UNIVERSITY of LEICESTER
Department of Geology

CONFIDENTIAL

CRUISE REPORT SHACKLETON 83/1

GEOPHYSICAL INVESTIGATIONS OF THE CAPE VERDE ARCHIPELAGO

LEICESTER UNIVERSITY

Department of Geology

SHACKLETON CRUISE 83/1

CONTENTS

ACKNOWLEDGMENTS

I would like to thank all those who sailed with us for their assistance and co-operation and for contributing to the happy atmosphere that is a characteristic of the Shack.

Ian Hill.

INTRODUCTION

This cruise forms part of a geophysical research project to investigate the structures and mode of formation of the Cape Verde Archipelago, and is associated with the Cape Verde's Magmatism Project, a multi-disciplinary investigation of the geology of the Cape Verde Islands in the context of their magmatic origin from the earth's mantle.

The aims of the cruise as originally planned were threefold:

(i) To determine the geological structures linking the two islands whose land geology was known in most detail (Maio and Santiago). This knowledge should provide models for the uplift mechanism which created the islands.

(ii) To determine the relationship of the volcanic centres to the pre-existing structures of the oceanic crust.

(iii) To sample seamounts surrounding the island archipelago to place limits on the areal distribution of the distinctive magmatism of the islands.

It was anticipated that this work would take 30 days of shiptime in the area. The cruise was scheduled to run from Dakar on 30th December 1982 to Freetown on 5th February 1983.

On 22nd November the P.S.O. was asked if the cruise could be mounted starting from Gibraltar on 2nd December. It was reported that all Leicester equipment was on board as was all R.V.S. equipment requested. The change of plan was due to an industrial dispute in England between the ship operators, N.E.R.C. and the National Union of Seamen (N.U.S.). The ship's cruise plans were altered so that she would only use Gibraltar as a port-call. On a 25 day cruise this would involved 14 days passage and 11 days science.

With a choice between this and zero shiptime, and thanks to great co-operation from Leicester University, a team of 4 scientists was assembled for the first leg.

Most of the Leicester equipment had been delivered to R.V.S., Barry, on 5th October and shipped by container to Dakar. Some parts of this had been loaded on the ship but the vast majority was found to be marooned in Dakar. In the 5 days left after this became known, as much as possible was duplicated and air-freighted to Gibraltar with the scientific party. An 'active-weight' dredge had been purchased by R.V.S. for this cruise but was not delivered to the ship.

With the limited time and lack of equipment for objective (iii), the majority of the time available was concentrated on objective (i) and also (ii). The progress of the cruise is recorded below.

LEG 1

Sailed Gibraltar 1530 2nd December 1982

Arrived Gibraltar p.m. 26th December 1982

Scientists

Dr. I.A. Hill Principal Scientific Officer)

Miss S. Brown)

Mr. R. Young) Leicester University

Mr. A. Pointing)

Research Vessel Services

Mr. S. Jones

Mr. D. Teare

Mr. E. Cooper

Mr. J. Strangward

Ship's Officers

G.M. Long	Master
A. Moore	Chief Officer
B. Richardson	2nd Officer
A. Brigden	3rd Officer
R. Morris	Purser/Catering Officer
W. Ashley	Radio Officer
C. Storrier	Chief Engineer
I. Bennett	2nd Engineer
J. Richards	3rd Engineer
G. Gimber	4th Engineer
F. Sharpe	Snr. Electrical Officer
R. McDonald	Chief Petty Officer (Deck) (Bo'sun)

LEG 2

Sailed Gibraltar	30th December 1982
Arrived Gibraltar	a.m. 22nd January 1983

Scientists

Dr. I.A. Hill	Principal Scientific Officer)
Miss S. Brown	)
Mr. R. Young	) Leicester University
Dr. B. Weaver	)
Dr. C. Stillman	)
Mr. P. Bentley	) Trinity College, Dublin
	) Edinburgh University

Research Vessel Services

Mr. K. Smith

Mr. M. Gallon

Mr. G. Knight

Miss D. Jones

Ship's Officers

G.M. Long	Master
D. Coverdale	Chief Officer
B. Richardson	2nd Officer
A. Brigden	3rd Officer
R. Morris	Purser/Catering Officer
W. Ashley	Radio Officer
C. Storrier	Chief Engineer
G. Batten	2nd Engineer
A. Grattidge	3rd Engineer
G. Gimber	4th Engineer
B. Smith	Snr Electrical Engineer
S. Francis	Chief Petty Officer (Deck) Bo'sun

NARRATIVE

The scientific party and relief officers flew to Gibraltar on 30th November, arriving in the early afternoon. At the airport there was only time for a very brief conversation with John Jones of U.C.L. before he boarded the return flight. The scientists went straight to the ship.

On board ship one of the U.C.L. aerials mounted on the starboard aft boat deck was removed and replaced with a multi-element high gain aerial for disposable sonobuoys. The boxes of Leicester equipment on ship were opened and contents checked.

1st December was spent visiting Gibraltar and assessing the state of onboard R.V.S. equipment. The seismic reflection system was in less than perfect condition. Two sections of the Geomechanique hydrophone were split and others had unknown damage but were producing low voltage output. The Bell and Howell 4020 and 4010 tape decks both had faults with transports and with amplification. The remainder of the equipment seemed to be in

good condition. The computer had a hardware fault in the memory and a replacement board was scheduled to arrive on 2nd December.

2nd - 6th December Passage to work area

The ship moved from its berth at 0800 and moved to anchor off the South Mole to await the memory board for the computer. This was delivered on board by the agent's launch and after a brief check the ship sailed at 1530 hrs.

