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Division of
EXPLORATION GEOSCIENCE

Institute of Minerals, Energy and Construction

REPORT ON THE SUPACLARK CRUISE, WOODLARK BASIN, PAPUA NEW GUINEA, APRIL 8-28 1990, RV AKADEMIK MSTISLAV KELDYSH

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CRUISE REPORT

SUPACLARK

SOVIET UNION - PAPUA NEW GUINEA - AUSTRALIA - CANADA - WOODLARK BASIN

R/V AKADEMIK MSTISLAV KELDYSH
with MIR manned submersibles

April 8 - 29, 1990

Lae (PNG) to Honiara (Solomon Islands)

USSR Cruise Leaders

Chief Scientist of Expedition:	Alexander Lisitsin
Assistant Chief of Expedition:	Yuri Bogdanov
Chief of Tectonics:	Lev Zonenshain
Chief Pilot:	Evgeni Chernyaev

PACLARK Participants

Ray Binns	(CSIRO, PACLARK Co-Chief Scientist)
Steve Scott	(University of Toronto, PACLARK Co-Chief Scientist)
Graeme Wheller	(CSIRO, Australia)
Mirek Benes	(University of Toronto, Canada)
Paul Itiogen	(University of Papua New Guinea)
Mapen Marcus	(University of Papua New Guinea)

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SUMMARY

The prime objective of the SUPACLARK leg of the 21st cruise of RV AKADEMIK MSITSLAV KELDYSH was to deploy MIR manned submersibles to explore three target areas in the western Woodlark Basin, a rifted continental margin considered prospective for active hydrothermal venting on the basis of results from PACLARK cruises in 1986-88. Seven long-duration dives were conducted.

Active low temperature vents forming extensive mounds and spires of Fe-Mn-Si oxide deposit ("Beaujolais") were located, studied and sampled at a number of sites on Franklin Seamount (2150-2250 m depths), a basaltic andesite volcano at the western end of the main Woodlark spreading axis. Inactive chimneys of barite-silica with disseminated sulfides ("Chablis") were also observed and sampled in two shallow depressions within the summit caldera of this volcano.

No focussed hydrothermal activity was found at the other two target areas. In 3300 m deep East Basin a body of relatively warm Mn-rich seawater overlies a floor of lightly sedimented basalts with numerous gjars and widespread Mn-oxide crusts. Diffuse venting along deep-seated structures (partly overlain by talus) is suspected. Near Dobu Seamount, an andesite-rhyolite volcanic zone (1500-330 m depth) at the far west of the rift extension into continental crust, suspect hydrothermal deposits photographed by PACLARK proved to be products of explosive submarine volcanism, strong bottom currents and gravitational mass wasting. This area appears to lack extensional fracturing and several cm of sediment cover suggests volcanism has been inactive for 500-1000 years. The presence of outcropping submarine rhyolites was confirmed.

In addition to the dives, further echo-sounding and magnetometer traverses, CTD-hydrocasts and sediment coring and grabs were conducted, providing additional data on the tectonics and geology of this area.

Reconnaissance operations were conducted in the central Woodlark Basin (to 152°36'E) beyond the area covered by earlier PACLARK cruises. A new CTD anomaly (T, Mn) located southeast of Franklin Seamount in this sector, 'open' to the south, needs further investigation.

INTRODUCTION

SUPACLARK was a joint marine geological/geophysical investigation of the Western Woodlark Basin by the USSR Academy of Sciences, CSIRO Australia and the University of Toronto, Canada aimed at furthering knowledge obtained on PACLARK I (1986), II and III (1988) of seafloor hydrothermal activity associated with initial rifting of continental crust where the Woodlark seafloor spreading axis is propagating into the Austral-Papuan continental margin. A program of manned dives with the USSR's MIR submersibles was integrated with a surface program of narrow beam echo sounding, CTD/hydrocast rosettes, and sediment coring and grabs plus some miscellaneous operations.

The PACLARK participants had prepared a document listing proposed dive targets, corer sites and CTD/hydrocast traverses from data obtained during previous cruises. Data from the PACLARK cruises was contributed to SUPACLARK, and the PACLARK participants also provided GPS navigation equipment, two 30 litre Niskin bottles and a Ti vent-water sampler.

The following report was prepared by PACLARK participants as an English-language record of the SUPACLARK cruise, an outstandingly successful international scientific collaboration. Locality data have been taken mainly from a log maintained during watches by the PACLARK team, which unavoidably contains a few information gaps. Minor alterations may be required when the Soviet cruise report, and Russian descriptions of Dives 1, 2, 4 and 6 become available.

Activities in this report are numbered in a continuing sequence from PACLARK I, II and III. Soviet station numbers are given for cross reference. The following abbreviations are used:

ES - Echo-sounding

H - CTD/Hydrocast rosette

S - Sediment sample (grab/corer)

DAILY NARRATIVE

Day 1 (Monday, April 9)

KELDYSH arrived in Lae, PNG, at 0730 and anchored in the outer harbour. Some of the CSIRO equipment, held in bond at the airport because the waybill was missing, was finally released thanks to the receipt of a fax of the waybill and very accommodating PNG Customs officials. Two scientists from the Indian Institute of Marine Geology in Goa, invited on the cruise by Prof. Lisitsin, and two senior students from the University of PNG in Port Moresby joined the group. The eight foreign scientists were transfered to the KELDYSH by its launch and we were underway at about 1900h. Track to WWB from Lae was ESE to the Trobriand Islands and south from there.

Meeting of all scientists discussed generalities about the PACLARK proposals for dives, CTD rosettes and sediment cores in the WWB. Priority dive targets were (1) Dobu Seamount, (2) Franklin Seamount, and (3) East Basin. Particular attention was directed to the pronounced ridge, thought to be the neo-volcanic zone, extending ESE from Franklin Seamount. In a 48 hour period, 25% of the time (12 hours) is to be devoted to dives and 75% (36 hours) to other research. Therefore, only 9 to 10 dives are anticipated in the 3 1/2 week cruise.

Dinner reception by Lisitsin for all of the foreign scientists.

Day 2 (Tuesday, April 10)

In transit to WWB on smooth seas. Turned southward towards WWB at 1800h.

Graeme Wheller got the Magellan GPS system with its external antenna up and running. Data are being collected continuously by a laptop PC although the ship would like to have it fed directly into its computer system. The GPS window is approximately 0220-1920h.

Science meeting (1615-1830h) of the PACLARK group with Lisitsin, Bogdanov and Zonenshain to plan first few days of operations. The Soviets are also interested in the ridge axis in the area between 152° and 154°E where there is very little data (magnetics, RAN standard bathymetry and two SNBESS bathymetry tracks) and which they feel has potential for interesting new studies. They stated that the priorities for dive targets and other investigations in the western sector might be changed if surface-ship studies indicate that some dives in the eastern sector should have higher priority.

A general meeting of all scientists (1900-1930h) set a program for the next several days. Watches for the PACLARK team were established as follows:

Period	Scientist
0000-0600	Graeme Wheller
0600-1200	Mirek Benes
1200-1800	Ray Binns
1800-2400	Steve Scott

Ship's clocks and GPS were advanced 1 hour to UTC + 11 hours at midnight

Day 3 (Wednesday, April 11)

ES-27 to 33 (Station 2152?) survey on N-S tracks from just E of Franklin Seamount to East Basin conducted by Zonenshain. While the survey was in progress, Zonenshain sketched on graph paper accurate bathymetry and interpreted the structure. Crossing of ridge extending ESE from Franklin Seamount shows what appears to be a small axial graben. Small high between Franklin Seamount and East Basin is a horst, arguably either continental crust or seafloor volcanics.

Magnetometer towed during ES-27 to 33 worked well. Data are being processed by the ship's Philips mainframe (128 Kb) computer.

Navigation problem during ES runs. Bridge is using the US Magnavox transit satellite system for navigation which gives a fix about every 20 minutes and is dead-reckoning between fixes. Bridge is zig-zagging the ship back to the predetermined straight-line course after each satellite fix. Furthermore, the ship being run on a predetermined grid in autopilot mode made a major deviation from course because a waypoint was entered incorrectly.

H-21 (Station 2153?) CTD rosette deployed over the pediment of Franklin Seamount to the SW of the caldera. Done mainly to collect bottom water for cleaning the 1.5 litre Niskin bottles. No CTD data were recorded because of a malfunction of the tape drive but no temperature or particulate anomaly was observed real-time, confirming the results of PACLARK I. Preliminary chemical analysis of water gave typical background values.

Began laying a net of 4 transponders (Station 2154?) around Franklin Seamount and calibrating their position. Began about 1500h and continued until about 1600h the next day. Transponders are on 50 m tethers.

We discovered that the schedule for the next day's activities are posted each evening on the bulletin board outside of the dining hall. Benes will translate this in a "Daily Schedule" file in the Macintosh.

Wheller has managed to clean the GPS records from our laptop computer of extraneous information and provide on disk lat., long. and time to the ship's computer centre for post-processing of ship's tracks. We can provide them with a disk whenever the ship is not doing anything involving GPS or whenever GPS is down. There does not seem to be any way that the Magellan output can be sent directly to the ship's computer for real-time processing. There is no cable between the bridge and lab, and no way to queue the input when the mainframe is occupied with other tasks. We can plot ship tracks with Cricket Graph on the Macintosh.

No watch overnight because of continued calibration of the transponders, except for Wheller up from 0300 to 0600h watching the GPS.

Day 4 (Thursday, April 12)

Transponders still being calibrated until about 1600h. Most of the rest of the day was spent respooling the main cable. A SUPACLARK office was set up in the Meteorology laboratory.

Benes and Wheller tried unsuccessfully to get the Diconex printer to work from the Mac. One problem seems to be mechanical (e.g. chattering of the print head against a stop; pretending to print but not putting ink on paper) and related to a low charge state on the rechargeable batteries. Resolution of this problem was thwarted when the 110v AC/DC converter for the recharger was accidentally plugged

into 220v and was destroyed. The ship's electronics people were unable to fix the charger but provided a laboratory DC power supply.

PACLARKers had tea with Lisitsin and Zonenshain while Binns showed his video taken during flight from Port Moresby to Lae, around Lae, KELDYSH's arrival in port and our arrival on KELDYSH.

Binns gave a slide show of PACLARK II camera tows at Dobu Seamount which seems to have impressed everyone that this is a good site in which to find hydrothermal activity and deposits.

Lisitsin has changed the dive schedule putting Bogdanov ahead of Binns so that Russians get dives #1, 2 & 4 and PACLARK gets dives #3 & 5. The reason for this change is that the only English speaking pilot is Evgeni Chernyaev (Chief Pilot) who must also do the first dive with Lisitsin in order to check out all systems and cannot do two dives in a row. An English-speaking pilot is deemed essential for safety and so that the observer and pilot can work closely together.

Scott started to prepare the titanium water sampler for MIR and showed Gordeev how to do it. The MIR people have extended the one short inlet tube with some titanium tubing that they had. They are hesitant to use a mechanical arm on MIR to deploy the sampler for fear that they might burn the hydraulic lines in hot water even though such deployment is done routinely by US and French submersible pilots. Also, a hydraulic piston with which to trigger the sampler was not availabe (one was subsequently found). They instead plan to mount the bottles on the end of a long metal pole attached to the deployable basket. Scott is concerned that it will be subject to considerable abuse sticking out in front of the sub and that it will be almost impossible to manoeuvre the sub carefully enough to get a good water sample.

Gusting wind delayed start of H-22.

Day 5 (Friday, April 13)

H-22. (Station 2155; first station that is numbered in the Soviet log book) CTD rosette was intended to be a south to north track from Southeast Basin and across East Basin. However, conditions of wind (10-20 kt SE) and currents from the E pushed the ship on a westerly course. No CTD or nephelometer anomalies were observed real-time.

H-23 (Station 2156) CTD rosette was intended to cross the H-3 track of PACLARK I but wind/current (see H-22, above) resulted in a WNW track across East Basin in the vicinity of the central rise. Water samples were taken (1.5 litre) but contained only background values of elements. No CTD or nephelometer anomalies were observed real-time but subsequent computer plotting, after the H-26 anomaly was discovered (see Day 10), revealed a temperature anomaly.

Dive-1 (Station 2157; Observer Lisitsin; Launched 1030h; on bottom 1251h; off bottom 2221h; time on bottom 9 hrs 30 min; on surface 0100 April 14) more or less followed PACLARK's proposed track FS-1 on the west flank of Franklin Seamount, into the breached caldera and up on the north rim, where

"Beaujolais" Fe-Mn-SiO2 hydrothermal precipitates had been seen on video during PACLARK II, and then back down into the caldera. Lisitsin reported discovery of active Beaujolais vents.

Dive-1 returned 1 grab, 1 net bag, 2 push cores and 2 manipulator samples of Beaujolais material from the caldera and its north rim of Franklin Seamount and several dm-size lumps of rock from the SW knolls and the caldera. Most of the Beaujolais material, on first examination at 0200h, is slightly indurated red Fe-rich and black Mn-rich sub-cm-size pieces in a red ooze matrix. The net grab contained an orange-red ooze. Lisitsin observed bulbous chimneys of manganese coated iron oxide up to 1 m high on the north rim. All of this, as seen subsequently in video, is quite extensive and commonly associated with green nontronite.

The chimneys are extremely friable and were difficult to sample. More irregular-shaped Fe-oxide chimneys, not Mn-coated, were seen in the caldera together with dm-thick layered and extremely friable Fe-oxide-rich material. The video clearly shows clear and, in one case, grey shimmering water being emitted from chimneys but its temperature could not be measured because MIR did not carry a deployable temperature probe on this dive.

Day 6 (Saturday, April14)

S-15 grab (Station 2158) and S-16 box corer (Station 2159) taken simultaneously at 3200 m in East Basin. The grab was successful but the box corer returned empty. The sediment contains abundant modern forams. Elutriate examined by Barash for forams contains considerable very fresh volcanic glass and rusty globules (off the corer? - they do not use a liner except for the bottom ½ m). These were separated. One dm-size lump of heavily Mn-coated basalt and several glass spalls were also recovered. The rock is a 2 cm thick crust with thick glass rind and drip features on its lower surface.

S-17 grab (Station 2160) and S-18 tube corer (Station 2161) deployed in the northern margin of East Basin at 3250 m. Wire out when bottom reached was 3840 m for S-17 and 3570 m for S-18. The corer returned only a small amount of ooze with glass chips. The grab recovered green coloured ooze and a 10x15 cm piece of basalt.

Station 2162 was not recorded in the Soviet log book - possibly the transit to H-24.

H-24 (Station 2163) CTD rosette on a S to N track mid-way between East Basin and Franklin Seamount was aborted after the first lowering when the conducting cable malfunctioned.

S-19 (Station 2164; grab) and S-20 (Station 2165; corer) deployed at the south end of East Basin at 3227 m depth. The corer returned only small ooze samples with a few chips of basalt glass. The grab was half full of light brown ooze, containing a few tiny glass chips.

Day 7 (Sunday, April 15)

Happy Easter! The Soviets commented that this is the first Easter in 70 years that can be celebrated openly in the Soviet Union.

S-21 (Station 2166; grab) and S-22 (Station 2167; corer) deployed in South Middle Basin at 3028 m depth. S-22 recovered 3.3 m of predominantly light khaki ooze with a coarser layer of probable turbidite which contains mica. S-21 contained similar ooze. Subsequent studies by Barash et al. showed a significant change in paleoceanographic conditions at 1.8 m depth signified by a change in colour from brown to green, a sharp decrease in total forams, an increase in cold water forams, a decrease in $CaCO_3$ and an increase in organic carbon below this depth thought to be due to deeper water conditions. C-14 dates show reversals in the upper metre of the core indicating turbidites. A radiocarbon age of 8,400 years was obtained at $\approx$1.6 m.

A long corer attempt in Southeast Basin was abandoned when drift direction was not as anticipated.

S-23 (Station 2168; corer) deployed in Southeast Basin at 3145 m depth. Material recovered consisted of 3.6 m of poorly laminated brown to olive ooze including slump breccia. The grab was not deployed simultaneously on this occasion.

A fifth transponder was laid (Station 2169) in the Franklin Seamount net and further calibrations were done.

Dive-2 (Station 2170; Observer: Bogdanov; Launched 1030h; submerged 1039h; on bottom 1332h @ 2369 m; off bottom 2321h; bottom time 9 hr 49 min; on surface 0059h April 16) examined the ridge extending ESE from Franklin Seamount and the Beaujolais deposits on the south rim and in the caldera visited on Dive-1. In effect, it combined PACLARK dive proposals FS-2 and FS-3. Samples returned included one Mn-coated basalt about 20 cm in diameter, one 50 cm chunk and a few smaller pieces of Mn-coated Fe-oxide hydrothermal chimney, two net samples of hydrothermal crust and sediment and two push cores and one grab of same. In situ temperature measurements were not made.

Bogdanov described mounds of Beaujolais 10 m across and 5-7 m high with 0.5-2 m high chimneys. Warm water was being emitted from the sides of the mounds.

Day 8 (Monday, April 16)

Transitted to Dobu Seamount to lay 4 transponders (Station 2171) and send Itiogen and Marcus ashore to go back to university classes in Port Moresby. The transponders were deployed on the tops of Dobu Seamount, Dobu West Ridge, Dobu East Ridge and Little Dobu Ridge. Spent most of the day surveying them.

Tested titanium water sampler in the swiming pool. Took sample okay but did not seal properly. Problem found to be a burr in the trigger barrel that inhibited the free movement of the sample closure valve. The problem was fixed by burnishing with fine emery paper.

H-25 (Station 2172) north to south yo-yo track east of Dobu Seamount near 151°02.4'. Nephelometer anomalies at about 700 to 800 m depth (250 to 350 mab) as was found on PACLARK I & II. Water samples were taken in 1.5 litre bottles. These proved to have normal background dissolved Mn. Continued into April 17.

