North Bransfield Basin: *R/V POLAR DUKE* cruise PD 4-88

Lawrence A Lawver (Institute for Geophysics, University of Texas, Austin, 8701 N. MOPAC Blvd., Austin, Texas 78759-8345)
Heiner Villinger (Alfred-Wegener-Institut, Postfach 120161, D-2850 Bremerhaven, Fed. Rep. of Germany)

During May, 1988, *R/V Polar Duke* collected a total of 2480 nautical miles of digitally-recorded single-channel seismic data in the vicinity of the northern Antarctic Peninsula. In addition, seventeen cores were taken, primarily for thermal conductivity measurements. We had planned to investigate both the Powell Basin (Figure 1) immediately to the east of the tip of the peninsula, and the King George Basin of Bransfield Strait. Unfortunately, multi-year ice coverage of both locations precluded our working in the Powell Basin at all, and allowed only coring and a very limited seismic survey in the King George Basin. Instead of our planned work, we took the opportunity to investigate the North Bransfield Basin and to complete a survey of the Hero Fracture zone that had been begun on a cruise aboard *R/V Polar Duke* in April 1987.

Extension between the Antarctic and Drake plates ceased at anomaly 3 [4.5 Ma] time. Prior to 4.5 million years ago, the North Bransfield Basin was the site of a fairly complicated triple or quadruple junction involving the Antarctic, Scotia, Drake and possibly South Shetland plates. If back-arc spreading had occurred in Bransfield Strait then there would have been a South Shetland plate between the South Shetland Trench and the spreading axis in Bransfield Strait. If on the other hand, Bransfield Strait is only 1.3 million years old as some investigators propose (Barker, 1982), then the Scotia, Antarctic and Drake plates would have met at a fairly standard triple junction prior to 4.5 million years. If subduction stopped or slowed dramatically as it would be expected to when the Drake-Antarctic Ridge ceased spreading 4.5 million years ago, it is difficult to explain the Bransfield Strait as a standard back-arc basin, since seafloor spreading would have started 3 million years after subduction had presumably stopped.

The North Bransfield Basin has an axial deep that appears linear to the southwest but becomes confused as it nears the southwest face of Clarence Island. There is also a lineated magnetic high but it does not coincide with the axial deep. The axial deep seems to step northward until it terminates abruptly at the very steep southwestern face of Clarence Island [61°15'S, 54°W]. We investigated the North Bransfield Basin by running 10 single-channel digitally recorded seismic lines orthogonal to the trend of the basin (Figure 2). We noticed the dramatic change in dip of the beds as we crossed the minor v-shaped depression on line G-H at 0220 (Figure 3). The seismic lines have been arranged so that the axial deep is aligned on each of them and corresponds to the line on the location figure (Figure 2). On line P-O, the v-shaped dip apparent on G-H is hardly noticeable but tilted beds can be detected to the northwest. A different v-shaped dip can be observed about 5 kilometers to the northwest, which again contrasts prominent tilted beds to the northwest of the dip with less prominently tilted beds across the v-shaped dip. We think that the tilted beds are produced by normal faults caused by a general extensional regime in the North Bransfield Basin. The same two sets of tilted blocks seen on G-H and P-O are apparent on M-N. To the northwest of the axial deep as many as three and possibly four southeasterly tilted blocks can be seen on J-I. Since the blocks all seem to be faulted in the same manner whether they are to the northwest or southeast of the axial deep, a cross-section of the North Bransfield Basin is reminescent of Wernicke's model for continental crustal extension. It is not similar to the accepted model for slow seafloor spreading that would have outwarding dipping blocks symmetrical about the axial valley. In the case of the North Bransfield Basin, the axial deep may not be a locus of seafloor spreading but may simply be the normal fault with the greatest amount of throw on it. The bathymetric map (Figure 2) of the North Bransfield Basin shows that some of the normal faults are quite linear and can be traced for 20 to 30 kilometers while the tilted blocks may be only 5 to 8 kilometers wide.

Clarence Island is bounded on the southeast by a linear deep known as the South Scotia Ridge which marks the active plate boundary between the Antarctic and Scotia plates. The Shackleton fracture zone to the northwest is also an active plate boundary between the Antarctic and Scotia plates and crosses Elephant Island. When the Drake plate ceased to exist, the Antarctic-Scotia plate boundary had to adjust to a ~110° bend near the southern point of Clarence Island. Both the eastern half of Elephant Island and Clarence Island are composed of blue-schists, indicating a high pressure, low temperature environment (Dalziel, 1984). We propose that Elephant and Clarence Islands being on the inside of the bend in the plate boundary are being squeezed up while the North Bransfield Basin is undergoing extension because it is on the outside of the bend in the plate boundary.

Acknowledgments

We wish to thank Captain Flight, the officiers and the crew of *R/V Polar Duke*. Karen Schmitt, the project coordinator, and Peter Jorgensen of ITT, were of great help to the science program. This work was supported by National Science Foundation grant DPP-86-15307.

References

Barker, P.F., 1982. The Cenozoic subduction history of the Pacific margin of the Antarctic Peninsula: ridg crest-trench interactions. Journal of the Geological Society of London, v. 139, p. 787-802.

British Antarctic Survey, 1985. Tectonic map of the Scotia Arc. 1:3000000. BAS Sheet (Misc.) 3. Cambridge, British Antarctic Survey.

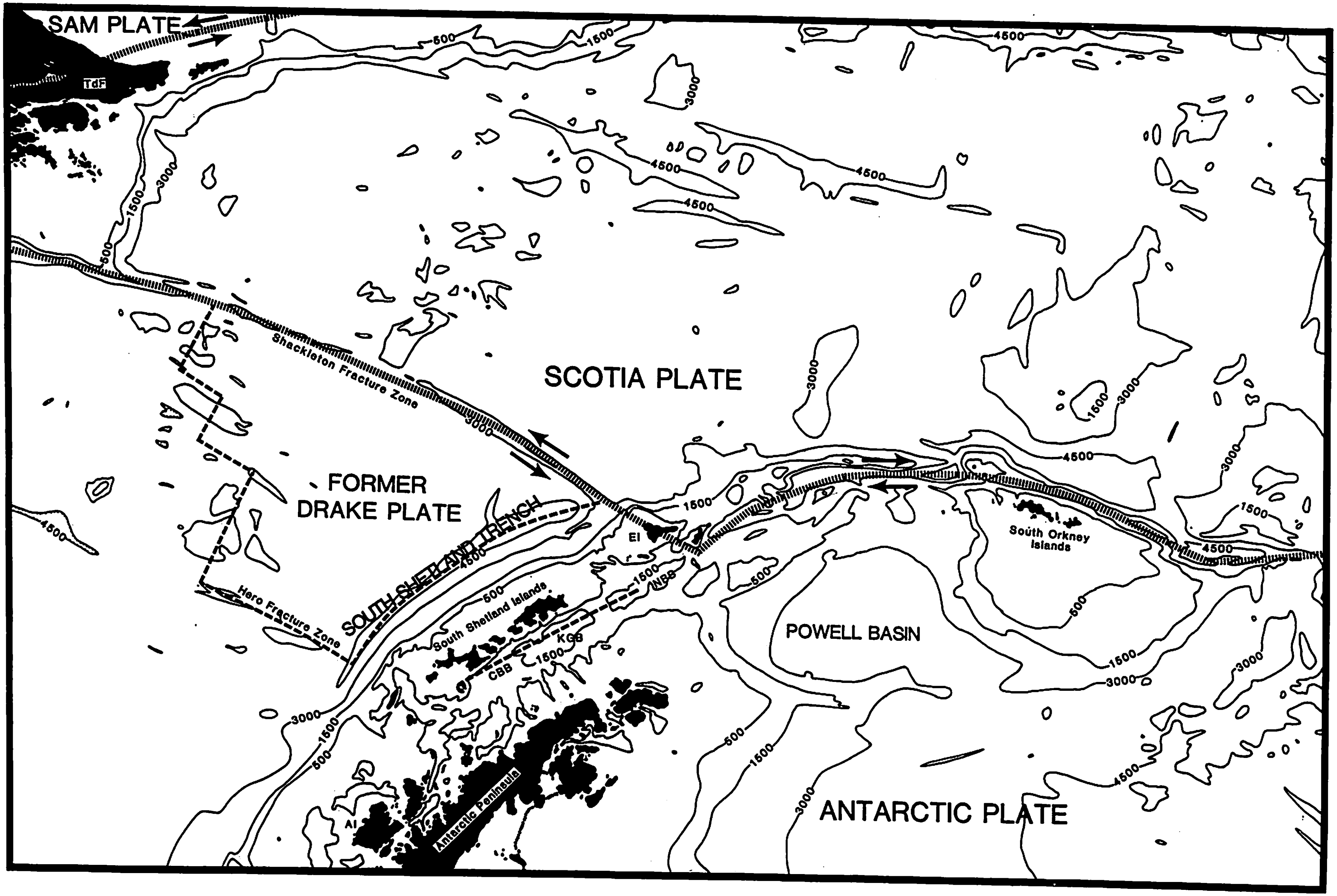
Dalziel, I.W.D., 1984. Tectonic evolution of a forearc terrane, southern Scotia Ridge, Antarctica. Geological Society of America, Special Paper 200, 32 pp.

