I.O.S.

R R S DISCOVERY
CRUISE 108

18 FEBRUARY - 3 MARCH 1980

GEOCHEMICAL SAMPLING ON THE NARES ABYSSAL PLAIN

CRUISE REPORT NO 98

1980

INSTITUTE OF OCEANOGRAPHIC SCIENCES

NATURAL ENVIRONMENT RESEARCH COUNCIL

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R. R. S. DISCOVERY

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Institute of Oceanographic Sciences,
Brook Road, Wormley, Godalming,
Surrey, GU8 5UB, England.

CONTENTS

ITINERARY

Depart Bridgetown, Barbados 1600 h 18 February 1980.

Arrive San Juan, Puerto Rico 0930 h 3 March 1980.

SCIENTIFIC PERSONNEL

J. D. Burton	Southampton University
M. S. L. Carpenter	I. O. S.
Miss H. Coyle	I. O. S.
F. Culkin	I. O. S. (Principal Scientist)
E. Darlington	I. O. S.
H. Elderfield	Leeds University
D. J. Hydes	I. O. S.
Mrs. H. A. Kennedy	Leeds University
R. Kidd	I. O. S.
D. Lewis	R. V. S.
M. J. McCartney	I. O. S.
R. J. Morris	I. O. S.
R. Pagett	Leeds University
R. Peters	I. O. S.
P. Ridout	I. O. S.
W. Simpson	I. O. S.
P. Statham	Southampton University
J. Thomson	I. O. S.
T. R. S. Wilson	I. O. S.

SHIP'S OFFICERS

P. H. P. Maw	Master
P. J. McDermott	Chief Officer
M. S. Putman	2nd Officer
P. J. Pepler	3rd Officer
D. Rowlands	Chief Engineer
T. A. Rees	2nd Engineer
D. E. Anderson	3rd Engineer
R. G. Whitton)	4th Engineers
A. P. Grattidge)	

R. Cotter	5th Engineer
F. P. Sharpe	Electrical Engineer
D. Taylor	Radio Officer
R. Overton	Purser/Catering Officer
G. A. Carss	Medical Officer

OBJECTIVES

1. Collection of bottom sediment samples by gravity- and box-coring for geochemical studies.

2. Collection of sediment pore water samples by in situ techniques and by squeezing sediment cores.

3. Collection of large volume water samples for analyses of nutrients, trace elements and dissolved organic carbon.

4. Collection of suspended particulate material from large-volume water samples for geochemical studies.

5. Recovery of moored particle trap deployed during Cruise 107.

6. Collection of surface and near-surface plankton for biochemical and trace element studies.

7. Collection of samples of sea surface films for geochemical and biochemical studies.

8. Implosion test of forged steel sphere.

NARRATIVE

The start of Cruise 108 was delayed by 5 days because of the late arrival in Bridgetown of the container ship carrying the Chemistry container laboratory and equipment and this made it necessary to alter the original sampling programme considerably. All equipment was on board by 1300 h on Monday 18th February and Discovery went to anchor outside Bridgetown harbour at 1600 h and finally sailed at 2145 h. The echo-sounder fish and 2 kHz profiler were launched and normal watches were started. During passage to the first station 8500 m of the main warp were tensioned.

At the first station (10163), which was reached at 1400 h/21st February, 2 successful hydrocasts were made to provide samples for trace element, nutrient, salinity and suspended particle determinations. After an initial failure, satisfactory core samples were obtained with the IOS box corer and the Kastenlot corer but the IOS in situ pore water sampler was found to be out of balance and failed to take a sample.

After completion of this station Discovery sailed to the northern edge of the abyssal plain to work on a ridge where ferromanganese nodules had been reported. The only ridge located was not very extensive, however, and so coring, pore water and water sampling were carried out in deeper water than had been intended (Station 10164).

