USAP 1989 CRUISE IV
R/V POLAR DUKE
CRUISE REPORT

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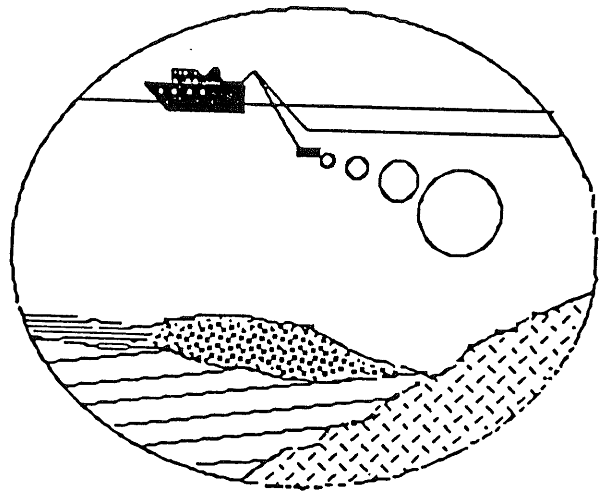

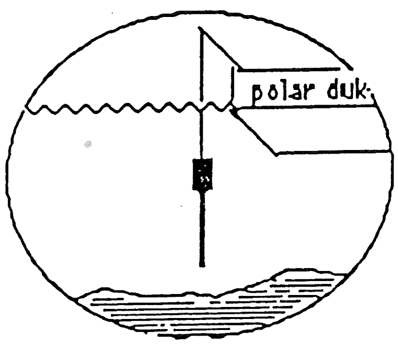

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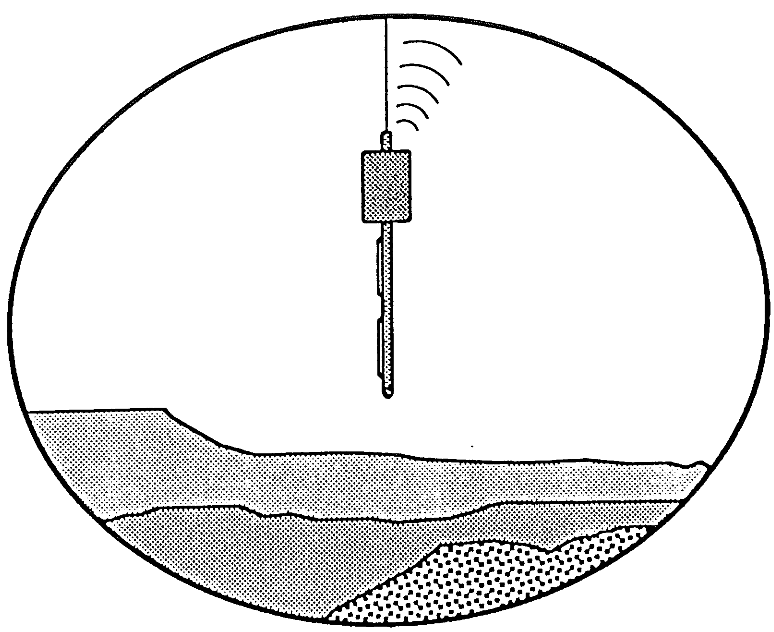

R/V Polar Duke Cruise Report
PD IV-89

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R/V Polar Duke cruise PD IV-89 was delayed approximately one month. It sailed from Punta Arenas, Chile on the 16th of April, 1989. It called at Palmer Station to let off one ITT employee and called at Marsh Base on King George Island to deliver 30 drums of helicopter fuel to the Chileans as a token gift for their assistance in the *Bahia Paraiso* disaster. From when we began the underway geophysical watch on the 18th of April, 1989 until we terminated the underway watch at 0814z on the 15th of May, 1989, we collected about 4500 km of underway 3.5 kHz and 12 kHz bathymetric data, excluding the work done in the King George Basin. About 3500 km of underway magnetics data were collected, primarily across the Drake's Passage and during the survey of the Shackleton fracture zone. We spent from 0400z on the 22nd of April until 1000z on the 4th of May in the King George Basin with one excursion towards Bridgman Island in an attempt to reach the North Bransfield Basin. During that time we made 54 successful out of 56 heat flow penetrations which were made on 8 separate profiles. We made 6 piston cores in the King George Basin, one of which failed because of equipment problems. While not on station during the time in the King George Basin, about 800 km of bathymetric data were collected and used to map the basin floor and to find interesting heat flow targets.

We were forced to leave the King George Basin because of deteriorating ice conditions. We then went to the Central Bransfield Basin and attempted to find sediments suitable for heat flow measurements. Unfortunately we found recent volcanic outcrops in two of the cores and a very recent but penetrable ash deposit at one site. Since ice conditions precluded us from further work in the King George Basin, the North Bransfield Basin and the Powell Basin and the sediments in the Central Bransfield Basin were unsuitable for heat flow measurements, we decided to use our remaining time in a seismic survey of the Shackleton Fracture Zone. We collected 500 km of high quality seismic data in the area where *R/V Surveyor* collected Seabeam data as part of this project. Very preliminary analysis of the seismic data indicates that it supports the hypothesis that the Shackleton Fracture Zone is transpressional and that the Scotia plate to the northeast of the fracture zone is underthrusting the Antarctic plate to the southwest of the fracture zone

Initial analysis of the heat flow values measured in the King George Basin indicate that they range from 50 to 480 mW/m^2. The worldwide average for heat flow is about 50 mW/m^2, so all of the heat flow measured in the King George Basin is average to very high. The heat flow measured is complex and does not fit a simple pattern. Present-day tectonic activity is occuring in the King George Basin but the nature of that activity requires further analysis of our results combined with the seismic coverage that we took as well as that taken by other researchers.

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Introduction

The primary purpose of this cruise was to take heat flow measurements in the basins around the Antarctic Peninsula. Last year on *R/V Polar Duke* cruise PD VI-88, we had attempted to do the necessary single channel seismic surveying in order to find satisfactory heat flow sites in the Powell Basin, North Bransfield Basin, and the King George Basin. Last year's cruise was so late in the season that the Powell Basin was completely covered with ice such that no work could be done there. The King George Basin was mostly covered with ice although we were able to take four cores there. Initially this year's cruise was scheduled for 15 March 1989 to 9 May 1989. Disaster struck on the 30th of January with the grounding of the *Bahia Paraiso* off of Palmer Station. The resulting oil spill caused *R/V Polar Duke* to be removed from its normal scientific work and to be used for standby assistance in the clean-up of the *Bahia Paraiso* mess. Ted Foster's cruise was canceled while Dieterich and Sidell (biologists) were eliminated from the 15

March to 9 May time period. Our ship time was eventually rescheduled to 16 April to 16 May 1989, with initial stops in Palmer and at Marsh Base on King George Island.

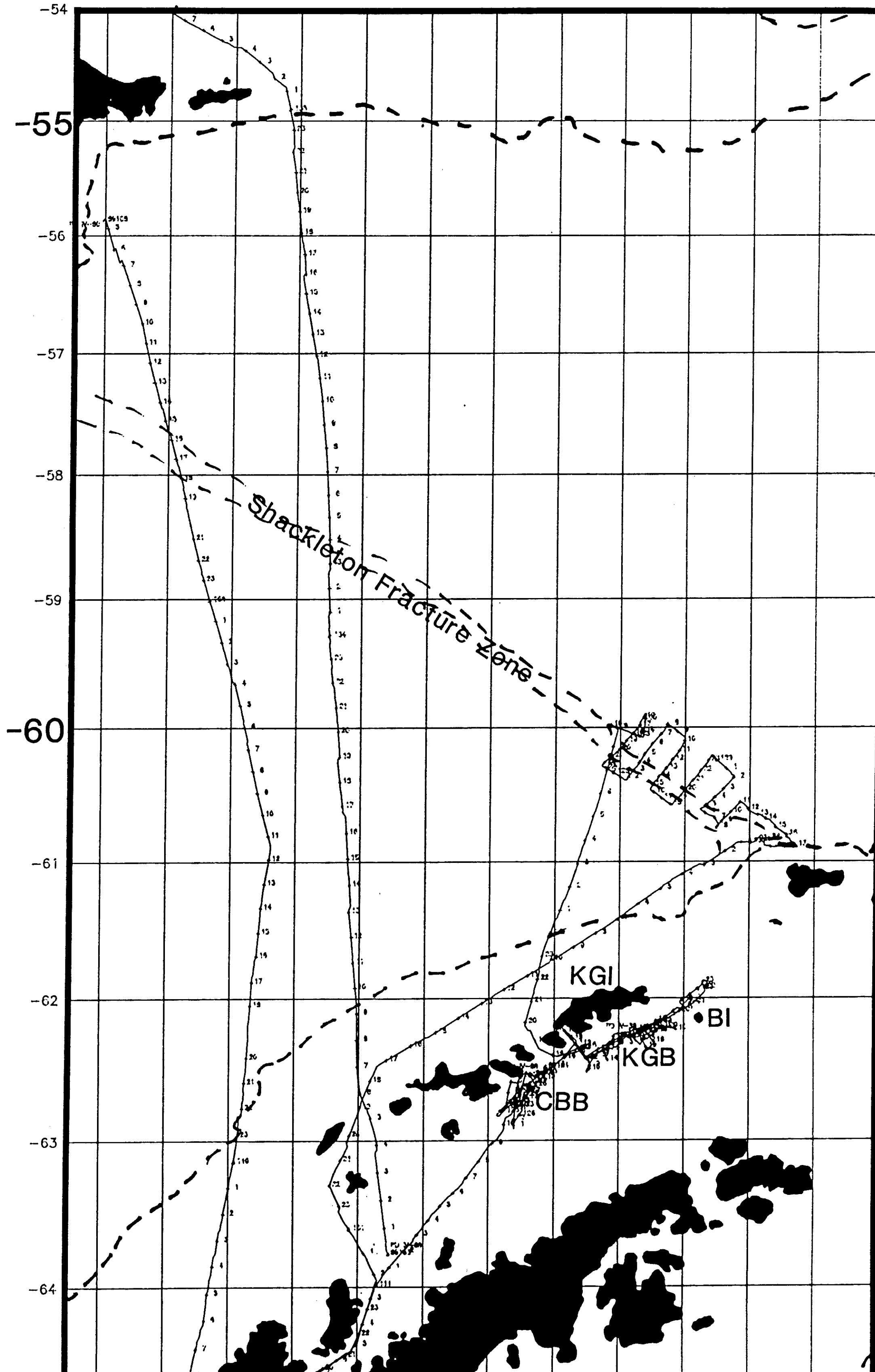
Our cruise track is shown in Figure 1. The hours are marked as well as the beginning of each new Julian Day. BI = Bridgman Island, CBB = Central Bransfield Basin, KGB = King George Basin and KGI = King George Island. The dashed lines indicate the approximate ocean-continent boundaries for Antarctica and for South America. The Shackleton Fracture Zone ridge is indicated by a pair of dashed lines. The actual plate boundary between the Antarctic and Scotian plates may switch from the Antarctic side of the ridge in the north to the Scotia plate side in the southeast.

Punta Arenas to Palmer Station

Enroute to Palmer, we turned on the 3.5 kHz and 12 kHz echosounders and deployed the magnetometer at 0400 on the 18th of April. The 3.5 kHz worked beautifully so the new transducer seems to have been worthwhile. On the crossing of Drake's Passage which was moderately rough, the 3.5 kHz gave consistently better bottom returns than the 12 kHz. The Shackleton Fracture Zone was crossed between 1500 and 1800z on the 18th of April. A minimum depth of 2344 meters was recorded. The South Shetland Trench was crossed almost exactly in the vicinity of the Hero Fracture Zone at about 2100z on the 19th of April. We stayed west of Anvers Island and approached Palmer Station from the southwest. We secured the underway geophysical watch at 1030z on the 20th of April. One of the deckhands [Brian], was found to have a seriously infected knee, so he was left at Palmer under the attention of the medical corpsman at Palmer. We recommenced the underway geophysical watch at 0330z on the 21st of April as we left the Gerlache Straits and proceeded to Marsh base. The weather was remarkably cold [down to -14°C or below] and we found the Bransfield Straits to be covered with a fair amount of ice. We made numerous course changes enroute to Marsh to avoid icebergs. We did not deploy the magnetometer because of the ice coverage. We arrived at Marsh at 1535 on the 21st and offloaded 30 barrels of helicopter fuel. The shore at Marsh and Bellingshausen bases was covered with at least 100 meters of brash ice so there was no opportunity to visit the bases.