Figure Captions

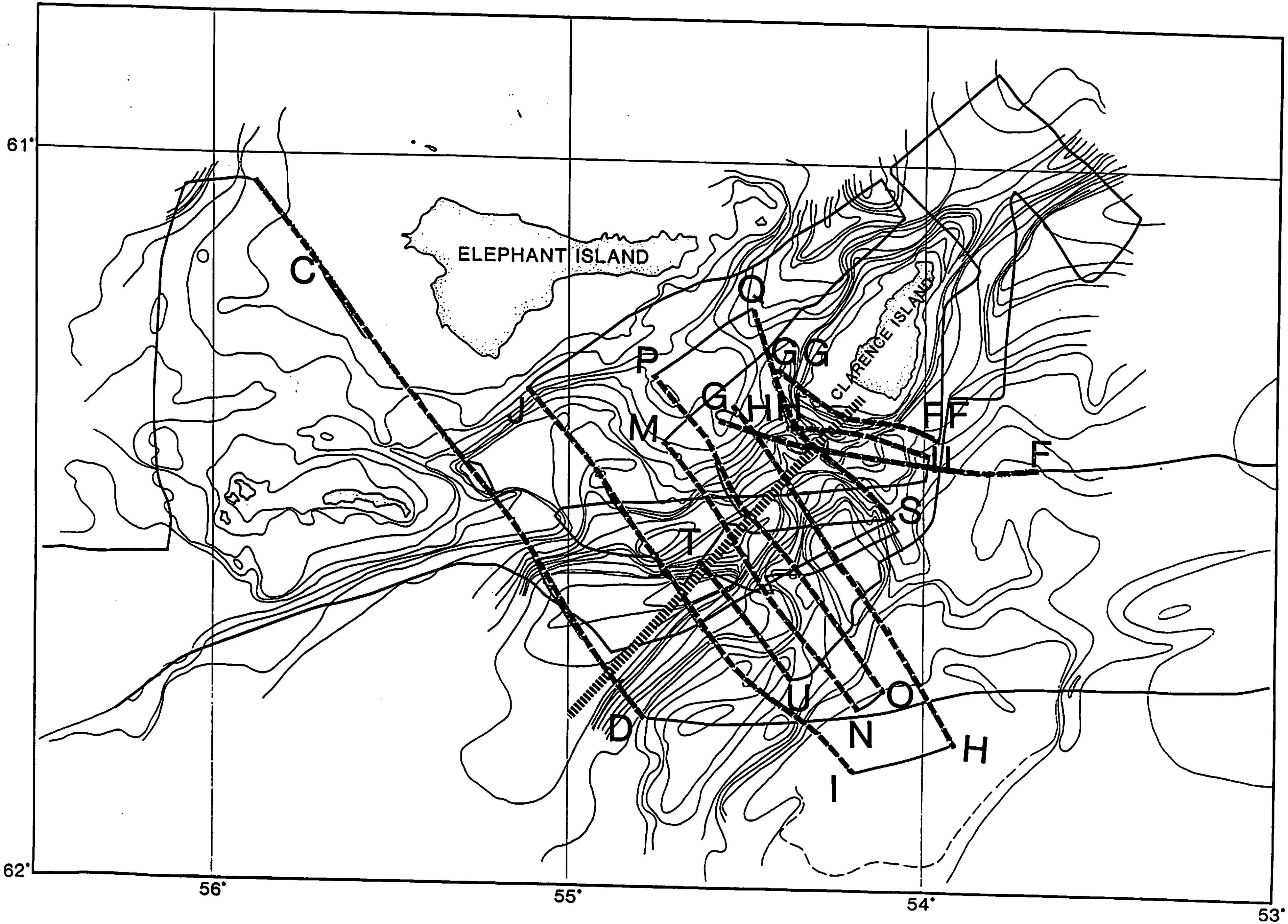
Figure 1. Generalized bathymetric map of the Antarctic Peninsula and western Scotia Sea region (taken from British Antarctic Survey Sheet (Misc.) 3). Contours are in meters. AI = Anvers Island, CBB = Central Bransfield Basin, EI = Elephant Island, KGB = King George Basin, NBB = North Bransfield Basin. Active plate boundaries indicated by heavy dashed line. Former Drake Plate boundaries indicated by lighter weight dashed line. Line of active volcanism in Bransfield Strait indicated by single dashed line. Arrows indicate directions of plate motions along active plate boundaries.

Figure 2. Detailed bathymetric map of North Bransfield Basin. Contour interval is 100 meters. Locations of single channel seismic lines shown in Figure 3 are indicated by dashed line. Axis of North Bransfield Basin used to align seismic profiles shown in Figure 3 indicated by a heavy dashed line.

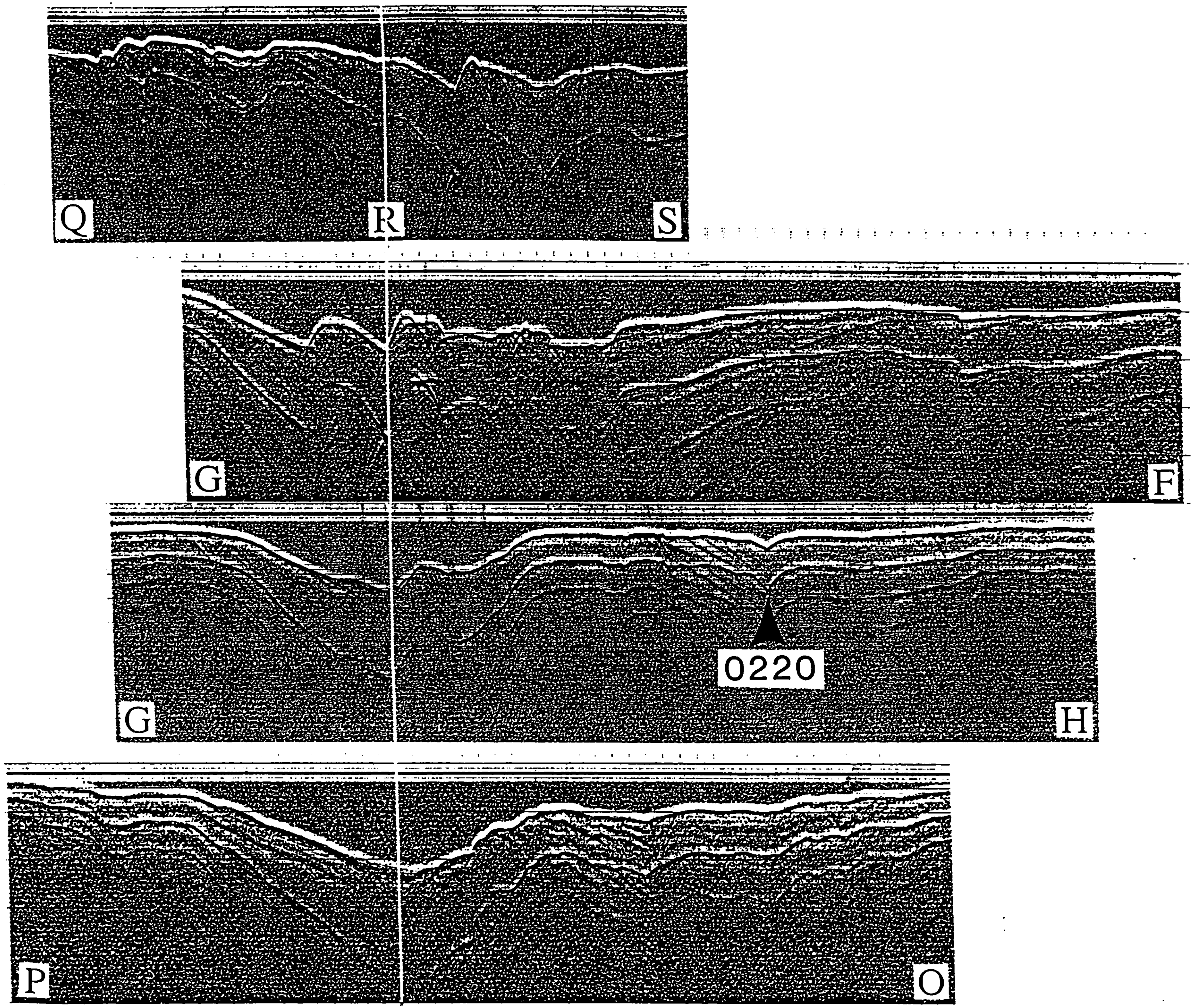
Figure 3. Digitally recorded single channel seismic lines are shown with northwest to the left. Arrow indicates 0220 on line G-H. A prominent multiple is seen on all of the seismic lines.