Discovery then proceeded south again to the position where a moored particle trap had been deployed during Cruise 107. Although the trap was easily located and accepted the release command, it failed to surface. On this station (10165) 2 hydrographic casts were completed and cores were obtained with the IOS box corer and with the IOS gravity corer fitted with a square cross section barrel. The Kastenlot corer was also used to obtain a core which was preserved intact for work on physical properties. During this operation the wire tension at the lower end of the main warp was measured.

On passage to the next coring station Neuston and Oxfam nets were operated (10166 and 10168) and surface films were collected (10167). A watch was kept for a French ocean-bottom seismograph which had failed to surface during Cruise 107 but no signals were detected.

The final full station (10169) was worked further west. The water column was sampled more intensively with three hydro-casts and the Kastenlot, box and square gravity corers and the pore water sampler were all operated successfully.

With the main programme completed, a box core, free from the grey turbidite material which had been found at the other stations, and pore water samples were taken at a station (10170) 3 miles up the Puerto Rico Outer Ridge and the Neuston net was operated (10171).

Discovery then sailed for the Puerto Rico Trench where, after a brief survey, a station (10172) with a corrected depth of 8340 m was chosen for an implosion test on a forged steel sphere which had been requested by the Ocean Engineering Group. The sphere was lowered on the main warp to a wire depth of 8300 m without any indication of implosion and was recovered, apparently undamaged.

The ship then sailed for San Juan, Puerto Rico and docked at 0930 h/3rd March.

REPORTS OF PROJECTS

HIGH RESOLUTION SEISMIC PROFILING

The 2 kHz seismic profiling system proved troublesome at the beginning and end of the cruise, because of earthing problems and a suspected cable break. Over the areas of interest on the Nares Abyssal Plain, however, the system worked perfectly and records were obtained of laterally continuous stratified sediments with sub-bottom penetration ranging between 20 and 80 metres. The profiler records are the equal of any that have been taken in such areas by 3.5 kHz systems and their quality gives confidence that the purchase of a commercial system is unnecessary. Streaming and towing of the array

presented no operational problems on such a station-intensive cruise, although for surveying an area for detailed coring a towing speed of 6 knots would be recommended. On the other hand the electrical problems which were encountered show that the system now required to be developed into a more reliable form (of similar precision to the echo-sounder). This small section array would also benefit from the addition of a small portable winch.

E. Darlington
R. Kidd

HYDROGRAPHIC WORK

Hydrographic casts were made at the stations listed in Table 1, using various combinations of 1 and 7.5L NIO bottles and 30L Niskin bottles. The 1L bottles were fitted with reversing thermometers to provide in situ temperatures and thermometric depths. They were positioned 10 m above each large-volume bottle and at other depths for which values for routine hydrographic parameters were required. Samples from the 1L bottles were taken for the determination on board of salinity, dissolved oxygen, dissolved silicon and reactive phosphate. Dissolved silicon was measured using an Automatic Chemistry Unit (Pye-Unicam AC1) but difficulties were encountered in the use of this instrument for measurement of reactive phosphate which, accordingly, was measured manually. For three stations samples were also subjected to photo-oxidation by irradiation with a 1 kW mercury-arc lamp, and subsequently analysed for reactive phosphate to determine, by difference from the un-irradiated aliquots, the concentration of dissolved organic phosphorus.

Samples of suspended particulate material were obtained by pressure filtration of the bulk of the large volume water samples through 0.4μm Nuclepore membrane filters or glass fibre filters. These will be examined by scanning electron microscopy with simultaneous X-ray analysis to determine the association of minor and trace elements with specific mineral phases (Wormley) and analysed for Mn, Al, Ti, C, N and rare earths (Leeds).

The filtrates were used for the following investigations:-

1) Trace elements were co-precipitated with Pb or Co- APDC. The Pb precipates will be analysed by neutron activation directly and the Co precipitates by dissolution in organic solvent followed by plasma analysis (Wormley).