Work in the King George Basin

We left Marsh Base at 1750z on the 21st of April. The seas were fairly rough in the Straits and the wind was very high, so we began to deploy the seismic gear while we were still in Maxwell Bay. We initially tried the 400 cu. in. Bolt watergun. It would fire for about 8 to 10 minutes, then ice up and cease to function. Finally at 2310z we replaced the Bolt gun with the old reliable 100 cu. in. Hamco watergun. We then proceeded with the underway geophysical gear to King George Basin. At 0200z on the 22nd of April we started to get terrible interference on the seismic records. After some searching we discovered the problem to be the Radio Operator using the ham radio outfit in the Marine Projects Coordinator's office. It is important in the future to

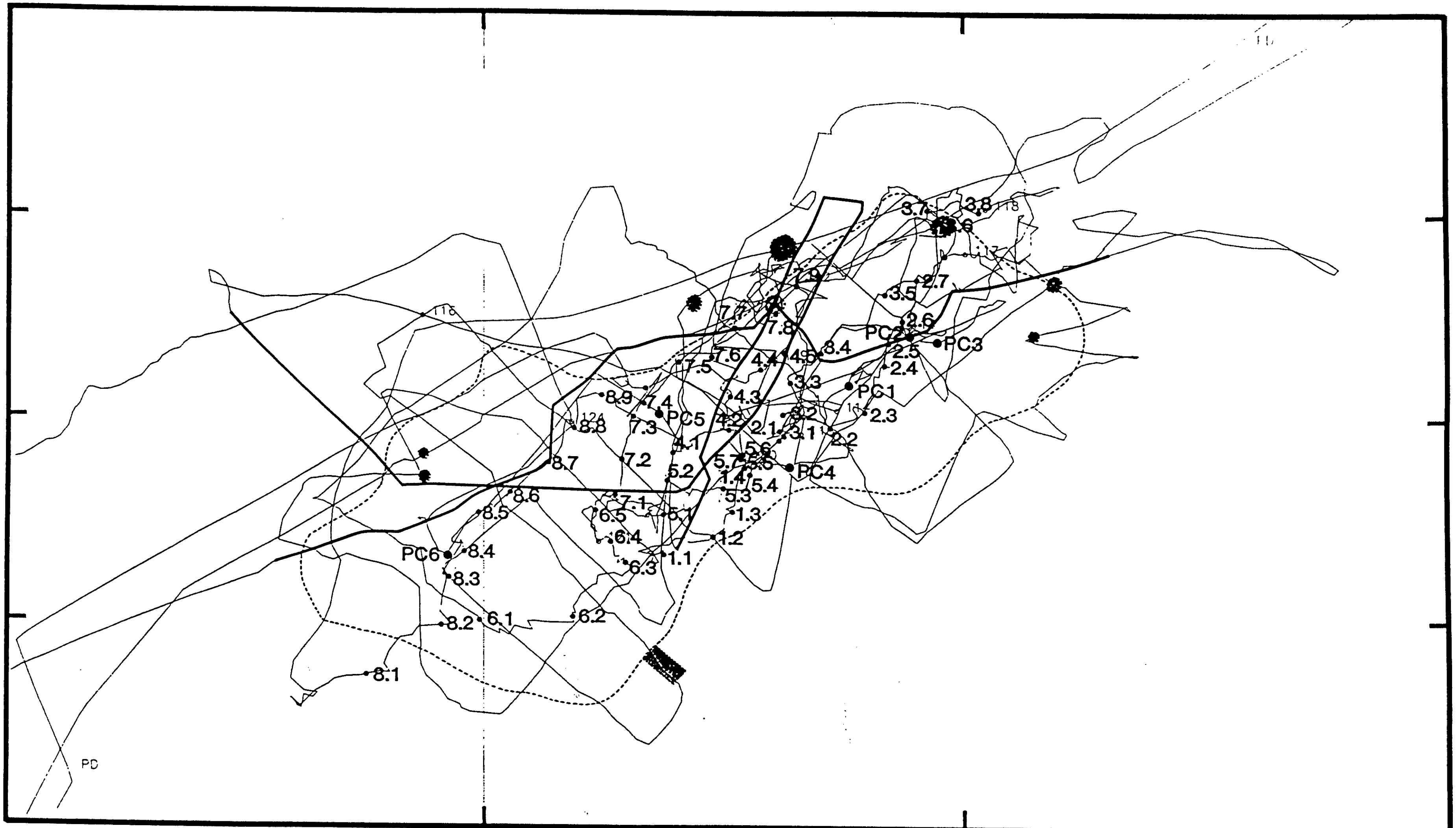


Navigation for PD IV-89
SCALE=1 2000000 at a latitude of -60

make it clear to all users of the Ham radio equipment, that the Ham radio equipment **cannot** be used while the seismic gear is out! The magnetometer was finally streamed at 0325z because it had been forgotten earlier. At 0439z the Hamco watergun stopped working. It was shut off, the pressure was bled down to 500 psi and then brought slowly back up until the gun started to work again. We think that the gun had iced up, and that by shocking it, the ice was broken loose and the airgun then started to operate again. At 0502z we hit the edge of the pack ice and altered course to the north. The underway geophysical gear was retrieved at 1100z on the 22 of April because of ice. It appeared that most of the King George Basin (KGB) was covered with multi-year ice that had drifted in from the Weddell Sea. We were able to make one nearly complete seismic crossing of the KGB from west to east but it involved much maneuvering through and around the ice. Our survey of the King George Basin is shown in Figure 2. The heavy lines indicate the single channel seismic coverage. The small dots are the heat flow stations while the large dots are the sites of the piston cores.

We then undertook a 3.5 kHz echosounder survey of the King George Basin to determine bottom characteristics and to find the southeastern edge of the basin. We found a suitable spot to use the piston corer and began coring operations at 2002z, 22 April 1989. Since the outside air temperature was extremely cold for this season [below -10°C] we faced some unusual problems with the coring operation. We were able to remove the core liner from the bottom barrel of the piston core without too much trouble. By the time we removed the core liner from the upper barrel, the liner had frozen to the barrel. As the core liner was extracted it broke in two and the upper section of the liner split lengthwise. The sediment from the previously removed lower barrel rapidly froze in the liner and expanded, even though it had been moved into the wet lab. The core caps were forced off by the expanded sediments. We decided that the core pipes had to be stored inside in the heated lower aft lab and the core liners had to be removed only after the barrels had warmed up. The coring operation became one of removing the core barrels as rapidly as possible from the coreweight and then waiting until the barrels had warmed up enough so that the liners could be easily removed. The first core recovered about 600 cm of material but with the expansion caused by the sediment freezing, it actually measured almost 610 cm. We moved a couple of miles and took a second core. At the second core site, the piston jammed in the core catcher and separated. We finally had to wash the sediments out of the liner to find all the pieces of the piston.

At 0300z on the 23rd of April we shifted to pressure testing the pressure cases for the heat flow instruments. The first test revealed a slight leak in one of the datalogger pressure cases. We then started a 3.5 kHz survey of the King George Basin. The King George Basin was covered with ice, roughly 9/10ths so we could only move at speeds of around 2 to 4 knots except for occasional patches where speeds of up to 6.5 knots were made for 15 minutes or so. On the southern margin of the basin, a wall of ice prevented us from preceeding south of 62°21'S at



CRUISE TRACK FOR PD IV-89

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57°32'W. We did a second pressure test of the heat flow pressure cases at 1420z on the 23rd of April. Repairs to the winch occupied the first two hours of the test. The pressure tests were successful and a third piston core was attempted. With the knowledge gained from the first core, we had no problems with removal of the liner from the barrels and we recovered 573 cm of sediments even though the outside air temperature was probably colder than it had been at the first station. At 2130z on the 23rd we stopped on station to attempt our first heat flow measurements. Unfortunately the high winds, blinding snow and rapid drift of the ship caused us to postpone the first heat flow station until the next morning when the bridge was better able to see the ice. Overnight a survey was undertaken of the southwestern corner of the King George Basin. We were again unable to penetrate as far south as we wished because of the ice accumulation.

We started our first heat flow station at 1400z on the 24th of April. The ice coverage of the area was moderately heavy but we were able to pogo-probe our way on a course of 080°. Pogo-probing consisted of moving the ship with the heat flow probe still in the water. As soon as the probe is obviously out of the bottom, it is brought up at 50 meters per minute and the bridge gets the ship underway for the next penetration. Typically the ship would move 1 to 2 km between penetrations at a speed of 1.5 to 2 knots. The probe was brought in for about 20 to 25 minutes and then as the ship arrived at the next penetration site, the wire was let out again. The probe would be stopped above bottom at about 70 meters off the bottom in order to obtain a reliable bottom water temperature and to give the bridge a chance to make any last minute maneuverings on the wire. The heavy ice coverage prevented us from doing much heat flow work after dark. Typically we tried to start the heat flow operations immediately after breakfast (~1200z) and we continued them until after dark. The heat flow probe has a 12 kHz pinger incorporated into the system. The pinger transmits tilt, thermistor, and battery condition data. After the second penetration of the first station (HF #1.2), we changed course and steamed north since the second penetration was actually out of the flat part of the basin. On the fourth penetration we recorded an extremely high thermal gradient (equivalent to a heat flow value of >479 mW/m^2) and all of the data thermistors were recorded on the 12 kHz recorder aboard the ship. It then became obvious that the designers of our heat flow instrument had set the minimum transmitted data to 0°C when in fact the bottom water temperature in the King George Basin was a remarkably consistent -1.4°C. We started on the fifth penetration at 2204z. The batteries did not have a full charge and the first heat flow station was terminated when the batteries went dead while the heat flow instrument was in the bottom.

On the 25th of April the ice seemed to have loosened up a little bit so we decided to put out the seismic gear to see if we could get at least some coverage of the King George Basin. We deployed the gear at 1320z and were able to collect seismic data until 2210z. We were able to get two partial north-south crossings and one nearly complete east-west crossing of the King George Basin. That night was again used for additional 3.5 kHz surveying of the margins of the basin. It was clear that the ice from the Weddell Sea was getting worse each day. In addition, the movement of the ice did not seem to make any sense. At times we could ascertain that the ice was moving at a knot or more but then a reference berg might be in the same spot on numerous different passes. We could not determine any consistent influence on the movement of the ice, neither tidal nor wind.

We stopped for Heat Flow station #2 at 1206z on the 26th of April. We started slightly northeast of the first station since the general drift of the ice seemed to be to the northeast. We made eight separate penetrations on station #2 with the last penetration started at 2336z and the heat flow probe was back aboard at 0032z on the 27th of April. Again the batteries died during the last penetration. The heat flow values appeared to be quite reliable with the first penetration giving the highest value of 248 mW/m^2. The rest of the night was spent surveying the northwest margin of the King George Basin. During the evening surveys, bottom bumps of interest were observed that are related to the active volcanicity along the northwestern margin of the Bransfield Straits. These are shown on Figure 2 as shaded areas. Sometimes the nighttime surveyor would get carried away investigating a particular bump and we would arrive on the heat flow station later than planned. We stopped on station #3 at 1331z on the 27th of April. We planned to parallel the course taken for penetrations #1.4 through #2.7 with station #3. Unfortunately we kept getting set to the east and tried to adjust our course by heading north. Even so penetration #3.5 wound up virtually on top of station #2.7. Since the preliminary measured values are 53 mW/m^2 and 62 mW/m^2 respectively, the two values actually gave a good check on the repeatability of our measurements. Station #3.8 was actually out of the flat part of the basin and because of the rapid drift of the ship we pulled out after only five minutes in the bottom. The weather was still unseasonably cold and windy.

The ice coverage had become much worse overnight and it was decided that we would have to retrieve the heat flow instrument after each penetration. While this gave the ship much better maneuverability because the bridge did not have to worry about snagging the wire on ice, it meant that we were only be able to make about five penetrations per day. Thanks to the skillful handling of the ship by the bridge officiers and the careful handling of the heat flow probe by the deck crew which included Peter Jorgensen and Cole Mather of ITT/ANS, and Angor (Shorty) Hansen [bosun] and Tom Janes [deckhand], getting the heatflow instrument back aboard and deploying it so frequently presented no real problems. On station #4, we were able to make five penetrations, three of which exceeded 200 mW/m^2. During the night, the margins of the basin were surveyed and interesting bumps were noted for possible later heat flow measurements. On the 29th of April we started the fifth heat flow station at 1138z. Again because of ice we retrieved the probe after each penetration. We also turned off the instrument while it was back on board rather than leaving it on continuously as we had the day before. As we had gotten more efficient in both getting the instrument overboard and understanding how to move the ship as quickly as possible, we were able to take seven separate penetrations in the time it had taken us to do five on the previous day. Starting with the fourth penetration of station #5 we tried to duplicate the very high heat flow that we had measured at station #1.4. Unfortunately with the complications of the ice and the very rapid drift of the ship, we were never able to get to exactly where we wanted to be. We made three separate attempts; #5.4, #5.6 and #5.7. It is unlikely that any of those penetrations were within a half mile of penetration #1.4. In fact penetrations #5.6 and #5.7 were taken in essentially the same spot except that during the 25 minutes that the probe was out of the bottom, the ship drifted about 3 cables. We then took core #4 and recovered 594 cm of sediments as close to #1.4 as possible.

At 0445z on the 30th April, we turned the ship over to the bridge who wanted to determine where the ice edge was between the King George Basin and King George Island. We found that the ice had moved to the northwest some and that there was no clear water to the northwest. Just to the west though was found a fair amount of open water and we were able to move for almost an hour at over 10 knots. We headed back into the ice and arrived at heat flow station #6 at 1450z on the 30th. We had problems with the meter on the winch that indicated the number of meters of wire. It would blowout the fuse and shut down. On station #6,we were only able to get five heat flow penetrations because movement through the ice became progressively more difficult. The probe was finally aboard at 0226z on the 1st of May. It was decided that surveying with the amount of ice present was not time efficient so we shut down operations while the heat flow batteries were recharged and the scientific personnel slept. We started heat flow station #7 at 1200z on the 1st. By morning the ice had moved and we were very close to the open water that we had found on the previous night to the west. After the first penetration we cleared the ice and were able to take an additional eight penetrations before we ran out of battery power and were on the northern margin of the basin. In fact the last measurement was in line with the recent volcanism along the northern edge of the basin and measured 297 mW/m^2, the second highest measurement made on this cruise. Since we were in clear water we decided to deploy the seismic gear and to try once again to get some seismic coverage of the basin. We also tried the Bolt watergun again. It did not work again. We also decided to deploy some sonobuoys to see if we could get any refraction results from the King George Basin. The sonobuoy results were disappointing since we had such a small source (100 cu. in. Hamco watergun).

As we continued to the east of King George Island, we found totally clear water and decided to see if there was any chance that we might be able to get to the North Bransfield Basin where we had done an extensive investigation the previous year involving seismic reflection, piston coring and magnetics. Unfortunately, just east of Bridgman Island our eastward progress was halted by continuous ice coverage. We then returned to the west, surveying one volcanic ridge enroute to the King George Basin. We finally retrieved the underway geophysics gear at

1345z on the 3rd of May and proceeded to the start of heat flow station #8 in the extreme southwestern corner of the King George Basin.

Heat flow station #8 started at 1500z on the 3rd of May. We made nine very efficient penetrations working along the ice edge. We finished the ninth penetration on the steep northwest margin of the basin. We actually terminated the heat flow profile before the batteries were low. We then took core #5 in the western part of the basin. We took a second core at 0555z on the 4th of May. We lost about an hour and a half of Sail Loop data because the satellite navigation system got an erroneous satellite fix that put us at least 20 miles off our correct position. Mark Wiederspahn was eventually able to correct the problem. We then put out the seismic gear, in hopes of getting a good sonobuoy record in the King George Basin. Unfortunately the ice closed in over the area of the flat basin floor and the last trip out of the King George Basin to the Central Bransfield Basin was not suitable for sonobuoy work. At 1135z on the 4th, the ice edge was found to extend all the way to King George Island and we had no choice but to bring in the gear and to head through the ice as best as possible.