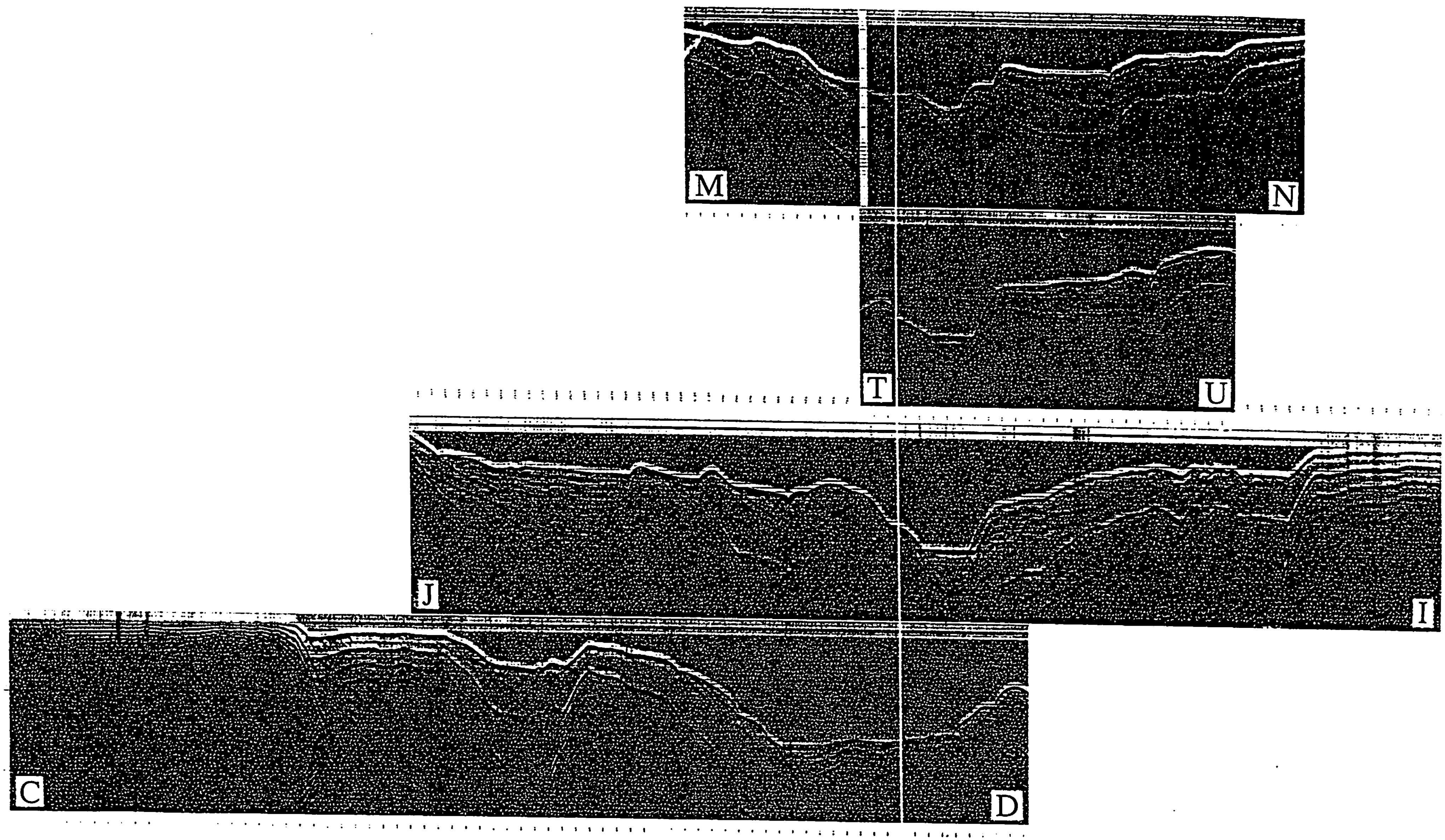


SAM PLATE
TdF
SCOTIA PLATE
Shackleton Fracture Zone
FORMER
DRAKE PLATE
SOUTH SHETLAND TRENCH
Hero Fracture Zone
South Shetland Islands
EI
NBB
KGB
CBB
South Orkney Islands
POWELL BASIN
Antarctic Peninsula
AI
ANTARCTIC PLATE
500
1500
3000
4500



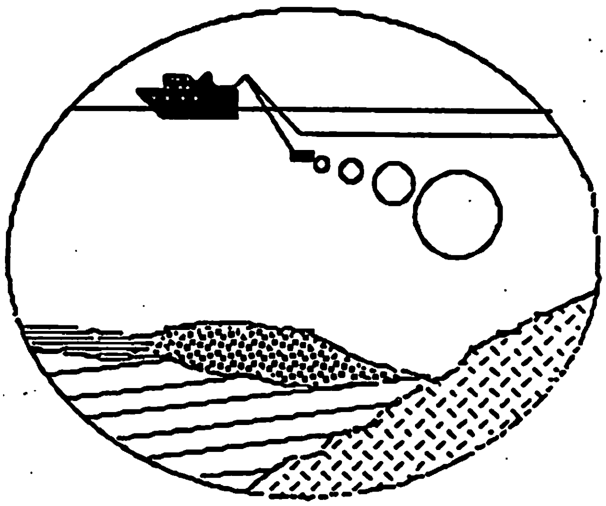
61°
62°
56°
55°
54°
53°
ELEPHANT ISLAND
CLARENCE ISLAND
C
Q
P
J
M
G
GG
HH
FF
F
S
T
U
O
N
D
H
I