Day 9 (Tuesday, April 17)

S-24 (Station 2173; grab) and S-25 (Station 2174; short corer) in the southwest part of South Valley. S-24 returned an unrecorded amount of ooze varying from brown to khaki. S-25 returned about 250 g of khaki coloured ooze with a 1 cm sandy layer (16-17 cm deep) of andesitic glass.

S-26 (Station 2175; grab) and S-27 (Station 2176; short corer) in the western end of the central depression of South Valley, SE from Dobu Seamount. S-26 recovered about 35 kg of khaki coloured ooze. S-27 recovered 21 cm of khaki coloured ooze, with a sandy layer at 17-19 cm.

Scott produced an instruction manual for the titanium water sampler.

Dive-3 (Station 2177; Observer: Binns; Launched 0945h; submerged 1005h; on bottom 1049h; off bottom 2201h; total bottom time 11 hr 12 min; surface 2232h) to explore West Dobu Ridge, Dobu Seamount and the saddle between them where PACLARK found CTD, water chemistry and photo/videos anomalies. Returned some 20 rock samples of rhyolite and andesite, one push core of sediment and considerable fauna.

No hydrothermal vents or precipitates were encountered. West Dobu Ridge contains large andesite pillows and 30 m diameter rhyolite domes. Clearly the rhyolites dredged on PACLARK II are in situ and are not exotic blocks from a subaerial eruption. Dobu Seamount is a sedimented andesite scoria cone being scoured by currents and with slumps on its west side. The "anomalous" areas identified in PACLARK II photos and videos are in a col where strong currents are winnowing sediment and volcanoclastic debris. PACLARK-interpreted 'gjars' were actually mass-wasting collapse structures.

After completion of dive, commenced 5 hour transit to east.

Day 10 (Wednesday, April 18)

S-28 (Station 2178; grab) and S-29 (Station 2179; short corer) in the basin NE of Cheshire Seamount. S-28 returned 1-2 kg of khaki coloured ooze. S-29 returned about 4.6 m of ooze, the top 0.5 m of which is brownish in colour and the remainder khaki.

Sediment trap array (Station 2180) was installed in the basin NE of Cheshire Seamount near 9°53.5'S 151°52.3'E in order to collect information on background sedimentation in Woodlark Basin. The array has 21 pairs of traps on a wire, the bottom end of which is weighted to the seafloor. The top at 100 m below surface to avoid shipping is attached to a grape-like cluster of floats and large blocks of syntactic foam. The first pair of traps is 30 mab, 5 pairs at 3 m intervals and others above these are at 20-50 m intervals. A current meter is at 20 mab. The trap will be recovered on May 21 by which time it will have been deployed for about one month. Echo sounder manned en route to next station.

S-30 (Station 2181; grab) and S-31 (Station 2182; short corer) were taken in Central Woodlark Basin near 9°58.7'S 152°09'E. The grab was completely full of light khaki-coloured ooze. The corer returned 1.4 m of brown to olive ooze, with oblique lamination indicating that penetration was not vertical.

Day 11 (Thursday, April 19)

H-26 (Station 2183) CTD rosette in East Basin crossed the PACLARK H-3 anomaly with 4 yo-yos south to north. Found temperature anomalies from 2600 m to the bottom in the vicinity of the H-3 anomaly but no nephelometer anomaly. The largest temperature anomaly was +0.045° at 65-70 mab. Dissolved Mn is 3.8 times background (190 μg/l vs 50 μg/l) in the deepest (highest T) water. Silica and nitrate are anomalously low here. Transit back to Dobu Seamount.

S-32 (Station 2184; grab) and S-33 (Station 2185; corer) at PACLARK proposed site DS-204, SW of Dobu Seamount. Grab was full of light green ooze with 4 cm of brownish ooze on top and contained pumice, pieces of wood and gastropod and pteropod shells. The core consisted of 18 cm of olive-green ooze with an 8 cm brownish top, and contained 2 mm-sized chips of andesite in the olive ooze.

Dive-4 (Station 2186; Observer Zonenshain; launched in rain shower 1105h; submerged 1120h; on bottom 1237h; off bottom 2300h; surfaced 2358h; on deck 0030h April 20) explored from east end of East Dobu Ridge to within 50 m depth of the top of Dobu Seamount (combining proposals DS-2 and DS-3) particularly examining "anomalous" areas photographed by PACLARK. The temperature probe, several lights and a current-measuring tube (lost at surface) sustained repairable damage when the the submersible accidentally rammed a cliff. Returned samples included 7 dm-size lumps of andesite and one push core with 11 cm of ooze.

Most lavas are highly vesicular, fresh and glassy. The ridge is constructive and not tectonic but Zonenshain opined that the rather heavily sedimented lavas were too old and unfractured to produce present-day hydrothermal activity. Two ages of lava (older has a very high magnetic susceptibility = Miocene?) were observed with 1.5 m of chalk-like sediment separating them. The sediment is not at all lithified and could not be sampled. Video captured an amusing duel between the MIR's manipulator arms and a large lobster. No hydrothermal vents or deposits were encountered.

Day 12 (Friday, April 20)

S-34 (Station 2187; grab) and S-35 (Station 2188; short corer) were taken in North Valley at 2213 m depth. The grab returned full of khaki ooze. The corer returned 2.5 m of pale green ooze of which the top 8 cm is oxidized to a brown colour. A bioturbated boundary occurs at 220 cm. Grey foram-rich sandy layers 1 cm thick occur at 87 cm and 228 cm; pods (ash?) are at 204 and 210 cm.

S-36 (Station 2189; grab) and S-37 (Station 2190; short corer) were taken in Cook valley. The grab returned full of khaki ooze. The corer returned 88 cm of pale olive green ooze of which the top 35 cm is oxidized to a pale brown colour. Ash(?) pods at 50 and 55 cm.

H-27 (Station 2191) CTD rosette east to west across East Basin more or less parallel to H-23 found the same temperature anomaly in the bottom water as H-26. The highest increase in temperature above background was +0.045° at 30 to 35 mab. The conducting cable failed again and will be replaced. The CTD will be down for about 3 days while this is being done. Subsequent analysis showed that Mn concentrations to five times background, negative Si anomaly, increase in conductivity but no change in salinity.

ES-34 to 37 (no station number) N-S echo sounding and magnetometer transects from Franklin Seamount eastward to 152°05'E to determine the location of the neotectonic zone. Continued overnight. The bathymetric profiles suggest two or three possible spreading episodes. Magnetics possibly show to Anomaly 3.

Day 13 (Saturday, April 21)

Dive-5 (Station 2192; Observer Scott; hatch closed 1021h; launched 1025h at 9°53.9'S 151°48.5'E; submerged 1032h; on bottom 1215h at 2598 m; off bottom 2314h at 2167 m; on surface 0215h; hatch opened 0256h) was a Beaujolais hunting and sampling expedition on the knoll northwest of Franklin Seamount and the north slope of Franklin Seamount as seen in CV-25 and dredge D-37, respectively, as well as sites on the rim and within the caldera of Franklin Seamount. All systems operated normally except that the tail rudder was lost. Returned samples included 2 sites of Beaujolais (NW Knoll and NW flank of Franklin Seamount), 2 pieces of angular rhyolite pumice which is abundant in the talus at one of the Beaujolais sites on the NW flank of Franklin, a joint block of "dike" from the south wall of the caldera and a barite ("Chablis") chimney from the drainback at the east end of the caldera, a bottom water sample taken with the titanium sampler and one Niskin sample of floculant above an active vent.

The so-called dikes on the caldera wall appear to be a jointed massive flow with a tubular/pillowed top. Dive-5 found sheet flows in the flat area W of Northwest Knoll as well as some up on the knoll itself; a large, hydrothermally inactive, sedimented deposit of Beaujolais about 350 m x 200 m on the northern top and part way down the north flank of the Northwest Knoll (same as seen in CV-25); two small (a few 10s of m) deposits of Beaujolais, one active and one probably D-37, on the NW flank of Franklin Seamount; three small deposits, two of which are active, on the north rim and caldera of Franklin

Seamount; a 100 m wide deposit in the lava drainback hole in the east end of the caldera; two small deposits on the SE wall of the caldera; and, a 150 m deposit on the south rim.

No site was deemed worth sampling for hot water; flow rates were estimated to be only about 1 cm/sec by observing the rise of particles in the shimmering water. Instead, a bottom water sample was taken with the titanium sampler and analysis proved it to be normal bottom water. A Niskin sample of floc in stirred-up hydrothermally active Beaujolais proved to be mineral (not yet identified) and not bacterial. The 2 to 5 cm of sediment on top of the Beaujolais on Northwest Knoll suggests that it is several hundred years old.

Subsequent analyses of Beaujolais from Dive-5 gave high values for As, V, Ni, Zn and Cu. The As is native by XRD. A polished section of Chablis chimney revealed barite with pyrite the only sulfide mineral.

Day 14 (Sunday, April 22)

S-38 (Station 2193; grab) and S-39 (Station 2194; short corer) were deployed adjacent to the supposed neovolcanic zone in central Woodlark Basin at 10°04.8'S 152°23.9'E. The corer returned only a small amount of ooze and a 1.5 cm flake of black glass. Strong current had caused cables to twist badly, causing recovery problems. The grab did not close.

Commenced deploying transponders in East Basin for next day's dive. Overflown by a RNZAF Orion surveillance plane. Visited by a small PNG motor launch.

Day 15 (Monday, April 23)

S-40 (Station 2195; grab) and S-41 (Station 2196; short corer) near the neovolcanic zone of central Woodlark Basin at 10°06.6'S 152°37'E to test for evidence of hydrothermal activity. None was found. The grab contained only a tiny amount of light brown sediment (probably emptied itself). The corer contained 4.3 m of laminated light grey/khaki fine sand to ooze with 40 cm of the oxidized top a light brown colour. Wood samples collected at 175 cm, 235-240 cm. The grab came up entangled in the corer wire and had to be cut free. No indications of hydrothermal activity.

Dive-6 (Station 2197; Observer Lisitsin; launched 1122h; submerged 1127h; surfaced 0205h April 24; on deck 0250h; over 9 hours on bottom; covered 7 nm) searched the entire length of the central ridge in East Basin (closely followed PACLARK proposal EB-1) for hydrothermal activity which might explain the CTD temperature and manganese anomaly. Returned samples included 5 Mn-coated basalts and a push core of ooze.

No evidence of hydrothermal activity was found. Large gjars oriented parallel and orthogonal to the ridge attest to tectonic activity. Weak temperature anomalies over talus. Water sampler failed to operate.

Day 16 (Tuesday, April 24)

The new CTD rosette cable was tested by tying weights onto it and letting all of it out. The cable snagged the bottom, was damaged but subsequently repaired.

S-42 (Station 2198; grab) and S-43 (Station 2199; short corer) tested the vicinity of the E-W ridge (presumed neovolcanic) southeast of Franklin Seamount for hydrothermal activity at 9°58.0'S 151°55.4'E (grab) and 9°58.2'S 151°55.2'E (corer). The grab was 3/4 full of red-brown ooze. The corer returned 115 cm (about 20? cm washed out) of laminated red-brown ooze, rather different in appearance to previous cores.

Two transponders were deployed on Franklin Seamount in preparation for a final dive there.

Tonga has granted permission for KELDYSH to carry out scientific activities in its territorial waters provided Tongan representatives are onboard and a copy of all data goes to Tonga. Fiji continues to refuse. Therefore, decided to curtail activities in Western Woodlark after a last dive on Franklin Seamount to collect water, recovery of transponders, resetting the timer on the sediment trap, and taking a grab/core of the Beaujolais on Northwest Knoll. The ship may proceed directly to Nuku'alofa, Tonga, bypassing Honiara where PACLARK participants were to disembark because customs formalities there, even if we stand off, could cost a day of time. The travel time to Nuku'alofa is 8 days with arrival anticipated for Sunday, May 4.

Day 17 (Wednesday, April 25)

ANZAC Day

H-28 (Station 2200) S to N yo-yo near 151°55'E across the east-west ridge east of Franklin Seamount seeking hydrothermal activity. No nephelometer or temperature anomaly.

H-29 (Station 2201) S to N yo-yo near 151°53'E across the same ridge (southeast of Franklin Seamount) as in H-28. Weak temperature (only +0.009°C) and nephelometer anomalies were recorded. Mn in the bottom 200 m is 230 μg/l vs background of about 40 μg/l. Si is anomalously low as in East Basin. The anomalies in T and Mn increase to the south and were maximum at the start of the traverse indicating that the source of the anomalies is still further to the south.

Dive-7 (Station 2202; Observer: Binns; Launched 1029h; submerged 1036h; on bottom 1229h; off bottom 2203h; surfaced 0050h April 26; on deck 0134h) was the last of the SUPACLARK series. It explored and sampled rocks and water from the top and caldera of Franklin Seamount. Returned samples included one large (40x30x30 cm, 15 kg) chunk and a smaller chimney of barite ("Chablis") spire, one 30x 30x15 cm Mn-coated lump of Beaujolais, two basalts, a grab of a few cm high Beaujolais spire surrounded by yellowish-brown precipitate, a push core, a partial vent water sample taken with the titanium sampler and two 1 litre Niskin samples from over the sampled vent.

The caldera has at least two central inverted conical depressions, filled with talus and floored by tube flows. The "dykes" on the south wall of the caldera are confirmed to be jointed massive flows with pillow or tube tops. Preliminary examination of the barite spire shows it to contain anhydrite and minor sulfide as well as barite. L+V fluid inclusions in anhydrite have a small vapour bubble so are low temperature. Water was sampled with the titanium sampler from a Beaujolais vent that was flowing at an estimated 5 cm/sec. Unfortunately, the sampler had been dropped into the soft precipitate which clogged the sample tubes resulting in only a ≈420 ml sample in one bottle and no sample in the other. This water has a pH of 6.3 (vs normal bottom water here of 7.6). The temperature probe, which gave every indication of working later (i.e. matched the CTD temperature on the ascent to surface), showed no rise in temperature in the vent flow (but values did not fluctuate so there is some doubt). Ambient temperatures near the vent (to 2.13 °C) were higher than normal (2.07 °C). Preliminary analysis of this vent water gave Si 330 μg/l (about 3x background), phosphate and nitrate significantly below background, Mn 1200 μg/l (vs background of 50 μg/l), Fe 300 μg/l (Fe/Mn is much lower than found in sediment starved environments but about the same as that at Guaymas Basin), Mg just slightly less than background seawater and salinity about the same as seawater.

At the daily evening science meeting it was learned that the sediment trap does not have an acoustic release and its top is 100 m below surface. There is considerable concern about how to recover it now that plans have changed. It is timed to release on May 21 but KELDYSH will be in Tonga.

A final decision to by-pass Honiara has not yet been made.

Day 18 (Thursday, April 26)

H-30 (Station 2203) took 30 litre Niskin samples of bottom water for isotopic analysis in the area of the weak T and high Mn anomaly south of the E-W ridge SE of Franklin Seamount.

S-44 (Station 2204; corer) made several attempts to hit the large Beaujolais deposit on top of Northwest Knoll, on the pediment NW of Franklin Seamount at 9°53.89'S 151°48.87'E, but finally missed. The 18 kt wind and relatively small size of the target conspired against us. Site was southwest of target in 2407 m depth. Only a few cc of sand-size foraminiferal sediment with black glass chips and small pieces of exotic pumice were recovered. A 1 cm piece of brown coated barite was also logged but not inspected: possibly it was pumice.

Decision made to proceed to Tonga via Honiara to let off the PACLARK people with the ship's launch.

Grappling for the sediment trap (Station 2180) was impeded by 15 m/sec (30 kt) winds. After 3 hours, the string was snagged and recovery commenced. Got the float and upper pair of traps onboard when the wire parted under a snap load and the remaining 2600 m of wire, traps and the current meter were lost (expletives deleted!).

Recovered transponders from East Basin.

Discussion between Lisitsin and Binns over the availability of GPS for the next three legs. This is in hand and will be assured with a telephone hook-up with Keith Crook.

Heading for Honiara in the late evening. Expect to arrive on Sunday morning April 29.

Day 19 (Friday, April 27)

Transitting to Honiara. Report writing.

Day 20 (Saturday, April 28)

Continuing transit to Honiara and writing reports. The laptop computer that was recording GPS data was freed up to help the task of writing reports. Solomon Island chain off our port side all day. Diconex printer on the Mac will not print when externally powered. Slowed ship in afternoon to time early Sunday a.m. arrival in Honiara.

Farewell dinner and discussion in Lisitsin's cabin.

Day 21 (Sunday, April 29)

PACLARKers taken ashore to Honiara by Customs launch at 1030h. End of SUPACLARK.

NAVIGATION

A Magellan Nav Pro 1000 GPS system owned by CSIRO was installed on the Keldysh bridge on 10 April. Another system owned by the University of Toronto was held in reserve. The Magellan external antenna was mounted on the starboard railing of the deck above the bridge about 25 m above sea-level. The Magellan magnetic mounting plate was used in conjunction with a steel plate produced by crew which was bracketed to the rail. Virtually all parts of the bridge area are made of aluminium, leaving no other convenient attachment point for the magnetic mounting plate. The coaxial cable from the antenna was draped over the side and entered the bridge through a porthole. Inside the navigation area behind the bridge proper, close to the porthole, the antenna cable was connected to the Magellan antenna/power junction box. Power to the box was 12 V DC, negative ground, 360 mA, from an old power supply provided by the crew. The junction box was located about 2 m from the GPS unit and secured by string to a wooden shelf bracket.

The unit, in its holder, lay horizontally on the bench or propped against the wall and connected by serial cable to the EPSON PC laptop, enabling continuous real-time downloading of position fixes to computer datafile. Because of the presence of a large mast obstruction to port of exterior antenna the terrain condition was set to 'Interrupted'. The unit was set to the WGS84 spheroid and operated in 2D

mode with antenna altitude specified as 25 m above sea-level. Display showed lat/long with decimal minutes to 4 places, and local time (UT+11 hrs except for 10/4/90 which was UT+10 hrs). Continuous logging was often suspended during extended periods of drift so the PC could be used for other tasks.