Central Bransfield Basin

Finally at 1745z, we again hit clear water and redeployed the seismic gear and proceeded to collect seismic data in the Central Bransfield Basin. We collected seismic, magnetics, and 3.5 kHz data until 1205z on the 5th of May. As is our practice, we first took piston cores to determine the sediment characteristics prior to taking heat flow measurements. The first piston core was in the western end of the Central Bransfield Basin. The bottom was so hard that we severely mangled the core cutter nose. The core consisted of rocks up to 3.5 cm across. 85% of the rocks were very fresh volcanic rocks with some glassy rinds and surface vesicles. Some fairly large grains could be seen in the volcanic rocks. In contrast the remaining 15% were clearly ice-rafted debris consisting of one piece 1.5 cm across of granite and some other chunks of green possibly serpentine material.

We then moved about one kilometer east into the Central Bransfield Basin and took piston core #8. It consisted of almost 600 cm of what appeared to be ash interlayered with a small amount of hemi-pelagic sediments. There are very definite black ashy layers, particularly prominent in the upper section of the core. We then moved to the northeast end of the Central Bransfield Basin approximately ten miles from the previous core. We collected only 20 cm of a very gravelly (presumably volcanic) ashy sediment. The trigger core actually collected 67 cm of sediments but also seemed to have bottomed in a very coarse layer. We tried one last piston core approximately half way between cores #8 and #9. We severely mangled another core cutter nose but collected about 42 cm of a very coarse sediment, again presumably volcanic. We decided that the nature of the bottom sediments in the Central Bransfield Basin, absolutely precluded any hope of taking heat flow measurements.

We had only found one core out of four that suggested that the heat flow gear could even penetrate. The extremely coarse nature of the bottom sediments and particularly the damage done to the core cutter noses suggested that the outrigger bows on the heat flow probe would be damaged or completely stripped off if we attempted heat flow measurements. Since Deception Island has erupted in the very recent past (<20 years ago), and presumably deposited vast quantities of ash in the Central Bransfield Basin, it is questionable if heat flow values would have told us anything worthwhile anyway. The porosity of the gravelly sediments would undoubtedly have allowed the free circulation of bottom water to some depth and probably given very low heat flow. If some of the glassy rinds found in piston core #7 were formed *in situ* then there may be active volcanism on the seafloor of the Central Bransfield Basin, which would drastically affect any measured heat flow. We finished core #10 at 2100z on the 5th of May.

We streamed the underway seismic gear at 2140z and started a survey of the northern margin of the Central Bransfield Basin in hopes that we might be able to work our way south and around the ice that cut us off from the southeastern part of the Central Bransfield Basin. We realized that we had run out of the basin before we got around the ice and decided to abandon any attempt to take heat flow measurements in the Central Bransfield Basin. We then decided to head back to the King George Basin to either take more heat flow measurements or to try another sonobuoy seismic refraction experiment. At 1622z on the 6th of May it became apparent that we could not get back into the King George Basin, because the ice was solid to King George Island. When we had been in the King George Basin earlier, there had always been open water between the ice edge and King George Island so there was little worry that we would be trapped in the ice by a sudden shift in weather conditions. We pulled in the seismic gear and exited the Bransfield Straits out Nelson Straits between Nelson Island and Robert Island.

Shackleton Fracture Zone Survey

During the months of January and February 1989, three scientists from the Institute for Geophysics including Keith Klepeis, had been aboard *R/V Surveyor*, a Seabeam equipped NOAA ship. They obtained some excellent Seabeam coverage of the Shackleton Fracture Zone in the vicinity of Elephant Island. Unfortunately the navigation data from *R/V Surveyor* left a lot to be desired, so we decided to collect three days of well navigated narrow beam 3.5 kHz data as well as seismic data. Prior to leaving the Central Bransfield Basin we had tried out a 360 cu. in. Bolt airgun and it had given excellent results. Dave Sandwell who had taken part in the Seabeam work on the Shackleton Fracture Zone was also interested in the abnormal Geosat signature over the Shackleton Fracture Zone. His Geosat data seemed to indicate that there might be some southwest over northeast compression on the southern end of the fracture zone near Elephant Island. We decided that the seismic data might be extremely useful with regards to this problem. Consequently we picked a point on the Shackleton fracture zone of 60°S, 58°W and headed for it through fairly rough seas. When we arrived at that point at 0850z on the 7th of May, it was decided that the seas were too rough to deploy the seismic gear. By 1230z, the seas had moderated slightly and it was decided that the seismic gear could be safely deployed. We then initiated a survey designed to cross completely the Shackleton Fracture Zone at right angles to its general northwest-southeast strike (see Figure 1 for the survey pattern).

The Shackleton Fracture Zone ridge appeared to be quite symmetrical with no evidence of deformed sediments on the southwest side. On the northeast side the sediments appeared to be possibly underthrust to the west but the trace of the active transform fault was observed some 10 to 20 kilometers to the east of the ridge. The sediments on the Scotia Plate clearly dipped to the southwest and were surprisingly thick. We could distinguish up to 1.3 seconds of penetration of what we assume is basement on the northeast side. The Bolt airgun worked very well. We finished the survey on the margin quite close to Seal Island immediately north of Elephant Island. Even though the Seabeam data indicated that the Shackleton Fracture Zone could be traced onto the continental margin, our three crossings did not show an indisputable extension of the Shackleton Fracture Zone unto the margin. Our survey on the margin does indicate that the 6.4 meter shoal indicated on the DMA chart 29104 at 60°48'S, 55°45'W is improbable at best and should be surveyed when time permits.

At 2305z on the 9th of May, 1989, we had to retrieve the seismic gear. At the time that we recovered the seismic gear, the seas were moderately high and the wind was up. Once we got the seismic gear aboard, the ITT personnel streamed the trawl winch wire rope with some lead donuts attached and let out 3000 meters of wire in an attempt to get the wire wound onto to the drum properly. The level wind had had problems on a previous cruise and Peter and Cole tried to correct the lay of the wire. After about two hours of steaming at 4 to 5 knots, we headed at full speed for Palmer Station. As we got underway to Palmer, we realized that we actually had a following sea and made excellent time, upwards of 12 kts. Because of the ice in Bransfield Straits we headed south, outside of King George and Livingston Islands. We then headed into the Gerlache Straits by turning eastward just south of Low Island. We had 70 knot winds that caused the ship to heel to starboard almost 10°. We secured the underway geophysical watch at 0615z on the 11th of May on our way into Palmer Station.

Palmer Station to Punta Arenas

We left Palmer Station at 1500z on the 12th of May. Our passage out Neumayer Channel was spectacular. We did not go through Lion Sound around Lion Island because that passage was covered with ice. We finally redeployed the magnetometer at 0030z on the 13th of May and headed towards South America, leaving the Bransfield Straits by passing between Smith and Snow Islands. Fortuitously, our track north to return to Punta Arenas via the Straits of Magellan neatly bisected a 150-km wide corridor that had virtually no previous bathymetric or magnetic coverage. We finally terminated the underway geophysics at 0814z on the 15th of May 1989.

Summary

With the exception of the ice coverage which severely restricted where we could work and impacted how quickly we could take stations, the cruise was extremely successful. The heat flow equipment that had only been tested on a very short cruise worked very well. The data from the King George Basin is very exciting and will require some detailed analysis. While the quantity of seismic data collected was very disappointing, the equipment worked well and the compressors, airguns and waterguns worked without any real problems. Bob Crimmens [ITT/ANS] was able to try out the Bolt Combi gun which had never really worked since it had been purchased. We found that it can not operate as a 360 cu. in. watergun as it freezes too rapidly. We did find that it could work both as a 125 cu.in. airgun and as an 325 cu.in. airgun. In the Scotia Sea we got upwards of 1.3 sec of TWT for penetration. While the bubble pulse is not particularly elegant, it did seem to give us the sediment thickness. The seismic streamer needs renovation but does work. John Anderson of Rice University has indicated that he has a technician that can refurbish the streamer.

Acknowledgements

As in the past, the crew on the ship from Captian Flight to the deck department did an excellent job. It is always a pleasure to sail with such a professional group of people. Peter Jorgensen and Cole Mathers are an excellent team and I greatly regret that Peter will not be part of the ship's compliment next season. If Cole Mather wanted to take on the Project Coordinator's thankless job, I think he would do an excellent job.

Heat flow measurement

Seiichi Nagihara

The 54 successful penetrations that were done in the King George Basin are shown in Figure 3. The heater pulse for *in-situ* thermal conductivity measurement fired for 22 of the stations. The heat flow measurements cover most of the basin on a 1 to 2 km spacing. The preliminary calculated heat flow values vary from 50 mW/m^2 to 480 mW/m^2. Such values may indicate the occurence of hydrothermal circulation and may be interpreted as evidence suggestive of recent intrusive activity in this basin.

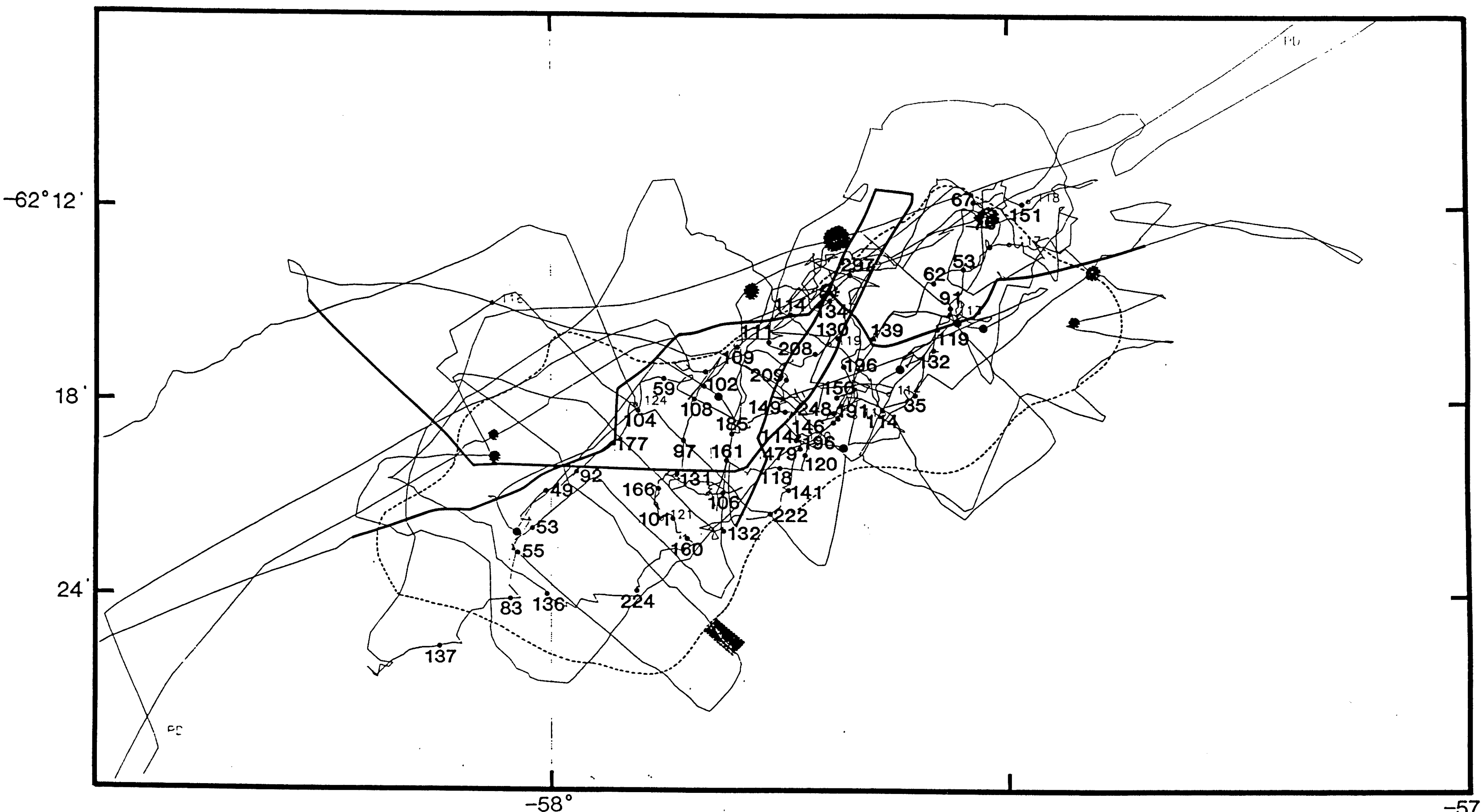
Instrumentation

The heat flow probe consisted of three outrigger bows attached to a 5 meter strength member. Although we had with us two complete sets of the electronics, we only used one of them because one of the pressure cases had an unidentifiable small leak.

Three sensor strings (with four thermistors each for a total of 12 thermistors) were used thoughout the cruise except for Station 1 (where only 2 of the 3 strings were active). All of the thermistors worked and none of the outrigger bows needed to be replaced. For most penetrations, each thermistor showed an ideal $F(\alpha,\tau)$ curve for the decay of frictional heat and for the heater pulse decay. There were some stations which indicated that a few of the thermistors close to the end of the string may have been overly disturbed.

We had several instrumentation problems. Battery power for the instrument (Gates rechargeable, D-cell) was one of them. The batteries for the data recorder lasted only 11 hours. We generally terminated our heat flow stations when the batteries died. Even though there is a back-up battery for the RAM, when the main battery supply dies, the data pointer for the probe operation system would occasionally go awry somehow. On those occasions, we had to execute a total memory dump to retrieve the data. We never lost any of the data but retrieval of the data was not always as straight forward as it should have been.

The heater pulse system also had a problem with battery power. The power supply was not strong enough to maintain its voltage when the heater pulse was fired. By experimentation in the lab, we discovered that the actual heater current varied between 3.3 and 3.7 Amps while the power circuitry is designed to have a constant current of 4 Amps. The cold bottom water temperature (-1.5 ^{o}C) was a significant factor in the weakening of the battery output. The *in-situ* thermal conductivity relies on the accuracy of the power. We can estimate the current fairly accurately by comparing the calculated thermal conductivity values to those measured on piston cores taken nearby.