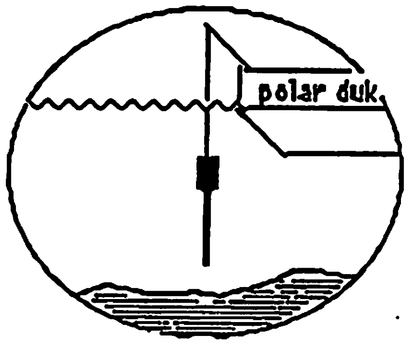

Q
R
S
G
F
G
0220
H
P
O


M
N
T
U
J
I
C
D

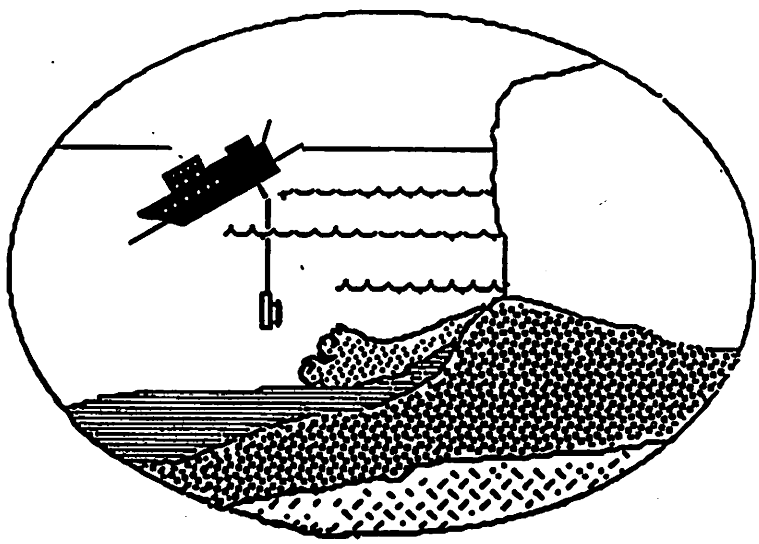
USAP 1988 CRUISE VI
R.V. POLAR DUKE
CRUISE REPORT

Chief Scientist:
Lawrence A. Lawver





Scientific Staff
Dr. Rich Hanson
Dr. Heiner Villinger
Dieter Beike
Dickson Cunningham
Ken Griffiths
Keith Klepeis
Kip Miller
Seiichi Nagihara
Peter Pope
Dr. Ian Dalziel, *in absentia*



30 APRIL 88 — 29 MAY 88

/

CRUISE REPORT 6
R/V POLAR DUKE 04-88

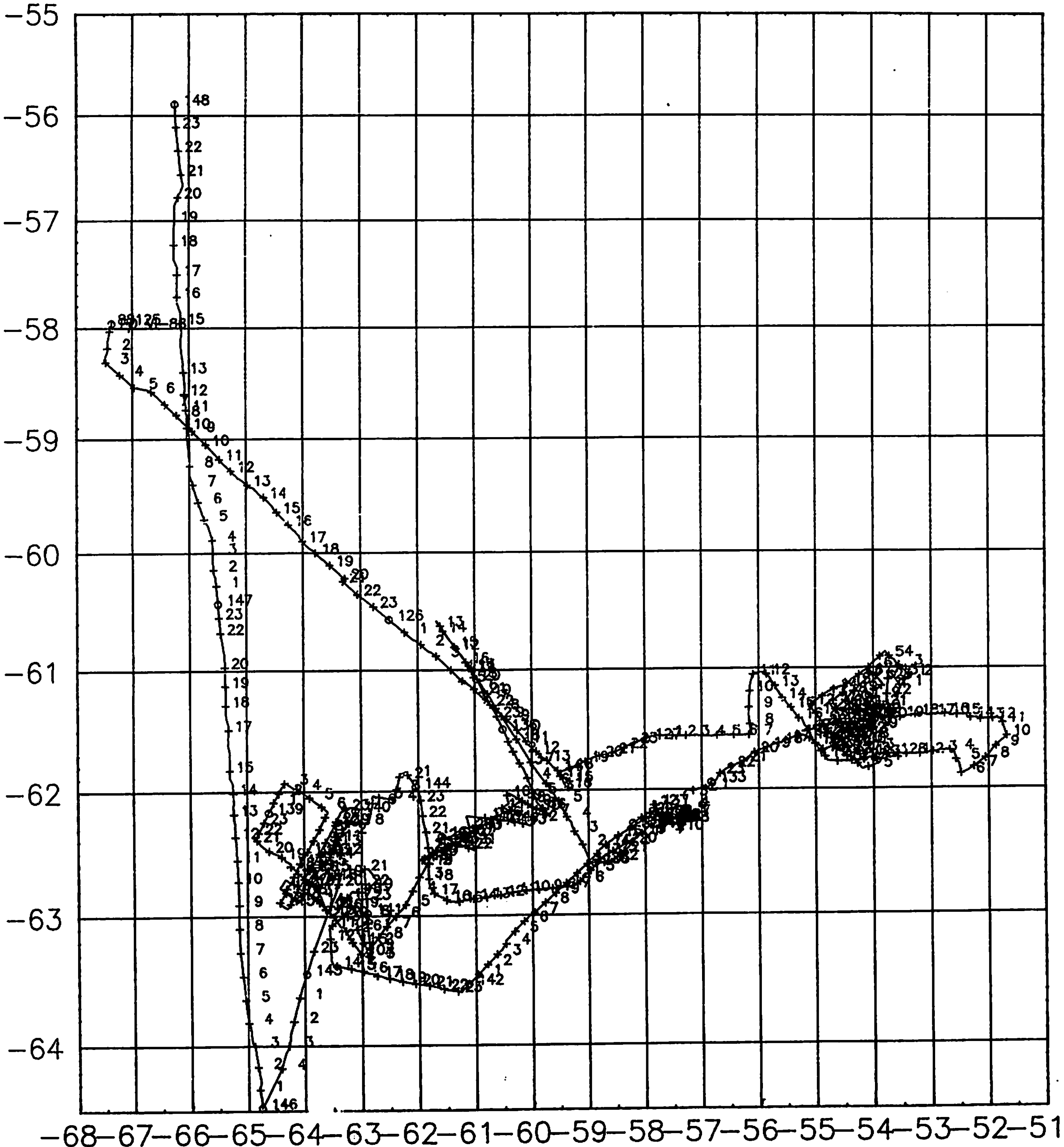
Participants: Lawrence A. Lawver, Chief Scientist, University of Texas, Austin
Heiner Villinger, Research Scientist, Alfred-Wegener Institute, Bremerhaven, FRG
Ken Griffiths, Research Engineer, University of Texas, Austin
Seiichi Nagihara, Research Assistant, University of Texas, Austin
Dieter Beike, Teaching Assistant, University of Texas, Austin
Peter Pope, Research Assistant, Rice University, Houston, Texas

Field Party; Peninsula Hardy, Chile
Rich Hanson, Professor, Ohio State University
Kip Miller, Research Assistant, Ohio State University
Dickson Cunningham, Research Assistant, University of Texas, Austin
Keith Klepeis, Teaching Assistant, University of Texas, Austin

✓

During Leg VI-88 of *R/V Polar Duke's* cruise (figure 1) to the Antarctic Peninsula, a total of 2480 nautical miles of digitally-recorded single-channel seismic data were collected. Seventeen core stations were made and are listed in Table 1. 3151.2 n.m. of underway magnetic field measurements were recorded. In addition to the shipboard work, a field party was left for 25 days at Peninsula Hardy. During the cruise we had hoped to investigate both Powell Basin and the King George Basin. Unfortunately, multi-year ice coverage of both locations precluded our working in the Powell Basin at all, and allowed only coring and a very limited seismic survey in the King George Basin. Instead of our planned work, we took the opportunity to investigate the North Bransfield Basin which may be a junction that connects transform motion along the Shackleton fracture zone and the South Scotia Ridge with extension in the Bransfield Straits. We also completed a survey of the Hero Fracture zone that had been begun by Dale Sawyer and James A. Austin (UTIG) on a cruise aboard *R/V Polar Duke* in April 1987.