Downloaded computer raw data files were named according to date and number of GPS session on date. For example, file "10APR901" contains position data collected during the first GPS session on 10 April 1990. Details of actual logged times are tabulated below. For the period of the cruise, the GPS window extended from between 0200 and 0300 to between 1900 and 2000, usually varying between subsequent days by about 5 minutes.

Summary plots of daily GPS fixes were made using the Macintosh graphics program CRICKET GRAPH and DICONIX printer. Raw data files (".DTA" suffix) were first processed on the laptop PC using the Magellan program RE4MAT, producing ASCII files (".ASC" suffix) containing details of position fixes in consecutive records. This occupied 4-5 hours of computer time for each day's position data. As GPS fixes for each day were typically contained in several files, a custom program GPSDATA was written by GEW to concatenate these data into single simplified ASCII files. This program also culled the position data by not including fixes with PDOP > 10 (i.e., those with poor accuracy resulting from satellite geometry) in its output files.

GPSDATA produced 3 concatenated output files. One file contained simplified fix data (latitudes and longitudes in decimal degrees; UT date and time; SQ for each satellite used; PDOP) which was given to the Soviets (".TFR" suffix). The second consisted of records containing tab-delimited latitudes and longitudes (".CRK" suffix) and was used to import GPS data into CRICKET GRAPH. The third consisted of records containing tab-delimited latitudes, longitudes and times (local) for fixes obtained immediately after each hour. These data were also imported into CRICKET GRAPH and were used to make time-marks on the summary plots.

Overall, the Magellan system worked very well and quickly became the perferred navigation method on the ship. Some improvements could be made to the software, however, to increase the effectiveness of the system. In particular, it would be very convenient to be able to plot position fixes on an A3 or B5 plotter in real-time. This would require the PC to have 2 serial ports, with data coming in from the Magellan through one and going out to the plotter through the other. This arrangement would be most useful during echo-sounding and magnetometer runs when the ship is trying to follow a pre-determined grid. Prior to the run, the proposed track could be drawn on the plotter together, if required, with digitised bathymetry and outlines of any nearby islands. Then, during the run, each position fix from the Magellan could be first saved in a file and then plotted as a point by the plotter in real-time. The result would be a continuously updated record of the ship's track. Signficant deviations between this track and that proposed could then be corrected as they become apparent during a run. This system could also be used to produce daily records of the ship's track in real-time. In addition, if a file record of position fixes is not required a TSR program using suitable interrupts could receive Magellan data and send it to the plotter, enabling the PC to be used for other tasks at the same time.

The existing data reduction program (RE4MAT) could also be improved to provide for batch processing of raw data files. At present, several hours are required for the PC to process the raw position data from a GPS window about 18 hours long. This processing is most conveniently done outside GPS windows. Typically, these data are stored in several files. To process these files an operator is at present required to restart RE4MAT for each raw data file and, to utilize the non-GPS time most efficiently, to be ready to do this after each raw data file is processed. This is typically not possible but the problem could be avoided if a batch file could be written which would cause RE4MAT to automatically process specified files consecutively.

Periods of Continuous GPS Logging:

Date	Period
(UT+ 10 hrs)	
10 April	1639-1730
	1735-1901
	1904-1905
(UT+ 11 hrs)	
11 April	0317-0318
	0340-0703
	1120-1331
	1414-1426
	1428-1650
12 April	0337-0426
	0458-0549
	0615-0850
	1001-1054
	1103-1253
	1309-1416
	1419-1433
	1456-1629
13 April	0328-1119
	1332-1434
	1531-1533
	1606-1610
14 April	0329-2038
15 April	0314-1557
	1609-1944
16 April	0259-2025
17 April	0300-0400
	0402-2003
18 April	0324-1959

Date	Period
19 April	0238-1320
	1501-1602
	1656-2019
20 April	0249-1541
21 April	0222-2011
22 April	0225-1741
23 April	0217-0537
	0607-0814
	1225-1227
	1436-1609
	1636-1716
	1801-1943
24 April	0231-0533
	0602-1733
	1757-1937
25 April	0211-1614
	1633-1716
	1755-1944
26 April	0209-1726
	1746-1940
27 April	0227-0247
	0304-0357
	0449-1044

Outside GPS time, navigation was by ship's Magnavox transit satellite receiver, or by the comparable Soviet 'Cheln' system. The latter used both US and Soviet satellites and provided more frequent fixes, but did not dead-reckon between these. Magnavox positions were repeated on monitors in many laboratories.

SHIP'S COMPUTING

Chief Scientist: Vladimir Kuz'min

Akademik Mstislav Keldysh carries a 15 year old Philips P800 mainframe computer, several Philips PM4400 Compact Computer systems and at least 3 Taiwanese-built IBM-compatible PC clones. The mainframe was originally used in a telephone exchange before its installation in Keldysh and has 128 Kb of main memory, although this may have been extended to 1 Mb. It is mainly used for seismic, acoustic, magnetometer and CTD data collection and can also be used to steer the ship along a

predetermined course. There has apparently been some discussion about replacing it, possibly with a VAX.

The PM4400 computers have two 360 Kb 5.25" disk drives and take up half a desk. They are used for data collection in the meteorology and CTD laboratories.

Of the PCs, 2 are XTs, with two 360 Kb disk drives, and one is an AT with a 3.5" 720 Kb disk drive and a 360 Kb disk drive. The AT and an XT are located in the geophysics section of the echo-sounding laboratory (4501) and the XT is in the Sediment Chemistry laboratory (4201). Commercial programs used on these computers include StatGraphics, Word Perfect, Norton Commander and games.

PACLARK participants brought an EPSON PC Portable (4.77/10 MHz V30 processor, 640 Kb RAM, backlit CGA screen, 20 Mb hard-disk, single 3.5" 720 Kb floppy disk drive) and a Macintosh Portable (MC68HC000 /15.6672 MHz processor, 2 MB RAM, liquid crystal display screen, 40MB hard drive, single 3.5" 1.4 Mb high-density, double-sided floppy drive). The Epson PC was mainly used to record position fixes from the Magellan GPS unit and was located next to the Magellan, and connected to it by the Magellan's serial cable, in the navigation area of the ship's bridge. Power was obtained from the ship's 220 V/50 Hz system via a surge-protector power board (with Australian-East European plug adaptor) brought from Australia and the PC's AC adaptor. This PC was powered on continuously for most of the SUPACLARK leg and did not falter. When not logging GPS data it was used by GEW to reduce the GPS raw data to simplified ASCII data files and for word processing. An Epson LQ850 24-pin dot matrix printer was brought for use with this PC but was not required except to process dive reports towards the end of the cruise.

The Macintosh was located in the SUPACLARK office in the Meteorology laboratory and was mainly used for word processing and plotting of GPS and CTD data. Power was obtained from the ship's system via the Macintosh's smart AC adaptor/transformer with North American-East European adaptor plug. An overhead lamp was required for comfortable viewing of the Macintosh screen, which was not backlit. A Kodak DICONIX M150 Plus portable inkjet printer was also brought for use with the Macintosh. Its 110V AC power adaptor was accidently fried in 220V early in the cruise and power was supplied from a DC power supply (9V, 1A) provided by the ship. For some reason, however, the printer only operated properly when powered from its rechargeable batteries and not from the DC supply. Consequently, the DC supply was only used to recharge the printer's batteries, leaving only short periods available each day for printer use although sometimes it could be persuaded to operate on the power supply. The trick was to start it printing on batteries and, when it stopped due to a low battery condition, switch to the external power suplly without going out of the print mode. This did not always work however.

ECHO SOUNDING AND MAGNETICS

Chief Scientist (Echo Sounding/Tectonics): Lev Zonenshain

Chief Scientist (Magnetics): Eduard Popov

Echo sounding and magnetic surveys were performed in eastern part of Western Woodlark Basin between 151°39'E and 152° 0.5'E to define the location and boundary of the volcanic zone that represents the western end of Woodlark seafloor spreading center.

The echo sounder is an Elac 12, 20, 30 kHz narrow beam with not more than 3° aperture angle. Bathymetry data were digitally recorded on magnetic tapes and later filtered for errors. Edited data were merged with GPS data and plotted in the form of bathymetry profiles. While an echo sounding survey was in progress, Zonenshain sketched on graph paper accurate bathymetry for preliminary interpretation of tectonic structure.

The proton magnetometer MPM-5 is a "homemade" instrument made at the P. P. Shirov Oceanographic Institute in Moscow in 1981. The magnetometer is towed behind the ship with a 350 m long KNG 2 x 2.5 cable. The magnetic field signal is recorded and displayed by an analog recorder KSPP-4 and also recorded digitally. The range of magnetic field intensities is 20,000-70,000 nT with an error not exceeding 1 nT.

The ship operated at a constant speed of 10 knots during echo-sounder/magnetic surveys. Radio transmissions interfered with the magnetometer.

Operations

ES-27	Period:	April 11	0211-0450h
	Start:	9°30.0'S	151°50.5'E
	End:	9°57.3'S	151°50.7'E

North-south track from just east of Franklin Seamount across the volcanic ridge into the basin south of Franklin. The track zig-zagged somewhat while the bridge learnt to use GPS effectively. GPS commenced soon after start. Minor deviations while Bridge learned to use GPS.

Small high between Franklin Seamount and East Basin is a horst of arguably either continental crust or seafloor volcanics and needs to be dredged.

ES-28	Period:	April 11	0502-0615h
	Start:	9°57.1'S	151°49.9'E
	End:	9°43.8'S	151°49.8'E

South-north track across Cheshire and Franklin Seamounts. GPS navigation. Minor course deviations. Northern part of profile shows thick layer of faulted Trobriand sediments. Tracks crossed Cheshire Seamount. Faulted block of the seamount doesn't appear to be a young volcano. It may be of volcanic origin, however sediment cover and degree of tectonic deformation suggest an older origin than Franklin Seamount. Profile south of Cheshire Seamount shows close-spaced faulting and significant sediment load in the basin located between the seamounts. Overall tectonic pattern suggests at least two, possibly three, tectonic events. First period of extension resulted in faulting of Trobriand sediments. Second period produced deformation and faulting around Cheshire Seamount. Third youngest period is represented by the eruption of Franklin volcano and the initiation of oceanic crust accretion.

ES-29	Period:	April 11	0643-0750h
	Start:	9°44.2'S	151°45.7'E
	End:	nr. 9°55.0'S	151°45.5'E

North-south track across East Basin. Navigation problems, especially when navigation lost at 0659h. Profile defines volcanic zone in the central part of the basin. The southern margin of the basin is bounded by faults dipping to the north. The volcanic zone is bounded on the southern margin by normal faults dipping to the south. Height of volcanic edifices doesn't exceed 100m.

ES-30	Period:	April 11	0800-0905h
	Start:	9°54.8'S	151°43.2'E
	End:	nr. 9°44.0'S	151°43.0'E

South-north track across the elevation that bounds East Basin on the south. Error in navigation led to an interruption in echo-sounder recording and erratic course. GPS apparently down; not logged by PC.

ES-31	Period:	April 11	0921-1005h
	Start:	9°44.3'S	151°41.7'E
	End:	nr. 9°52.0'S	151°41.7'E

North-south track across East Basin. No GPS logged. Computer automatic navigation problems resulted in a mismatch of echo-sounder data.

ES-32	Period:	April 11	1015-1100h
	Start:	nr. 9°52.0'S	151°41.0'E
	End:	nr. 9°44.0'S	151°41.0'E

South-north track across the central part of East Basin. No GPS logged. Profile shows the floor of the basin to be heavily sedimented. Volcanic zone in central and northern part of the basin suggests continuation of seafloor spreading into eastern part of the basin.

ES-33	Period:	April 11	1115-1156h
	Start:	9°44.1'S	151°39.8'E
	End:	9°51.2'S	151°40.5'E

South-north profile across Middle Basin. GPS recommenced soon after start. Flat sedimented floor of basin. Possible continuation of volcanic zone into Middle Basin in the northern part of the basin.

ES-34	Period:	April 20	1617-1850h
	Start:	9°53.8'S	151°50.0'E
	End:	10°20.0'S	151°50.0'E

No GPS logged; navigation probably by Magnavox. North-south profile started at the summit of Franklin Seamount and across the basin south of Franklin up to the southern margin of the rift zone. Survey defined continuation of the volcanic zone in the basin south of Franklin. Volcanic edifices up to 100 m high were observed. Series of five tilted blocks, rotated along the north dipping normal faults, forms the southern part of extensional zone. Magnetometer didn't work during this profile. Same area was covered by ES-35.

ES-35	Period:	April 20	1923-2150h
	Start:	10°20.0'S	151°49.2'E
	End:	9°54.5'S	151°48.7'E

Magnavox navigation. South-north profile to confirm structure and magnetic field that wasn't recorded during previous run ES-34. The morphology suggests the possibility that the basement south of Franklin Seamount is of volcanic origin but is old and is deformed by younger tectonic events in a series of horsts and grabens. Magnetic survey shows high magnetic anomaly for this region.

ES-36	Period:	April 21	0025-0446h
	Start:	nr. 9°37.0'S	152°05.0'E
	End:	10°20.0'S	152°05.1'E

GPS commenced at 0222h. North-south profile east of Franklin and Cheshire Seamounts across rift margins and central neovolcanic zone. New territory for PACLARK.

ES-37	Period:	April 21	0454-0720h
	Start:	10°20.1'S	152°04.1'E
	End:	9°55.0'S	152°03.9'E

GPS navigation. South-north profile across the rift and central neovolcanic zone east of 152°E, parallel to ES-36 to define magnetic lineations and the geometry of extensional deformation.

Summary

Morphological and magnetometer studies confirmed the continuation of the Woodlark seafloor spreading system as far west as 151°40'E. Franklin Seamount represents a major volcanic structure located at the point of the propagator. The volcanic zone continues westward from Franklin through East Basin into Middle Basin in the form of individual volcanic centers up to 100 m high. Depressions between the volcanic zone and the southern margin of the basin are heavily sedimented. The morphology indicates a broad distribution of volcanic material north of the central volcanic zone up to the northern margin of the basin.

Evolution of the rift structure appears to be an episodic process as proposed by previous studies of the PACLARK group. Zonenshain pointed out differences in the character of faulting, morphology and sedimentation across the rift zone and proposed at least two, and possibly three, stages of rifting.

There is a dramatic change in the character of the extensional mode at 151°40'E. A postulated major transfer fault accommodates distinct differences in the amount of extension applied to the continental crust. East of 151°40'E, seafloor spreading is well established. The magnetic survey defined the Bruhnes magnetic anomaly for recent seafloor spreading in the central part of Woodlark and suggested the possibility of older oceanic crust in a marginal rift zone or continental crust deformed by extensional processes and impregnated by volcanic intrusions. Cheshire Seamount may represent a fragment of continental crust enclosed within older oceanic crust. No indications of oceanic crustal accretion were found west of the transfer fault at 150°40'E.

CTD/HYDROCASTS

Chief Scientist (CTD): Vyacheslav (Slava 2) Lukashin

Chief Scientist (Water chemistry): Vyacheslav (Slava 1) Gordeev

KELDYSH carries a standard Neil Brown CTD rosette (temperature, salinity, oxygen, pressure) with a nephelometer and capable of holding 1.5 litre or 30 litre Niskin bottles. Two 30-litre bottles were

provided by CSIRO. The handle was broken off one of the endcaps in transit. Depth off bottom is determined by pinger; there was no altimeter. Real-time visual dislays are digital only; there are no analog displays on which it would be easier to detect real-time anomalies. The CTD is used for normal hydrographic work and, particularly on this cruise, for "plume hunting". It is also used, with the transmissometer, to determine bottom conditions for diving (temperature, visibility) although a smaller unit can be deployed for this purpose. All of the people involved are highly professional.

Plume hunting consists of CTD/nephelometer yo-yoes (what the Russians call "zig-zags") and taking 1.5 litre water samples for shipboard analysis of Fe and Mn and many other elements. A complete set of dissolved Mn, Si, phosphate and nitrate analyses is available from a rosette station within 12 hours. Other analyses come later.

The first lowering was done mainly to check the system and to fill the 1.5 litre bottles with bottom water. This water, to which is added acid, is left in the bottles for 24 hours in order to clean them.

The CTD is housed in a room starboard forward on 5 (bow well) deck. The CTD is wheeled out on a trolley on rails, attached to the conducting cable and put over the starboard side. Voice communication with the winch operator on deck is by means of a loud speaker. Recording of CTD data is done in an adjacent room.

Water chemistry is done in a "clean" lab adjacent to the CTD data centre. There is a large group of people working in Gordeev's well equipped chemistry lab and Lein's microbiology lab. They are capable of analysing onboard ship Mn, Fe, Si, Mg, NO_3, PO_4, Cl, H_2S and several other elements with standard shore laboratory precision.

Operations

H-21 (Station 2153?)	Period:	April 11	1338-1550h
	Start:	9°54.9'S	151°48.3'E
	End:	9°54.8'S	151°47.8'E

GPS navigation. Over knoll on western pediment of Franklin Seamount. One cast only done mainly to test the equipment and fill the 1.5 litre bottles with bottom water for cleaning. Acid was added to the bottles and the solution was left in the bottles for 24 hours. Problems with the pinger and the tape recorder. Preliminary analyses of water gave normal background values.

H-22 (Station 2155)	Period:	April 13	0034-0151h
	Start:	9°52.4'S	151°40.9'E
	End:	9°51.9'S	151°40.6'E

Navigation by Magnavox. Ridge south of East Basin. The intention was to do a south to north crossing of East Basin, starting over Southeast Basin. However, wind (15-20kt southeast) and current (from east) pushed the ship in a westerly direction south of Moresby Seamount. No CTD or nephelometer anomalies were found. Water samples gave normal background concentrations of elements.