CRUISE TRACK FOR PD IV-89
SCALE=1 2?0000 at a latitude of -60

The software for the system operation had some problems as well. 1) The heater pulse misfired, frequently when the probe was on the way up. 2) Even more frequently, the pulse did not fire at all, even though little or no change of the tilt and depth were recorded. 3) Temperatures below 0 °C did not show up in the accoustic signal.

Fortunately, none of these problems were fatal. Over all, the heat flow instrument worked very well, particularly when one considers that we had had only one short test cruise a few months previous. The battery problems can be solved by putting another set of the batteries in parallel to the first set. The software problems are being worked on and will be solved by careful study of the source program.

Results

54 successful penetrations were made in the King George Basin (Table and Fig.). In nearly all cases, the thermal gradient was linear. The heater pulse successfully fired for 22 of stations.

The observed heat flow values (calculated by assuming a thermal conductivity of 0.85 W/mK for every station) vary from 50 to 480 mWm^2. The values around Station 1.4 show large variation (140 - 480 mW/m^2) within a few kilometers which is typical of hydrothermal fields.

In spite of the large variation, we can still recognize that heat flow in the basin is generally very high. 1/3 of the data show values higher than 150 mW/m^2. Certainly tectonic activity in the basin is presently occuring. If a standard age-versus-heat flow comparison is assumed, one could certainly argue that the Bransfield Strait is less than 4 million years old. The high values are appearent in the central part of the basin, along the southeast edge of the basin as well as one high value on the northern wall. In contrast, the northeast and southwest regions of the basin show heat flow values of less than 100 mW/m^2.

Station	Latitude °S	Longitude °W	Depth	Heat pulse	Sensors	Remarks
HF1.1	62.365	57.833	1990	Yes	8	
HF1.2	62.360	57.763	1787	No	8	
HF1.3	62.344	57.741	1995	No	8	
HF1.4	62.318	57.730	1991	No	8	very high HF
HF1.5	62.304	57.685	1993	Yes	8	dead batteries
HF2.1	62.299	57.674	1993	Yes	12	
HF2.2	62.299	57.609	1998	Yes	12	
HF2.3	62.293	57.599	1995	No	12	
HF2.4	62.274	57.580	1995	Yes	12	
HF2.5	62.259	57.570	1991	Yes	12	
HF2.6	62.246	57.554	1986	No	12	
HF2.7	62.231	57.538	1979	No	12	
HF2.8	62.218	57.507	1976	No	12	

Station	Latitude °S	Longitude °W	Depth	Heat pulse	Sensors	Remarks
HF3.1	62.307	57.695	1994	No	12	
HF3.2	62.296	57.679	1996	Yes	12	
HF3.3	62.278	57.678	1988	No	12	
HF3.4	62.255	57.625	1988	No	12	
HF3.5	62.232	57.547	1979	No	12	
HF3.6	62.206	57.527	1863	No	12	
HF3.7	62.197	57.523	1962	No	12	
HF3.8	62.194	57.468	1935	No	12	basin edge
HF4.1	62.310	57.780	1987	Yes	12	
HF4.2	62.302	57.750	1988	No	12	
HF4.3	62.287	57.745	1984	Yes	12	
HF4.4	62.276	57.709	1979	Yes	12	
HF4.5	62.264	57.681	1979	Yes	12	
HF5.1	62.347	57.827	1988	No	12	
HF5.2	62.338	57.785	1990	No	12	
HF5.3	62.335	57.739	1994	Yes	12	
HF5.4	62.320	57.711	1993	Yes	12	
HF5.5	62.310	57.742	1990	Yes	12	
HF5.6	62.320	57.728	1995	No	12	
HF5.7	62.322	57.718	1993	No	12	
HF6.1	62.403	57.957	1974	Yes	12	HP too late
HF6.2	62.389	57.900	1983	Yes	12	
HF6.3	62.374	57.845	1988	Yes	12	
HF6.4	62.359	57.874	1987	Yes	12	
HF6.5	62.345	57.891	1985	Yes	12	
HF7.1	62.337	57.862	1987	No	12	
HF7.2	62.301	57.846	1982	No	12	
HF7.3	62.278	57.814	1984	No	12	
HF7.4	62.283	57.812	1982	No	12	
HF7.5	62.271	57.799	1919	No	12	basin edge
HF7.6	62.266	57.745	1977	No	12	
HF7.7	62.249	57.736	1971	No	12	
HF7.8	62.242	57.696	1953	No	12	
HF7.9	62.232	57.671	1978	No	12	
HF8.1	62.426	58.122	1906	Yes	12	
HF8.2	62.402	58.045	1965	No	12	
HF8.3	62.377	58.041	1971	Yes	12	
HF8.4	62.362	58.022	1975	No	12	
HF8.5	62.346	58.003	1979	No	12	
HF8.6	62.336	57.970	1977	No	12	
HF8.7	62..321	57.930	1979	No	12	
HF8.8	62.303	57.905	1978	Yes	12	
HF8.9	62.288	57.885	1811	No	12	

Coring Report - PD IV-89

Sally Zellers

Piston coring was very successful on this cruise. Of the 10 piston cores taken on this cruise, six were made in the King George Basin and four were made in the Central Bransfield Basin. Preliminary core descriptions and a summary of the coring stations are included.

Despite a few problems with fitting together core barrels, coring operations went smoothly. Usually at least five people were involved in coring operations (Sally, Larry, Peter, Cole, Tom or Shorty). Since the box of 100 set screws that was on board R/V Polar Duke for PD VI-88 disappeared from the coring gear between cruises, we had to make do with only 14 set screws. Consequently we used only 2 set screws in each connection instead of the four or six possible. Although no set screws were lost; one screw cracked and many were loose when the corer was recovered. A separate problem concerns the fact that some of the collars and core cutters have four screw holes in them while the new pipes have six holes in them. So far we have not had any real problems with the fact that the holes do not match but obviously only two screws can be used to make the connections. A decision needs to be made as to whether it is easier to go with four holes or six holes on all pieces. We feel that four screw holes are more than adequate but even so the missing set screws need to be replaced.

At first, several people were needed to assemble the coring apparatus. For the first few cores, it was necessary for us to use pipe wrenches to twist the core barrel into the collar of the coreweight and into the collar between the barrels. Prior to core #6, Peter and Cole ground down the ends of two of the core barrels so they would easily slide into the collars. Finally, Shorty stamped the ends of the barrels and the two collars with numbers. After grinding and marking the barrels, setting up the piston corer was quite easy.

Another problem that we had assembling the corer, was that many of the core liners were no longer cylindrical and therefore did not easily slide into the barrel. For the first core, we made the mistake of pounding it in with the rubber mallet. Getting it out proved nearly impossible. We greased a couple of liners and put them in the core barrels. Even so, it was still very difficult to remove the core from the barrels when warped liners had been used. Finally we decided to use only the liners that easily slid into the barrels.

The piston was put together using the copper spacers that were made during the PD VI-88 cruise. The O-ring/spacer arrangement worked very well. Twice, however, the piston failed to work properly. For core #2, the bottom part of the piston was lodged in the core catcher in the bottom of the core barrel and the piston broke apart . The piston may have been pushed too far down the barrel and the stainless steel core catcher had disintegrated. The bottom of the piston lodged in the core catcher which was completely mangled. From then on, only the two old reliable copper core catchers were used. Additional reliable copper core catchers are needed.

After the piston is put into place in the barrel, the cable is taped to the eye hook at the top of the weight stand. This is to prevent the piston from moving up the liner during descent through the water column. The tape is supposed to break when the core penetrates the sediment. The tape broke too early on core #6. The piston was found lodged in the top of the liner of the upper barrel and only one filled barrel was recovered. The upper barrel had about 50 cm of sediment which accidently dropped on the deck. Above this sediment there was a column of water which indicated that the piston had moved up from the bottom of the barrel before the corer penetrated the bottom.

The actual deployment of the corer went very smoothly each time. Peter and either Tom or Shorty rigged up the trigger core arm, measured out the scope, and deployed the core. Larry operated the port gunnell winch which was used for moving the core along the track to the stern and for lowering the trigger core. The trigger core was lowered until the end of the chain (attached to the winch cable) was about 2 m off of the deck. Peter then secured the chain to the deck and removed the chain from the winch cable. The chain was then attached to the trigger arm. Cole operated the main winch to tip the bucket and to lower the core. Once the bucket was tipped, the trigger arm was attached and then cable for the scope was attached to the trigger arm using electrical tape.

Retreival of the core back onto the deck also went smoothly. However, until the ends of the barrels were ground down, we did have problems taking the core barrels apart. For the first core it was quite cold (<-10 °C). We had to use a pipe wrench to remove the core barrels from the weight stand. We then used the rubber mallet and long steel plunger to try to extrude the core. When we were removing the upper piece of core, it cracked in half and the uppermost piece split lengthwise. The liner cracked and split because the core had frozen. The cores were placed in the port cold lab where cores are normally stored. The cores continued to freeze and also expanded, popping off their core caps. We stored the cores upright outside the starboard lab van until thermoconductivity measurements could be taken. We decided to take the core barrels off and bring them inside the lower aft lab to let them warm up before we attempted to remove the core.

Coring operations were affected by problems with the tension meter and the wire-out meter on the winch. For the first core, the tension meter was broken, and we did not use a pinger. We told the winch operator the water depth calculated from the 12kHz recorder [we assumed a speed of sound in water of 1500m/s]. The winch operator let out the cable to near that assumed depth and watched the tension on the cable as it hit. Since he did not see a clear hit by watching the sheave jump, he let out an extra 200 m of cable without seeing a hit. Even so, a complete core was recovered. A pinger was used for cores #3, and #4. For cores #6 through #10, the tension meter worked, but the wire-out meter was broken.

Five out of the six cores taken from the King George Basin were successful. Coring proved to be less successful in the Central Bransfield Basin. Only one out of four cores in this region contained full recovery (Core #8). Cores #7 and #10 hit hard volcanic debris which mangled the cutter head. Core #9 encountered gravelly ice rafted debris which prevented further penetration.

R/V Polar Duke Coring Stations

All 6 meter piston cores

Sta. No.	Date	Time	Lat . °S	Long.°W	Recovery
1.	22 April 89	2055z	62°16.433	57°36.283	605 cm
2.	23 April 89	0157z	62°14.575	57°32.608	0 cm
3.	23 April 89	1850z	62°14.635	57°28.931	565 cm
4.	30 April 89	0315z	62°19.249	57°39.646	591 cm
5.	4 May 89	0359z	62°17.860	57°49.033	549 cm
6.	4 May 89	0634z	62°21.974	58°02.170	350 cm
7.	5 May 89	1352z	62°46.016	59°33.424	25 cm
8.	5 May 89	1549z	62°45.317	59°31.178	563 cm
9.	5 May 89	1847z	62°35.860	59°21.939	20 cm
10.	5 May 89	2014z	62°39.700	59°22.848	42 cm

Thermal Conductivities of Core PD IV-89

Robert Munroe

Apr. 17

Set up the equipment for needle probe conductivity. There are 5 Fenwal probes, one of which has the wrong connector for the test leads to the constant current source. The other 4 are similar, being 2.9 inches long and 0.036 inches in diameter. Of these 4, one is in working order with all the circuits OK; one has one open circuit and the other two were cast into 1/2 space probe configuration with both circuits intact. There is a fused silica standard consisting of a cylinder 1.6" in diameter and 1.5" long cut in half and grooved to accept the probe. There is a jar of Wakefield. A Keithley Recording DMM is used to time and store the voltage output of the probe.

Using the good probe, a test was made in the fused silica standard with Wakefield on the interior faces, after the probe and standard had come to temperature equilibrium in a block of styrofoam; approximately 1-1/2 hours. Ken Griffiths made a plot of temperature against ln of time on the Macintosh+ using the constant C=6.17 to convert probe voltage to temperature (Plot # 1). The curve indicates that the small size of the fused silica relative to the probe greatly influences the temperatures. A value for the thermal conductivity consistent with Ratcliffe's values can't be reasonably obtained.

A 3/4 lb coffee can was used to prepare jello as a low conductivity standard. After setting, a measurement was made at room temperature (Plot #2). All points except the first lie on the line, the slope of which yields a conductivity of 0.627 w/mK, within 2% of the conductivity of water. As the in situ temperature of the core, and also the hold where the core was stored and tested was near 0°C, a measurement was attempted with the jello frozen. However, pockets of ice formed in the jello rather than a homogeneous mixture and the resulting curve was erratic.

Apr. 26

Testing began on core PC-1. Holes were drilled every 10 cm through the core liner with a 1 mm twist drill bit borrowed from the ship's shop. The results of the first 10 measurements were encouraging as all points but the first two were on line. The conductivities appear about 3% higher than Seiichi expected. The equipment was set up on top of two freezers in the open hold. The ambient temperature in the hold varied from a few degrees below 0°C to a few degrees above. All of the data from the testing was converted and plotted with the Macintosh+ by Sally.

Apr. 27-30.

Testing continued on cores PC-1 and PC-3. Sally conducted about half of the measurements. On Apr. 30 the heater circuit on Probe S/13 opened up. We decided to use one of the half space probes removed from the block. As no identifying marks appear on the probe it is labeled as Probe #1. A measurement was made with Probe #1 at 370 cm in core PC-1 where a measurement with Probe S/13 had been made 1-1/2 hours earlier. Using a conversion C=6.17 the value for the conductivity was 1.17 w/mK (Plot 3). By trial and error, and a lot of plotting by Sally, a value of C=4.7 was adopted. This gave the same conductivity as Probe S/13 for PC-1 at 370 cm (Plots 4 and 5). Another jello standard was prepared and the conductivity measured with Probe 1 was k=0.70 w/mK (Plot 6). As no comparison was possible using Probe S/13 it was decided to adopt C=4.7 for the conversion factor for Probe #1.

May 2-12

Testing continued on cores PC 4, 5, 6, and 8 and the trigger core from core 2. While testing on the last section of core the ship left the dock at Palmer and the core was knocked out of the cradle. Probe #1 was bent but fortunately the circuits were not damaged and the final measurements are not significantly different.