The participants from Austin departed on American Airlines flight 574, on the 26th of April 1988. We brought with us a Macintosh Plus but had trouble with it fitting under the seat on the plane to Dallas. In Dallas all the luggage had to be put through the x-ray machine and covered with security tape prior to its being checked in at Dallas. Apparently that did not happen in Houston. In Miami we met with Peter Pope from Houston, and Rich Hanson and Kip Miller from Ohio State. All nine of us flew on Pan Am flight 453 from Miami to Santiago. The flight departed Miami on time and landed in Santiago on time. All passengers were obliged to depart the plane in Buenos Aires with all of their carry-on luggage. We were met by Jimmy Videla F., the AGUNSA agent in Santiago who ushered us through customs with no difficulties. Although we had requested double rooms at the Hotel Monte Carlo we were told that there were not enough rooms and that we had been booked into the Hotel Conquistador. We asked that that be changed, which it was. We wound up in Gran Suites in the Monte Carlo which cost 9900 pesos ($41) for three people. The rooms were quite nice and the Monte Carlo is about one block from the Plaza



NAVIGATION FOR PD VI-88 R/V POLAR DUKE

SCALE=1 5000000 at a latitude of -60

Pergola which is a great place for a beer and snack. The Cafe Biografo which is also near Hotel Monte Carlo is a very nice 'English Pub'. The next morning we were met at the hotel at 0700 by Jimmy and taken in three vehicles to the airport. Breakfast was not included in the cost of the room at the Monte Carlo and should be avoided since a very good breakfast is served on board the LanChile flight to Punta Arenas. The luggage that we had stored at the airport was retrieved without fuss and we checked into the flight. With the exception of two people who got lost with a new driver, there were no problems in Santiago. Heiner Villinger who was to have joined us for the Lan Chile flight, was stranded in Buenos Aires when his KLM flight was cancelled at Buenos Aires because of engine problems. He arrived in Santiago on Avianca and flew on Ladeco the same evening at 1800 to Punta Arenas.

The flight to Punta Arenas was fantastic and those on the left side of the plane saw most of the southern Andes to south of Puerto Montt. There were low clouds from Cap Prat southward. We were met at the Punta Arenas by an agent from Comapa that spoke excellent English. We were taken by van to Hotel Los Navegantes. They insisted that we had reserved six rooms, 5 doubles and a single. With intervention of the agent we checked into five double rooms. I explained to the desk that Heiner Villinger would be arriving on the Ladeco flight. After putting our luggage in our rooms, Rich Hanson, Ken Griffiths and I went down to the ship. We found out that Karen Schmitt, the ITT rep on board the ship was off for the afternoon and evening. After trying to find out what we could about air freight shipments and the condition of gear on board the ship we departed and had lunch. We returned to the hotel to collect the entourage.

I reminded the hotel of Villinger's arrival when I went out for dinner. After dinner I took the graduate students down to the ship and toured the ship. The guard was finally found in the Messhall. We had met some of the crew and Karen Schmitt in Sotito's. Heiner arrived while we were at dinner, the hotel insisted that he did not have a reservation and they knew nothing of his staying with me. Consequently he was put into another single by himself.

On Friday morning, we checked out of the hotel and sent the luggage by taxi to the ship. The rest of us walked to the ship. Once on board we began to discover the extent of the problems with the airfreight shipments. All the airfreight shipped from Rice University had arrived on board the ship. In addition, one box of magnetic tapes had also arrived with the Rice University material. Three boxes of magnetic tapes, one box of Scotch 88 tape, and the two drill pipes modified as heat flow probes had not arrived. These five pieces had been included in a 24-box shipment that included hazardous chemicals for the next cruise as well as a 17-foot long antenna. Either the antenna or the hazardous chemicals caused the airfreight shipment to be diverted from air to sea. We were told that the shipment would arrive in Punta Arenas on Sunday, 1 May 1988. We had hoped to have the necessary boxes sent by air to Puerto Williams and then brought to the ship via the pilot's boat.

We found the underway Geophysics lab in fairly good condition. It had just been painted and was quite neat and tidy, we quickly changed that. From the time that we got on board, Ken and Heiner were extremely industrious in trying to comprehend the convoluted single-channel seismic system. Bob Crimmens, the airgun technician, initially reported that one of the HAMCO waterguns was frozen, it was successfully unfrozen. At 1300 on Friday, Carlos and Jamie Scott, the marine technician began the clothing issue. We were not issued UVic floatcoats as had been the case last year. I feel very strongly that when floatcoats are issued to individuals, they have an incentive to keep them clean. General issue floatcoats quickly become wet and muddy. There is still a shortage of Mustang suits in X-Large sizes. After clothing issue, I accompanied Karen to Patricio Calderon's office at Comapa to learn what we could about the airfreight shipment. At 1600, Karen and I spoke with Bruce Carter. In the interim, Ken and Heiner had determined that a Compaq computer that was supposed to be used with the single channel system, was missing. Bruce Carter reported that the Compaq had been shipped by air from Paramus and that he would try to find it and get it included with the other items sent to Puerto Williams. Steady progress was made by Ken and Heiner in demystifying the single-channel seismic system (scss).

Saturday started with an introductory talk by the chief mate, Fred Flight. We sailed at 1000 on the 30th of April. We learned enroute to the pilot's station that the airfreight shipment had not been put on the ship at Valparaiso and that it was still sitting in Valparaiso. We found that there was a stock of extra magnetic tapes on board *R/V Polar Duke* so decided that we would risk recording on them instead of waiting for our good tapes. We also determined that there was a goodly supply of Scotch 88™ tape on board so did not need to purchase extra in Punta Arenas since our box of Scotch 88™ was also amongst the missing airfreight. If the used magnetic tapes that we recorded the seismic data on, do not give us any post-cruise problems then the lack of airfreight will not have caused irreparable damage [first two tapes seem fine, 17 June 1988]. We passed through Beagle Channel without any problems and dropped off the field party at Peninsula Hardy. The day that they were dropped off was fairly windy and miserable. They did not take with them either a Honda™ generator or walkie-talkies. The lack of both of these would be a problem later on. On the evening of the second of May we left the Chilean pilot at the Pilot Station which meant a six hour back-track and will mean that we have to proceed to the pilot's station prior to our going to Peninsula Hardy to recover the field party at

Peninsula Hardy.