H-23 (Station 2156)	Period:	April 13	0400-0750h
	Start:	9°48.1'S	151°42.0'E
	End:	9°47.4'S	151°38.0'E

GPS navigation. East Basin. The intention was to cross the H-3 track of PACLARK I but wind and current (see H-22) pushed the ship on a WNW course just south of the central rise of East Basin. Preliminary results showed no obvious CTD or nephelometer anomalies but subsequent computer processing of data, after H-26 (see below), showed a temperature in the same general vicinity as for H-26. Water samples gave normal background concentrations of elements.

H-24 (Station 2163)	Period:	April 14	1145-1430h
	Start:	9°53.1'S	151°46.2'E
	End:	9°51.7'S	151°44.6'E

GPS navigation. Intended to be a south to north yo-yo traverse mid-way between East Basin and Franklin Seamount but was aborted after the first downcast because of a malfunction in the cable.

H-25 (Station 2172)	Period:	April 16-17	2100-0441h
	Start:	nr. 9°44.7'S	151°03.0'E
	End:	9°48.9'S	151°00.6'E

Radar and Magnavox navigation until 0300h then GPS. South Valley east of Dobu Seamount. Intended north to south yo-yo from 500 mbs to 30 mab of 15 legs covering 13 n mi from near the north margin to a couple of n mi north of the south margin; achieved southwesterly track. The rosette was brought to surface at approx. 0230 for repairs and then the traverse was continued. Nephelometer anomalies (defined as readings >1300; typical background 1100) were found at 250 to 350 mab. No temperature anomalies. Dissolved Mn in the CTD anomalous areas are normal background of 40 to 60 μg/l. The CTD probably recorded a nepheloid layer peculiar to this area of a partially enclosed basin with steep slopes and abundant transported sediment.

CTD cable damaged and being repaired. This caused some delay in planned CTDs.

H-26 (Station 2183)	Period:	April 19	0021-0443h
	Start:	9°50.2'S	151°41.7'E
	End:	9°45.6'S	151°40.9'E

Magnavox navigation until 0238h then GPS. East Basin. South to north yo-yo in the general vicinity of the PACKLARK H-3 track. Temperature anomaly but no nephelometer anomaly (in same area as PACLARK's particulate and Mn anomaly) below about 2700 m reaching +0.045° at 65 to 70 mab. Only one reading at this depth but several others showed weaker temperature anomalies that can be correlated from profile to profile. Mn reaches 190 μg/l in the +0.045° water sample and is >150 μg/l, increasing downward, in the anomalous layers, versus background of 50 to 70 μg/l. Si and nitrate are anomalously low in this layer.

H-27 (Station 2191)	Period:	April 20	1030-1445h
	Start:	9°48.1'S	151°41.7'E
	End:	9°46.7'S	151°38.5'E

GPS navigation. East Basin. Parallel to H-23, finding the same temperature anomaly as H-26 (+0.045° at 30 to 35 mab). Cable failed again and will be replaced. Profiles as follows:

Profile	Time	Location	Depth (m)	Horizon (m)
1	1100	9°47.98'S 151°41.17'E	3242	3202-2607
2	1145	9°47.79'S 151°40.70'E	3242	2607-3150
3	1228	9°47.57'S 151°40.28'E	3218	2713-2311
4	1250	9°47.48'S 151°39.93'E	3227	2805-3163
5	1310	9°47.30'S 151°39.74'E	3240	2800-3201
6	1030	9°48.17'S 151°41.76'E	3242	2840-3200

H-28 (Station 2200)	Period:	April 25	0020-0358h
	Start:	9°58.9'S	151°54.1'E
	End:	9°55.1'S	151°55.3'E

Magnavox navigation until 0207h then GPS. East-west ridge southeast of Franklin Seamount (FS-5 of PACLARK proposal) to determine if this ridge is hydrothermally active. S to N yo-yo using new CTD cable. No CTD anomalies.

H-29 (Station 2201)	Period:	April 25	0514-0801h
	Start:	9°59.1'S	151°53.0'E
	End:	9°56.4'S	151°52.5'E

GPS navigation. South to north yo-yo further to the west over the same ridge as H-28. Weak and patchy CTD anomalies. Mn in the bottom 200 m is up to 230 μg/l vs a normal background of about 40 μg/l. Si is anonamously low. These results are the same as those from East Basin (H-26). The anomalies in T and Mn increase to the S and were maximum at the start of the traverse indicating that the source of the anomalies is still further to the south.

H-30 (Station 2203)	Period:	April 26	0343-0730h
	Start:	9°58.3'S	151°52.9'E
	End:	9°58.0'S	151°53.2'E

GPS navigation. Vertical profile south of the east-west ridge southeast of Franklin Seamount in the area of the weak T and high Mn anomaly to collect 30 litre Niskin samples for isotopic analysis. The first 3 of 8 samples were taken 30 mab and the remainder above at shallower depths. Profile as follows:

Profile	Time	Location	Depth (m)	Horizon (m)
1	0328	9°58.45'S 151°52.93'E	2723	0-1500
2	0550	9°58.40'S 151°52.98'E	2746	0-2740

SEDIMENT CORES AND GRABS

Chief Scientist: Yuri Bogdanov

Sediments are collected by means of box corers, gravity corers and grabs from the ship, and by small push corers from MIR. Box corers are of two sizes; only one unsuccessful attempt to use them (S-16) was made on this cruise. Gravity corers are 8 cm in diameter and have lengths of about 6 and 10 m. Grabs are made by Petersen in Sweden. Push cores operated from MIR are rectangular about 5x5x20 cm.

A pinger is not used on the corer wire. This makes accurate positioning of the corer extremely difficult where such is required, especially when there is a large wire angle.

The deck handling system for the corers is very good. The transom is sloped which eases deployment and recovery. The weights around the collar of the corer sit on a wooden cradle that slides towards the stern when the corer is picked up with the winch wire that passes through a sheave on the A-

frame. On recovery, the weights are lowered onto the cradle and the corer is slide back by means of a motorized capstan with a wire through a deck mounted sheave wheel. A scientist runs the winch.

At each site, both a grab and a core are taken. Each is given a different station number. The dual operation requires taking advantage of the ship's drift so that the grab, with less steep wire angle, does not interfere with the corer (normally deployed 15 minutes after the grab). Coordinates below are generally the ship's position when grab or corer reached bottom, so are not exact. Soviet laboratory records (cards) generally listed slightly different coordinates, but it is not clear how these were estimated. They do not appear to be GPS position of initial deployment, and may have been taken from the Magnavox monitor.

The upper 0.1-0.2 m of core is usually disturbed, hence the grab sample. Samples are taken out of the grab by means of rectangular boxes that are inserted and then lifted out with a hand underneath (and half an arm buried in mud!), giving a 16-20 cm 'core' which is placed on a tray and taken to the lab for immediate processing. The boxes have a slide on one side which is pulled out and then the rest of the box is slid up over the sample. The sample is cut vertically with a knife and laid down.

A liner is not used in the sediment corers except for thin plastic sheeting which is inserted in the bottom 0.5 m. Cores are very effectively removed from the barrel by detaching the lower nose-cone and flap-valve at the base, attaching a hose, and extruding the sediment hydraulically through the top end. Cores are carried into the lab on one-meter long halved PVC pipe, are cut longitudinally with a wire, separated and processed immediately. First, Eh and pH are measured in situ every 10 cm, magnetic susceptibility every 5 cm, and smear slides are made every few cm. There are about 12 Eh electrodes for this purpose.

Operations

Number	Station	Type	Lat.	Long.	Depth	Recovery
East Basin						
S-15	2158	grab	9°48.4'S	151°41.0'E	3233	Sediment with abundant modern forams; elutriate with considerable very fresh volcanic glass which was separated; 2 dm-size lumps of heavily Mn-coated basalt (one is 2 cm thick crust with thick glass and drip features on lower surface)
S-16	2159	box corer	"	"	"	unsuccessful
North margin of East Basin						
S-17	2160	grab	9°46.9'S	151°40.1'E	3250	a small amount of ooze and one 10 cm pillow fragment

Number	Station	Type	Lat.	Long.	Depth	Recovery
S-18	2161	corer	9°46.8'S	151°40.3'E	3251	small amount of green ooze with glass chips retained by plastic liner at nose
South end of East Basin						
S-19	2164	grab	9°49.0'S	151°41.4'E	3224	half full of light brown ooze, rare glass chips
S-20	2165	corer	9°49.05'S	151°41.5'E	3227	a few chips of basalt glass retained by plastic liner
South Middle Basin						
S-21	2166	grab	9°59.2'S	151°35.1'E	3029	full of soft brownish ooze
S-22	2167	corer	"	"	3028	3.25 m of predominantly light khaki ooze with a coarser layer of probable turbidite which contains mica (i.e. continental provenance). Subsequent studies by Barash et al. showed a significant change in paleoceonographic conditions at 1.8 m depth signified by a change in colour from brown to green, a sharp decrease in total forams, an increase in cold water forams, a decrease in CaCO3 and an increase in organic carbon below this depth thought to be due to deeper water conditions. C-14 dates show reversals in the upper metre of the core indicating turbidites. A radiocarbon age of 8,400 years was obtained at ≈1.6 m.
Southeast Basin						
S-23	2168	corer	9°57.1'S	151°43.5'E	3145	3.6 m core grading from pale brown unconsolidated ooze to semi-consolidated olive silt to dark greenish grey silt. Some bioturbation and slump breccia.
Southwest part of South Valley						
S-24	2173	grab	9°49.9'S	151°00.8'E	1238	khaki ooze with a high proportion of sand
S-25	2174	corer	"	"	1248	small but unrecorded core recovery, with 1 cm sandy layer containing andesite glass at 16-17 cm

Number	Station	Type	Lat.	Long.	Depth	Recovery
Southeast of Dobu Seamount						
S-26	2175	grab	9°48.9'S	151°01.3'E	1354	about 35 kg of khaki ooze
S-27	2176	corer	"	"	1356	21 cm of khaki ooze with sandy layer at 17-19 cm
Basin east of Cheshire Seamount						
S-28	2178	grab	9°45.2'S	151°54.6'E	2719	1-2 kg of khaki ooze
S-29	2179	corer	9°44.9'S	151°54.8'E	2678	about 4.6 m of ooze, the top 0.5 m of which is brownish in colour and the remainder khaki. Possibly one unit.
Central Woodlark Basin						
S-30	2181	grab	9°58.7'S	152°08.5'E	2748	completely full of light khaki ooze
S-31	2182	corer	9°58.7'S	152°09.1'E	2744	1.4 m of laminated brown to olive ooze recovered; oblique entry?
Southwest of Dobu Seamount						
S-32	2184	grab	9°48.4'S	150°57.8'E	1043	full of light green ooze with 4 cm of brownish ooze on top and contained pumice, pieces of wood and gastropod and pteropod shells
S-33	2185	corer	9°48.45'S	150°57.8'E	1037	only 18 cm disturbed core retained by plastic corer; green ooze with a brownish top and contained chips of andesite glass, especially in lower (?) green layer
North Valley						
S-34	2187	grab	9°40.7'S	151°10.7'E	2213	full of brownish unconsolidated to semi-consolidated ooze
S-35	2188	corer	"	"	"	2.45 m of pale green ooze of which the top 8 cm is oxidized to a brown colour. A bioturbated boundary occurs at 220 cm. Grey foram-rich turbidites 1 cm thick occur at 87 cm and 227 cm; pods (ash?) are at 204 and 210 cm.
Cook Valley						
S-36	2189	grab	9°43.8'S	151°27.7'E	2591	full of khaki ooze
S-37	2190	corer	"	"	2596	88 cm of pale green ooze of which the top 30 cm is oxidized to a pale brown colour. Ash(?) pods at 50 and 55 cm.

Number	Station	Type	Lat.	Long.	Depth	Recovery
Central Woodlark Basin						
S-38	2193	grab	10°04.8'S	152°23.9'E	3061	did not close; no sample
S-39	2194	corer	10°04.8'S	152°23.7'E	3047	only a small amount of ooze and a 1.5 cm flake of black glass (no vesicles)
S-40	2195	grab	10°06.6'S	152°36.4'E	3254	only a few g of light brown sediment (came up entangled in the corer wire)
S-41	2196	corer	10°06.6'S	152°36.5'E	3273	4.30 m of light grey/khaki fine sand to ooze with 40 cm of the oxidized top a light brown colour. Graded units and slumps in lower section.
East-West ridge East of Franklin Seamount						
S-42	2198	grab	9°58.0'S	151°55.4'E	2795	3/4 full of red-brown ooze
S-43	2199	corer	9°58.2'S	151°55..2'E	2813	115 cm (about 20? cm washed out) of laminated red-brown ooze; grading in lower units
Knoll Northwest of Franklin Seamount						
S-44	2204	corer	9°54.1'S	151°48.6'E	2407	Attempted to hit the large Beaujolais deposit on top of Northwest Knoll, on the pediment NW of Franklin Seamount at 9°53.89'S 151°48.87'E, and missed. Only a few g of sand-size foraminiferal sediment with black glass chips and small pieces of exotic pumice were recovered.

Summary

Both the grab and the corer were generally most effective samplers, and operations considerably extended the coverage by PACLARK cruises.

Preliminary lithological logs were prepared by Binns of all long cores but these are not repeated in detail here to prevent confusion with the much more thorough Soviet logging. Marked sedimentological differences between sub-basins are evident. Some 120 small reference samples representing major units were taken for retention at CSIRO. Except for S-39 (missed), samples of glass chips, where present, were elutriated for later microprobe analysis.

No obvious indications of hydrothermal activity were evident macroscopically or in shipboard Fe and Mn analyses, though Mn-coated forams in one core (S-22, S-23 or S-29?) were reported at a depth equivalent to an age of 150 years. Shipboard radionuclide and micropalaeontological studies indicate

sedimentation rates ranging from 7 cm/1000 years (S-23, Southeast Basin?) to 16 cm/1000 years (S-22, South Middle Basin).

A feature of interest is the presence of sandy layers rich in andesite glass at about 15 cm depth in all three cores (S-25, S-27, S-33, see also Dive 4) taken near Dobu Seamount, confirming indications from PACLARK cores that volcanism here has been inactive for a significant period (≈1000 years?).

SUBMERSIBLE OPERATIONS

Chief Pilot: Evgeni Chernyaev

KELDYSH carries two 18 tonne MIR submersibles built by the Rauma Rapola Company of Finland in 1986-87. Their depth capability is 6000 m but they have been to 6100 m. Each carries a pilot, a co-pilot/engineer and a scientist. Only one submersible is used at a time; the second is for rescue. Minimal conditions for diving are 2 m swell and 10 m/sec (20 kt) wind. Technical crew consists of a Chief Pilot (Evgeni Chernyaev) and 7 "submersible engineers", one of whom (Victor Nisheta) is also a pilot. Dives are done only every two days. Each cruise is allotted only a certain number of transponder nets ("polygons"), three in our case.

Propulsion is by means of a large steerable stern propellor with a rudder attached below and two conventional side mounted and rotatable thrusters. MIR has a high tail with a moveable diving plane and carries the communications transducers. Bottom time may be as long as 12 or more hours.

Navigation is by means of a NAVAC system using Finnish-built transponders each with a range of 11 km. Up to 4 transponders were used to make a polygon during SUPACLARK. Navigation can be done either from the sub or from surface but not both simultaneously. Only the first method was used on SUPACLARK. The NAVAC system gives the range to all readable transponders and, if three transponders report, gives x, y and z coordinates relative to a chosen origin as well as a calculated latitude and longitude. Shadowing by topography and possible erros in surveyed transponder positions caused considerable problems during SUPACLARK dives. Commonly, only one or two transponders reported. Lev Zonenshein programmed a hand calculator to give both solutions to dual reports.

The procedure used to survey the transponders was not monitored by PACLARK participants. In some cases, transit satellite fixes rather than GPS data were apparently used, constituting a possible source of minor error.

The MIR sphere contains the usual radio and underwater telephone systems, a side-scan sonar, a 90° sector (forward to down) terrain avoidance sonar, a 3-component magnetometer, a data logger and a cassette deck (not exciting music).

The MIRs normally carry the following external equipment on a dive:

- 2 hydraulic arms
- 2 extendable (about 40 cm) sample baskets about 100x30 cm wide and 30 cm deep.
- 1000 watts of lighting
- pan and tilt Osprey video with a Betacam VCR
- 35 mm still camera with about 100 exposures mounted beside the video (there is also a bracket for a second camera to provide stereo)
- CTD (Neil Brown)
- temperature probes, hull mounted and deployable
- sampling devices: 2 rectangular push corers approx. 4x4x25 cm; scoop nets for fine sediment with an opening of approx. 15 cm; split cylinder grab approx. 20x5 cm when closed.
- 2 fixed Niskin bottles of 1 litre capacity; 3 more can be attached

Launching is over the starboard side by means of an articulated crane. A cone and pinion connection is made to MIR for pickup. Sway is damped by two large pads that grasp either side. These were seen not to work too well on a rough day. The ship's launch and a Zodiac are in the water during launching and recovery. A rope from the launch to the bow of the sub helps to control orientation and spin. The exercise is done very efficiently and expertly in 10 to 15 minutes. Communications with the sub and the transponders are checked from a hydrophone on the launch prior to diving. The launch also stands station over the sub when the ship is being moved for better comunications. Separate towfish from the starboard side of KELDYSH are used for voice communications and transponder navigation. In Scott's opinion the side-launch system of MIR is superior to stern A-frame launches done by everyone else. Heave is not as significant a factor as it is for a stern launch and roll on KELDYSH is damped. Clearance over the side with the articulated crane is very good; MIR can be rotated by the crane without coming close to hitting the ship. Despite this, Zonenshain says they are unhappy with their system and want to get a big A-frame for stern launching. MIR was damaged once when it hit the side of the ship.