Requests were made to use the passage time to collect data in the vicinity of the Canary Islands and D.S.D.P. site 139. Both these were refused due to the lack of permission to work in territorial limits. The ship made a direct passage down the African coast in good weather, with winds increasing as the trade-wind belt was entered.

7th December (J D. 341)

At 1830 hrs the ship passed the 200 mile limit for the African coast and hove to while the P.E.S. transducer fish and the hull mounted sidescan sonar transducer were deployed. On getting under way the magnetometer fish was streamed, then the Geomechanique 30 m seismic streamer and a 1500C airgun with 300 in^3 chamber. Lead weights were added to the tow cable of the streamer to depress it. On trying to record data from this seismic system it was found that the 4010 tape deck was u/s because of a failure of the amplifier power supply. The 4020 tape deck produced only noisy records after considerable adjustment of individual channel amplifiers. It was difficult to record a clean key-pulse record.

With the seismic system streamed, speed was gradually increased to 8 knots and a good quality record was obtained at that speed. Careful checks were kept on tow-cable and air hose tensions but no damage was evident.

8th December (J D 342)

Seismic profiling across the Cape Verde Rise continued all day, interrupted by 3 airgun failures, each involving air leakages, none thought to be connected with towing speed. At 1251 an Ultra disposable sonobuoy was launched and used to set up the aerial/receiver/tape deck system. Because of the trials conducted, and the difficulty experienced in setting up the tape deck record amplifier little useful data was recorded. At 1903 a second sonobuoy was launched at D.S.D.P. site 368. Despite a sea state of 5-6, the sonobuoy radio signal was received for 2 hours giving a range of 15 miles. The reflected seismic signal from the sonobuoy was clipped at all ranges indicating that the hydrophone input gain may be too high.

9th December (J D 343)

The ship was steaming SSW across the Cape Verde Rise towards the islands of Boa Vista and Sal, collecting a vertical reflection profile across the thickening sedimentary wedge towards the islands. It was intended to deploy the 24 channel streamer when about 30 miles from the islands and make three crossings of the ridge extending north-south from Maio to Sal. At this point the sea state was too bad to deploy the long array, and the 30 m Geomechanique streamer failed due to water in its pre-amplifier. With no profiling capability, plans were altered to perform two east-west magnetic and gravity profiles.

10th December (J D 344)

The northern headland of Santiago was passed during the night and the westward profile to 25' 15' W completed by 1000. For the eastward profile the repaired short streamer and 300 in^3 in airgun were streamed, the profile continuing until 0820/11th.

11th - 12th December (J D 345-346)

During this period a series of tracks were steamed between Maio and Santiago to attempt to provide a link between the previous land surveys on these islands. The exact tracks were chosen for the scientific requirement to survey as far inshore as possible and limited by the poor bathymetric charts for the area available and the reluctance of the master to make close approaches to an uncharted lee shore. During this survey continuous bathymetric, gravity and magnetic data were recorded with single channel profiling using a 600B airgun with 40 in^3 chamber, and side scan sonar where water depths were small enough (less than 300 m).

On a final pass to the south-east across the area a sonobuoy was dropped at 2330 over a sediment pond located by the previous profiling. The sonobuoy had been opened and its electrics modified to decrease the hydrophone gain. Unfortunately, it sank immediately on deployment and a second unmodified sonobuoy was used to record at this point.

13th - 15th December (J D 347-349)

Shackleton steamed to the SE from the island of Maio to perform two east-west magnetic traverses for comparison with those previously recorded north of the islands. The east to west line was covered at full speed with the only problem being a noisy magnetometer bottle which was changed at 2200 hrs on 13th December. Having reached 25' 15' W, the ship turned north for a second profiling track and the Geomechanique 30 m streamer and airgun were deployed.

During the east going profile performed at 6 knots there were two failures of the 300 in^3 airgun, each resulting in a data gap of about 20 minutes. Another sonobuoy station was recorded and again a modified one sank, while an unmodified one gave a good but clipped record for 2½ hours.

15th - 19th December (J D 349-353)

At the end of the east going magnetic profile at 1520 the airgun and hydrophone were recovered and the ship proceeded due north to begin multichannel reflection profiles. At 1730 the ship slowed to 4 knots and the multichannel streamer was deployed, the task being completed at 2230. Several sections of the streamer were punctured and temporary repairs were made. On counting the sections it was discovered that the streamer had only 23 active sections. Six Ashbrooke depth controllers were added to the streamer spaced evenly every 4 active-passive pairs and set at 40 ft depth.

Having deployed the streamer, it was not until after 0200/16th that the 4020 tape deck was adjusted sufficiently to record the 12 nearest sections. The 4010 tape deck was u/s precluding attempts to record the remaining 11 hydrophone sections. Over the following days the 4020 tape deck needed close attention to reduce the noise spikes being added to the data on recording.

During the 3 days of multichannel profiling there were 4 airgun failures each of which resulted in the loss of 20 to 60 minutes of data. The tracks streamed were those planned for the first few days of work, which had to be postponed due to poor weather conditions. The Santiago-Maio area was crossed by 2 intersecting tracks, then 3 crossings of the Maio-Sal ridge were made. Initial impression of the near channel records shows that the sediment penetration is disappointingly low.

The profile was continued out to the north-east of the islands on a track passing west of D.S.D.P. site 368, giving a good comparison with the data collected on the approach to the area.

The long array was recovered between 0800 and 1500 on the 19th. Several more split sections were found and much oil was leaked on deck. During this process instructions were received to dump the explosives from the magazine, and this was completed between 1530 and 1650.

At this point, the ship was close to the 200 mile limit for the African coast and well north of the area of scientific interest. Scientific watches were discontinued.