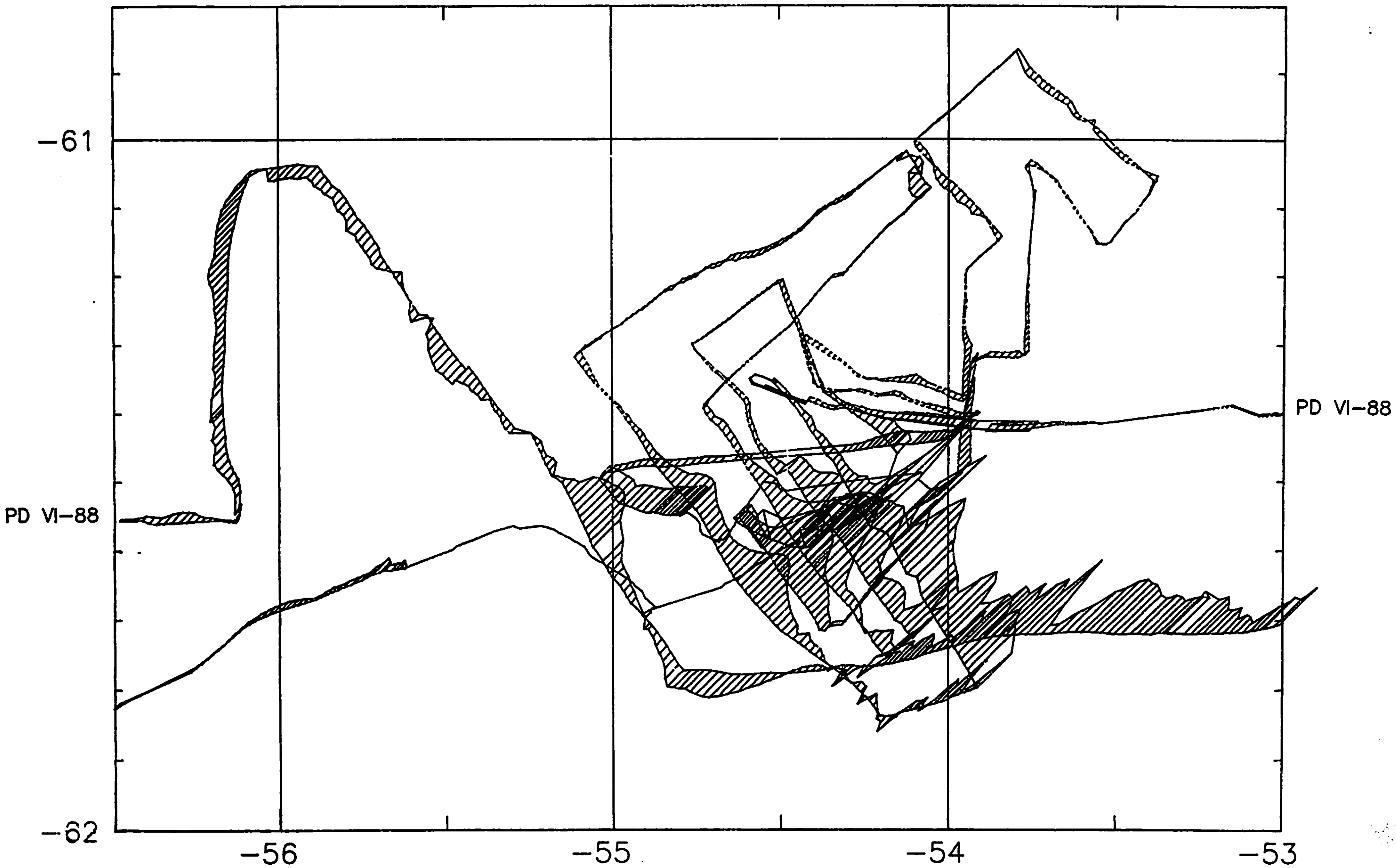
We started across the Drake's Passage on the third of May. It was a rough and unpleasant crossing. We first deployed the magnetometer on the third of May. The connector plugs between the magnetometer cable on the Maggie reel and the cable that connected into the magnetometer in the lab were in poor condition. Ken Griffiths determined that we were not getting a signal from the magnetometer bottle to the recorder. We determined that a splice that had been made on the last (?) trip was wet and the whole system was shorting out. The connector plugs were removed from the magnetometer cable and very crude connections were made when the magnetometer was streamed. The standard connectors need to be replaced on the cables properly so that they do not accumulate moisture and so the system does not short out. The magnetometer cable itself has a number of places where the exterior coating on the cable seems to be bunched up, possibly caused by strain on the cable. As best as we could determine there is not a spare magnetometer bottle on board R/V Polar Duke. The short in the cable was repaired prior to our turning onto our planned track to cross the extinct spreading center at 59°07'S, 65°35'W. We ran across the extinct spreading center and collected a superb magnetic anomaly profile starting just after anomaly 5 (on approximately 9 Ma old crust), crossing the 4.5 Ma old extinct spreading center, and ending at anomaly 6 (20 Ma) just prior to the South Shetland Trench (SST). We slowed to deploy the seismic system at 2006z on the 4th of May. We began to record single-channel seismic data at 2140z (04 May 1988). We crossed the SST between 0800 and 0900z on the 5th of May. It reached a depth of 5062 meters (750m/s assumed water velocity, uncorrected). The 12kHz echo-sounder worked well in all water depths if there was not a beam sea. The 12kHz works best with Low Power output set at 10 with the receiver output power set on square wave and varied between about 3 (for shallow water) to 6 (for deep water). Our course had been 135° from when we turned onto the crossing of the extinct fracture zone at 0300z [04-05-88] until 1500z [05-05-88] when we turned to 070° to proceed along the western margin of King George Island for a seismic line for Peter Pope. When we had cleared King George Island we headed for Powell Basin with a slight detour to collect seismic crossings of Eadie Island and Elephant Island for Ian Dalziel. Both profiles were moderately disappointing since the shallow water depth did not lend itself itself to very deep penetration. In fact, except for the ubiquitous recent flat-lying sediment cover both islands seemed to be bedrock fairly close to the surface. We then crossed the North Bransfield Basin orthogonal to its tectonic trend and headed for Powell Basin.

At 0400z [7 May 1988] we turned to a course of 160° to cross Powell Basin. Less than two hours later we were forced to change course to 055° in order to run parallel to the ice edge. The water depth had dropped off from 450 meters on the shelf near Clarence Island to 2490 meters when we had to change course. At 0805z we were forced to turn to 035° and by 1010z we were on a heading of 320° to stay out of the ice. We were ultimately forced to 265° which was back towards Clarence Island. On our return we estimated that the ice edge was being driven north at greater than a knot since it then covered areas that we had just crossed earlier in the evening. Since the Powell Basin was out of bounds for any seismic surveying and coring we retreated to the North Bransfield Basin (NBB). In the end we made seven complete or partial crossings of the NBB, orthogonal to its tectonic trend.

The tracks covering the North Bransfield Basin are shown in figure two. Dalziel (1984) reports pillow basalts from the southwest end of Clarence Island. We were able to follow the trend of the North Bransfield Basin directly into the southwestern end of Clarence Island. The large magnetic anomaly seen in figure 2 does not follow the deepest part of the basin as the basin steps northeast towards Clarence Island. Besides the seven orthogonal crossings of the NBB we also ran two long lines and one short line parallel to Elephant Island to see if we could find an expression of the Shackelton fracture zone since Dalziel (1984) postulates that the Shackleton fracture zone crosses Elephant Island and continues into the NBB. We did not see anything on our lines that appeared to be a crossing of the Shackelton fracture zone.

We ran one additional survey to the east and northeast of Clarence Island hoping to map the South Scotia Ridge which is the transform boundary between the Antarctic and Scotia plates. As we were attempting to return to the NBB we were almost caught between the advancing ice from the Powell Basin and Clarence Island. We retreived the seismic gear at 2211z on the 10 May 1988. We then took four cores in the NBB along our seismic lines. Areas of NBB which had previously been clear were now covered with drifting multi-year ice. The four cores are stations 1 through 4 listed in Table 1. On completion of the fourth core we streamed the seismic gear and the magnetometer and got underway (1804z 11 May 1988) for the King George Basin (KGB). As we approached the eastern end of King George Island we encountered very heavy ice cover and eventually had to pull in the gear (0524z 12 May 1988) as the wind-driven ice covered our track. We then spent two days piston coring in KGB and got excellent recovery with three cores with over 570 cm each recovered, see Table 1, stations 5 through 9.

At 1236z on the 13th May 1988 we again streamed the underway geophysical gear (UGG) to survey the central Bransfield Strait in hopes of finding an ice-free region to the south. The ice-edge effectively kept us islandward of the central Bransfield Basin. At 2315z we heard during our daily radio contact with the field party on Peninsula Hardy, that