2) Aliquots were processed on board to separate and concentrate dissolved Fe and Mn

in a form suitable for storage for subsequent analysis at Southampton. The metals were complexed with a mixture of 1:1 ammonium pyrrolidine dithiocarbamate and diethyl-ammonium dithiocarbamate, the complexes extracted into 1,1,2-trichloro-1,2,2-trifluoro-ethane, and the metals back-extracted into concentrated nitric acid. The nitric solutions were diluted and stored in polypropylene containers. All operations were carried out in an atmosphere of filtered air using a laminar flow cabinet, in order to minimize contamination from air-borne particles.

3) On representative samples from one profile several alternative treatments were also employed to give information on the chemical forms of the metals. Aliquots were passed through columns of polymeric adsorbent (Amberlite XAD-2) and the adsorbed material eluted with a mixture of methanol and ammonium hydroxide, while further aliquots were analysed after photo-oxidation and after cycling through changes in pH. These approaches should provide information on the occurrence of colloidal and organically associated forms of the metals. Additional samples were frozen for return to Southampton for further analyses of trace metals and for further experiments on speciation.

4) Separate aliquots of water were filtered through pre-combusted glass fibre filters and stored for later analysis, at Southampton and Liverpool Universities, for dissolved organic carbon.

5) Water samples were stored for subsequent analysis, at the Institute of Hydrology, of dissolved iodine species.

6) Additional surface water samples were filtered for subsequent manganese and rare earth element analyses (Leeds).

J. D. Burton
F. Culkin
E. Darlington
M. J. McCartney
R. Pagett
W. R. Simpson
P. J. Statham

IMPLOSION TEST ON FORGED SPHERE

At the request of the Ocean Engineering Group an implosion test was carried out in the Puerto Rico Trench on a forged steel sphere. The test incorporated the use of a leak detector to telemeter the water level inside the sphere. The sphere was lowered to a wire depth of 8300 m without any implosion. Unfortunately the telemetry unit itself

sustained a minor leak which caused it to fail at 5400 m during the descent, though no serious damage was done to the electronics or the pressure sensor. The sphere was recovered undamaged and returned to Wormley for examination.

E. Darlington

MAIN WARP STRAIN MEASUREMENT

It was possible to attempt only one series of measurements using the main warp strain telemetry unit but the system appeared to work well. Two pulses relating to the strain were produced, one showing the instantaneous average and the other the peak strain. These provided some intriguing data which will have to be carefully analysed. However, it would appear that the experiment could be usefully repeated in the future.

E. Darlington

PARTICLE TRAP

The IOS free-fall particle trap was deployed at 23°43.6'N, 61°29.7'W on 28/1/80 during Discovery Cruise 107. It was located on 25/2/80 and acoustic interrogation revealed that the release unit was lying flat on the sea-bed. The release channel was opened with some difficulty because of the unfavourable aspect of the transducer's polar diagram, but when the ship had been manouvered into the optimum position the release indicated a successful firing. Since there was no indication of lift-off, however, it must be assumed that the buoyancy unit had failed or come adrift. It is not known when this failure occurred as it was not possible to monitor the mooring all the way to the bottom when it was laid.

E. Darlington
W. Simpson

PORE WATER STUDIES

A total of seven drops were made with the IOS Mk II pore water sampler, and eight cores were subsampled on deck and squeezed, at in situ temperatures in an oxygen-free atmosphere, with two different squeezing systems.

The in situ sampler performance was characterised by teething troubles. Although these could not be rectified completely with the facilities available a very considerable improvement was achieved. The first two drops, at stations 10163 and 10164, were totally unsuccessful. After mechanical and electrical improvements, a drop at 10165 failed only because the bottom detector threshold, a trial and error adjustment, had been set too high. A repeat drop, with the threshold adjusted, tripped correctly and sampled

for 18 minutes in 5800 m. On recovery it was found that only small samples had been taken. A leak in the manifold was located and rectified. Samples were returned successfully at the remaining two stations 10169 (2 drops) and 10170. These were, however, always smaller than expected, reaching a maximum of 45% of design maximum at the last lowering.