20th - 22nd December (J D 354-356)

The state of the multichannel streamer was very poor and the scientific requirement for this cruise was for only 12 channels. It was decided to strip all the streamer from the winch drum and reconfigure the serviceable parts to give a 14 channel streamer (12 in use and 2 spare). This was achieved by the combined efforts of scientists, technicians and deck crew without any serious problems. The unwanted sections were coiled on the foredeck with all punctured sections drained of oil ready for off-loading at Gibraltar.

LEG 2

During the port-call at Gibraltar from 27th - 30th December, efforts were made to improve the state of serviceability of the scientific equipment. The faulty sections of Geomechanique streamer were off-loaded into a container along with some of the scientific equipment no longer required. The fairlead for the streamer was moved 45 cm to starboard so that it was in line with the winch drum. A good gravity tie was established with the gravity station on the South Mole used at the beginning of Leg 1. The meter drift was found to be negative, but consistent with that of the previous legs. Drs. Stillman and Weaver brought out a portable microscope to replace the ones stranded in the container in Dakar, and grinding equipment was bought in Gibraltar to allow the making of thin sections from dredged material.

Spares which were requested during the course of the first leg failed to arrive. There were no spare parts for airguns or the Bell and Howell tape decks, even though the ship waited for the incoming flight on the afternoon of the 30th. The new 'active weight' dredge, which had been

purchased by R.V.S. for this leg, failed to arrive. It had not been shipped from Barry until mid-December and was still on a container ship bound for Gibraltar. A set of Portuguese charts of the islands ordered by the master also failed to arrive. It appears that requests sent by radio to Barry had not been passed on to the relevant departments for action.

Passage to work area, 30th December - 4th January (J D 364-004)

The passage was carried out in good weather conditions with a high average speed. The computing technicians were involved in tracing a fault in the processing computer, while the Bell and Howell 4020 tape deck was repaired as well as possible with adjustments to the tensioning and brakes on the transport as well as to the record and reproduce amplifiers. After this had been done it was found that the deck could no longer replay tapes recorded on the first leg. The reason for this has not yet been established. During the passage 2½ hours were lost due to repairs to the main engine coolant system.

4th-5th January (J D 004-005)

Scientific watches started just after 1200 on crossing the African 200 mile limit. The ship hove-to to deploy the P.E.S. fish, and the magnetometer bottle was streamed after this. Almost immediately there were problems with the P.E.S., with the drive motor overheating and stopping. It failed several times over the next few days but was nursed back into life. There was no spare drive motor. Apparently, the faults lay in the circuit boards supplying power to the motor.

Course had been set for the northwest corner of the Cape Verde Archipelago to collect a multichannel seismic profiling line across the island ridge between Santo Antao and Sao Vicente, and also to cross over 2 charted seamounts which were regarded as potential dredging sites. The position of the first was crossed at 1500 on 5th January, but no bathymetric

rise was found. A short box survey was carried out but revealed no trace of the seamount so the search was abandoned. The Geomechanique hydrophone array was deployed and seismic profiling began at 2200.

6th - 7th January (J D 006-007)

The seismic profile was continued with gravity and magnetic measurements. The ship passed through the Canal Sao Vicente in the early afternoon of 6th in poor visibility. Three disposable sonobuoys were deployed along the line to obtain good velocity information. To ensure an adequate signal level on these sonobuoy recordings, the line was shot with two 300 in^3 airguns towed on a common bridle. At 2030 on the 6th one of the guns began to leak. It was discovered that the fault was in the fire chamber seal and the seal and chamber were replaced, the new chamber being 160 in^3. The 300 in^3 chamber was the same one which had been associated with seal failures on the first leg.

At 1730 the ship crossed the position of a second charted seamount but again no trace of it was found. The seismic profiling was continued to the south, then eastwards to the north of the island of Boa Vista during the remainder of 6th and 7th January. 7th January was remarkable for the Harmattan wind which gave very poor visibility and covered everything on the ship with a layer of fine Sahara sand. The 160 in^3 chamber airgun failed again and the line was continued with only one airgun. Investigation showed that the problem might lie in the ovaling of the main housing seating by 3 thou. in.

8th - 9th January (J D 008-009)

The multichannel seismic profile continued over the elevated ridge north of Boa Vista then turned south-east to cross the sediment accumulation on the east flank of the islands while headed for a third seamount. The Geomechanique multichannel hydrophone was recovered between 1200 and 1400 and the site survey for dredging commenced at 1500. The seamount was

located and 3 dredges taken during the night. All 3 contained some hard rock, but the volume in each was low. The rocks were alkaline pillow lavas and hyaloclasites with some coarse grained conglomerates. Carbonate sand was also recovered. Drs. Stillman and Weaver managed to produce thin sections of these samples on the equipment improvised in Gibraltar. A full report of their dredge samples is included below. The only problems with dredging occurred on the third haul when the bucket became stuck and a line tension of 7 tons was recorded before the bucket pulled free. All dredging was made difficult by an unexpected WNW set of the ship at 1.5 knots while the wind was from the northeast.

Immediately after the first dredge haul was recovered the PES recorder exploded and caught fire. Luckily, no-one was very close to it and the fire was quickly extinguished. Mike Gallon reported that a second PES was reputed to be on board but that he had failed to find it. A quick search of the hold revealed the PES and it was installed and running within an hour.