DIVE RESULTS

DIVE 1

Location:	Franklin Seamount
Scientist:	Lisitsin
Pilot:	Chernyaev
Launched:	1030 13 April
Submerged:	1100
On Bottom:	1251 @ 2460 m
Off Bottom:	2221 @ 2170 m
Bottom Time:	9 hr 30 min
Surfaced:	0100 14 April

Dive 1 followed more or less track FS-1 as proposed by PACLARK northward across the western pediment of Franklin Seamount, into the breached caldera and up onto the north wall where "Beaujolais" hydrothermal Fe-Mn-SiO_2 was seen on video during PACLARK II, and back down into the caldera and its central crater. All systems functioned normally. Navigation was from the MIR.

Returned samples totalled 14 and included 5 dm-size lumps of Mn-encrusted basalt lava and two vesicular basalts at first thought to be of dykes (with high magnetic susceptibility), 4 pieces of Beaujolais chimney, 2 push cores of Beaujolais, 1 grab of Beaujolais and one scoop net of Fe-rich sediment at the Beaujolais site. Photography consisted of 38 colour slides and 2½ video cassettes.

The pediment of the seamount has very rough topography with little sediment. In general there are pillow and tube flows on the slopes and broad domes (sheet flows? lobate flows?) on the flats. Talus and pillow talus on the cliffs. Dikes were observed in the wall of the caldera. "Beaujolais" (Fe-Mn oxide + SiO2) material was seen on top of the north rim of the caldera and within the caldera itself. Most of the Beaujolais material, on first examination at 0200, is slightly indurated red Fe-rich and black Mn-rich sub-cm-size pieces in a red ooze matrix. The net grab contained an orange-red ooze. Lisitsin observed bulbous chimneys of Mn-coated Fe-oxide up to 1 m high on the northern rim. All of this, as seen subsequently in video, is quite extensive and commonly associated with green nontronite. The chimneys are extremely friable and could not be picked up by the arm. More of irregular shaped Fe-oxide chimneys, not Mn-coated, were seen in the caldera together with dm-thick layered and extremely friable Fe-oxide-rich material. The video clearly shows clear and, in one case, grey shimmering water being emitted from chimneys but its temperature could not be measured because MIR did not carry a deployable temperature probe.

DIVE 2

Location:	Franklin Seamount
Scientist:	Bogdanov
Pilot:	Nisheta
Launched:	1030 15 April
Submerged:	1039
On Bottom:	1332 @ 2369 m
Off Bottom:	2321 @ 2130 m
Bottom Time:	9 hr 45 min
Surfaced:	0059 16 April

Dive 2 more or less followed tracks FS-2 & 3 as proposed by PACLARK, starting at about the middle of the ESE ridge on the east side of Franklin Seamount, zig-zagging northwesterly along this ridge and climbing to the rim of the seamount to the Beaujolais deposits on the north side, and down into the caldera.

All systems functioned normally.

Samples returned included one Mn-coated basalt about 20 cm in diameter, one 50 cm chunk and a few smaller pieces of Mn-coated Fe-oxide hydrothermal chimney; two net samples of hydrothermal crust and sediment and two push cores and one grab of same. Photography consisted of colour slides and 2 videotapes.

The ridge is constructional, not tectonic. There is no axial cleft. Two ages of lavas are seen on the ridge: older sedimented and younger sediment-free on top of the older. There is no evidence of hydrothermal activity along the ridge.

Mounds of Mn and Fe oxides up to 5-7 m high and 10 m across at their base, topped by 0.5-2 m high pillars are found near the caldera walls in a field about 200 m across. Elsewhere, hydrothermal precipitates appear to be draped against the caldera walls and surrounded by metalliferous sediment and bright green nontronite. The constructional features of mounds are very irregular and can be best described as "turd-like". Low temperature venting (T not measured) is prevalant from the sides of mounds. Video shows an example of warm water being emitted from under an eave and curling around the end of the eave. Precipitates are very fragile and difficult to sample.

DIVE-3

Location:	West Dobu Ridge and Dobu Seamount
Scientist:	Binns
Pilot:	Chernyaev
Launched:	0945 17 April
Submerged:	1005
On Bottom:	1049 @ 948 m
Off Bottom:	2201 @ 334 m
Bottom Time:	11 hr 12 min
Surfaced:	2232

Dive-3 explored the ridge to the immediate west of Dobu Seamount, the col between this ridge and the seamount and went to the crest of the seamount, effectively combining PACLARK dive proposals DS-1 and DS-4. All systems functioned normally. Because of the shallowness of the dive, the temperature in the sphere was a balmy 18°C. Twenty samples, some large, of rhyolite and basalt, one push core of glass sediment from the foot of a rhyolite outcrop and several fauna were returned.

Dive 3 combined PACLARK proposals DS-1 and DS-4. No indications of hydrothermal activity were seen. The 'anomalous' outcrops and crusts photographed and video'd on Main Col during PACLARK II proved the result of strong bottom currents concentrating fine debris around andesite and rhyolite outcrops. Inferred 'chimneys' were outcrops of scoriaceous andesite, some with reddish surafces probably due to weathering. 'Gjars' interpreted from PACLARK video seem mostly to be collapse features associated with mass wasting rather than extensional tectonism.

Rhyolites crop out extensively around the eastern end of West Dobu Ridge. Some show ropy flow surfaces. Rhyolites and andesites crop out in close proximity but age relations remain uncertain. Possible 'basement' of older andesite or basalt was also seen on Main Col and West Dobu Ridge. The slopes of Dobu Pinnacle show extensive effects of mass wasting, one consequence being a false youthful appearance of fine andesitic debris relative to ooze. Products of submarine explosvie andesitic volcanism are nonetheless present.

DIVE-4

Location:	East Dobu Ridge to Dobu Seamount
Scientist:	Zonenshain
Pilot:	Nisheta
Launched:	1105 19 April
Submerged:	1120
On Bottom:	1237 @ 1390 m
Off Bottom:	2300 @ 383 m (energy exhausted)
Bottom Time:	10 hr 23 min
Surfaced:	2358

Dive-4 explored from east end of East Dobu Ridge to within 50 m depth of the top of Dobu Seamount particularly examining "anomalous" areas identified by PACLARK, and effectively combining PACLARK dive proposals DS-2 and DS-3. The temperature probe, several lights and a current-measuring tube (lost at surface) sustained repairable damage the the submersible accidentally rammed a cliff.

Returned samples included 7 dm-size lumps of vesicular andesite and one push core of ooze with a concentration of andesite glass chips at 5-11 cm depth. Most lavas are highly vescicular, fresh and glassy. The ridge is constructive and not tectonic but Zonenshain opined that the rather heavily sedimented lavas were too old to produce current hydrothermal activity. No gjars or other signs of extensional tectonism were seen. Two ages of lava (older has a very high magnetic susceptibility = Miocene?) were observed with 1.5 m of unlithified chalk-like sediment separating them. Video captured an amusing duel between the MIR's manipulator arm and a large lobster.

No hydrothermal vents or deposits were encountered. Mass-wasting phenomena seen by Dive 3 on Dobu Pinnacle were confirmed.

DIVE-5

Location:	Franklin Seamount & NW Knoll
Scientist:	Scott
Pilot:	Chernyaev
Launched:	1025 21 April
Submerged:	1032
On Bottom:	1215 @ 2598 m
Off Bottom:	2314 @ 2167 m
Bottom Time:	10 hr 59 min
Surfaced:	0215 22 April

Dive-5 was a Beaujolais hunting and sampling expedition on the knoll northwest of Franklin Seamount and the north slope of Frankln Seamount as seen in PACLARK CV-25 and dredge D-37, respectively, as well as sites on the rim and within the caldera of Franklin Seamount. All systems operated normally except that the stern rudder had been torn off.

Returned samples included 2 sites of Beaujolais (NW Knoll and NW flank of Franklin Seamount), 2 pieces of angular rhyolite pumice which is abundant in the talus at one of the Beaujolais sites on the NW flank of Franklin, a jointed block of "dyke" from the south wall of the caldera and a barite ("Chablis") chimney from the drainback at the east end of fhe caldera. The so-called dikes on the caldera wall appear to be a jointed massive flow with a tubular/pillowed top.

Dive-5 found sheet flows in the flat W of Northwest Knoll as well as some up on the knoll itself, a large, hydrothermally inactive, sedimented deposit of Beaujolais about 350x200 m on the northern top and part way down the north flank of the knoll (same as seen in CV-25), two small (a few 10s of m) deposits of Beaujolais, one active and one probably D-37, on the NW flank of Franklin Seamount, three small deposits, two of which are active, on the north rim and caldera of Franklin Seamount, a 100 m deposit in the lava drainback hole in the east end of the caldera, two small deposits on the SE wall of the caldera and a 150 m deposit on the south rim. No site was deemed worth sampling for hot water; flow rates were estimated to be only about 1 cm/sec by observing the rise of particles in the shimmering water. Instead, a bottom water sample was taken with the titanium sampler and its analysis proved to be normal bottom water. A Niskin sample of floc in stirred up hydrothermally active Beaujolais proved

DIVE-6

Location:	East Basin
Scientist:	Lisitsin
Pilot:	Nisheta
Launched:	1122 23 April
Submerged:	1127
On Bottom:	time not recorded, depth approx. 3300 m
Off Bottom:	time not record, depth 3140 m
Bottom Time:	over 9 hours
Surfaced:	0205 24 April

Dive-6 searched the series of central ridges in East Basin for hydrothermal activity which might explain the CTD temperature and manganese hydrocast anomaly. The track followed PACLARK proposed EB-1 closely, and was 7 nautical miles long. The titanium water sampler did not trigger because of a problem with the hydraulics.

Returned samples included five Mn-coated basalts and a push-core of ooze.

No evidence of concentrated hydrothermal activity was found. Large gjars up to 10 m deep oriented parallel and orthogonal to the ridge attest to tectonic activity.

Each hill evident on the SeaBeam chart appears to be an independent volcanic ediface 60-100 m high, with possibly hollow dome roofs and some evidence of summit caldera collapse or extension. The eastern slopes are faulted, with scarps to 70 m high, possibly reflecting a transform fault system. Most lava surfaces are covered with a few cm of ooze bu the floors of gjars are unsedimented talus.

Anomalous temperature fluctuations (0.01-0.02°) were noted on the CTD over talus and new faults. These were inferred to reflect diffuse venting from deep-seated structures, including some buried by talus.

DIVE-7

Location:	Franklin Seamount
Scientist:	Binns
Pilot:	Chernyaev
Launched:	1029 25 April
Submerged:	1036
On Bottom:	1229 @ 2614 m
Off Bottom:	2203 @ 2197 m
Bottom Time:	9 hr 34 min
Surfaced:	0050 26 April

Dive-7 was the last of the SUPACLARK series. It explored and sampled rocks and water from the top and caldera of Franklin Seamount. All systems operated normally.

Returned samples included one large (40x30x30 cm, 15 kg) chunk of barite ("Chablis") spire plus a smaller piece of chimney, one 30x30x15 cm Mn-coated lump of Beaujolais from an actively venting site plus some smaller pieces, two basalts, a grab of a few cm high Beaujolais spire surrounded by yellowish-

brown precipitate, a push core, a partial vent water sample taken with the titanium sampler and two 1 litre Niskin samples from over the sampled vent.

The caldera has numerous collapse scarps forming its walls and at least two inverted conical depressions filled with talus and floored by tube flows. A number of smaller half-funnel shaped craters with a cliff on one side occur at the western end of the caldera. The "dykes" in the caldera walls are confirmed to be jointed massive flows.

Preliminary examination of the barite spire shows it to contain anhydrite and minor sulfide as well as barite. L + V fluid inclusions in anhydrite have a small vapour bubble so are low temperature.

Water was sampled with the titanium sampler from a Beaujolais vent that was flowing at an estimated 5 cm/sec. Unfortunately, the sampler had been dropped into the soft precipitate which clogged the sample tubes resulting in only a ≈420 ml sample in one bottle and no sample in the other. This water has a measured pH of 6.3 (vs normal bottom water here of 7.6) but was slowly rising during the measurement from 6.1 indicating that an acid gas, probably CO2, was exsolving. The temperature probe, which later gave every indication of working (i.e. matched the CTD temperature on the ascent to surface), showed no rise in temperature in the vent flow but there is some doubt it operated properly at the active site. Ambient temperatures near the site (to 2.13°C) were higher than normal (2.07°C).

Summary

Helped by their relatively long duration, these seven MIR dives addressed all high priority PACLARK targets.

The Dobu Seamount area, with andesites and rhyolites, has been effectively ruled out as a site of hydrothermal activity. Possible hydrothermal fractures and gjars inferred from PACLARK photogaphs and video have alternate explanations in terms of explosive volcanism, bottom currents, and mass-wasting and associated collapse. PACLARK CTD-hydrocast anomalies probably correlate with turbid near-bottom water reflecting currents and sedimentation arising from proximity to land.

The most prospective areas of the East Basin floor were also well explored, without finding any concentrated hydrothermal activity. However, dive observations support the probability that the central ridges of East Basin reflect the western-most extend of extensional sea-floor spreading, perhaps incipient.

Fe-Mn-Si oxide deposits on Franklin Seamount, sampled and photographed on PACLARK I and II, have now been thoroughly investigated. The discovery of active low-temperature venting at some sites, and of barite chimneys close by, are major achievments of the SUPACLARK cruise. No massive sulfide deposits were seen in the areas traversed and CTD/hydrocasts near Franklin Seamount do not suggest the presence of active black smokers. The failures to obtain an undiluted sample of vent fluid from active Beaulolais sites, and to measure temperatures with complete confidence, were minor disappointments relative to the overall success of the dive program. PACLARK participants collected sub-samples from most of the submersible collections for future laboratory analysis.

VENT FLUID

Chief Scientist: Vyacheslav (Slava 1) Gordeev

A Walden-type titanium vent water sampler was loaned by Energy, Mines and Resources Canada for the cruise as well as for the following two legs. Notes made by Scott in 1983 and his imperfect memory constituted the instruction manual. A detailed manual was written, illustrated with photographs and printed during the cruise.

The sample bottles came with one long and one short inlet tube which is an incompatible combination if the bottles are paired as is normally done. The MIR engineers welded a piece of titanium tubing they had onto the short one to make both the same length.

Triggering the bottles proved to be troublesome. An early idea to mount the sampler on the end of a rigid pole in front of MIR and trigger it with an arm was discarded when the potential danger to the sampler from collisions was pointed out , as well as the extreme difficulty that would be encountered in holding the sampler in the vent by having to manoeuvre the whole submersible and not just an arm. The final design, a good one, was to mount a small hydraulic cylinder on top of the two valve chambers that, on instroke, pulled a plate against sleeves that were the correct length to open the inlet valve. The sleeves were around the normal triggering bolts in the trigger plunger. This setup is illustrated in the instruction manual. The hydraulic lines were permanently installed so the bottles had to be attached to the cylinder before a dive and detached after a dive while in MIR's sample basket, a minor inconvenience from normal procedure.

The sampler was placed on top of a short platform at the front of the right (as seen from inside the sphere) basket for ease of access by the left arm. It was held in place with thin breakaway copper wire.

Results

Dive-5 (Franklin Seamount)

Vent fluid with sufficiently robust flow (at least several cm/sec) was not found so a bottom water sample was taken instead while the sampler was still in the basket. The triggering mechanism worked well. The left bottle did not take a full sample, possibly because the side of the basket impeded the motion of the sample piston.

Analyses of the water showed it to be normal bottom water with a normal pH of 7.6.

Dive-6 (East Basin)

Again, vent water was not found and an attempt to take a bottom water sample was unsuccessful because of a failure of the hydraulics.

Dive-7 (Franklin Seamount)

Vent fluid was sampled in one of the conical depressions in the caldera. Considerable difficulty was encountered in triggering the bottles. The hydraulic trigger worked normally but the sampler had been dropped into soft Fe-oxide ("Beaujolais") and needed to be shaken, pounded and poked with the other hand to get it to work at all. The right bottle took 420 ml (capacity 750 ml) and the left took nothing. Upon examination on surface, both inlet tubes were thoroughly clogged with Beaujolais material which must have inhibited/prevented the flow of vent water.

Preliminary analytical results were as follows (Gordeev):

Parameter	Value	Note
Volume:	about 420 ml	Not measured accurately. The drawn fluid contained considerable red suspended material.
pH (20°C):	6.25	Measured minutes after the sample was drawn. The pH started at 6.1 and slowly drifted upward over a period of minutes to stabilize at 6.3, suggesting that CO2 was being exsolved.
Alkalinity	3.24	relatively high vs background of 2.7
Salinity	≈ seawater	
Mg	slightly < seawater	
Mg/Cl	≈ seawater	
PO_4, NO_3, NO_2	much < seawater	2-3x below background
NH_3	1 μg/l	very high
Si	330 μg/l	3x seawater
Mn	1200 μg/l	vs seawater background 40-50 μg/l
Fe	300 μg/l	
Fe/Mn	0.25	about the same as for Guaymas Basin but much lower than for sediment starved ridge crests such as 21°N EPR, 11°N EPR.
H_2S	0	nil

PETROLOGY

Volcanic Rocks

Samples of volcanic rocks were returned by all submersible dives and two sediment grabs. Chips of mafic volcanic glass were also recovered in several corer operations. Larger specimens were measured and described in Russian in the lithology laboratory (Zonenshein) and were tested for magnetic susceptibility before being broken by sledge hammer on deck (some cut by diamond saw) and subdivided into several research and reference collections. They were not systematically photographed.