Recommendations:

1. A new, more automated system could be easily and rather inexpensively developed with a better source and a computer linked to a DMM and a plotter.
2. A conductivity standard of appropriate size should be added.
3. Additional probes, preferably of sturdier construction, should be purchased. I'll send the address of the USGS supplier of probes.

Conclusions:

The data appear internally consistent at least with the group measured by the same probe. Probe 1 should be checked again in jello and possibly the conversion factor reevaluated.

Preliminary Core Descriptions

Sally Zellers

Core 1: Full core but it froze while we were taking it out. Additional freezing took place in port cold storage room. Top section of core cracked in half as we took it out of barrel. Bottom section expanded from both ends by about 10 cm.

Top section: No description because core is all taped up

Middle Section:

0-100 cm	Green grey mud; Shrinkage away from liner
100-106 cm	50% air gap
106-130 cm	Shrinkage away from liner
130-152 cm	Very little sediment, muddy water present (20%)

Bottom Section

0- 26 cm	Taped up
26- 80 cm	Shrinkage and abundant cracks
80-110 cm	Minor shrinkage and small cracks
110-148 cm	Larger cracks, some shrinkage
148-160 cm	Increase in amount of shrinkage
160-195 cm	Minor shrinkage and small cracks
195-295 cm	Very little shrinkage, but some large cracks
295-303 cm	Taped up

Cracks near 250 cm, 190 cm
150 cm near shrinkage

Trigger Core 1 - Brown to green grey mud. Mud from cutter head in a different bag.

Core 2: Piston got stuck on the bottom so no core was recovered. Also a different core catcher, made from aluminum, was used. The core catcher collapsed and was pushed through and got stuck in the cutter head. After this the only two copper core catchers were used.

Trigger core: Green grey mud

Core 3: Almost full core recovery. Removal of liner from core barrel was easier when core barrel brought inside wet lab to warm up.

Top:

0- 15 cm	Green grey mud ; some shrinkage	
15-260 cm	A few minor cracks	
	30-40 cm	Large vertical crack
260-270 cm	Some black streaks	

Piece of mud between barrels in plastic bag

Bottom:

275-300 cm	Green grey mud
300-305 cm	Shrinkage; color and grain size change to dark brown to black grains (Ash)
305-320 cm	Green grey mud

320-330 cm Increase in grain size; change to black grains; shrinkage
330-380 cm Green grey mud mottled with corser black grains
380-400 cm Green grey mud mottled with corser black grains; some longitudinal crcks
400-440 cm Green grey mud mottled with corser black grains; no cracks
440-470 cm Long crack; color same
470-475 cm Shrinkage and water present; Increase in coarse black grains
475-490 cm Longitudidinal crack
490-540 cm Increase in mottling, increase in coarse black grains
540-648 cm Green grey mud with black streaks

Trigger core: Green grey mud; water present

Core 4: Almost full core recovery.

Top section
0-20 cm Green grey mud; some shrinkage; some water
20-60 cm Bubbles common
65-250 cm Large continuous vertical crack (formed after conductivity measurements)
240-286 cm More small cracking, increase in amount of black grains
Piece from bottom of upper section in separate bag

Bottom section
286-591 cm Green grey mud, very few black grains; Horizontal and vertical cracks throughout.
Piece from bottom of upper section in separate bag

Trigger Core: Green grey mud

Core 5: Almost full core recovery. Bad Sat fix on the way down.

Top section
0-50 cm Green grey mud with dark grains; water present
50-80 cm Same as above; bubbles present
80-130 cm Increase in amount of black grains; large crack starting at 80 cm
140 cm Horizontal cracking
145 cm Large horizontal crack
150-190 cm Green grey mud, fewer darker grains; several large horizontal cracks, some smaller vertical cracks.
190-234 cm Green grey mud; a few small cracks
234-245 cm Green grey mud, mottled with coarser black grains

Bottom section
245-280 cm Green grey mud; longitudunal cracks
280-320 cm Green grey mud; horizontal cracks increasing in size; large crack at 317 cm
320-490 cm Green grey mud; minor cracks
490-549 cm Green grey mud; horizontal cracks

Trigger core: Green grey mud; water and air bubbles present;
Mud from core catcher in plastic bag.

Core 6: Piston got stuck at top of upper barrel. Only bottom barrel contained sediment. Liner had to be cut to get piston out. Tape holding wire probably loosened on way through water column.

Small amount of mud in upper barrel, placed in separate bag

0-170 cm Green grey mud with several wide, vertical, streaks of coarse, black grains
170-210 cm Same as above but fewer streaks
210-300 cm Green grey mud; minor black streaks

Trigger core: Green grey mud with a few black streaks
Core catcher and cutter head in separate bag

Core 7: Piston core hit rocky bottom. About 30 cm recovered. Cutter head on piston core was mangled. Trigger core was empty and its cutter head was slightly abraded..

Small recovery - very watery; black sand size grains, rocks up to 3.5 cm, and green grey mud
Soime of the rocks in separate bag

Rocks from PC-7 Majority are black to olive brown, vesicular, basalts.
Some are weathered
Several pieces age very glassy
Pieces range from fine sand size to 35 mm

Other pieces:
1 piece of granite (2 cm long)
1 piece of green meta-sediment (1.5 cm long)
2 pieces of green colored schist (1.5 to 2 cm long)
1 piece of white rock (quartzite?)

Core 8: Full core recovery. Probably composed of volcanic ash.

0-80 cm Very fluid mixture of green grey mud (50%) and black ash (50%).
80-200 cm 90% Black ash mottled by 10% green grey mud; some water and bubbles.
200-340 cm Mixture of green grey mud (50%) and black ash (50%).
340-354 cm Green grey mud with minor amount of black grains.
354-404 cm Green grey mud with large vertical crack
404-562 cm Green grey mud; minor amount of black grains throughout
Large crack at 553 cm

Core catcher and cutter head in separate bag

Trigger core: Green grey mud, mottled with black grains and streaks.
Core catcher and cutter head in separate bag

Core 9: Small amount of gravelly mudstones. Gravels are a mixture of various lithologies.

Small recovery:
0-10 cm Green grey mud with black grains
10-23 cm Gravel

Trigger core: Green grey mud mottled by black grains

Core 10: Piston core hit rocky bottom. About 40 cm recovered. Cutter head on piston core was mangled even more than core 7.

Small recovery
Mainly coarse black grains, rocks with brown muddy water.

Some of the rock pieces in separate bag.

Trigger core: Mixture of green grey mud and black ash

CORING INVENTORY

12	Set Screws	
1	Small hex wrench for set screws - One end very worn	
1	Large hex wrench for screw in piston	
1	Compete Piston - includes stopper, O-ring, 5 copper spacers and a washer	
1	Partial Piston - missing lower 2 cm; has small stopper	
1	Brass plunger (small) for pushing out core liners	
1	Long steel plunger	
9	Large O-rings for piston	
13	Core barrels - 2 with ends ground and marked with numbers	
3	Collars	#1 - Works well, marked with 22 and 33
		#2 - Works O.K., not marked
		#3 - Does not fit over barrels easily
19	Cutter heads	
2	Good copper core catchers	
1	Bad copper core catcher (missing two teeth)	
14	Totally useless flimsy stainless steel core catchers	
1+	Boxes of liner caps	
16	Core Liners - 10 bad (would not slide in easily), 6 liners not tried	
1	Compete Trigger core set up	
	Trigger Arms	
1	Metal pin attached to line - used with trigger arm	

Several miscellaneous pieces of pipe or steel plates, etc.

Reflections on Polar Duke Seismics

Mark Wiederspahn, UTIG

Backdeck Equipment

Guns

The HAMCO 100 cu. in. water gun works well, and only very occasionally hangs up. The Bolt 340 cu. in. water gun is essentially useless; it works well for 8-10 minutes before slowly degradading in power and eventually ceasing altogether. The Bolt 125 cu. in. air gun worked well, but had to be pressure cycled to un-hang it rather more frequently than the 100 cu.in. gun. This involves lowering and raising the over-pressure blowoff limit. We also used the water gun chamber as a large airgun; it did not seem especially more powerful.

The first HAMCO water gun fire box (labelled HAMCO in the lower center) would not fire the Bolt gun. The gun could be fired manually, presumably due to a longer pulse. The second unit would fire the Bolt gun, and seemed to have a larger voltage (60 V vs. 30 V) and a longer pulse width.

Streamer and Streamer winch

The streamer worked fairly well, but seems noisy on all channels to me. Some sections (3 and 4?) have small amounts of air in them, and need filling. Both connectors of the deck cable-streamer joint were corroded from storage; perhaps mating dummy connectors could be fitted to ensure watertightness during periods of non-use. This connector is difficult to seat properly in cold weather, causing 120 Hz noise if the contacts are not made. Warmth and careful greasing of the o-ring helped. The winch can't be run quickly else the motor begins to stutter. If slip rings were fitted, the cable's electrical condition could be evaluated before deployment, saving valuable ship time. If slip rings are impractical or expensive, then a a hole should be cut in the inner drum, the tow point made by clamp to the drum, and the plug run out through the cover plate over the axle. The raised tow point as it is rigged now makes wrapping the leader quite difficult, and may eventually lead to broken leader wires. Turning the axis of the winch so it faces directly aft would substantially ease the job of level winding, especially with the core rails rigged. Two turning blocks would be then be required to tow the streamer off the starboard fantail. It would be nice to have a second leader onboard. It may also not be wise to put all sections overboard in case of catastrophic loss; we did anyway. If it were easier to take apart the sections and re-rig, we probably would not have.

Lab Wiring, Amplifiers and Filters

The patch panel wiring is mechanically very fragile. The advantages and rationale behind the "summing" of separate unlike streamer sections needs to be documented; these aren't very apparent. There is a large amount of line noise when the deck cable is disconnected from the streamer. It would be nice to have a shorting connector (in the watertight mating plug mentioned above) to evaluate this noise.

The fire pulse connectors (60 volts) are exposed banana jack plugs. This ought to be fixed. Put bnc connections on the gun wires, or put banana jacks on the patch panel.

Hooking two Ithaco amplifiers to one section caused a large amount of line noise. I don't think this should occur.

Lab Hardware

We put the seismic computer on the lower wood shelf, and taped the keyboard to two boards wedged underneath the cpu box. The monitor fits nicely on top. Channel 0 was installed with inverted polarity, meaning a positive input will go onto tape as a negative number. We left it this way, presuming that there was some reason it was so. Channel 1 should be hooked to channel 2 input on the terminal board; we discovered this too late to collect any multi-channel field data.

The second tape drive doesn't load. This seems to be a mechanical problem rather than an electronics problem, but I did not have time to check out all aspects of those circuits.

The digitizer had a dc offset of about 7-9 counts, and was within a few counts at ± 2.5, 5, and 9 volts.

The computer both triggered and was triggered by the Lamont grey relay and cycle timer box. There were no timing diagrams for the overall system, and I suspect that the first sample on tape may occur at different times depending on whether the computer or the grey box triggers the guns. We always used the latter.

Although there is a disk with a diagnostic program for the DT2827, there are no instructions on its use. The board seemed to work fine, but it failed the diagnostic (DIODAT upper-lower byte copy failed). The import of this is unclear.

The Alloy tape interface board is difficult to use, and does not allow access to many capabilities which are useful. For example, the software should be able to write up to 64k byte records; it can only write 16268 bytes. The software should be able to unload a tape at the end of recording so the user knows that the tape is finished; this too can not be done. However, the Alloy tape board can write more than 4096 bytes (in contradiction to what was thought before the cruise) and can encounter the End of Tape sticker without requiring a power down/up restart to continue.

Software

Problems known at the beginning of the cruise:

1) proper seg-y tapes were not created.
2) it was difficult to predict the correct number of shots/tape.
3) there was a byte shift in the first tape block of each shot.
4) deep water delay did not work.

Other problems became evident during testing and use. In response to these problems, I did a large amount of programming to try to improve the program. The next section is part of the READ.ME file on the floppy left in the "SEISMIC SYSTEM BOOT DISKS" box on the ship. The source code is also in the directory "c:\seismics" on the #1 Compaq.

NEW SEISMICS MAY 1989 READ.ME

Introduction

This file is READ.ME. It describes the contents of the minimal source archive of the "new" seismic system, resulting from work by Mark Wiederspahn (MW), University of Texas Institute for Geophysics, during PD-IV-89. The existing files were sources from John Fischer (working for Lamont-Doherty) and Nathan Myers (working for ITT/Antarctic Services). The originals are still available on other floppies.

Installation

This software **REQUIRES** a ***COMPAQ 286*** with a working hard disk, an Alloy tape interface board, and a Data Translation A/D board.

To install it from the 360 kb floppy, labelled "**NEW SEISMICS MAY 89**", place this floppy into the a: floppy drive, and warm boot the Compaq, by typing CTRL ALT DEL (all three at once).

The file "autoexec.bat" on the floppy copies files to a new directory on the hard drive "c:\newseis". It then changes the default directory to this directory and compiles the program, "seismic.exe" from sources. After this completes (about 3 minutes) you should type the command "mkother" which builds several useful programs which work with seg-y tapes on this system.

PLEASE READ THE INTRODUCTION IN THE FILE "SEISMIC.C". IT IS NOT JUST FOR PROGRAMMERS!

MW has attempted to itemize every problem, whether fixed or not fixed, which he has encountered.

Origin and Status of Programs

Dale Chayes of Lamont wrote dmaacq.c

which

John Fischer (and John LaBreque?) modified to make seismic1.c, and seismic2.c (one and two drive versions)

to which

Nathan Myers added getinc.c and getinp.c (PANEL interface routines)

and which

Mark Wiederspahn changed significantly.

to yield:

seismic — which writes real segy, and uses a fixed disk file in between tapes, needing only one drive for continuous recording. Deep water delay is implemented and tested.

MW believes that "seismic" works at least as well as "seismic1", but due to time constraints, it has NOT BEEN TESTED during 24 hour production, only in "small" chunks of just over one tape.

seismic1 — gently modified version which fixes only the byte shift problem and counts feet of tape used automatically. It loses ~5 minutes of data between tapes, and write "blocked" segy, not real segy.

seismic2 — has not been touched by MW.

t — reads segy tapes, prints min, max, avg volts and most useful trace header value. Works on segy or blocked segy tapes

plot — plots segy tapes on the screen. very pedestrian, but plots every point on tape, and allows you to vary the start index. Works on both normal and blocked segy tapes.

sgydmp prints values from traces on a segy tape.

