtech XII system harware design has great potential for launch installations and other marine based applications, from my understanding the software available does not presently support our immediate applications and is therefore presently unsuitable.

APPENDIX D OCEAN CLIMATE CHEMISTRY DATA

CRUISE: IOS to Tuktoyaktuk NWT., July 1989 and
Tuktoyaktuk NWT. to IOS, Sept. 1989.

OCEANOGRAPHIC TECHNOLOGIST: Valerie A. Forsland

During the passages from IOS to Tuk and return the following data sample schedule was maintained:

1. Continuous sampling of CO2 and methane in the atmosphere and pCO2 and methane in seawater - analysis every hour. Position and related weather data was logged on the SAIL computer for the durations of the passages. There were no interruptions in the data collection. The system was turned off in Dutch Harbor for maintenance. A pump repair was made on the trip south and the system restarted after a system disk problem was resolved some 18 hours later.

2. Discrete samples from the seawater sampling loop:

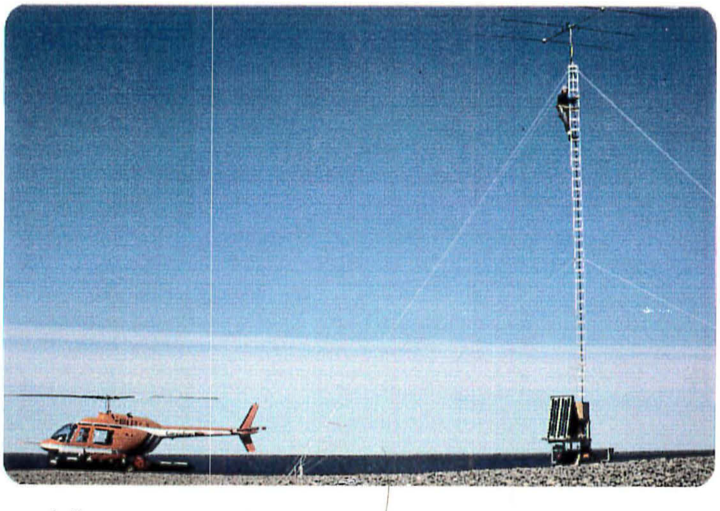
		NORTH samples	SOUTH samples
1) Total CO2	-	50	49
2) Seawater C13	-	50	49
3) Nutrients	-	200	98
4) Salinity	_	50	49
5) Alkalinity	-	49	44

3. Air flask samples - samples for IR (infrared) analysis - CO2 ppm in air - sampled daily at noon and midnight on the southwards voyage for calibration of the GC analysis.

4. Weather observations were made at all stations and during periods of significant weather change. True wind-speed, wind-direction and barometric pressure were recorded every hour; recorded by the observer and by the officer of the watch in the bridge log. Positions and related oceanographic data were recorded on the SAIL system.

ARGO Gear Assembled in Tuktoyaktuk

Chartered Sikorsky S-61 Helicopter



Tide Gauge Antenna


Canada
JOHN P TULLY

FIELD REPORT STATISTICS: MONTHLY ..... FINAL FIELD ..X..

YEAR: 1989 FROM July 12 TO Sept 29

ESTABLISHMENT: C.H.S. HYDROGRAPHER-IN-CHARGE: G.H. Eaton

Project Name	Project Number	Project Number	Project Number	Project Number	Total
1. HYDROGRAPHY Beaufort Sea	7710/89				
2.					
3.					
4.					
No. of Personnel (person days = PD)					
Hydrographers/(3 persons work 3 days= 3/90)	10/563				
Scientists	1/36				
Students	3/153				
Electronic Technicians	3/128				
Ships Officers and Crew	24/1678				
Helicopter Personnel	1/2				
No. of Vehicles					
Ships	1				
Launches	4				
Land Vehicles					
Aircraft (specify type) Helicopter	Bell 206B and Sikorsky S-61				
Hours flown - Transport Canada					
Hours flown - contract	56.7				
Work Record					
Total days in field	81				
Total days actual field work	81				
Total person days worked (staff)	880				
Days lost (weather) ship/launch					
Days lost, other causes (specify)					
Sounding Kilometres					
Launch	24255				
Ship	4784				
GEBCO	10936				
Spot (through ice)					
Total Sounding	39975				
Reconnaissance (track)					
Area Sounded (sq. km.)	2750				
Shoals Examined by:					
Ship					
Launch	27				
Other (specify)					
Total Examination	27				
Navigational Aids Positioned					
Fixed Aids (including ranges)	1 Racon				
Floating Aids	1				
Conspicuous Objects					

Project Name	Project Number	Project Number	Project Number	Project Number	Total
1 HYDROGRAPHY Beaufort Sea	7710/89				
2					
3					
4					
Control Stations					
New stations built	1				
Stations recovered and rebuilt	12				
Tower stations built					
Total stations built	12				
No. of stations occupied	7				
No. of stations permanently marked	1				
Measured, km -- distances	2.9				
- Elevations	4				
- Heights	1				
- Clearances					
Tide and Current Data					
Tide gauges established/recovered (e.g.2/1)	2				
Tide staffs established					
Bench marks established	1				
Old bench marks checked out	3				
Current meters stationed/recovered(e.g.5/4)					
Oceanography/Geoscience					
No. of Oceanographic Stations	106				
Gravity Profile-Surveyed (km)					
Gravity Profile-Track (km)					
Seismic Profile-Surveyed (km)					
Side Scan Profile-Surveyed (km)					
No. Gravity Stations					
Magnetic Profile-Surveyed (km)					
Magnetic Profile-Track (km)	10936				
No. of Water Samples	106				
Bottom Samples, Numbers of:					
Grab - cores e.g. 10-2					
Armed Lead					
Samples retained					
Miscellaneous Items					
Wharves Surveyed					
Shorelining (km)					
Rocks and other obstructions fixed					
No. of Electronic Positioning Sites (Hi-fix Six Argo, etc.)	5 Argo 3 Trisponder				
No. Calibrations - Positioning Systems	continuous				
Low Water line (km)					

Note: Items that are not applicable indicate with a N/A.