Brief notes on the original specimens were entered in a PACLARK sample log (Binns) and PACLARK subsamples were assigned CSIRO museum numbers commencing with 106701. Tiny chips were also taken of any rind glass on samples that were too small to subdivide from corer washings. The only significant sample missed was the small chip of black basaltic glass recovered by corer S-39 (2194) from the central Woodlark Basin 25 miles east of Franklin.

Basaltic samples from Franklin Seamount (Dives 1, 2, 5 and 7; corer S-44) included a range of pillow fragments and crusts from sheet flows or tube flows (some with drainback features). Their glass rinds (5-10 mm thick) were essentially non-vesicular and most contained visible plagioclase microphenocrysts. Interiors are aphanitic, dull grey to black, and more vesicular. These samples closely resemble those collected previously from Franklin Seamount during PACLARK cruises.

In addition, several submersible samples (Dives 1 and 5) were collected from scarp exposures at first thought to be possible dykes, but subsequently considered to be the interiors of massive flows. These contained numerous small miarolitic cavities or irregularly-shaped vesicles and had higher magnetic susceptibility than the glassy samples. A thin section of one prepared on board showed a crystalline "dolerite" microfabric.

Two pieces of pumiceous rhyolite (with mottled Mn-Fe crusts) were collected by Dive 6 (location 2-1) from a talus bank on the northern flank of Franklin Seamount. These resemble fragments dredged nearby by PACLARK D-4 and D-37, and the submersible observations indicate they are local outcrops rather than exotica as formerly presumed.

Basaltic samples from East Basin (Dive 6; grabs S-15 and S-17; chips in S-18, S-19 and S-20) also included pillow fragments and drained crusts from sheet flows or tube flows with prominent non-vesicular glass rinds. Most resemble the Fe-Ti basalts, lacking phenocrysts, from PACLARK dredge D-35 but one small chip washed from corer S-20 (2165) contains mm-size plagioclase phenocrysts (compare PACLARK D-3A).

The small black basaltic glass chip, aphanitic and non-vesicular, recovered at 3047 m depth from 10°04.9'S 152°23.9'E by corer S-39 (2194) confirms the existence of young volcanic rocks near the inferred spreading axis well east of Franklin Seamount.

Dives 3 and 4 recovered a number of splendid large specimens from pillow and tube flow outcrops on the volcanic ridge west and east of Dobu Seamount, as well as vesicular andesitic talus and scoria similar to material recovered on PACLARK cruises. Although the outcrop samples were not characterised by refractive index measurements on board, the highly vesicular nature (several generations?) and bronzy colour of their cm-thick glass rinds are comparable with previous collections of K-Mg rich basaltic andesites to andesites from the Dobu sector. One pillow sector from location 19, Dive 3, contains a unique 3x5 cm xenolith of cherty white to glassy grey material.

Dark vesicular basalt or andesite samples recovered from Location 3, Dive 4, on East Dobu Ridge (with relatively high magnetic susceptibility) and from Locations 6 and 15, Dive 3, on West Dobu Ridge lack glassy rinds and warrant further examination as a possible older volcanic sequence or basement (c.f. PACLARK D-19).

Pumiceous rhyolite samples collected from West Dobu Ridge by Dive 3 resemble those in previous PACLARK dredge hauls. Some contain visible feldspar phenocrysts.

Hydrothermal Deposits

Beaujolais and Chablis samples returned from Franklin Seamount by Dives 1, 2, 5 and 7 were described in Russian by Bogdanov and briefer notes were entered in the PACLARK log (Binns). Larger samples were extensively photographed by PACLARKers before being broken by hand or cut by diamond saw (Chablis) or hacksaw (Beaujolais) for subdivision. Fragmentary samples from grabs, bags or submersible corer were randomly subdivided. Small fragments of uncertain location left in the submersible baskets after dives were either discarded or kept as souvenirs or material for general distribution.

The internal portions of Beaujolais samples range from pale yellow to deep red-brown in colour and vary from exceedingly soft to friable but moderately lithified. No sample possessed a central chimney-like orifice but some contained irregular mm-scale internal cavities lined by soft brown deposit or flinty siliceous layers. The external surfaces of most larger and many smaller samples were coated with mm-thick crusts of sooty to pistular black Mn-oxide. Occasional internal black patches or 'veins' of similar black material in some specimens may represent overgrown crusts. Bright greenish nontronite (which became nondescript yellowish buff on drying) occurred as coatings and possible veinlets in two large manipulator samples and on many of the deeper push-core samples.

A large Beaujolais sample from inactive Location 1, Dive 5 (an older site, where the basal mounds were moderately sedimented by ooze) contained several hollow worm casings about 20 mm long and 3-4 mm in diameter, with brown mineralised walls about 0.5 mm thick. Similar worm casings collected by grab from a small spire on ooze at Location 3, Dive 7, had broken into numerous fragments.

Both the Chablis chimney top from Location 4, Dive 5, and the small chimney from Location 1, Dive 7, possess an irregular central orifice 3-5 cm across, extending full length, and lined by 1-3 mm

euhedral crystals of pale green to white barite. The chimney walls are comprised of concentrically-laminated finer pale grey material, including felted acicular barite and some chalcedonic silica lining small irregular cavities. The larger sample from Location 1, Dive 7, (the collapsed main chimney) lacks a central orifice (this was presumably on the portion not collected). A paper thin black Mn oxide crust partly coating the outer surface of all 3 samples is very friable and easily abraded.

Black pistular or sooty Mn oxide crusts 1-3 mm thick occurred on surfaces (rinds and side fractures) of many basalt samples from Franklin Seamount and East Basin. These were scraped off several specimens and retained for later analysis.

RECOMMENDATIONS FOR FUTURE WORK

1. Investigate the T-Mn anomaly south of the east-west ridge southeast of Franklin Seamount. The CTD survey (H-29; Station 2201) started in the highest part of the anomaly and then proceeded northwards where the anomaly diminished. The source of the anomaly may therefore be south of 9°58.5'S 151°52.9'E.

2. Investigate further the T-Mn anomaly in East Basin. Dive-6 did not find the source of the anomaly and it was concluded that the source was buried by talus.

3. Determine the nature of the crust outside of the neovolcanic zone in the eastern sector. Magnetics suggest that it could be continental crust intruded by dikes.

4. Magnetic survey at the transition from true oceanic crust to continental crust from 151°30'E to 152°E.

5. Heat flow survey of all sediment basins incuding Goodenough Bay.

6. Determine the nature of the walls of South Valley.

7. Dredge the east-west ridge southeast of Franklin Seamount.

8. Extend the investigation of the neovolcanic zone further east to find the depleted end-member MORB.

9. Do detailed camera/video deep-tows of East Basin to map the gjars seen on Dive-6 and possibly find the source of the T-Mn anomaly. The use of video would require a pressure housing capable of withstanding 3300 m vs 2000 m for the current housing.

10. Gravity survey of Western Woodlark Basin including Goodenough Bay.

11. Map the bathymetry (and hand dredge?) Dei-dei crater with a small boat, portable echo sounder and GPS navigation.

12. Dredge the small high between Franklin Seamount and East Basin (see ES-27).

13. Sidescan sonar survey. Can Brian Taylor do this in 1991?

14. Multichannel seismic survey (to be done by John Mutter with PACLARK help in 1991).

15. Land geology of Dobu Island.

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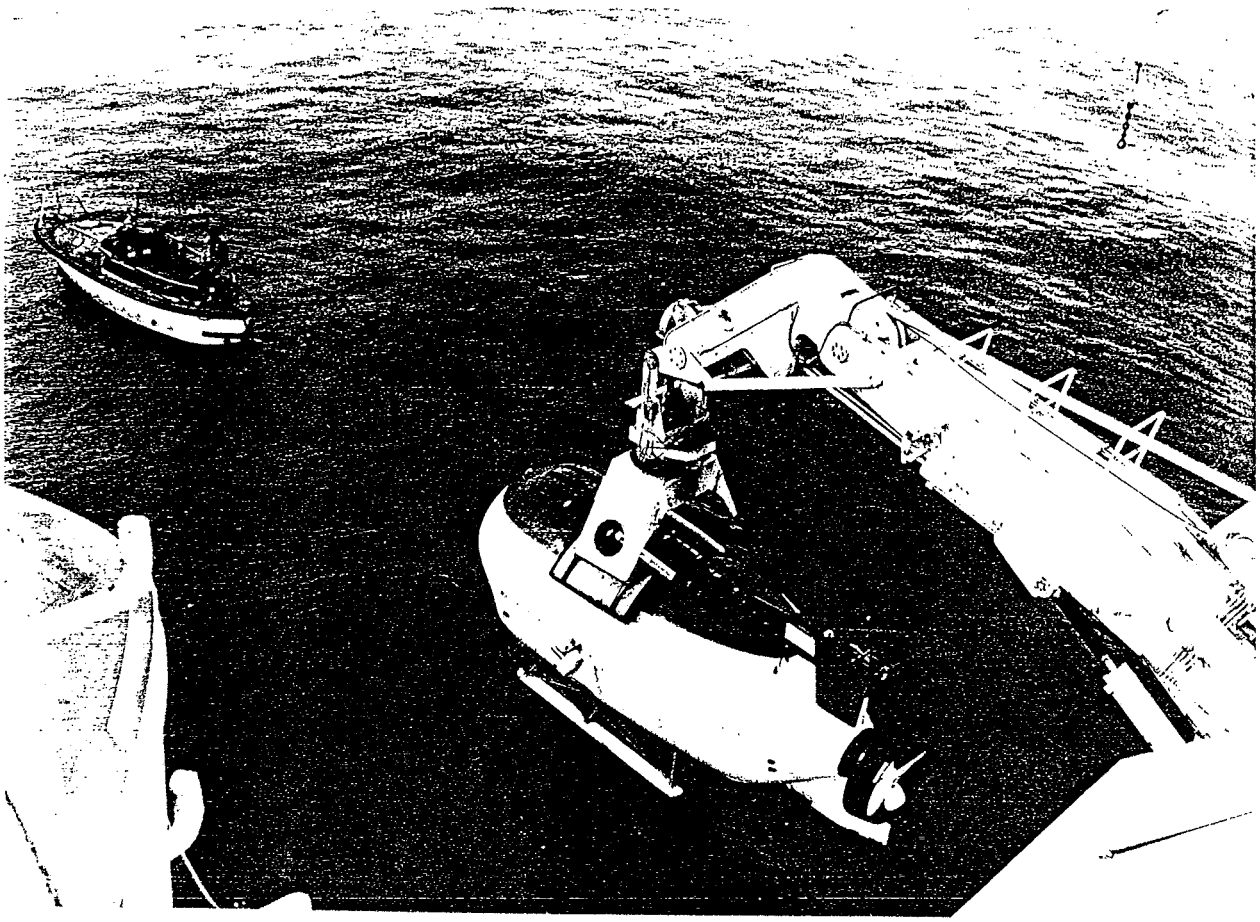


APPENDIX

LIST OF SUPACLARK STATIONS

WOODLARK BASIN, PNG

APRIL 1990

The following list cites ship's position (degrees and decimal minutes) during operations, taken from the cruise log maintained by PACLARK participants or from the computer file of GPS locations.

Abbreviations for navigation

SF	Transit satellite fix
SD	Transit + dead-reckoning (Magnavox)
GPS	Global Positioning Satellite system
LR	Radar on land points
?	Log does not specify

Abbreviations for operations

ESM	Echo-sounding and magnetometer
H	CTD-hydrocast
S	Sediment grab or gravity core
Xpdr	Transponder deployment or survey

PACLARK numbers follow on from PACLARK I-III operations

Compiled July-August 1990
R.A. Binns

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG p
2152?	ESM-27	11	0211	9°30.0	151°50.5		SD	Cheshire Smt to	Start	11
			0314	40.25	50.06		GPS	Franklin Smt	Brief GPS	
			0340	44.88	50.22		GPS		Next GPS	
			0345	45.74	50.28		GPS			
			0400	48.42	50.47		GPS			
			0415	51.07	50.61		GPS			
			0430	53.69	50.79		GPS			
			0445	56.42	50.69		GPS			
			0450	57.29	50.72	2683	GPS		End	14
?	ESM-28	11	0502	9°57.11	151°49.87	2712	GPS	Franklin Smt to	Start	14
			0515	54.97	50.09		GPS	Cheshire Smt		
			0530	52.41	50.00		GPS			
			0545	49.78	49.84		GPS			
			0600	47.17	49.82		GPS			
			0615	44.59	49.86	2580	GPS			
			0620	43.79	49.75		GPS		End	15
?	ESM-29	11	0643	9°44.21	151°45.68		GPS	East Basin to	Start	15
			0645	44.50	45.66		GPS	Southeast Basin		
			0659	46.91	45.75		GPS		Last GPS	
			0750	55.0	45.5		?		End, intended WP	16
?	ESM-30	11	0800	9°54.8	151°43.2		SD	Southeast Basin	Start	16
			0905	44.0	43.0		?	to East Basin	End, intended WP	17
?	ESM-31	11	0921	9°44.3	151°41.7		SD	East Basin to	Start	17
			1005	52.0	41.7		?	Southeast Basin	End, intended WP	18
?	ESM-32	11	1015	9°52.0	151°41.0		?	East Basin	Start, intended WP	18
			1100	44.0	41.0		?		End, intended WP	18
?	ESM-33	11	1115	9°44.1	151°39.8	3100	SD	Middle Basin	Start	19
			1120	44.90	40.05		GPS		First GPS	
			1130	46.64	40.25		GPS			
			1145	49.23	40.50		GPS			
			1156	51.19	40.47		GPS		End	19

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2153?	H-21	11	1338	9°54.85	151°48.34		GPS	Franklin Smt	Start	20
			1402	54.77	47.84		GPS			
			1430	54.64	47.24		GPS			
			1500	54.47	46.78		GPS			
			1530	54.22	46.65		GPS			
			1550	54.10	46.54		GPS		End	23
2154?	Xpdr	11-12						Franklin Smt	Transponder deployment	
2155	H-22	13	0034	9°52.4	151°40.9		SD	Ridge S of East	Start	33
			0102	52.88	40.36		SF	Basin	Fix	
			0151	51.9	40.6		SD		End	34
2156	H-23	13	0400	9°48.13	151°41.95		GPS	East Basin	Start	37
			0430	48.05	41.52		GPS			
			0500	47.84	41.19		GPS			
			0525	47.79	40.93		GPS		GPS gap	
			0600	47.67	40.37		GPS			
			0630	47.52	39.90		GPS			
			0700	47.43	39.45		GPS			
			0730	47.37	38.62		GPS			
			0750	47.40	38.04		GPS		End	39
2157	DIVE 1	13	1030	9°55.73	151°48.35		GPS	Franklin Smt	MIR-2 deployed	40
		14	0155	53.6	49.5		SD		Recovered	48
2158	S-15	14	0338	9°48.26	151°42.33	3200	GPS	East Basin	Deployed grab	48
			0500	48.38	41.04	3223	GPS		On bottom	49
2159	S-16	14	0359	9°48.30	151°41.90	3248	GPS	East Basin	Deployed box corer	49
			~0450	48.35	41.70	3237	GPS		On bottom	49
2160	S-17	14	0700	9°46.61	151°41.89		GPS	East Basin	Deployed grab	50
			0808	46.86	40.05	3250	GPS		On bottom	51
2161	S-18	14	0715	9°46.63	151°41.55			East Basin	Deployed tube corer	50
			0803	46.84	40.28	3251	GPS		On bottom	51
2162?	Transit?	14							No record of station	

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2163	H-24	14	1145	9°53.07	151°46.24		GPS	Ridge NW of	Start	52
			1200	53.19	45.91		GPS	Franklin Smt		
			1230	52.80	45.67		GPS			
			1300	52.25	45.66		GPS			
			1330	51.72	45.64		GPS			
			1400	51.60	45.24		GPS			
			1430	51.70	44.57		GPS		End	53
2164	S-19	14	?	9°49.04	151°40.94	3224	?	East Basin	Deployed? Lab. card	-
			2050	49.04	41.36	?	GPS		Grab on bottom	61
2165	S-20	14	?	9°49.01	151°41.64	3227	?	East Basin	Deployed? Lab. card	-
			2039	48.99	41.51		GPS		Corer on bottom	60
2166	S-21	14	?2355	?	?		?	South Middle Basin	Grab deployed?	-
		15	0033	?	?	3029	?		On bottom	63
			0037	9°59.16	151°35.07		SF		Fix after	
2167	S-22	14	?2355	?	?			South Middle Basin	Corer deployed?	
		15	0033	?	?	3028			On bottom	63
			0037	9°59.16	151°35.07		SF		Fix after	
2168	S-23	15	0416	9°57.26	151°43.97	3150	GPS	Southeast Basin	Corer deployed	64
			0455	57.07	43.51	3145	GPS		On bottom	64
2169?	Xpdr	15						Franklin Smt	Transponder calibration	
2170	DIVE 2	15	1030	9°56.34	151°52.27		GPS	Franklin Smt	MIR-1 deployed	67
		16	0130	54.9	48.8		SD		Recovered	72
			0150	54.72	49.10		SF		Fix	
2171?	Xpdr	16						Dobu Smt	Transponder deployment	