Programs seismic1 and seismic2 are available on other floppies.

The following is the introduction to the main program.

```
/* seismic.c    "NEW SEISMICS MAY 1989"
*
* this is an annotated and updated version of the program
* "seismic1.c" dated 22feb87. It has significant enhancements
* and bug fixes over the original.
*
* Comments flagged by a "%" were made by:
*
*                       Mark Wiederspahn
*                       University of Texas Institute for Geophysics
*                       8701 Mopac Blvd
*                       Austin TX 78759
*                       Tel: (512) 471-6156
*                       Fax: (512) 471-8844
*                       Tlx: (910) 874-1380 answerback "UTIG AUS"
*                       Internet: markw@utig.ig.utexas.edu
*
* He would appreciate hearing about any comments, suggestions or errors.
*
* In some areas there are so many changes or additions
* that this procedure is unwieldy; in such cases the header
* comments for that section will identify MW as the principal
* culprit. MW worked on the program during PD-IV-89 April-May, 1989.
*
*       A textual note: adjust your editor (MW uses Norton NE) to
*       echo tabs as 4 spaces to keep the indentation from
*       becoming unwieldy. To print this program, put it through
*       filter ??? so the tab stops will line up on the output.
*
*       As an alternative, use the horizontally compressed print
*       option of the Centronics printer, which is the default at
*       this writing.
*
* -----------------------------------------------------------------
* making an executable from the sources:
*
* The command procedure "mkseismic.bat" does all steps below, and
* can be invoked by "mkseismic".
*
*       All modules are readable C language source except PANEL35.S,
*       which is a binary concatenated object library. See DeSmet C
*       LIB88 documentation for its format. Presumably it comes from
*       the Lifeboat PANEL package. All routines not in PANEL35.S nor
*       in any visible source file are from STDLIB.S, which contains
*       the standard C io library, a version of the Alloy tape routines,
*       and a version of the DeSmet screen routines.
*
* to compile:
```

```
* C88 seismic.c
*       options: -nDEBUG to compile debugging printout stuff.
*                       creates file "debug.out".
*               -nPLOT_LINES to plot lines instead of points on the screen
*               -nMULTI_FILE to permit multiple files per tape.
*       eg.  "c88 seismic.c -nDEBUG" turns on debugging output.
*
* C88 tape_block.c
* C88 scrtics.c
* C88 sgyhdr.c
* C88 swap.c
* C88 getincnew.c
* C88 getinpnew.c
*
* to link:
* BIND seismic tape_block scrtics sgyhdr swap GETINCnew GETINPnew PANEL35.S
*
* ------------------------------------------------------------------
*
* Known (or possible) problems which have *NOT* been resolved yet:
*
*       MW is reasonably sure that the first sample is not exactly
*               at any specific multiple of one sample interval after the
*               trigger, based on attempts to digitze the output of the
*               Lamont "grey box" trigger signal.  If the timing is precise,
*               the waveform should be the same whether the computer shoots
*               or the box shoots.  This does not seem to be the case.
*               Users should be careful of any interpretation of
*               absolute times during a trace, especially since gun phone
*               triggers are not at present used.
*
*       5 seconds of dead time may not be enough to switch tapes -
*               with an external trigger one shot will be missed at the
*               end of the tape, if you plot lines.  6 seconds or plotting
*               dots at 5 seconds of dead time is ok.
*
*       If the computer triggers the guns, timing problems will ALWAYS
*               occur at the end of a tape, due to similar problems.
*               If you don't like this, use "seismic1" and miss 3 minutes.
*
*       variable "lastnow" seemed to have no purpose.
*               It is retained anyway, but is not referenced.
*

*       Two channels seem to work - the secret is to hook up the input
*               to (channel number)
*2 inputs! This is detailed in the DT-707
*               portion of the manual (p E-5, table E-1) and is not at all
*               intuitive.  We got this working too late to try with field data.
*               Ground all unused inputs if they have cables on them, so they
*               don't act as antennas.
*
*       control C or control BREAK may hangup if a dma trasfer is
*               in progress from the a/d unit?
```

```
*
*       the julian day of year starts at 0, rather than 1, which
*               is the generally accepted convention. 0 origin comes
*               from Unix conventions. Left as is for now.
*
*       the Alloy tape controller is reported to hang up the system
*               requiring a power off/on reset to get unhung. MW's
*               experience in writing tape to EOT sticker many times
*               contradicts this; in any case, the normal setting of
*               2300 feet / tape should allow pleny of margin for
*               retries or error, so EOT should never be seen, unless
*               restarting a tape in the middle. The user should then
*               estimate the amount remaining in the setup menu.
*
*       the actual cycle time which results is one second longer
*               than that set by the user if in "computer shooting"
*               mode and the record length is one second shorter than
*               this cycle time; 2 second dead time is required.
*               The external trigger case is ok.
*
*       the cycle time (period) *MUST* be set for external trigger as
*               well as internal trigger. It acts as a retrigger lockout
*               for both cases. This is perhaps unexpected by the user.
*
*
*       Inadequate provision exists for restarting recording in the
*               middle of a tape. The user must enter the correct number
*               of feet, or manually terminate recording based on time,
*               or EOT will be detected (with possibly unfortunate results).
*
*       as a matter of programming style, long routines all in one file
*               encourage poor modularity and sloppy thinking. This ends
*               the sermon for today.
*
* ----------------------------------------------------------------
*
* Problems corrected:
*
*       note: the first two changes were made in the source code for
*               seismic1.c itself, as these were deemed most essential.
*
*       code involving byte shift within first 3800 bytes of data trace
*               fixed. This apparently was known (tlx from John LaBreque of
*               4/25/87) but has never been fixed in the official base version,
*               resulting in several cruises with problem data.
*
*       difficulty of estimating "number of scans" per tape circumvented
*               by counting feet used as the tape is recorded. It is accurate
*               to a few per cent. 2300 is a good nominal value. Number of
*               feet used and total feet to be used are printed each shot.
*
*
*       the original program wrote "blocked-segy", although no external
*               or internal admission of this "feature" was made. Blocked
```

```
*               segy can't be read directly by seismic processing packages,
*               since it isn't a standard.  The program now writes real segy.
*               As a beneficial side effect, the program now uses less tape
*               since fewer or shorter records are written.  The Alloy tape
*               card apparently will not write more than 16,268 bytes (this
*               is by actual trial and error, mw 29apr89).  Dale Chayes of
*               Lamont, the original "tutil.a" author, thought more than 4k would
*               fail.  This has not been resolved at this writing.  Up to 8,000
*               samples has been demonstrated to work, however.
*
*       since only 8 kb of a/d dma buffer space was allocated, records made
*               at fast cycle times, with more than 8kb of data per shot
*               (all channels) could find that the higher buffer began to
*               record over the data in the top part of the lower buffer
*               before this data was copied to a segy trace buffer in program
*               memory (lower 640kb).  The size of the dma has been enlarged,
*               and a test made at run time to warn the user if the current
*               size is too small.  A working deep water delay maked this
*               less of a problem, as well.
*
*       if the program were restarted midway during a tape, additional
*               segy reel headers would be written, violating the segy
*               standard.  This is now a compile time option: MULTI_FILE.
*               Strictly speaking, such a tape is not legal segy anyway.
*               This affects:
*                                                  defined      not defined
*               warning if not at BOT on startup   NO           YES
*               rewind tape at F10 (end)           NO           YES
*               write reel headers at startup      YES          NO
*               write reel headers only at BOT     NO           YES
*
*       record number always starts at 2 on a reel (should be 1) and
*               F10 (stop) writes a trace with the same record number as
*               the previously written shot.  This is fixed.  Probably some
*               number besides line sequence number should count up across
*               tapes recorded in one session.
*
*       many instances of:
*                       char    foo[xx];
*                       foo[0]  = "this is a string";
*               were changed to:
*                       strcpy( foo, "this is a string" );
*               The former sequence only changes the first byte, so far as
*               MW can determine.  It should not produce the desired result
*               in most dialects of C, and the assembly code shows it is
*               changing only the first byte of the target string, as expected.
*
*       ebcdic translation table was missing a few commas in initializer sequence.
*               DeSmet C compiler apparently did not care?
*
*       deep water delay code resulted in large trace to trace start
*               jitter, derived from the 18 msec system clock resolution.
*               The implementation is changed to digitize starting at the
*               trigger (0 delay), but to plot or write to tape starting at
```

```
*               the delay (which now is in *TENTHS* of seconds, and can be
*               changed on the fly in 0.1 sec increments with F2/F4 )
*
*       the x value of plotted points was not modulo 640, so each
*               centerline below the first was one line lower than it
*               should have been.  This is fixed, so zero volts in always
*               results in a line going through scrtic's tick marks.
*
*       If the file PANEL.VDU is not in the current directory, then
*               no panel of parameter choices is displayed; now a
*               notice of this problem is given to the user, naming
*               PANEL.VDU as the missing entity.
*
* ------------------------------------------------------------------
*
* Capability added:
*
* The program checks to make sure you have a writable tape.
*               If you don't, data will be written to disk until you do.
*
* This version is still a single drive version, however, code to
*               write data to fixed disk during tape changes means that
*               continuous recording is now possible with one drive.  The
*               drive can be taken offline between shots with no impact
*               in the data recorded IF it is later put back online.
*               This capability may require a winchester disk; it may
*               not work for floppies, unless you boot from a stripped
*               down 1.2 Mb floppy, and run the system slowly.  It takes
*               about 5 minutes to swap a tape on the cipher f880's;
*               there must be space to store this length of data:
*               300/(cycle time) * (240+(record length/sample interval)*2)
*               bytes.  For example, 5 seconds of 2 mil data taken each
*               10 seconds needs about: 300/10 *240+(5/.002)*2 = 157,200
*               bytes, or about a sixth of a 1.2 Mb floppy.
*
*               If you hook up a Bernoulli box, then this method could be
*               used as a fallback in case both tape drives were inoperable.
*               No reel headers are written for the disk file, however.
*
* The program will warn you at startup if you aren't at the beginning of
*               a tape; it will act as though you are adding to an existing
*               segy tape, but will not check for sequence numbers or correct
*               positioning (at this writing).
*
* Simpler and more readable routines for reading and writing segy
*               headers have been written, in file "sgyhdr.c".  The byte
*               swap is integral to the placing of the datum in the header.
*
* Verbose code has been shortened, and  obscure sequences
*               annotated or recoded to become more clear (I hope).
*
* The scale factors for screen display are changed and scale tics
*               added.  Tics are at 5 volts, trace centerlines at 10 volts.  That is,
*               a trace which just touches another trace is being overdriven.
```

```
*               Code to plot lines or dots can be selected at compile time.
*               Define "PLOT_LINES" for lines; Dots is the default.
*               Lines take about twice the time to plot.
*
* Code to warn of overdrive is added to the segy output routine.  If
*               the absolute value of the voltage is greater than ODRIVE (below)
*               fraction of full scale, a warning will be printed each shot.
*
* All planned exits from the program occur at the bottom of the
*               main loop.  This allows cleanup to be done in one place.
*
* The ebcdic header translation table is 8 bit, not 16 bit now.
*/
```

SHIPBOARD ELECTRONICS

Ken Griffiths, Research Engineer

Cruise IV-89 marked my second opportunity to work aboard R/V Polar Duke. We had the underway geophysics systems up and running much faster this time than last year, when all but one of our group were new to the ship. This year, we had a working 3.5 kHz echo sounder and the full complement of computers were on board. Since we had a working knowledge of the ship's electronics, we were able to bring needed parts and instruments from Austin. The cruise was very successful, and I look forward to participating again.

Echo Sounding

Both the 12 and 3.5 kHz echo sounders were used throughout the cruise. There were no hardware problems with either system. Data quality ranged from excellent to nonexistent. As we saw last year on the 12kHz echo sounder, some combinations of sea state, course and speed could completely wipe out any record. This proved true with the 3.5 system as well. Overall, the 12kHz sounder produced marginally better records, except in deep water. We saw very little penetration with the 3.5kHz echo sounder. The jury is still out on whether this is a limitation in the system, or just the conditions in our location. If one considers the unique area where R/V Polar Duke works, I would strongly recommend that consideration be given to a major upgrade in the echo sounding capabilities of the ship. We should be collecting first-class data on every cruise, and that data should be transmitted in a timely fashion to the people updating the DMA charts of the region.

Magnetometer

The magnetometer was deployed during all transits and during the geophysical survey legs, particularly the Shackleton fracture zone survey. We relocated the recorder from the corner behind the ladder to a shelf on the after bulkhead. This put it up in view and made it much easier to control. We then looked at the winch and the deck cable. The connector between the magnetomenter cable on the reel and the cable into the lab had not been replaced. We removed it last year because we had determined that it had been crushed and the data was severely degraded and existed by twisting the bare wires together. We discussed using the CTD winch sliprings that were onboard so that the cable would not have to be unplugged for each deployment and recovery [and possibly forgotten as happens]. There was no documentation for the sliprings onboard so I decided against using them. The normal CTD current is about 1 amp while the maggie polarize current is on the order of 10 amps. I had visions of welding the contacts together. We had brought a pair of waterproof connectors with us from Austin so these were spliced onto the cable. I cut back the deck cable (the cable from the winch to the lab) as far as I could, but never found uncorroded shield braid. This cable needs to be replaced. The connectors would then need to be redone to carry the shield through to the lab.

We carried the spare sea cable onboard but were not able to test it. We did test the spare magnetometer recorder on the transit leg north, and it worked well. We also noticed some sensitivity (lower signal strength, higher noise) to the ship's course. This generally means that the sensor cable is not long enough to minimize the ship's magnetic influence, but there can be other causes. We just ran out of time and were not able to pursue this further. My recommendations for the magnetometer are to install sliprings on the winch and to renew the deck cable. Connectors matching the slipring will be needed for both sea cables.

I would suggest that the magnetometer be routinely used any time possible. It, like the echo sounder, can provide valuable, new information almost anywhere the Polar Duke works. The extra cost is very small. We have a great opportunity here, and I hate to see us not getting the most out of it.