9th - 12th January (J D 009-012)

This period was spent mainly on a continuation of the detailed survey of the area between the islands of Boa Vista, Maio and Santiago. At 0415 on the 9th the dredging was completed and the ship set course westwards. By 1000 the shallow water area was being approached. A 40 in^3 airgun with WSK, the Geomechanique short hydrophone (G30), EG&G 263 hydrophone and sidescan sonar were deployed. The G30 failed immediately and it was found that the pre-amp. built on the first leg had corroded due to water leaks into its housing and would have to be completely rebuilt again. At 1800 a 3 kJ sparker was deployed and both sparker and airgun data were recorded using the 263 hydrophone.

During the 9th and 10th a grid of lines was completed over the ridge between Boa Vista and Maio. Results reveal thin poorly laminated sediments overlying a rough, rocky and highly magnetic basement. At 1700 on 10th the G30 hydrophone was still under repair and plans were altered to perform a

series of gravity traverses whilst the seismic profiling capability was restored. The ship covered a variety of tracks to the south and west of Maio and Santiago including a close approach to the port of Praia in the early hours of 11th January. A second approach to the coast of Santiago at 0550 failed to produce the required gravity data within 3 miles of the coast when the master moved the position of the track line without informing the P.S.O., such that the ship turned away from the coast in water depths of 1700 metres.

During the daylight hours of the 11th the deck crew were engaged in preparing for coring whilst the gravity survey progressed in fine weather. A considerable length of main warp was damaged in this process (about 200 m) and had to be discarded. At 1620 the ship hove-to to set up the core-bomb holder and core bomb on the starboard rail. The repaired G30 hydrophone and 40 in^3 airgun were then streamed for the approach to the coring site.

On the first leg a sedimentary basin was located in the region between the islands of Maio and Boa Vista. Along its western edge it appeared on profiling records to have an erosional trough which exposed seismic reflectors occurring in the lower half of the sedimentary sequence in the basin. It was intended to core in this trough to ascertain the age of these sediments. The feature was located at 2037 and the towed geophysical gear recovered and the ship returned to station by 2045. The ship was manoeuvred on station by keeping constant radar ranges on the coast of Santiago, and this was very successful. The corer was assembled with 1500 lb bomb and 3 m barrel and lowered to the sea bed. (During this process an hydraulic pipe burst on the A-frame.) It triggered faultlessly at 2350. By 0003 on the 12th it was discovered that the corer was held fast in the sediment. Whilst hauling,an hydraulic flange on the winch vibrated loose and began to leak oil. At this point it was found that the winch brakes would not hold against a wire tension in excess of 3000 lb. Repairs were made and hauling continued, until a pennant wire broke under a tension of 9 tons, leaving the

corer and pinger on the sea-bed. The main warp was recovered but had kinked and partially unlayed on the sudden release of tension. 800 m were paid out and discarded.

By 0600 this had been completed and the ship had steamed south of Santiago to commence a northward profiling line. The repaired G30 hydrophone was deployed with 2 large airguns with 300 and 160 in^3 chambers. Neither would seal correctly but by 0650 the 300 in^3 gun was operational so the profile was shot using only one gun. Two sonobuoy lines were shot over thick sediment accumulations between Santiago and Maio, one terminated prematurely by another airgun failure. While both airguns were stripped and rebuilt the ship headed northeast and deployed a 3 kJ sparker, 263 hydrophone and side-scan sonar on entering shallow water at 1412. A traverse was started along the Maio to Boa Vista ridge to intersect those lines recorded on 9th and 10th January. By 1730 a 300 in^3 airgun was working and redeployed and 2 sonobuoy lines were shot along the ridge.

12th - 14th January (J D 012-016)

At 2130 on the 12th the ship turned westwards to conduct two magnetic traverses across the oceanic reversal anomalies in the area enclosed by the islands. This proceeded uneventfully except for a period of one hour when the ship was hove-to for engine room repairs. During the day there was a gradual increase in the wind strength to 15-20 knots from the northeast. At 1349 on the 13th the ship turned eastwards again and was making only 7 knots into sea and swell. At 1600 a 300 in^3 airgun and the G30 hydrophone were streamed and seismic profiling continued through the night running eastwards then NNE towards a seamount for another dredge station.

At 0740 on the 14th all towed gear was recovered and at 0800 the ship hove-to. Since the coring station the crew had unspooled main warp wire in the hold to make a new termination, and had found that it was forming 'catspaws'. This was certainly due to unwinding under zero tension wire

that had been heavily stressed by the coring. A weight was attached to the end of the main warp and 2800 m of warp paid out, then retrieved. The length paid out was greatly in excess of the maximum length of warp used on this cruise and this was regarded by the PSO as an over-reaction, but was required by the mate and chief engineer. At 1112 the ship got under way again and headed for the charted seamount. Again, the chart was incorrect and no seamount was found during the course of an 8 hour box search. Since the Admiralty charts give the nature of the bottom on a sounding of 42 fathoms, it is assumed that the sounding is correct but the position is in error by at least 15 miles.

The search was broken off at 2100 on the requirement of the master to begin passage to Gibraltar at an average speed of 7.5 knots to dock at 0300 on 23rd January. An extension of scientific time of 12 hours was requested but refused. Bathymetric, magnetic and gravity readings were continued up to the African 200 mile limit which was reached at 0430 on 16th January. At 0815 the ship hove-to to recover the PES fish and the corer bomb frame. Passage continued to Gibraltar.

Passage to Gibraltar

On 17th January a wash-up session was held amongst scientists and technicians and also the master. The equipment performance, organisation and scientific program were reviewed and the lessons learnt were discussed. The results of this discussion are included in the following sections of this report. All agreed that the session was a useful exercise. During the ensuing days time was spent replaying data tapes, preparing data files using the processing computer, continuing initial interpretations of the data and writing reports. Light entertainment was provided by speculation about the meaning of the stream of terse messages from Barry, concerning the progress of the strike, and the ship's future program.