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2172	H-25	16	2025	9°44.72	151°02.96		GPS	Dobu Smt	Last prior GPS	
			2100	-	-		LR		Start	80
		17	0024	45.84	02.50		SF		Fix	
			0142	48.6	02.7	1196	SD	(Dubious)	CTD surfaced	81
			0211	49.6	02.7	1190	SD	(Dubious)	New start	
			0300	47.75	01.13		GPS		First GPS	
			0330	48.03	01.17		GPS			
			0400	48.33	00.86		GPS			
			0422	48.52	00.82		GPS			
			0441	48.90	00.61		GPS		End	82
2173	S-24	17	0450	9°49.00	151°00.60		GPS	South Valley	Grab deployed	82
			0527	49.93	00.79	1238	GPS		On bottom	82
2174	S-25	17	0505	9°49.55	151°00.67		GPS	South Valley	Corer deployed	83
			0522	49.87	00.75	1248	GPS		On bottom	83
2175	S-26	17	0640	9°48.00	151°01.40		GPS	South Valley	Grab deployed but held	83
			0804	48.86	01.33	1354	GPS		On bottom	84
2176	S-27	17	0750	9°48.79	151°01.35		GPS	South Valley	Corer deployed	84
			0811	48.90	01.34	1356	GPS		On bottom	84
2177	DIVE 3	17	0945	9°46.97	150°58.81		GPS	West Dobu Ridge,	MIR-2 deployed	85
			2310	-	-		(SD)	Dpbu Smt	Recovered	92
2178	S-28	18	0525	9°45.41	151°55.53	2767	GPS	Basin E of Cheshire Smt	Grab deployed	93
			0610	45.17	54.63	2719	GPS		On bottom	94
2179	S-29	18	0555	9°45.13	151°55.11	2726	GPS	Basin E of Cheshire Smt	Corer deployed	94
			0630	44.88	54.75	2678	GPS		On bottom	94
2180	Sediment traps	18	1230	9°54.40	151°53.52	2602	GPS	Basin E of Cheshire Smt	Initial trap deployment	96
			1534	53.49	52.32	2642	GPS		Release float	96
2181	S-30	18	~1900	9°58.67	152°08.46	2748	GPS?	Central Woodlark	Laboratory record-Grab	105
			1933	58.72	09.04		GPS		Logged during haul	105

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2182	S-31	18	~1900	9°58.67	152°09.12	2744	GPS?	Central Woodlark	Lab record-corer	105
			1933	58.72	09.04		GPS		Logged during haul	105
2183	H-26	19	0021	9°50.2	151°41.7	3065	SD	East Basin	Start	106
			0126	48.95	40.72		SF		Fix - dubious	
			0150	48.42	39.23		SF		Fix - dubious	
			0238	47.84	41.50		GPS		First GPS	107
			0300	47.36	41.45		GPS			
			0330	46.65	41.16	3240	GPS			
			0400	46.13	41.35		GPS			
			0430	45.68	41.18		GPS			
			0443	45.59	40.92		GPS		End	108
2184	S-32	19	0923	9°48.43	150°57.91	1048	GPS	South Valley	Grab deployed	109
			0937	48.43	57.75	1043	GPS		On bottom	109
2185	S-33	19	0933	9°48.43	150°57.79	1043	GPS	South Valley	Corer deployed	109
			0945	48.44	57.67	1037	GPS		On bottom	109
2186	DIVE 4	19	1105	9°47.59	151°03.15		GPS	East Dobu Ridge and	MIR-1 deployed	110
		20	0030	-	-		(SD)	Dobu Smt	Recovered	116
2187	S-34	20	0244	9°41.0	151°10.9	2214	SD	North Valley	Grab deployed	117
			0250	40.88	10.99		GPS		First GPS	
			0333	40.67	10.67	2213	GPS		On bottom	117
2188	S-35	20	0300	9°40.79	151°10.96	2213	GPS	North Valley	Corer deployed	117
			0335	40.67	10.67	2213	GPS		On bottom	118
2189	S-36	20	0630	9°44.05	151°28.09	2675	GPS	Cook Valley	Grab deployed	118
			0712	43.85	27.71	2591	GPS		On bottom	119
2190	S-37	20	0650	9°43.95	151°27.94	2607	GPS	Cook Valley	Corer deployed	119
			0718	43.83	26.75	2596	GPS		On bottom	119

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2191	H-27	20	1030	9°48.10	151°41.69	3252	GPS	East Basin	Start	120
			1100	47.93	41.33	3185	GPS			
			1130	47.83	41.02	3247	GPS			
			1200	47.65	40.54	3244	GPS			
			1230	47.56	40.20	3222	GPS			
			1300	47.44	39.85	3244	GPS			
			1330	47.10	39.48	3240	GPS			
			1400	46.96	39.07	3273	GPS			
			1430	46.79	38.64	3190	GPS			
			~1445	46.73	38.47		GPS		End	121
-	ESM-34	20	1617	9°53.80	151°49.96		GPS?	Franklin Smt to south	Start (no GPS file)	121
			1850	10°20.04	50.00		SD?		End	128
-	ESM-35	20	1923	10°20.0	151°49.2		SD?	Franklin Smt area	Start	128
			2150	9°54.5	48.7		SD?	and south	End	128
-	ESM-36	21	0025	9°37.0	152°05.0		SD?	Central Woodlark	Start, intended WP	128
			0041	39.44	05.29		SF		Fix	
			0204	53.19	03.95		SF		Fix	
			0223	56.25	04.24	2630	GPS		First GPS	
			0230	57.36	04.55		GPS			
			0245	59.69	04.99		GPS			
			0300	10°02.24	05.01		GPS			
			0315	04.43	05.00		GPS			
			0330	06.95	04.95		GPS			
			0345	09.49	05.01		GPS			
			0400	12.13	04.99		GPS			
			0415	14.73	05.06		GPS			
			0430	17.29	05.02	1980	GPS			
			0446	20.03	05.05	1379	GPS		End	129

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
-	ESM-37	21	0454	10°20.11	152°04.07		GPS	Central Woodlark	Start	129
			0500	19.15	04.00	1602	GPS			
			0515	16.44	04.11		GPS			
			0530	13.95	04.09	1737	GPS			
			0545	11.41	04.04		GPS			
			0600	08.86	04.02	2035	GPS			
			0615	06.29	04.04		GPS			
			0630	03.63	04.05	2558	GPS			
			0645	01.08	03.95		GPS			
			0700	9°58.48	03.94	2679	GPS			
			0715	55.88	03.93		GPS			
			0720	54.99	03.94	2457	GPS		End	130
2192	DIVE 5	21	1025	9°53.93	151°48.54	2456	GPS	Franklin Smt	MIR-2 deployed	132
		22	0256	54.13	48.96	2359	GPS		Recovered	136
2193	S-38	22	0710	10°05.22	152°24.10	3050	GPS	Central Woodlark	Grab deployed	137
			0800	04.80	23.90	3061	GPS		On bottom	137
2194	S-39	22	0725	10°05.03	152°24.06	3030	GPS	Central Woodlark	Corer deployed	137
			0807	04.81	23.70	3047	GPS		On bottom	137
-	X pdr	22						East Basin	Deploy & survey transponders	
2195	S-40	23	0246	10°06.56	152°36.04		GPS	Central Woodlark	Grab deployed	146
			0340	06.59	36.42	3254	GPS		On bottom	147
2196	S-41	23	0255	10°06.60	152°36.12		GPS	Central Woodlark	Corer deployed	146
			0345	06.56	36.48	3273	GPS		On bottom	147
2197	DIVE 6	23	1112	9°47.5	151°41.2		GPS	East Basin	MIR-1 deployed	148
		24	0235	45.78	41.39		GPS		Recovered	150
2198	S-42	24	1000	9°58.91	151°55.01	2847	GPS	Graben SE of	Corer deployed	152
			1103?	58.01	55.38	2795	GPS	Franklin Smt	On bottom	152

STATION	PACLARK	April	TIME UT+11	LAT S	LONG E	DEPTH m	NAV	LOCATION	NOTES	LOG P
2199	S-43	24	1015	9°58.65	151°55.05	2967	GPS	Graben SE of	Corer deployed	152
			1052	58.18	55.21	2813	GPS	Franklin Smt	On bottom	152
2200	H-28	25	0020	9°58.9	151°54.1		SD	SE of Franklin Smt	Start (after test)	162
			0058	58.42	54.07		SF		Fix	
			0151	57.46	54.89		SF		Fix	
			0207	57.42	54.81		GPS		First GPS	
			0230	57.03	55.05	2546	GPS			
			0300	56.46	55.41	~2600	GPS			
			0330	55.78	55.36	2506	GPS			
			0358	55.12	55.26	2503	GPS		End	163
2201	H-29	25	0514	9°59.06	151°52.97	2700	GPS	SE of Franklin Smt	Start	164
			0530	58.80	53.07		GPS			
			0600	58.37	52.95		GPS			
			0630	57.93	52.85		GPS			
			0700	57.44	52.79		GPS			
			0730	56.92	52.64		GPS			
			0801	56.37	52.52		GPS		End	164
2202	DIVE 7	25	1022	9°53.58	151°50.06		GPS	Franklin Smt	MIR-2 deployed	165
		26	0134	-	-				Recovered	
			0210	52.86	49.68	2848	GPS		First GPS after	171
2203	H-30	26	0343	9°58.25	151°52.86	2706	GPS	SE of Franklin Smt	Start	172
			0400	58.12	52.79		GPS			
			0430	57.97	52.69		GPS			
			0500	57.84	52.65		GPS			
			0530	57.81	52.72		GPS			
			0600	58.33	53.06		GPS			
			0630	58.29	53.10	2747	GPS			
			0700	58.44	53.04		GPS			
			0730	57.99	53.23		GPS		End	173
2204	S-44	26	~0950	9°53.91	151°48.98		GPS	Franklin Smt	Corer deployed	173
			1030	54.13	48.60	2407	GPS	(NW Knoll)	On bottom	174

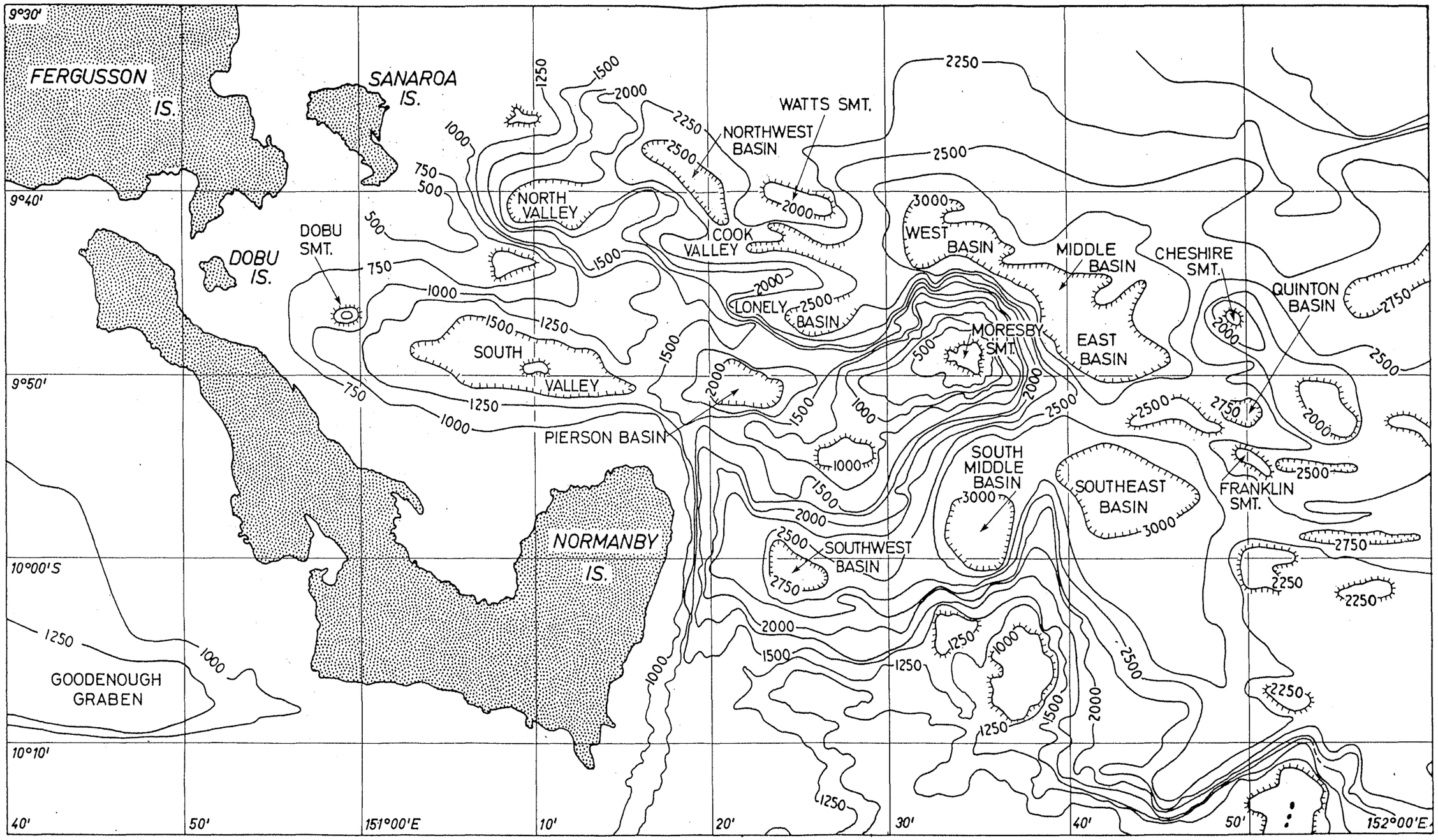
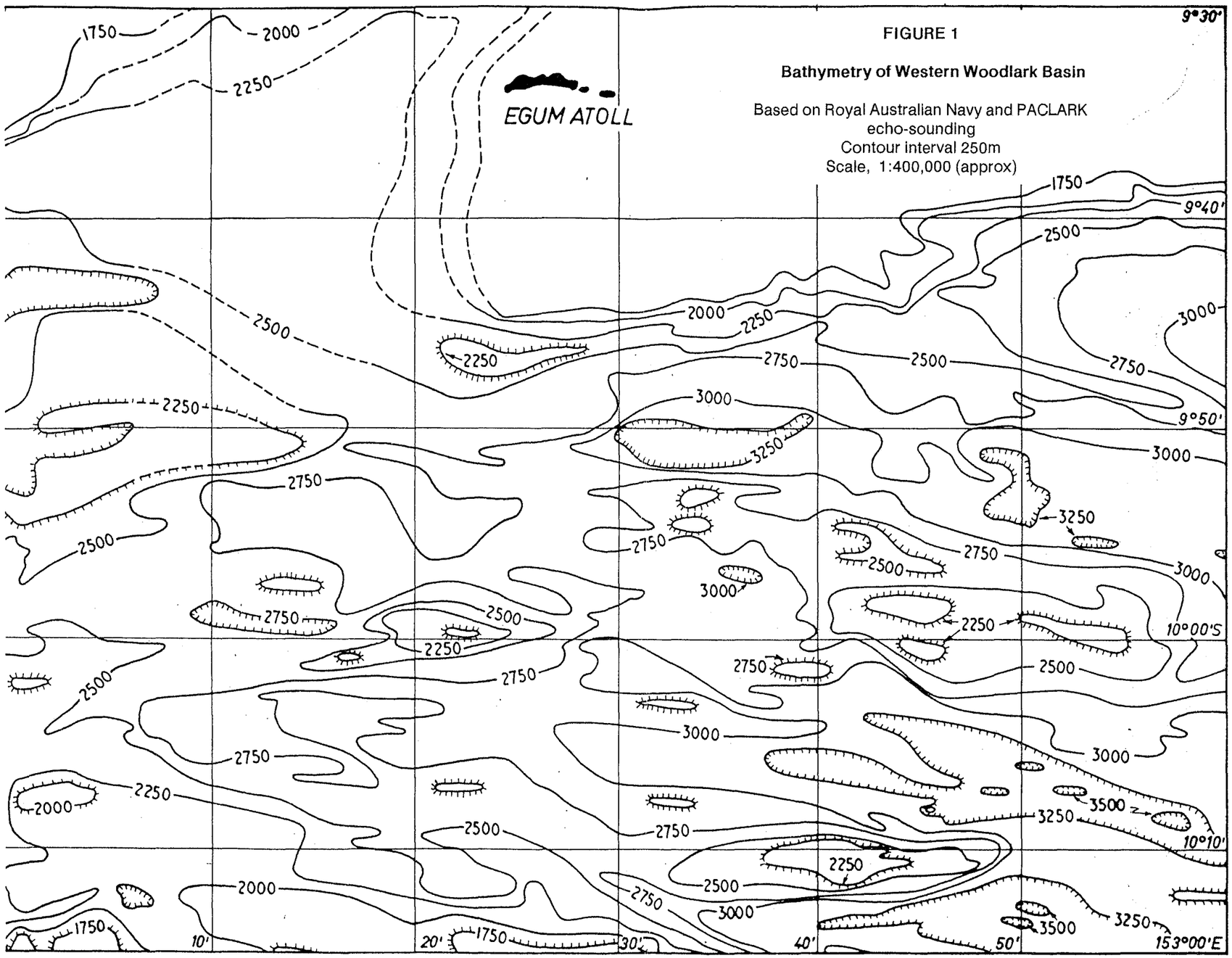

9°30'
9°40'
9°50'
10°00'S
10°10'
40'
50'
151°00'E
10'
20'
30'
40'
50'
152°00'E
FERGUSSON IS.
SANAROA IS.
DOBU IS.
DOBU SMT.
NORMANBY IS.
GOODENOUGH GRABEN
NORTH VALLEY
NORTHWEST BASIN
WATTS SMT.
COOK VALLEY
LONELY BASIN
SOUTH VALLEY
PIERSON BASIN
WEST BASIN
MIDDLE BASIN
CHESHIRE SMT.
QUINTON BASIN
MORESBY SMT.
EAST BASIN
SOUTH MIDDLE BASIN
SOUTHWEST BASIN
SOUTHEAST BASIN
FRANKLIN SMT.
500
750
1000
1250
1500
2000
2250
2500
2750
3000

FIGURE 1

Bathymetry of Western Woodlark Basin

Based on Royal Australian Navy and PACLARK
echo-sounding
Contour interval 250m
Scale, 1:400,000 (approx)