The fine sedimentary material of this region is not easily filtered, so that it is a very demanding area for the use of this technique. The superpenetration problem experienced using the IOS Mk I sampler in this type of material has been overcome. Residual operational problems remaining at the end of this cruise were a poor reliability of the sampling period control clock, apparently caused by voltage spikes from the valve control circuits, and a small but significant leak in the manifold which has not yet been traced.

The modified IOS shipboard squeezing unit, which uses hydraulic squeezers, proved very rewarding and gave good-sized samples with no major problems. To assist in understanding the technology of squeezing and sample preservation the University of Leeds squeezer system, incorporating Reeburgh-type squeezers of PVC/PTFE construction, was operated simultaneously on samples from the same cores. Samples from both systems were analysed on board for silicate, phosphate, and alkalinity. Aliquots were also fixed and stored for subsequent analysis for trace metals, nitrate and iodine.

E. Darlington
H. Elderfield
D. Hydes
H. Kennedy
R. Peters
P. Ridout
T. R. S. Wilson

SEDIMENT SAMPLING

Two corers were used for most of the sediment sampling programme, viz the 30 x 30 cm IOS box corer and a Kastenlot 15 x 15 cm square box gravity corer with a 2 m barrel. Both corers operated satisfactorily, although the softness of the brown and grey clay sediments encountered on the cruise resulted in greater penetration than is customary. The sediment/water interface was well preserved in all the box cores. Cores were also obtained at two stations with a modified IOS gravity corer, using a square cross section barrel fitted with removable panels to facilitate sub-sampling, but in these cores the interface was not well preserved because of the deep penetration.

All the box and gravity cores were sampled for pore water squeezing, the box cores via vertical sub-cores, and the Kastenlot cores via multiple sub-cores at right angles to the barrel. Sediment samples were taken from all core at selected depths for geochemical and physical investigations, at Wormley and Leeds, of the solid phase. Sediment samples and archive sub-cores from box cores were stored frozen as soon as possible. One complete (2 m) Kastenlot core was preserved intact at 4 °C for physical property studies. After the first station core descriptions, supported by smear slide microscope analyses, were started on all Kastenlot cores as soon as they were opened.

M. Carpenter
H. Coyle
R. Kidd
R. J. Morris
R. Peters
J. Thomson

SURFACE FILMS AND PLANKTON

Surface films were sampled at 2 stations and stored for lipid analysis. Plankton hauls were made at 4 stations using surface and sub-surface nets. Samples were washed free of salt and stored frozen for element analysis. Some samples were also preserved in buffered formalin for taxonomic work.

R. J. Morris
R. Pagett

10166								
	27/2	23°32.7'	61°29.3'	N.N(4)	0	0052-0325		
10167	27/2	22°59.0'	63°09.9'	S.F.S.	0	1932-2042	Surface film and water samples	
10168	28/2	23°11.9'	63°45.0	N.N.	0	0027-0121		
		23°12.8'	63°50.5'	O.X.F.				
10169	28/2							
# 1		23°44.9'	65°11.9'	B.G.C.	5760	1224-1619	129 cm core	5760
# 2		23°44.7'	65°12.1'	H.C.	1500-5000	1632-2048	Deep cast to 5000 m	5760
# 3		23°44.9'	65°13.0'	P.W.S.	5760	2100-0046	20% sample	5760
# 4	29/2	23°44.8'	65°13.0'	K.C.	5760	0055-0454	215 cm core	5760
# 5		23°43.6'	65°12.9'	H.C.	0-1250	0500-0723	Shallow cast to 1250 m	5760
# 6		23°41.8'	65°12.4'	B.C.	5760	1118-1625	No core	5760
# 7		23°42.4'	65°09.6'	P.W.S.	5755	1636-2050	38% sample	5755
# 8		23°42.1'	65°09.9'	H.C.	165-1800	2107-2257	Intermediate cast to 1800 m	5760
# 9		23°41.4'	65°09.0'	B.C.	5760	2308-0332	No core	5760
10170	1/3							
# 1		21°43.6'	65°30.5'	B.C.	5460	1500-2045	60 cm core	5460
# 2		21°44.6'	65°29.9'	P.W.S.	5480	2132-0117	45% sample	5480
10171	2/3	21°35.8'	65°30.9'	N.N.	0	0252-0424		
10172	2/3	19°53.0'	65°50.6'	1 Forged Sphere	8300	1757-2330	Sphere failed to implode	8340