CRUISE STATISTICS

	LEG 1			LEG 2			TOTAL		
	TIME		DISTANCE	TIME		DISTANCE	TIME		DISTANCE
	days	hr.	n.mls.	days	hr.	n.mls.	days	hr.	n.mls.
Total at sea	24	19	4686	22	20	4719	47	15	9405
Passage time	12	5	2541	11	5	2792	23	10	5333
Total scientific time	12	14	2145	11	15	1927	24	5	4072
Bathymetric data	12	14	2145	11	065	1866	23	20	4011
Gravity data	12	14	2145	11	15	1927	24	5	4072
Magnetic data	12	13	2113	10	17	1877	23	6	4000
Single channel reflection profile	5	12	927	2	12	329	8	0	1256
12-channel reflection profile	3	16	483	2	16	367	6	8	850
3 kJ sparker profiles	-	-	-	-	17	85	-	17	85
EG & G side-scan sonar	-	11	60	-	12	60	-	23	120
Kelvin Hughes side-scan sonar	-	9	48	-	-	-	-	9	48
Data logger	12	10	-	11	15	-	24	1	-
Stations (incl. site surveys)	-	-	-	1	3	112	1	3	112

SAMPLING STATIONS OCCUPIED

Station No.	Latitude	Longitude	Time arrived (JD/GMT)	Time departed (JD/GMT)	Time on station (hrs)	Water depth (m)	Sampling type	Remarks
83/008/D1	15° 20.1'N	21° 57.7'W	008/1650	008/2024	3.5	2400	Rock dredge	Rock samples and sand recovered
83/008/D2	15° 20.4'N	21° 54.1'W	008/2200	009/0032	2.5	1500	Rock dredge	Rock samples and sand recovered
83/009/D3	15° 19.3'N	21° 52.7'W	009/0222	009/0356	1.5	800	Rock dredge	Rock samples and sand recovered
83/011/C1	15° 14.4'N	23° 30.2'W	011/2045	012/0227	5.7	1040	Gravity corer 3 m barrel	Corer and pinger lost when unable to retrieve corer from sediments

SONOBUOY STATIONS

Station No.	Frequency Channel No.	Time of Deployment	Position Lat.	Position Long.	Duration (hrs.)	Range (n.mls.)	Comments
1	17	342/1251	18° 03.28'N	20° 53.63'W	2	14.0	Test purposes only
2	20	342/1903	17° 30.78'N	21° 21.10'W	2	13.8	
3	20	346/2329	15° 20.9' N	23° 24.0' W	0	0	Not received
4	20	346/2333	15° 20.9' N	23° 24.0' W	2.4	12.6	
5	17	348/1748	14° 30.56'N	24° 25.16'W	0	0	Not received
6	10	348/1752	14° 30.56'N	24° 25.06'W	2.8	22.8	
7	17	006/0000	17° 54.5' N	24° 11.1' W	2.7	16.0	
8	5	006/1225	17° 1.0' N	25° 0.5' W	1.5	8.7	
9	17	006/2130	16° 20.3' N	25° 18.5' W	2.5	13.5	
10	11	007/2031	16° 23.8' N	22° 59.8' W	1.6	10.7	
11	20	008/0500	16° 5.3' N	22° 11.7' W	2.2	12.4	
12	20	012/0926	15° 13.5' N	23° 33.5' W	1.4	8.7	
13	16	012/1225	15° 17.9' N	23° 27.0' W	1.0	5.0	Short duration due to gun failure
14	10	012/1830	15° 41.3' N	23° 8.3' W	2.1	10.0	
15	16	012/2021	15° 50.5' N	23° 3.4' W	0.9	4.9	Short duration due to course change
16	16	013/1655	16° 8.8' N	24° 51.8' W	2.3	15.8	
17	20	014/0530	16° 25.0' N	23° 40.6' W	2.2	12.7	

EQUIPMENT PERFORMANCE

1. Satnav (Magnavox)

Performed reliably throughout with occasional power failures due to faults in the ship's supply. Both E-M log and gyro also performed well.

2. Data Logger/Computer

Performed very well except for a minor persistent fault on the processing computer. The logger failed for about 5 hours on Leg 1 but ran continuously on Leg 2, the only interruptions being due to spikes on the ship's supply affecting the tape drives. The calcomp plotter failed towards the end of Leg 1, but was repaired with facilities on board.

The system has been a great advantage to the cruise. Its greatest limit is the lack of flexibility of the software - a topic on which I will comment separately to S.C.G.

3. Deep Echo-Sounder (PES)

The PES is not matched correctly to the Kelvin Hughes hull mounted transducer although this caused no trouble. The outboard fish was used almost exclusively during this cruise and performed reliably. Only one PES unit was mounted in the laboratory. On first operation (day 341) the TVG was u/s but was quickly repaired. The unit worked reliably during the first leg, but had a series of circuit board failures in the second leg culminating in the explosion of a power supply capacitor on day 008. This left the unit u/s but a second PES unit was found in the hold, and this performed satisfactorily for the remainder of the cruise.

4. Proton Magnetometer (Varian)

Performed reliably throughout, although producing only a poor phase lock in field strengths of 32000-32400 nT., and this only with the maximum polarize current of 6 amps. Changing bottles had no effect on this. It was found that the bottle cables tended to be rather short and a heading error of about 20 nT. was measured. The servoscribe recorder worked well.

5. Gravimeter (Lacoste)

Performed reliably with a low negative drift consistent with previous cruises. A power supply unit was replaced between Legs 1 and 2.