Polar Duke Computers and Computer Network

There are three main computers available on R/V Polar Duke. These are the Compac 286 Deskpro systems. One is dedicated to the Sail loop logging system. A second is the basis for the seismic acquisition system. The third, normally used with the CTD, was available for general purpose use during our leg. Realizing that the single machine would not provide enough computing power for our program we brought three Macintosh Pluses and an IBM PC.

In order to make the most effective use of the computing resources now available we decided to build a network with four of the machines. We installed two of the Mac Pluses in the Underway Geophysics Lab, with 20 and 45 Mbyte disks. The third Mac Plus, with a 100 Mbyte disk, and the Compac 286 were installed in the Starboard Lab Van. Standard Appletalk cables were used to connect the Macintoshes. We installed a Tops Flashcard in the Compac to put it on the network. An Imagewriter II network printer was also installed in the Lab Van.

In order to connect the two labs, we brought cable in case it was needed. Running wire from the Underway Geophysics Lab (aft upper lab) down to the hold would have been a major task since there would have been at least two watertight penetrations needed. We found a multiconductor cable that runs from the upper aft lab, down through the hold and on towards the bridge. There was a short stub spliced onto this cable in the hold. I spliced an Appletalk connector on the top end and a 75 foot extension on the lower end, this was run across the hold and into the forward end of the starboard lab van. While the network did work, it showed quite a bit of background noise. The open cable leading toward the bridge was suspect. With the help of Bob O'Leary we traced it through a junction box in the air-conditioning room. By terminating the cable with a resistor at this junction the noise was gone.

On the software side we used the TOPS network system. This is a distributed file server scheme that makes any mounted volume on any computer available to any user. The user treats these volumes as if they are on his local computer. A brief example can show how useful this was. We wanted to plot navigation and depth on the HP plotter in the Underway Lab. I happened to be working on the Mac down below. I mounted the sail navigation data in the Bernoulli drive on the Compac and pulled it over to the Mac. Filtering that data to 5-minutes, I then combined it with the depth data from the Mac in the Underway Lab. The resulting file was left on the disk down below, but was available to the plotting program running up in the lab.

Overall, I feel our network experiment proved very successful. The physical installation went very rapidly once we discovered the unused cable. I left those connections onboard, the lower end is coiled on top of the lab van. The software worked well, a bit more transparent to the user on the Mac's than on the Compac. Four computers, no waiting. If the one you wanted was in use, another could serve just as well.

Sonobuoy Operations

During the cruise we attempted seven sonobuoy lines in the King George Basin. Two of the buoys were successful. The problems with the others were typical of the older military buoys. On two the radio was lost early. The other three were very noisy and we suspect that the hydrophones did not deploy properly.

The sonobuoy system consisted of an ICOM R-7000 receiver fed by a 10-element Yagi antenna mounted on the helicopter deck. The signal from the receiver was passed through the seismic system Ithaco amplifier and Kronhite filter, then to an EPC recorder. We had originally planned to record the signals on the digital system, but we did not sort out the multichannel feature in time. So we opted to continue the normal digital seismic record and use just the chart recorder for the buoys. Finding the spare EPC recorders unusable, we used the 3.5 kHz echo sounder recorder for the single channel seismic trace during sonobuoy operations in order to free up the EPC 3200 recorder for the sonobuoys.

If all this sounds somewhat unplanned, it was. It was only just prior to sailing that all the pieces came together. We found the R-7000 receiver onboard (coming back from Palmer?), and the sonobuoys turned up tucked away in the warehouse. I rigged a single Yagi antenna and we installed it on the helicopter deck during our first stop at Palmer Station. There is no RF signal generator onboard so we had no way to test the full system.

That having been said, the experiment worked reasonably well. Our results were getting better each time, until the ice cover forced us out of the King George Basin. The receiver bandwidth is narrow for the buoys so the close-in, strong signals were hard to tune. As the range opened the receiver performance improved. The audio response of the receiver is uncharacterized. We could hear the 3.5 kHz signal as well as the gun so the top end is probably fine. The lower frequency cut off is a question. For routine use I would not want to use that receiver without calibration and probably modifying the front end bandwidth. With more time to prepare, we could have mounted the antenna higher. This would have helped the radio range limitations. Unfortunately, many high antenna locations on R/V Polar Duke cannot be serviced at sea. Lastly, larger sound sources are always helpful for refraction work.

EPC Graphic Recorders

At various times during this cruise we used all five of the EPC recorders onboard. Two of the units need repair and are being returned. The general practice was to use the two 4603 models for 12 kHz and 3.5 kHz echo sounding. They were in continuous use. The model 3200 was used for the seismic record and sonobuoys.

EPC Model 4603 s/n 309

This recorder was used for 12 kHz echo sounding. Some time base drift occurred when used with the pinger on the core wire, or the heat flow probe. No problems were encountered with echo sounding.

EPC Model 4603 s/n 592

This recorder was used for 3.5 kHz echo sounding. Similar time base problems as s/n 309. Used in start-stop mode for seismic data when using the 3200 for sonobuoys. A limitation on this model is that the slowest sweep is 4 seconds. In deeper water an external delay box is needed. We brought from Austin an EPC Model 1000 Crystal Delay Unit. This is a generally useful dual channel delay and timer. I would recommend that a Crystal Delay Unit be acquired as a permanent part of the Polar Duke's lab equipment.

EPC Model 4600 s/n ?

This recorder was stored over the starboard lab van. Shipping labels show that it came from Dr. John Anderson. It would work some of the time at 1 second sweep rates. It never worked at the slower rates, or in start-stop mode. We sent it back with the sea shipment.

EPC Model 3200S s/n 297

This was our main seismic and sonobuoy recorder. It performed well throughout the cruise.

EPC Model 3200 s/n 125

We were never able to use this older style 3200 recorder. There appears to be a clock/timing/trigger problem that prevents the recorder from staying in synch. Time lines show up in random locations. This recorder uses a different stylus belt than the 3200S. We are also sending this recorder back for repair. I strongly recommend that it be modified or upgraded to the 3200 "S" style. This will greatly simplify keeping track of belts and paper for these machines.

Paper and Belts:

We used 20 rolls of paper this cruise. Belts were not counted, but one per roll of paper is reasonable. Most of the paper was used for the echo sounders, very little was used for seismic work. Typical consumption was 14"/hr for the 12 kHz echo sounder and 10"/hr for the 3.5 kHz.

Supplies onboard 15 May 1989:

For	4600's	12 Rolls of Paper	12 Stylus Belts
	3200	30 Rolls of Paper	24 Stylus Belts
	3200S	same paper	23 Stylus Belts

Suggest ordering:

4 ea. Unit Support Kit No. 800003 for the 4603 recorders.
2 ea. Unit Support Kit No. 800465 for the 3200S recorders.

SAIL LOOP

The sail loop logging system was used throughout the cruise. Based on our experience last year we made a number of changes to the logging program before we left port. These changes were in the nature of bug fixes and increased functionality. More work can be done. I believe it is time for a serious look at the overall sail system, and probably another re-write of the program. The newer implementations of the Basic language allow much more modular code and better error trapping. This is very important to accommodate the diverse nature of R/V Polar Duke users.

The sail system should be run any time the ship is at sea. Because the primary data recorded with the sail loop are time and navigation, the sail loop provides the framework for all of the other underway and station data. Even for users of single points, such as an XBT, the instantaneous position information may be inaccurate. A satellite update may move the station position many miles. Logging the continuous data stream allows this to be checked and edited, if necessary. The real-time printout makes it easy to check back without interrupting the logging just to read the digital file. A quick scan of the paper record may be the best form of quality control. It is invaluable during the editing process.

For our cruise PD IV-89, the old sail loop program was saved as DUKESAIL.OLD and the updated version is named DUKESAIL.BAS. The program can be run from the

SAIL directory on drive C:. The new master floppy disk will boot and run the program in drive A:

From a cold start:

C:\> cd sail

C:\SAIL> basica dukesail

Will get things off and running.

The program opens a new file every hour, or when it is first started. A problem in the past was that if for some reason the program had to be restarted during the same hour that it had been running, a new file would be written, and all the prior data was lost. This has been fixed in the current version. The program may be restarted at any time without losing data.

The program left onboard will default to sample every minute. This is as fast as the navigation data is available from the Magnavox SatNav. The sample rate can be changed at startup, or by changing the values in program lines 740 and 760. We used a 30 second sample rate any time we had the magnetometer deployed. One minute data fits nicely on a page of printer paper. The program now starts a new page, and writes a page header, at the beginning of every hour.

The sail system now writes the entire Magnavox first line to the disk file and printer. The earlier programs only wrote the time and navigation data. This left one guessing if the navigation was GPS, Transit or dead reckoning, and how good it might be. Editing was very difficult. This is a change from the old file structure, however, it still fits on one line. Because of the varied nature of this Magnavox line it may be better treated as a free form comment, rather than a fixed file structure.