Abbreviations

B.C.	Box corer
B.G.C.	Box gravity corer
H.C.	Hydrocast
K.C.	Kastenlot corer
N.B.	Niskin water bottle
N.N.	Neuston net
O.X.	Oxfam net
P.T.	Particle trap
P.W.S.	Pore water sampler
S.F.S.	Surface film sampler

STN.	DATE (1980)	LAT.(N)	LONG(W)	GEAR	DEPTH (m)	SAMPLING TIME GMT	REMARKS	MEAN SOUNDING (m)
10163								
# 1	21/2	23°37.6'	59°41.2'	B.C.	5880	18.10-2149	Pre-tripped, no sample	5880
# 2	21/2	23°40.3'	59°40.0'	H.C.	1500-5000	2210-0329	Deep cast to 5000 m	5850
# 3	22/2	23°41.3'	59°40.9'	B.C.	5858	0333-0756	72 cm core	5858
# 4	22/2	23°41.1'	59°41.8'	P.W.S.	5840	0814-1341	Out of balance, no sample	5840
# 5	22/2	23°42.3'	59°41.5'	H.C.	0-1250	1350-1552	Shallow cast to 1250 m	5855
# 6	22/2	23°43.5'	59°41.7'	K.C.	5871	1609-2003	185 cm core. Surface water sample	5871
10164								
# 1	23/2	26°14.0'	60°20.7'	K.C.	6135	1220-1617	205 cm core	6135
# 2		26°13.1'	60°21.0'	H.C.	1500-5000	1628-1951	Deep cast to 5000 m	6140
				S.F.	0	1959-2148		
# 3		26°12.5'	60°22.6'	P.W.S.	6140	2210-0200	No sample	6140
# 4	24/2	26°12.3'	60°24.0'	H.C.	0-1250	0218-0419	Shallow cast to 1250 m	6140
# 5		26°04.9'	60°24.7'	B.C.	5550	0749-1244	55 cm core	5550
10165								
# 1	25/2	23°43.8'	61°29.7'	H.C.	1500-5000	0505-0855	Deep cast to 5000 m	5825
# 2		23°43.8'	61°29.4'	B.C.	5826	0948-1405	64.5 cm core	5826
# 3		23°43.5'	61°30.4'	P.T.	5830	1421-1642	Particle trap failed to surface	5830
# 4		23°43.7'	61°29.7'	P.W.S.		1823-2234	No sample	5820
				N.W.B.	0		Surface water sample	
# 5		23°43.7'	61°29.6'	B.G.C.	5824	2258-0237	107 cm core	5824
		23°44.7'	61°28.7'					
# 6	26/2	23°44.7'	61°28.3'	H.C.	0-1250	0316-0530	Shallow cast to 1250 m	5825
# 7		23°45.4'	61°28.1	P.W.S.	5822	0553-0938	20% sample	5822
# 8		23°45.0'	61°27.5'	B.C.	5825	1040-1634	68 cm core	5825
# 9		23°45.5'	61°28.5'	K.C.	5825	1718-2137	Core kept intact for study of physical properties	5825