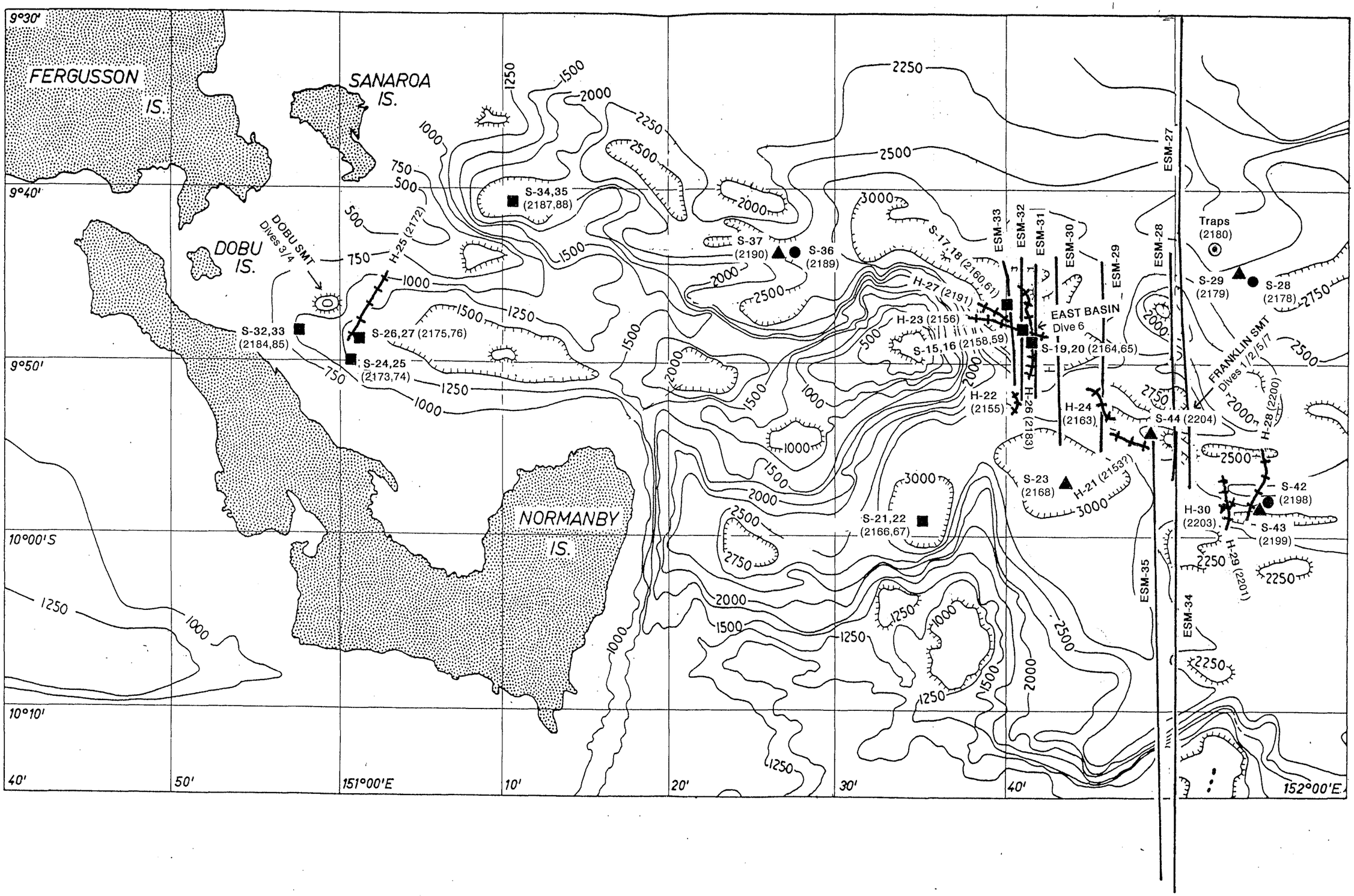

9°30'
9°40'
9°50'
10°00'S
10°10'
40'
50'
151°00'E
10'
20'
30'
40'
152°00'E
FERGUSSON IS.
SANAROA IS.
DOBU IS.
NORMANBY IS.
DOBU SMT Dives 3/4
S-34,35 (2187,88)
S-37 (2190)
S-36 (2189)
H-25 (2172)
S-32,33 (2184,85)
S-26,27 (2175,76)
S-24,25 (2173,74)
S-17,18 (2160,61)
H-27 (2191)
H-23 (2156)
S-15,16 (2158,59)
S-19,20 (2164,65)
EAST BASIN Dive 6
H-22 (2155)
H-24 (2163)
H-26 (2183)
S-44 (2204)
S-23 (2168)
H-21 (21532)
S-21,22 (2166,67)
Traps (2180)
S-29 (2179)
S-28 (2178)
FRANKLIN SMT Dives 1/2/5/7
H-28 (2200)
S-42 (2198)
H-30 (2203)
S-43 (2199)
H-29 (2201)
ESM-27
ESM-28
ESM-29
ESM-30
ESM-31
ESM-32
ESM-33
ESM-34
ESM-35

FIGURE 2

SUPACLARK Operations, Woodlark Basin

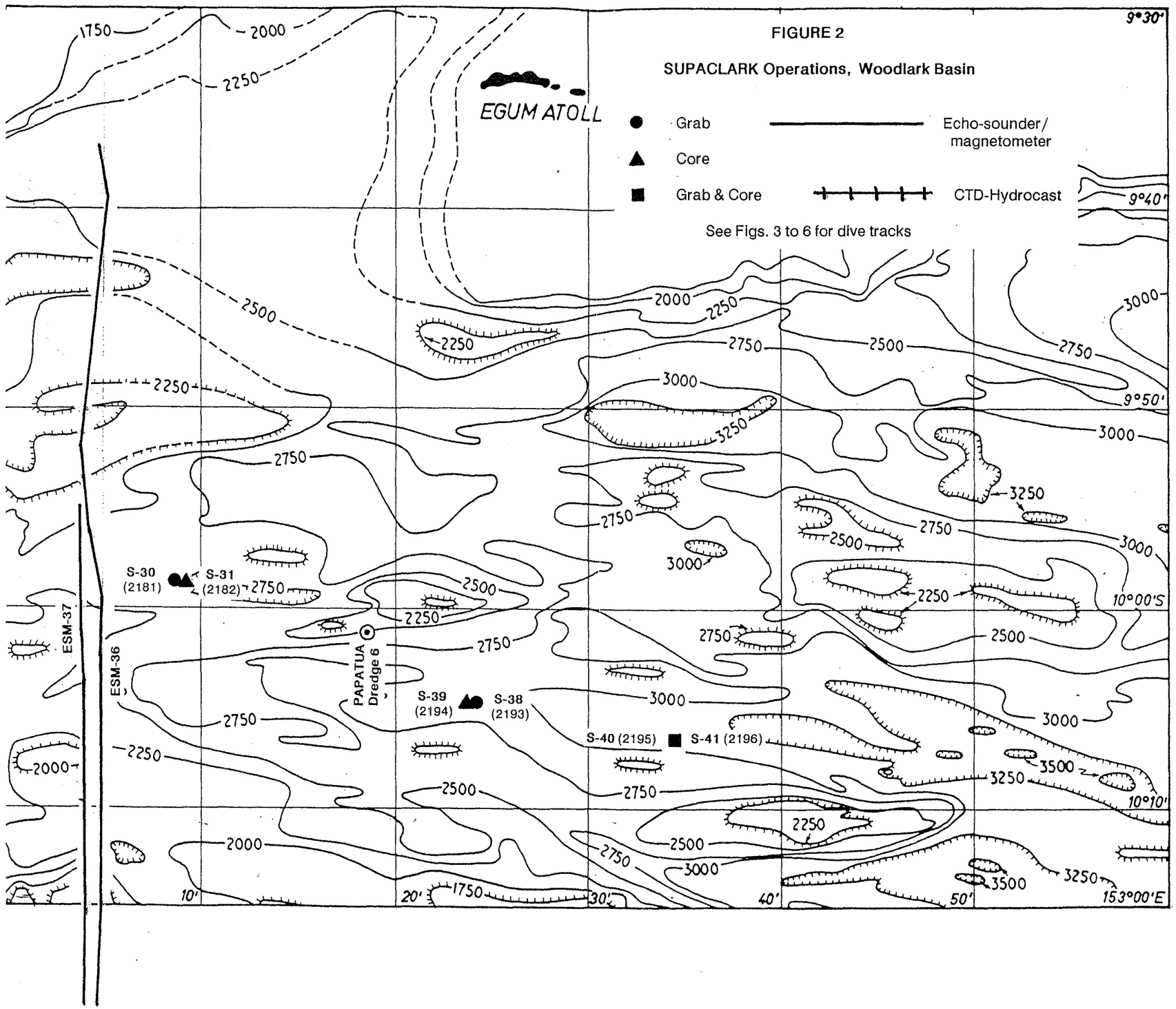


FIGURE 3

SUPACLARK Operations, Franklin Seamount Area

Grab
Core
CTD-hydrocast -GPS -Satnav
PACLARK III SeaBeam
Dive (approx. track)
Echo-sounder/ -GPS magnetometer -Satnav
Scale 1:50,000 approx.

9°53'
9°54'
9°55'
9°56'
9°57'
9°58'
9°59'
151°48'
151°49'
151°50'
151°51'
151°52'
151°54'
151°55'

ESM-28
ESM-27
ESM-35
ESM-34

DIVE 5 (2192)
DIVE 7 (2202)
DIVE 1 (2157)
DIVE 2 (2170)
S-44 (2204)
H-21 (2153?)
H-29 (2201)
H-28 (2200)
H-30 (2203)
S-42 (2198)
S-43 (2199)

FIGURE 4

SUPACLARK Operations, East Basin Area

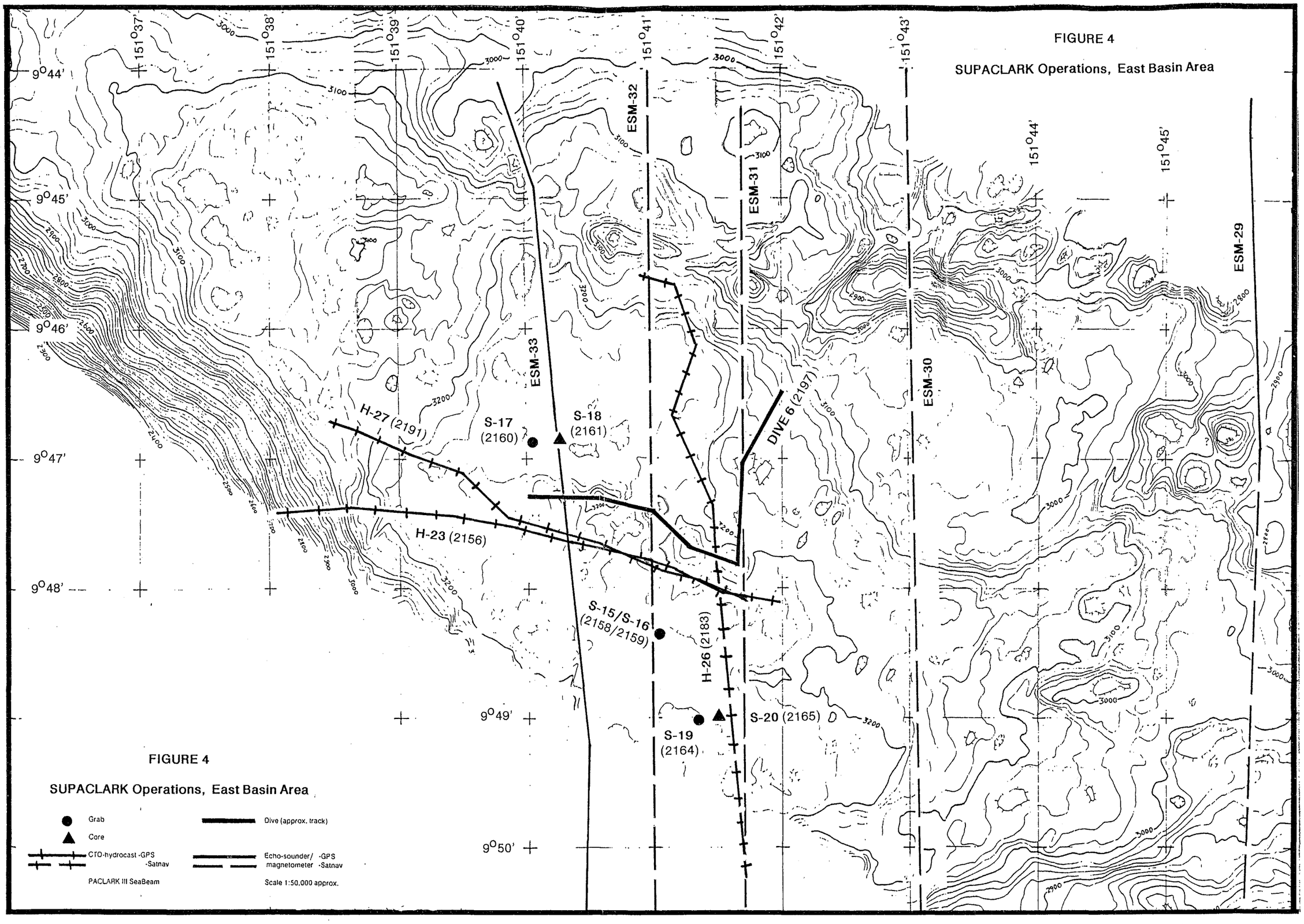


FIGURE 4

SUPACLARK Operations, East Basin Area

Grab

Core

CTD-hydrocast -GPS -Satnav

PACLARK III SeaBeam

Dive (approx. track)

Echo-sounder/ magnetometer -GPS -Satnav

Scale 1:50,000 approx.

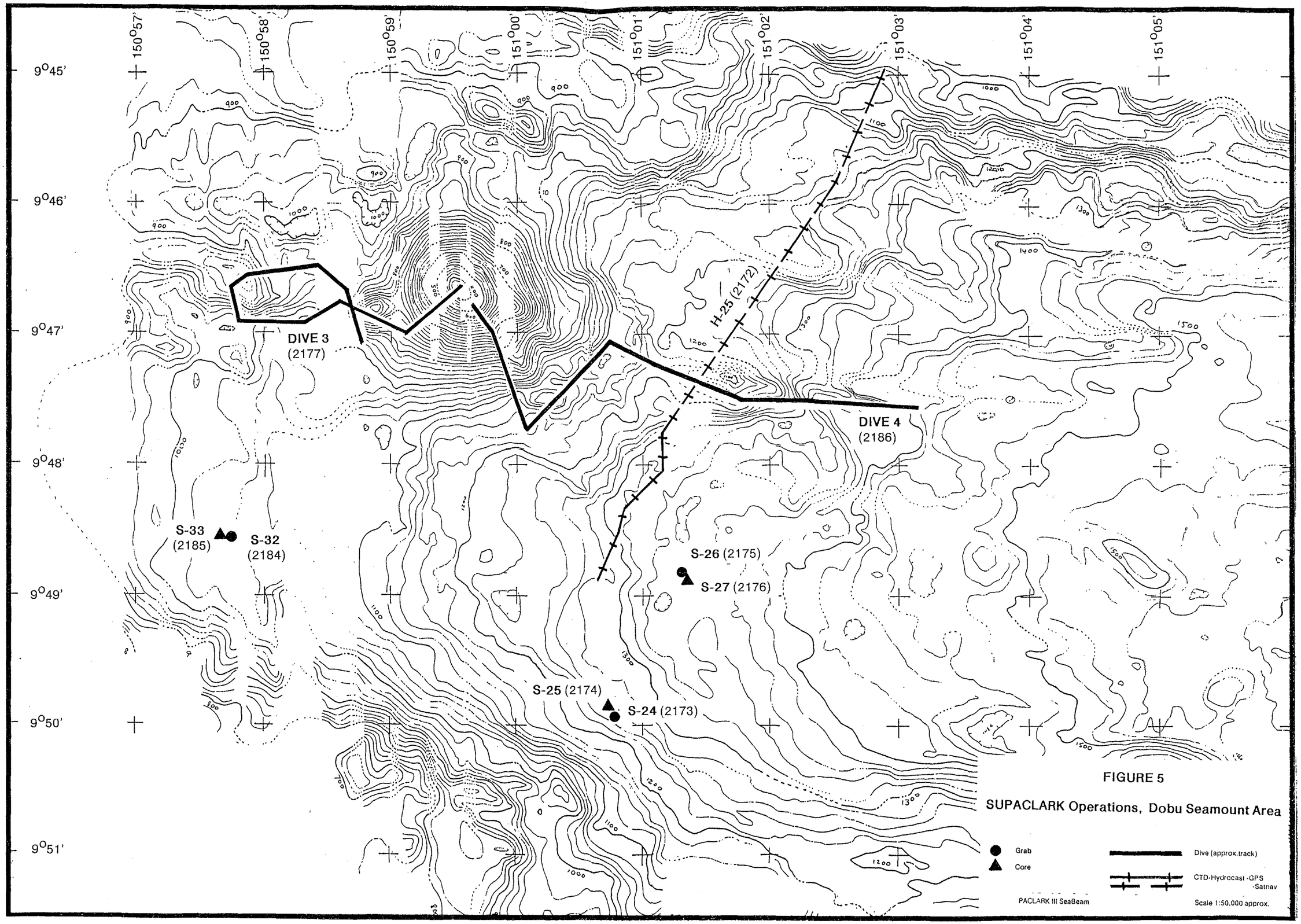


FIGURE 5

SUPACLARK Operations, Dobu Seamount Area

FIGURE 6

Franklin Seamount: SUPACLARK Dive Tracks

Dive 1 (2157) 13 April 1990

Dive 2 (2170) 15 April 1990

Dive 5 (2192) 21 April 1990

Dive 7 (2202) 25 April 1990

Tracks are approximate
PACLARK III SeaBeam, contour interval 20m

Scale, 1:20,000 (approx)