Since we had a number of utility programs for the Macintosh computers I added code to open the second communications port and echo the data written to file. By cabling this output over to the Mac's serial port we were able to monitor the full sail data stream. We used programs for real-time navigation plotting and magnetics display. I left this code in the program. To remove it comment out lines 935 and 3117.

```
10 REM *********************************************************************
30 REM ************ BY J.L. LABRECQUE SEPTEMBER 1986 **********************
40 REM *********** DUKESAIL MODIFIED FROM PROGRAM FIRESAIL ****************
50 REM *********************************************************************
60 REM PROGRAM FIRESAIL*****************************************************
70 REM              BY J.L. LABRECQUE ABOARD THE USNS LYNCH 9/12/84
80 REM *********************************************************************
90 REM ******************     PUSH-DOWN MODIFICATION HISTORY    **************
100 REM  02/24/87  NATHAN MYERS  REWROTE PROGRAM IN BLOCK STRUCTURE
110 REM  02/24/87  NATHAN MYERS  ADDED CODE FOR DATA REDUCTION TO CONSERVE SPACE
120 REM  02/24/87  NATHAN MYERS  ADDED CODE FOR INPUT OF CAPRICORN II WEATHER INFO
130 REM  11/17/88  B.D. SCHIEBER  ERROR FIX OF ERROR TRAPPING ROUTINE.
140 REM          ADDED PROMPTS FOR DATA DISK AND OPTIONAL WEATHER ACQ.
150 REM          EDITED TO ALLOW FOR ADDITIONAL MODULES.
151 REM
152 REM  04/17/89  KEN GRIFFITHS  ADD ROUTINE TO PRINT DATA TO LINE PRINTER,
153 REM          FILE APPEND TO PREVENT  LOSING OLD DATA
154 REM          ADDED MAGNAVOX LINE 1 NAVIGATION INFORMATION.
155 REM          REPEAT DATA TO COM2 PORT FOR TESTING.
160 REM *********************************************************************
170 REM
180 REM INITIALIZE VARIABLES, TIME, DATE, COM PORTS, ETC
190 REM
200 COLOR 15
210 DEFINT I-N
220 CLEAR
230 REM INITIALIZE DATA VARIABLES
240 TTIME$=SPACE$(8)
250 GMT$=SPACE$(8)    : REM ZULU DATE AND TIME FROM MAGNAVOX
260 LAT$=SPACE$(11)   : REM LATITUDE
270 LON$=SPACE$(11)   : REM LONGITUDE
280 SPEED$=SPACE$(4)  : REM SHIP SPEED IN KNOTS
290 HDG$=SPACE$(5)    : REM SHIP HEADING IN DEGREES
295 LINE1$=SPACE$(24) : REM LINE 1 INFO FROM MAGNAVOX
300 MAG$=SPACE$(7)    : REM MAGNETOMETOR READING
360 BATHY$=SPACE$(6)  : REM BATHYMETRY DATA FROM EDO DEPTH-TRACKER (METERS)
430 FIRST=1
440 WHILE (FIRST=1)
450    FIRST=0 : NEWFILE=0
460    C$=","
470    SCREEN 0,0:WIDTH 80
480    KEY OFF:CLS:CLOSE
490    BLK$="                                                                      "
500    ON ERROR GOTO 3150
510    REM
520    LOCATE 1,1
530    PRINT "*****************************************************************************"
540    PRINT "***                    D U K E S A I L                                    ***"
550    PRINT "*** DUKESAIL SAMPLES THE SAIL LOOP AS OFTEN AS YOU LIKE                   ***"
560    PRINT "*** FILES ARE OPENED AND CLOSED EVERY HOUR TO PROTECT AGAINST DATA LOSS ***"
570    PRINT "*** NOTE: MAGNAVOX 1107 MUST BE SET TO DISPLAY GPS AND GDRT AND         ***"
580    PRINT "*** TO PRINT RESULTS EVERY MINUTE.                                      ***"
590    PRINT "*** IF YOU TERMINATE THE PROGRAM, TYPE 'CLOSE' TO CLOSE ALL FILES       ***"
600    PRINT "*****************************************************************************"
610    LOCATE 12,1
620    PRINT " PLEASE FILL IN THE FOLLOWING QUESTIONS CAREFULLY"
630    PRINT " DATE IS",DATE$
640    INPUT " TO CORRECT THE DATE ENTER DATE AS MM-DD-YYYY OTHERWISE PRESS ENTER" ;D$
650    IF(D$<>"")THEN DATE$=D$
660    PRINT " "
670    PRINT " TIME IS",TIME$
680    INPUT " TO CORRECT THE TIME ENTER **GMT** AS HH:MM:SS OTHERWISE PRESS ENTER";T$
690    IF(T$<>"")THEN TIME$=T$
700    PRINT " "
```

```
710  PRINT " DATES AND TIME ARE ",DATE$,TIME$
740  INTERV=60:NEWINT=60
750  PRINT " THE SAMPLING RATE IS ",INTERV:INPUT" ENTER A NEW RATE OR PRESS RETURN";NEWINT
760  IF (NEWINT<1) THEN INTERV=60
770  REM  INPUT " IS WEATHER DATA BEING GATHERED (Y/N) ";WEATHER$
771  WEATHER$="N"
780  PRINT " "
790  INPUT " ENTER DRIVE TO SEND DATA TO (defaults to D:) ";DRIVE$
800  IF DRIVE$="" THEN PRINT"":PRINT"DEFAULTING TO BERNOULLI DRIVE D:":DRIVE$="D:"
810  IF INSTR(DRIVE$,"A")>0 OR INSTR(DRIVE$,"a")>0 THEN DRIVE$="A:"
820  IF INSTR(DRIVE$,"B")>0 OR INSTR(DRIVE$,"b")>0 THEN DRIVE$="B:"
830  IF INSTR(DRIVE$,"C")>0 OR INSTR(DRIVE$,"c")>0 THEN DRIVE$="C:"
840  IF INSTR(DRIVE$,"D")>0 OR INSTR(DRIVE$,"d")>0 THEN DRIVE$="D:"
850  IF INSTR(DRIVE$,"E")>0 OR INSTR(DRIVE$,"e")>0 THEN DRIVE$="E:"
860  IF INSTR(DRIVE$,"F")>0 OR INSTR(DRIVE$,"f")>0 THEN DRIVE$="F:"
870  INPUT " IF THE ABOVE ARE CORRECT PRESS ENTER, OTHERWISE TYPE NO";D$
880  IF(D$<>"") THEN CLS: GOTO 610
890  IF DRIVE$ = "A:" THEN INPUT" ENTER A LABELED DATA DISKETTE INTO DRIVE A: AND PRESS RETURN ";DD$
900  IF DRIVE$ = "B:" THEN INPUT" ENTER A LABELED DATA DISKETTE INTO DRIVE B: AND PRESS RETURN ";DD$
910  CLS:LOCATE 1,1:PRINT DATE$;TIME$
920  REM  **************** OPEN SAIL LOOP COM PORT ************************
930  OPEN "COM1:300,N,8,2,RS,DS" AS #1
935  OPEN "COM2:9600,N,8,1,RS,DS" AS #2
940  CLS:LOCATE 1,1:PRINT DATE$,TIME$
950  REM ********* SET UP MODULE POLLING LIST **************
960  PRINT " MODULE ADDRESSES CORRESPOND TO SAIL STANDARD,1981"
970  PRINT "------------------------------------------------"
980  PRINT "3  ADDRESS OF THE MAGNAVOX/GPS-1107 SERIAL MODULE"
990  PRINT "20 ADDRESS OF MAGGIE SERIAL MODULE"
1050  PRINT "26 ADDRESS OF BATHYMETRIC DEPTH TRACKER"
1070  IA(1)=3:IA(2)=20:IA(3)=26:IP=3
1080  REM INTERV IS SAMLPING INTERVAL IN SECONDS
1090  PRINT " SAMPLING INTERVAL IS ",INTERV," SECONDS"
1100  PRINT " USE TILDE KEY (~) TO STOP PROGRAM AND SAVE DATA"
1110  GOSUB 3320  :  REM GET FIRST FILE TO OPEN
1115  GOSUB 5000  :  REM printer newpage routine
1120 WEND
1130 REM
1140 REM *********  BEGIN PROGRAM MAINLINE  **********************
1150 REM
1160 WHILE (FIRST=0)
1170  REM ****** CHECK FOR CHANGING HOUR AND CLOSE FILE ON THE HOUR ******
1180  FHR$=MID$(TIME$,1,2): IF FHR$<>FHRL$ THEN LOCATE 14,1:PRINT "CLOSING FILE ";FIL1$:CLOSE #3:NEWFILI
1190  REM
1195  IF NEWFILE=1 THEN GOSUB 5000 : REM printer newpage routine
1200  IF NEWFILE=1 THEN GOSUB 3320 : REM GET NEW FILE & OPEN IT
1205  IF NEWFILE=1 THEN GOSUB 5000 : REM printer newpage routine
1210  REM
1220  REM ********WAIT FOR TIME TO GET SAMPLE ************
1230  DONE=0
1240  WHILE (DONE=0)
1250    SEC=VAL(MID$(TIME$,7,2))
1260    LOCATE 1,1:PRINT DATE$,TIME$
1270    IF SEC MOD INTERV=0 THEN DONE=1
1280    IF SEC=SSEC THEN DONE=0 ELSE SSEC=SEC
1290  WEND
1300  REM
1310  BEEP : REM ******** TIME TO GET A SAMPLE *********
1320  DAT$=""
1330  TTIME$=TIME$
1340  REM ************* START SAMPLING *****************
1350  REM
1360  FOR I=1 TO IP
1370   IAD=IA(I)
```

```
1380    LOCATE 22,1
1390    PRINT "SAMPLING MODULE",IAD
1400    NAM=INT(IAD/10)+48
1410    IUN=(IAD MOD 10)+48
1420    REM
1430    REM ***************** CLEAR OUT COM1 BUFFER ****************
1440    WHILE (LOC(1)>0)
1450      A$=INPUT$(1,#1)
1460    WEND
1470    REM
1480    REM ********** SEND "ATTENTION!" TO SAIL MODULE ***************
1490    PRINT #1, USING "!";CHR$(35);CHR$(NAM);CHR$(IUN);
1500    TOT$=""
1510    REM
1520    IF LOC(1)<0 THEN GOSUB 3450 : REM WAIT TILL DATA COMES TO BUFFER
1530    A$=INPUT$(1,#1) :REM PRIMING READ
1540    REM
1550    IEND=0
1560    WHILE (NOANS=0 AND IEND=0)
1570      LONG=0
1580      WHILE (IEND=0 AND NOANS=0)
1590        ACCUM=1
1600        IF A$=CHR$(10) OR A$=CHR$(13) THEN ACCUM=0
1610        IF A$=CHR$(3) THEN IEND=1: ACCUM=0
1620        REM ******** FLUSH DATA IN EXCESS OF 255 CHARS *******
1630        WHILE (LONG=1 AND IEND=0 AND NOANS=0)
1640          IF LOC(1)<0 THEN GOSUB 3450
1650          A$=INPUT$(1,#1)
1660          IF A$=CHR$(3) THEN IEND=1
1670          ACCUM=0
1680        WEND
1690        IF ACCUM=1 THEN TOT$=TOT$+A$:A$=""
1700        REM CHECK THAT MODULE ANSWER DOES NOT EXCEED 255 CHARACTERS
1710        IF LEN(TOT$)>=254 THEN LONG=1
1720        DONE=0
1730        WHILE (IEND=0 AND DONE=0)
1740          IF LOC(1)<0 THEN GOSUB 3450
1750          A$=INPUT$(1,#1)
1760          DONE=1
1770        WEND
1780      WEND
1790      REM
1800      REM ************ DATA REDUCTION ********************
1810      REM ******* REDUCE MAGNAVOX 1107 OUTPUT ********
1820      REM REDUCE LINE LENGTH BY REMOVING EXTRA BLANKS ALLOW ONLY 1 BETWEEN VARIABLES
1830      REM PRINT AND STORE MAGNAVOX OUTPUT
1840      DONE=0
1850      WHILE (IAD=3 AND DONE=0)
1851            REM GET MAGNAVOX LINE 1 DATA
1853          ST1=INSTR(TOT$,"LAT")-52
1856          IF ST1<1 THEN GOTO 1860
1858          LINE1$=MID$(TOT$,ST1,24)
1860        LENT=LEN(TOT$)
1870        BLL$=MID$(TOT$,1,1)
1880        NAVDAT$=BLL$
1890        FOR MI=2 TO LENT
1900          BL$=MID$(TOT$,MI,1)
1910          IF BLL$=" " THEN IF BL$=" " THEN GOTO 1940
1920          NAVDAT$=NAVDAT$+BL$
1930          BLL$=BL$
1940        NEXT MI
1950          POINTER=INSTR(NAVDAT$,"LAT")
1960          IF POINTER>0 THEN LAT$=MID$(NAVDAT$,POINTER+4,11)
1970          WHILE (LEN(LAT$)<11)
```

```
1980            FOR K=1 TO (11-LEN(LAT$))
1990             LAT$=" "+LAT$ : NEXT K
2000           WEND
2010           POINTER=INSTR(NAVDAT$,"LON")
2020           IF POINTER>0 THEN LON$=MID$(NAVDAT$,POINTER+4,11)
2030           WHILE (LEN(LON$)<11)
2040             FOR K=1 TO (11-LEN(LON$))
2050             LON$=" "+LON$ : NEXT K
2060           WEND
2070           POINTER=INSTR(NAVDAT$,"GMT")
2080           IF POINTER>0 THEN GMT$=MID$(NAVDAT$,POINTER+4,8)
2090           WHILE (LEN(GMT$)<8)
2100             FOR K=1 TO (8-LEN(GMT$))
2110             GMT$=" "+GMT$ : NEXT K
2120           WEND
2130           POINTER=INSTR(NAVDAT$,"SPEED")
2140           IF POINTER>0 THEN SPEED$=MID$(NAVDAT$,POINTER+6,4)
2150           WHILE (LEN(SPEED$)<4)
2160             FOR K=1 TO (4-LEN(SPEED$))
2170             SPEED$=" "+SPEED$ : NEXT K
2180           WEND
2190           POINTER=INSTR(NAVDAT$,"HDG")
2200           IF POINTER>0 THEN HDG$=MID$(NAVDAT$,POINTER+4,5)
2210           WHILE (LEN(HDG$)<5)
2220             FOR K=1 TO (5-LEN(HDG$))
2230             HDG$=" "+HDG$ : NEXT K
2240           WEND
2250         DONE=1
2260       WEND
2270       REM ****** REDUCE MAGNETOMETER READING ******
2280       DONE=0
2290       WHILE (IAD=20 AND DONE=0)
2300         IF LEN(TOT$)>7 THEN TOT$="#20"+MID$(TOT$,LEN(TOT$)-6,7)
2310         DAT$=DAT$+TOT$
2320         REM  DATA REDUCTION
2330         POINTER=INSTR(TOT$,"#20")
2340         IF MID$(TOT$,POINTER+3,1)<>"#" THEN MAG$=MID$(TOT$,POINTER+3,7)
2350         WHILE (LEN(MAG$)<7)
2360           FOR K=1 TO (7-LEN(MAG$))
2370           MAG$=" "+MAG$  : NEXT K
2380         WEND
2390         DONE=1
2400       WEND
2650       REM  ******** ACCUMULATE BATHYMETRY **************
2660       DONE=0
2670       WHILE (IAD=26 AND DONE=0)
2680         DAT$=DAT$+TOT$
2690         POINTER=INSTR(TOT$,"#26")
2700         IF MID$(TOT$,POINTER+3,1)<>"#" THEN BATHY$=MID$(TOT$,POINTER+6,6)
2710         WHILE (LEN(BATHY$)<6)
2720           FOR K=1 TO (6-LEN(BATHY$))
2730           BATHY$=" "+BATHY$ : NEXT K
2740         WEND
2750         POINTER=INSTR(BATHY$,";")
2760         IF POINTER>0 THEN MID$(BATHY$,POINTER,1)="6"
2770         POINTER=INSTR(BATHY$,":")
2780         IF POINTER>0 THEN MID$(BATHY$,POINTER,1)="7"
2790         DONE=1
2800       WEND
2920     WEND
2930     TOT$=""
2940   NEXT I
2990   REM
3000   REM *********** OUTPUT ROUTINES ************
```

```
3010    FOR IPP=14 TO 22 :LOCATE IPP,1:PRINT BLK$:NEXT IPP
3020    LOCATE 14,1
3030    PRINT "MAGNAV ";DATE$;TTIME$;NAVDAT$
3040    PRINT "DATA ";DATE$;TTIME$;C$;DAT$
3060    DDATA$=""
3070    DDATA$=GMT$+" "+DATE$+" "+LAT$+" "+LON$+" "+SPEED$
3080    DDATA$=DDATA$+" "+HDG$+" "+TTIME$
3090    DDATA$=DDATA$+" "+MAG$+"  "+BATHY$+"  "+LINE1$
3110    PRINT #3, DDATA$
3115    LPRINT DDATA$
3117   PRINT #2, DDATA$
3120    IF INKEY$ = "~" THEN PRINT "SAVING DATA AND EXITING TO SYSTEM":CLOSE:SYSTEM
3130 WEND
3140 END
3150 REM ROUTINE FOR ERROR DETECTION
3160 ENUM=ERR:ELINE=ERL
3170 CLOSE
3180 BEEP
3190 REM CLS
3200 LOCATE 14,1
3210 PRINT "************I' M DEAD ON ERRORS ";ENUM," AT LINE ";ERL;"*********"
3220 BEEP
3230 PRINT " **************************HELP!!!!****************************"
3240 BEEP
3250 PRINT "********************RESTART ME QUICK!!!!************************"
3260 BEEP
3270 PRINT "************PRESS `CNTRL-BREAK' THEN HIT THE F2 KEY *******"
3280 BEEP
3290 GOTO 3180
3300 END
3310 REM ***************************************************************
3320 REM SUBROUTINE TO GET & OPEN NEW FILE ON THE HOUR -- EVERY HOUR.
3330 REM
3340 LOCATE 17,1
3350 PRINT "DATE AND TIME ARE:" DATE$,TIME$
3360 FIL$=MID$(DATE$,1,2)+MID$(DATE$,4,2)+MID$(DATE$,9,2)+MID$(TIME$,1,2)
3370 FIL1$=DRIVE$+FIL$+".DAT":PRINT " OPENING FILE ",FIL1$
3380 FHRL$=MID$(TIME$,1,2)
3390 REM  *** OPEN NEW DISK DATA FILE EVERY HOUR
3400 OPEN FIL1$ FOR APPEND AS #3
3410 HEADER$=" GMT      DATE      LAT       LON     SPD  HDG  COMPTIME  MAGGIE  DEPTH   MAGNAVOX LINE 1
3420 PRINT #3,HEADER$
3430 NEWFILE=0
3440 RETURN
3450 REM ****************************************************
3460 REM SUBROUTINE TO WAIT FOR ANSWER FROM MODULE
3470 REM AND GET DATA IF THERE IS SOME THERE
3480 NOANS=0
3490 RED=0
3500 WHILE ((LOC(1)<1) AND NOANS=0)
3510    RED=RED+1
3520    IF RED>500 THEN NOANS=1
3530    IF RED>500 THEN LOCATE 23,1:PRINT "NO RESPONSE FROM MODULE # ";IAD
3540 WEND
3550 RETURN
5000    REM  ******  printer newpage routine  *****
5015    WIDTH "lpt1:",255
5017    LPRINT CHR$(12)
5020    LPRINT HEADER$
5030    RETURN
```