6. Hull-Mounted Side-Scan Sonar (Kelvin Hughes)

Few good records were obtained with this equipment, despite considerable efforts. This may be partly due to the rough weather experienced on the first leg. It was not operated on the second leg.

7. Towed Side-Scan Sonar (EG & G)

This was towed from the TSD winch on the patio deck via blocks on the A-frame and the port side davit. The winch worked well but gave some trouble with poor contacts on the slip-rings.

The data obtained were only useful in water depths less than 150 metres and the starboard channel gave consistently poorer results than the port one. The operating box has few diagnostic outputs and it is difficult to assess how far below its optimum this equipment was performing.

8. Seismic Profiling Systems

A. Seismic Sources

i. 3 kJ Sparker. Worked reliably and satisfactorily throughout.

ii. Bolt 600B Airguns. Only one was used and that always with 40 in^3 chamber and wave-shape kit (WSK). It performed very reliably.

iii. Bolt 1500C Airguns. These were very unreliable with a succession of failures as tabulated below. The trigger cable failure can be regarded as fair wear-and-tear, but the persistent problems with leaking seals on fire chambers can only be explained by either sub-standard quality seals or poor maintenance of the guns. The latter is far more likely.

iv. Compressors. These worked well throughout the cruise except for a tendency of the forward compressor to trip out under light loading conditions and require manual resetting. The cause of this is unknown

TABLE OF AIRGUN FAILURES

Date	Time	Gun type	Chamber size	Time run	Firing rate	Cause of failure
342	1057	1500C	300"	15½ hr.	16 sec.	Fire chamber seal***
342	1331	1500C	300"	2½ hr.	16 sec.	Air line holed between gun and towing bracket
342	1500	1500C	1000"	2 hr.	20 sec.	Leak at loosened airline coupling in tail fairing
348	1400	1500C	300"	5 hr.	16 sec.	Fire chamber seal***
348	2109	1500C	300"	7 hr.	16 sec.	Welded hoop bracket broken off tail, rupturing airline
350	0545	1500C	300"	31 hr.	20 sec.	Fire chamber seal***
350	2330	1500C	300"	17½ hr.	18 sec.	Broken air-hose coupling in tail fairing
352	1210	1500C	300"	37 hr.	18 sec.	Firing cable broken
006	1643	1500C	300"	18½ hr.	16 sec.	Fire chamber seal***
007	0145	1500C	160"	9 hr.	16 sec.	Fire chamber seal***
012	1324	1500C	300"	6½ hr.	16 sec.	Fire chamber seal
012	1724	1500C	160"	-	-	Failed to seal - cracked main housing

*** All on the same airgun which has ovaled main housing.

At the end of this cruise two out of three 1500C guns were u/s.

B. Hydrophones

i. EG & G 263. Worked reliably despite being left on deck in an untidy heap for an unknown period prior to this cruise. The inboard summing box should have a more sanitary power supply.

ii. Geomechanique 30 m hydrophone. Produced excellent signal to noise ratio at up to 8 knots towing speed though it does need extra weights added to the cable to depress it. The great weakness is in the outboard pre-amplifier housing. On both legs this leaked and the amplifiers had to be completely rebuilt. It should be a relatively easy job to make a housing with double o-ring seals that will be watertight. This problem is apparently longstanding. Why has it not been corrected?

iii. Geomechanique multi-channel array. This has been a source of considerable trouble. The scientific programme for this cruise requested a 12 channel streamer, but when the cruise was hurriedly re-scheduled the 24 channel array used by Dr. J. Jones of U.C.L. was aboard. It was known to contain leaking sections at the start of the cruise but it was assumed these could be repaired during the first deployment.

When it was deployed some sections were split to such an extent as to be irrepairable on board. These splits were taped up as well as possible. On counting the sections it was found that there were only 23 active. The streamer was used for 3½ days but due to tape deck failure only 12 channels could be recorded.

On recovery the streamer was found to have suffered further damage including shark bites. There were so many damaged, deflated sections that it was decided to strip the sections from the winch drum and rebuild the good sections into an effective short streamer. This occupied 2½ days of passage time on the return to Gibraltar but was intended to provide a reliable 12 channel array for the second leg. The surplus sections were off-loaded in Gibraltar. The fibreglass tail-buoy was very useful, but lost its generator spinner through

unknown causes.

The flexotir winch performed faultlessly, except for a leaky hydraulic coupling. The fairlead on the poop rail was badly placed which leads to great pressure on the array elements as they are spooled to the starboard side of the drum. It was moved 45 cms to starboard at the end of the first leg.

On the second leg the array worked well with no problems except some surface damage to the outer casing of one section, probably due to fish attacks.

C. Sonobuoys

Worked well with no failures except for sinking of those opened during attempts to modify the hydrophone gain. The biggest failing is the supply of receiving aerials. The three fitted to the ship (bridge Yagi, bridge Omnidirectional, aft Yagi) were all poorly sighted and/or of low gain. Our own high gain aerial mounted on a scaffold pole aft was far superior. Why is a good well-sighted aerial not fitted to the ship?

i. Pre-amplifiers. That for the 30 m hydrophone and the Bell and Howell amplifiers for the long array were trouble free.

ii. Tape decks. These are perhaps the weakest link in the whole system. The 4010 deck was u/s throughout both legs of the cruise with tape transport and electronic failures. The 4020 was nursed through also with transport and electronic defects. Considerable noise was added to signals on recording such that for part of the time it proved impossible to record and replay a square wave key-pulse.

Different technicians attempted to adjust the record and reproduce amplifiers for optimum effect but the result of this is that we find at present that we cannot replay tapes recorded during the first leg with the system used on the second leg.