MAGNETIC ANOMALIES FOR NORTH BRANSFIELD BASIN

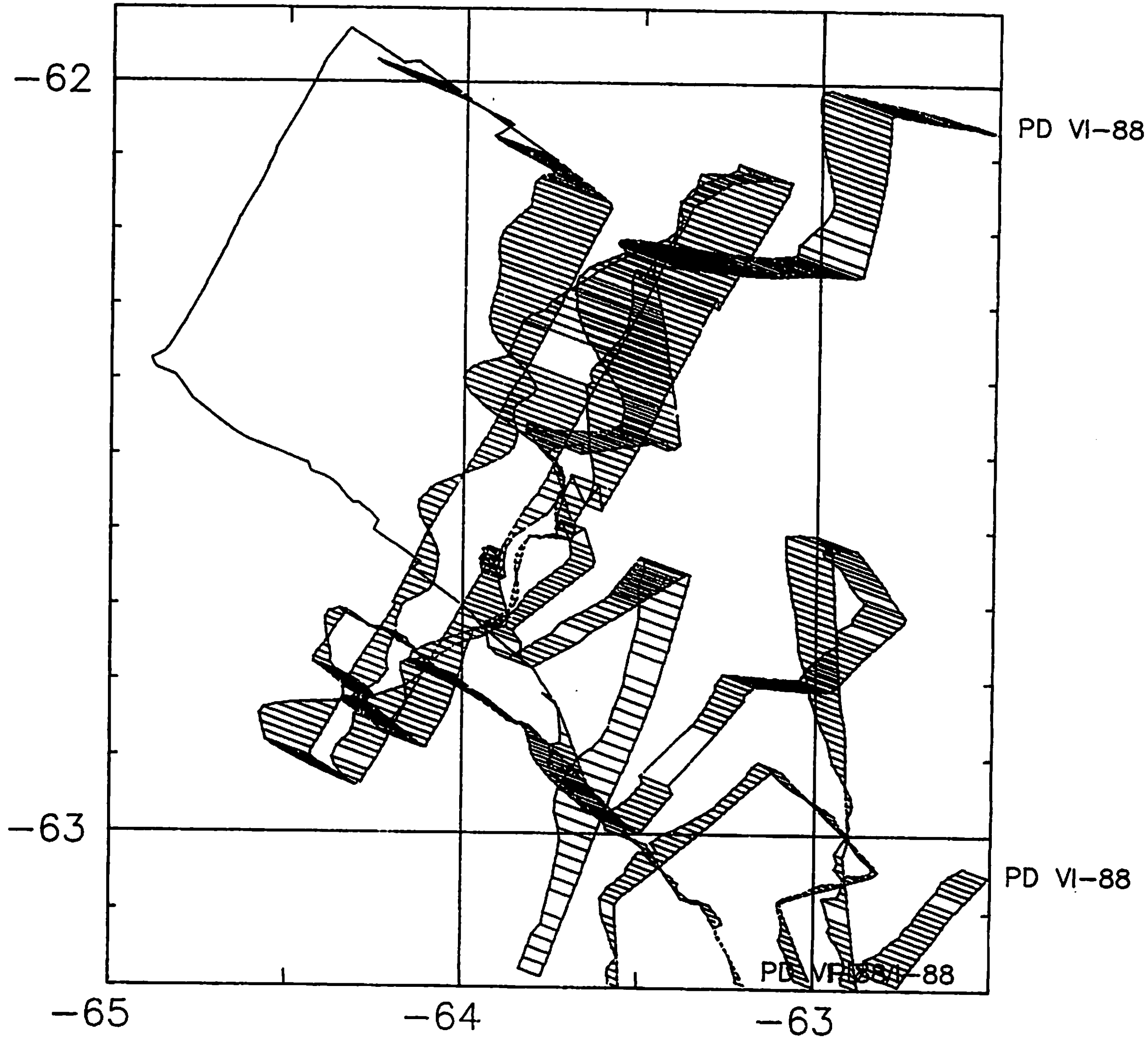
SCALE=1 800000 at a latitude of -62

one of their Zodiacs™ was overdue and that three people were not at camp. We broke off our surveying operations at 2352z and headed full-speed to Peninsula Hardy. At 1410z (14 May 1988), the missing zodiac returned to basecamp and we changed course to return to the shelf area off King George Island. We streamed the magnetometer then and later streamed the seismic gear as we approached the South Shetland Trench (1726z 14 May 1988). We then surveyed the margin looking for coring sites for Peter Pope. At 1630z on the 15th of May, we retrieved the UGG and began coring operations. While we did not expect good results on the margin because of the coarse nature of the sediments we were actually quite pleased with the results, see table 1, stations 10 through 17. At two sites we recovered cores of 220cm and 241cm.

At 1053z, we began a survey of the Hero Fracture Zone and Smith Island region. During an R/V Polar Duke cruise in April 1987, Dale Sawyer and Jamie Austin initiated a seismic survey of the Hero fracture zone. We attempted to trace the Hero Fracture Zone into the South Shetland Trench. Figure 3 shows our tracks in the vicinity of the Hero Fracture Zone. While the Hero Fracture Zone had a distinct bathymetric and magnetic signature and traces of the magnetic signature can be seen in the trench, there is no evidence that the Hero Fracture Zone extends across the trench and interacts with the upper plate. At 1500z on 17 May 1988, the magnetometer connection became wet and ceased to function properly. The cause was not determined until 0430 on 18 May 1988. The connection which was made by stripping back the wires and twisting them together worked satisfactorily for most of the cruise but is not recommended as standard practice.

Upon completion of the Hero Fracture Zone survey, we again attempted to survey King George Basin. We made two long transits up and down the central Bransfield Strait. We were only able to get two short passes across the northern King George Basin and decided to return to one last pass of the Hero fracture zone to map the South Shetland Trench in the immediate vicinity of the Hero Fracture Zone. There are major magnetic anomalies along the length of the Bransfield Strait which are not consistent with a simple 'back-arc' extensional picture as has been always assumed for Bransfield Strait. We will combine our three lines in the Bransfield Straits with those of John Anderson (October 1986, RUBBS-86 cruise on *R/V Polar Duke*). The seismic gear was retreived at 1810z on the 23rd of May 1988. For the most part the seismic gear worked flawlessly. The Hamco airguns are quite reliable and the Glycol system keeps them from freezing up. The streamer seems to work well but a better streamer could probably be found.

After the CTD winch was tested for the next cruise, we deployed the magnetometer again (1940z 23 May 1988) and headed for Palmer Station. The magnetometer was retreived at 0400z on the 24th of May 1988 and we arrived at Palmer Station at 1230z (24



MAGNETIC ANOMALIES FOR HERO FRACTURE ZONE

SCALE=1 1000000 at a latitude of -62

May 1988). We departed Palmer at 1900z the same day and headed for Peninsula Hardy. After we passed the South Shetland Trench we deployed the magnetometer at 0912z (25 May 1988) and had a fairly rough crossing to the Pilot station at Cabo de Hornos. The magnetometer was secured at 0015z on the 27th of May. We arrived at Peninsula Hardy at first light on the 28th (1230z). We retreived the field party. They left their camp meticulously clean. We returned to Punta Arenas, arriving at 0200z on the 29th of May after a spectacular passage through the Beagle Channel.

We feel that this was an extremely successful cruise which has given us valuable information that will shed new light on the plate junture between the Shackelton Fracture Zone, the South Scotia Ridge and the North Bransfield Basin. We also were able to complete the Hero Fracture Zone survey. Without the competent and cheerful help of the ITT personnel and the ship's crew we would not have been successful. In particular, we would like to thank Captain Henry Flight and the real dedication and hardwork of Karen Schmitt.

PD VI-88 CORING OPERATIONS

Coring operations during *R/V Polar Duke* cruise VI-88 went very smoothly once a workable technique was developed. The technique employed on cruise VI-88 can be improved. In all, fifteen of seventeen cores were successful and there were no pre-trips on any of the piston cores.

Thirteen new core barrels were sent down from Rice University by John Anderson. Unfortunately they were a little too large in diameter and did not fit the existing stainless steel collars attached to the weightstand.Peter Pope machined one of the four collars such that it now has a slightly larger inside diameter so that the new core barrels fit. There was still a problem with the new core barrels fitting into the collar on the weightstand. Peter borrowed a disc sander and the appropriate grinding disk and ground down the ends of two of the new core barrels to fit the weightstand collar. It was then discovered that the new core barrels had six holes drilled in them for the dog screws while the weightstand collar only had four holes drilled in it. The new cutter noses also had six holes drilled in them. Since all of the old coring equipment had four holes and the new six holes they mate but with only two holes in common. We were concerned that only two dognosed screws holding the core barrel to the weightstand might not be enough. Consequently we used one of the old core barrels at the top and then a new core barrel below using the machined collar. At the first core site, which was in the North Bransfield Basin, an unknown coring location we attempted a two barrel gravity core. The upper core barrel (old) bent, but we were able to recover 254.5 cm of core. At the second site we attempted a one barrel gravity core using another old 4-hole core barrel. At station two, 221 cm of material were recovered. On the fourth core most of the material was washed out and we decided to go to piston coring since we had no stopper valves to retain the gravity core material.