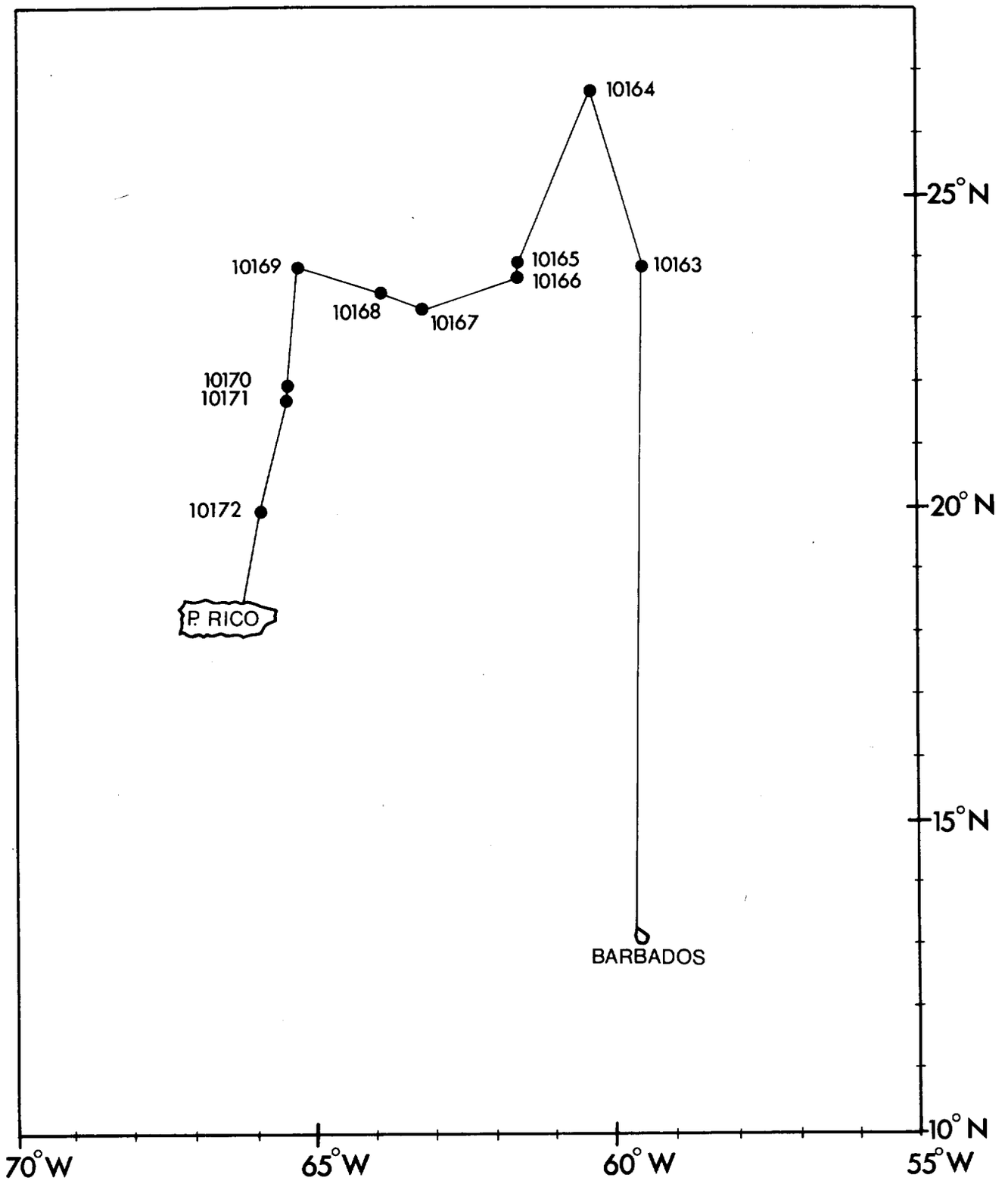

FIG. 1 **DISCOVERY CRUISE** 108 **track and station positions**