It is extremely frustrating to have such an expensive array of airguns and hydrophones and yet such a poor recording facility.

iii. EPC.S. These all worked well with no problems.

iv. Filters. The two filters supplied were insufficient for the majority of the time. Five or six would be a more realistic number.

9. Bottom Sampling Equipment

Before the cruise considerable efforts were made by the PSO to obtain an 'active weight' dredge system. Although the system was purchased by R.V.S. it was not supplied to the ship for this cruise.

Conventional rock dredges were available but there was a shortage of swivels and weak-links with which to rig them. This lack of swivels also affected rigging of the corer and precluded any further attempts at coring when the first corer was lost.

The main winch eventually showed its ability to provide a line tension of nine tons, but only after a leak in the hydraulic system and poor performance by the braking system.

SCIENTIFIC RESULTS

Within the limited time available it is felt that the cruise has been quite productive. Of the total scientific time of 24 days, more than 2 days were spent collecting opportunistic data on passage outside the area of main interest. During the remaining time the ship worked continuously to produce the data shown in the cruise statistics. Interpretation of the data is obviously only at a preliminary stage but the following points are felt to be the main achievements of the cruise.

1. East-west magnetic profiles have identified the M sequence reversal anomalies within, and to the south of, the archipelago. This not only allows definition of maximum offsets of oceanic fracture zones in the area, but also suggests that the oceanic crust has not been greatly modified by later

reheating or magmatism. The density of tracks is not as great as originally intended and will not be sufficient to tightly define individual fracture zones.

2. The shallow-water area between the islands of Boa Vista, Maio and Santiago has been mapped in considerable detail. The main features are:

(a) The area between Maio and Boa Vista has only a thin layer of sediment overlying highly magnetic, acoustically opaque besement. This probably contains volcanic complexes and a dyke swarm as seen on Maio.

(b) There is a basin of flat lying sediments between the islands of Maio and Santiago. Its western edge is sharply truncated by an erosional trough trending NNW. West of this there appears to be an area of deformed sediments. The NNW trough may well be of tectonic importance in view of the differing sedimentary pattern on each side, and the occurrence of NNW trending lineations in the nearby land geology. The retrieval of core samples of the basin sediments would be of enormous value to geological interpretation of this data and must be regarded as a high priority for future work.

(c) Sufficient gravity data has been obtained to produce a well defined gravity map of the area to aid interpretation of major structures.

3. Reflection profiling in deep water areas surrounding the islands reveals a distinctive sedimentation pattern with disturbed (slumped) sediments close to the islands and well laminated (turbidite?) sedimentation at greater distance. It is hoped that more detailed study will allow estimates of pelagic and volcanogenic content of these sediments.

4. The major conclusion to be reached from attempts to sample seamounts for geochemical studies is that there are less seamounts than previously thought. A detailed report of the rocks recovered from the single seamount sampled is included below. The results are encouraging in suggesting that a detailed dredging program would provide useful information on the geological history

of these seamounts as well as data for geochemical studies. The lowered estimates of the number of seamounts suggests that those which do exist as major features must be regarded as of increased importance in the tectonic pattern of the area.

Preliminary Report on Samples Dredged from Boa Vista Seamount, Cape Verde Islands

Compiled on board RRS Shackleton, 19th January 1983.

Location of Seamount

The seamount referred to as the Boa Vista Seamount lies approximately 36 nautical miles SE of the island of Boa Vista and 62 nautical miles ENE of the island of Maio, its summit at approximately lat. 15°20 N, long. 21°53 W.

Location of Dredge Hauls

Three dredge hauls were made; in each the dredge dragged about half a mile of sea bed:

D1: from 15°20.1 N, 21°57.7 W, to 15°20.6 N, 21°58.0 W; in water depth 2400 ± 50 m; on W flank of seamount.

D2: from 15°20.4 N, 21°54.1 W, to 15°20.9 N, 21°54.6 W; in water depths 1560 to 1200 m; high on W flank of seamount.

D3: from 15°19.3 N, 21°52.7 W, to 15°19.9 N, 21°52.8 W; in water depths 850 to 650 m; on SE corner of summit.

General Nature of Samples Recovered

The dredge used was of standard pattern with steel frame and wire net, towing a cylindrical steel bucket. The hauling gear was protected by weak links on the dredge closure which activated a tripping line if wire tension of 5 tons was exceeded. In hauls 2 and 3, jamming on obstructions sheared the weak links resulting in a reduction of the haul recovered from the dredge, though not from the bucket. The samples comprised rock fragments from cobble to block size, maximum diameter c. 30 cm; the bucket contained both sand and rock samples.

Hauls D1 and D2 provided much the same type of material from the western flank of the seamount: a coarse foraminiferal sand with abundant coral debris containing blocks which had the morphology of pillow rinds. These had convex surfaces embossed with contiguous hemispherical variolitic blisters of c. 1 cm diameter. The convex surfaces were often smooth and apparently built up of successive layers of uniform black material. This black material appeared to be a replacement for original volcanic rock as it was soft and sectile, with a deep brown streak. The inner, concave surfaces were often encrusted with yellow-brown mottled granular material, possibly palagonitised hyaloclastite, of grain size 0.1 to 1.0 cm. This possible hyaloclastite also occurred as separate blocks of dimensions similar to the 'pillow rinds'. Other black blocks were less regular in form and resembled typical pahoehoe ropy lava or spatter. The black material appears to be a hydrated oxide pseudomorphic pillow basalt which, from the uniformity of the pseudomcrph texture, was apparently aphyric and non-vesicular.