Part of our initial reluctance to use the piston core apparatus, apart from the additional time required to piston core as opposed to gravity coring was a problem with fitting the piston in the core liners. The rubber 'O-rings' would be compressed too much if the two pieces of the piston were tightly screwed together. If they were not tightly screwed together then they came apart and we lost part of the piston on one of the first stations. With the 'O-ring' compressed the piston would not clear the entire length of the clear plastic core liner. Heiner Villinger solved the problem by having the engineers make up some copper spacers that were placed inside the 'O-ring' so that the two parts of the piston could be tightened together but the 'O-ring' was not "over-compressed". Silicone grease was used on the 'O-ring' to help it slide through the liner. It was not determined whether the problem occurred with the old or the new 'O-rings'.

Chain was used to attach the trigger core to the trigger arm. The piston core set-up was assembled on deck prior to the bucket being tilted upright. The trigger core was lowered by rope using a capstan. This was not satisfactory and we would recommend that the 'chain' be attached to one of the airgun winches and lowered by winch. When it fully overboard the trigger core and chain could then be shackled to the trigger arm. On the second piston core (station #6) the bale on the weightstand snapped off. Luckily this occurred prior to the core assembly being removed from the bucket. Apparently the bale had been "supercooled" when it had been welded to the weightstand and when the coring wire lifted the weightstand to a vertical position it snapped off. We replaced the stand with another that was secured on the fantail.

The other major problem with the coring gear occurred with the new core retainers. Several of the new core retainers disintegrated with use. Initially the problem consisted of the thin stainless steel 'teeth' which had been welded to the steel ring that fit over the end of the core barrel and was held in place by the cutter nose came apart at the weld and would not retain the core material. At least twice the 'teeth' separated completely and were lodged in the core itself, up to 2 meters up the core liner. Five core retainers failed before two acceptable ones were found. They then worked well until the end of the coring operations.

The seventeen core stations are listed in table one. In general we would say that the coring was extremely successful.

R/V Polar Duke Coring Stations

Sta. No.	Date	Time	Lat. °S	Long. °W	Type	Recovery
1.	11May88	0144z	61°35.341'	54°41.640'	6-meter gravity core	254.5 cm
2.	11May88	0420z	61°30.126'	54°32.941'	3-meter gravity core	221 cm
3.	11May88	0803z	61°29.317'	54°05.029'	3-meter gravity core	255 cm
4.	11May88	1305z	61°41.819'	54°54.206'	3-meter gravity core	57 cm
5.	11May88	1753z	62°15.638'	57°28.986'	6-meter piston core	572 cm
6.	12May88	2103z	62°13.043'	57°35.487'	6-meter piston core	300 cm
7.	13May88	0102z	62°15.623'	57°37.542'	6-meter piston core	277 cm
8.	13May88	0409z	62°14.893'	57°38.441'	6-meter piston core	569 cm
9.	13May88	0819z	62°18.664'	57°43.597'	6-meter piston core	595 cm
10.	15May88	1740z	62°32.723'	61°53.259'	3-meter gravity core	57 cm
11.	15May88	1953z	62°32.834'	61°53.868'	6-meter piston core	32 cm
12.	15May88	2112z	62°27.080'	61°28.960'	6-meter piston core	25 cm
13.	16May88	0101z	62°19.809'	61°03.798'	3-meter gravity core	small
14.	16May88	0150z	62°20.192'	61°06.116'	3-meter piston core	220 cm
15.	16May88	0440z	62°14.460'	60°42.121'	3-meter piston core	130 cm
16.	16May88	0807z	62°05.420'	60°10.568'	3-meter piston core	241 cm
17.	16May88	0955z	62°09.261'	59°54.950'	3-meter piston core	small

Echo Sounding

The 12 kHz echo sounder was used for the entire cruise, the 3.5 kHz system never worked. Excellent data was taken in over 5 seconds of water. In some cases, though, it was difficult to find the bottom in only a few hundred meters of water. The key was sea state, course and speed. With an icebreaker hull it is impossible to avoid bubble sweep-down over a flush mounted transducer. Different transducer locations might help a bit, but will never solve the problem.

The few routes to improvement all involve getting the transducer away from the normal flow lines. A towed fish is an option, but echo sounding should be simple and reliable. A towed fish is neither. A second possibility is mounting the transducer on a retractable "probe" that projects through the ship's hull. This can work well with smaller transducers. A 12kHz transducer would need a 12 to 16 inch opening, a 3.5kHz transducer at least 36 inches.

The common solution is to mount the transducers in a "bathtub" attached to the hull. This concept has been sucessfully used by many oceanographic ships over the years. For example, Eltanin transducers were mounted in this manner. Multiple transducer arrays can be accomodated, so higher power levels can be achieved. For quality echo sounding and sub-bottom profiling this is the approach to pursue.

For the near term, the existing 3.5 kHz transducer should be replaced. The topside electronics check out correctly. The 10kW booster amplifier can be far too powerful for that transducer/head pressure combination and should only be used with care.

Magnetics

We acquired some excellent magnetics data. The magnetometer may be one of the most powerful tools in understanding this complex part of the world. The problems we had were minor and can be readily solved.

When we first deployed the magnetometer we found the waterproof deck connector on the reel crushed and unrepairable. Both mating connectors did not have dummy plugs sealing them and would have been suspect in any event. Without any spares onboard we were forced to splice the cable at each deployment. This was the cause of some lost data but allowed us to continue work. The first electronics unit failed with a shorted transistor on the power supply/printer board. It needs to be returned for repair. The spare unit has a bad printer but we were able to use it for the rest of the cruise.

It is not clear why the plug was under the cable on the drum. We rerouted the wire through the hub. A slip ring assembly would be an excellent investment here. The magnetometer can be towed at any speed, and should be used during transit on any cruise. The key is simple and reliable deployment and recovery. With the lab electronics sending data to the SAIL logger only routine monitoring should be needed. This would provide additional valuable data for only a marginal increase in effort.

Seismic System

The seismic system is somewhat like a dancing bear. It is not how well it dances, but the fact that it dances at all. In fact, when we started, there was no seismic system, the computer having been sent off for repair and not returned. We built up a system using the #3 Compaq and boards found down in the electronics shop. This left no off-line computer available for quality control or navigation processing (the ITT Xtra computer was tried but couldn't use some of the boards necessary). Limited testing onboard showed that we were getting data to tape. Only one tape drive was used because the interconnecting cables could not be located.

The front end electronics (amplifiers and filters) are only marginal for this type system. It is very easy to over drive this cascade of boxes into badly distorted signals. This occurs without any warning from the recording system. Signal level monitoring is critical and we opted to give up some of the converter resolution in order to prevent distortion.

The recording system does not write proper SEG-Y tapes. There is a bit shift that has to be corrected in processing and the blocking is non-standard. We will have to run all of the tapes made on this leg through a reformating routine before any further processing is possible. The lack of any quality control or post acquisition plotting system onboard substantially reduces the confidence level.

We recorded the analog data on two EPC chart recorders, a 3200 and a 4600. The second 3200 was in poor condition. While the 4600 does work in start-stop triggered mode, this is not the preferred machine. The mechanical parts in all of the EPC recorders onboard are showing signs of wear. It is strongly recommended that both 3200 recorders be returned to EPC for repair and upgrading to the 3212 series.

Overall, the seismic system should still be considered experimental and not a tool for routine use.

SAIL System

The SAIL loop data system worked quite well. The hardware, especially, functioned without any failures. The software, however, is quite fragile. We made some minor changes in the program to handle our special requirements, but more needs to be done. For instance, the problem of losing data in the hour file if the program is restarted is still there.

One of the strong points of the SAIL concept is the ease of adding modules to the loop as cruise requirements change. This philosophy is extremely valuable on a multi-discipline ship such as the Polar Duke. The software should follow this philosophy and provide for easy configuration to accomodate changing sensors. At the end of this cruise we had many millions of bytes of blanks on file for gravity and weather sensors no longer onboard. Essential navigation quality data (DRT time, GPS HDOP, satellite fix times) was not logged. Since this system would normally be placed on-line when the ship sails there is not time for a major program rewrite and checkout on each cruise.

With reasonable planning and additional programming the SAIL software can reflect the inherent flexibility of the hardware concept. This system can provide a strong basis for all Polar Duke operations.