Haul D3 from the summit of the seamount provided more varied material. Most of the blocks were massive, sub-rounded to sub-angular, and composed of altered vesicular porphyritic lava, either in the form of individual blocks up to 30 cm long or as cobbles and pebbles in a conglomerate cemented in a carious carbonate which in some cases appears to be barely lithified. The lava is highly vesiculated, unlike the pseudomorphed variolitic pillows, and a substantial proportion of the vesicles are filled with zeolites and calcite. Phenocryst phases include serpentine after olivine, black pyroxene and/or amphibole and altered plagioclase feldspar.

The sand from all three dredges comprised well washed and sorted spherical foraminifera, calcite debris, fragments of coral and lithic fragments or volcanic rock. Little or no silica sand is to be seen.

Speciment list and photo-record

Colour photographs of hauls: D3-1 photo 83/01/2-1
D1-1 83/01/2-2
D1-2 83/01/2-3
D1-2 83/01/2-4

Numeration system for samples: year day haul bucket(1) net(2) sample nc.
e.g. 83/ 008/ D1 - 1 / 1

Sample	Black/white photo
83/008/D1-1/1	
1-1/2	83/01/X1-1
1-1/3	
1-1/4	
1-1/5	
1-1/6	83/01/X1-2
1-1/7 (collection of small fragments)	
1-1/8	83/01/X1-3
1-1/9	
1-1/10 (sand sample)	
83/008/D1-2/1	
1-2/2	83/01/X1-5
1-2/3	
1-2/4	
1-2/5	
1-2/6	83/01/X1-6
1-2/7	
1-2/8	83/01/X1-4
83/008/D2-1/1	
2-1/2	83/01/X1-7
2-1/3	
2-1/4	
2-1/5	83/01/X1-8
2-1/6	
2-1/7	
2-1/8	83/01/X1-9
2-1/9	
2-1/10 (sand sample)	
83/008/D2-2/1	
2-2/2	83/01/X1-10
2-2/3	

	2-2/4	
	2-2/5	
	2-2/6	
	2-2/7	83/01/X1-11
	2-2/8	
83/008/D3-1/1		
	3-1/2	
	3-1/3	83/01/X1-12
	3-1/4	
	3-1/5 (sand sample)	
83/008/D3-2/1		
	3-2/2	
	3-2/3	83/01/X1-13
	3-2/4	
	3-2/5	
	3-2/6	
	3-2/7	83/01/X1-14
	3-2/8	
	3-2/9	
	3-2/10	
	3-2/11	83/01/X1-15

A total of 49 samples + assorted fragments + 3 sand samples.

Petrography of samples

For a preliminary study 8 samples have been prepared by coring through large blocks using a rock drill (normally used for palaeomagnetic studies). The cores provide interior samples free of the superficial surface alteration; thin sections were made from typical examples and examined using an Open University MacArthur microscope (without proper polarising facilities).

2-1/5 Black microvesicular aphyric basalt. Vesicles mainly empty, occasionally lined with encrustations of small ?calcite crystals.

3-1/1 Grey microvesicular porphyritic basalt. Vesicles less than 2 mm diameter, some filled with fibrous zeolites and calcite.

Phenocrysts - feldspar, pyroxene and/or amphibole.

Feldspar - laths up to 3 mm long, scattered individuals, all altered.

Pyroxene and/or amphibole - prismatic to acicular, up to 4 mm long, often clustered. Black in hand-specimen, colourless to pale brown in thin section; non-pleochroic; optics suggest titanaugite, habit is that of amphibole.

Groundmass - intersertal network of feldspar microlites with interstitial granules of opaques, ferromagnesians and yellow-brown ?hydrated glass.

3-1/2 Buff-grey vesicular porphyritic lava. Phenocrysts: brown serpentine pseudomorphing olivine, skeletal pyroxene and/or amphibole.

3-2/1 Buff extremely vesicular porphyritic lava; vesicles up to 2 mm, large filled with calcite and zeolites, some with spirit-level infills. Phenocrysts: feldspar - individual laths; pyroxene and/or amphibole, in clusters.

3-2/2 Buff-brown porphyritic lava. Phenocrysts: abundant small brown serpentine patches, pseudomorphs after olivine.

3-2/5 Grey-buff highly microvesicular porphyritic lava. Vesicles up to 1 mm many surrounded by alteration zones (groundwater alteration?). Phenocrysts - serpentine (olivine pseudomorphs), pyroxene and/or amphibole, similar in form and optics to that of 3-1/1. Groundmass - intersertal feldspar laths with interstitial opaques and ferromagnesians and alterations products as in 3-1/1.

3-2/6 Grey amygdaloidal porphyritic lava. Vesicles very abundant, small and filled with two generations of calcite and zeolites. Phenocrysts: feldspar - abundant small individuals; some square section ?nepheline.

3-2/7 Pale grey microvesicular porphyritic lava. Phenocrysts: feldspar, pyroxene and/or amphibole, much brown serpentine after olivine.

Summary

Almost all samples from the flanks of the seamount (dredges 1 and 2) are of completely replaced variolitic pillow lava and hyaloclastite. Chemical

analysis is necessary to determine the original nature of the lava, but it was probably aphyric or microphyric.

The top of the seamount (as represented by dredge 3) comprises a different suite of lavas; highly vesicular and porphyritic, with co-existing feldspar and pyroxene and/or amphibole crystal phases and totally replaced olivine. The lavas possible represent members of an alkaline olivine basalt suite, possibly hawaiites and mugearites. Some more undersaturated nepheline-bearing varieties may be present. These lavas have been recovered solely as boulders, cobbles and pebbles, sometimes cemented by carbonate into a recent conglomerate. The lava fragments clearly show erosion and transport with abrasion and rounding of the blocks. No pillow fragments have been found. The style of alteration does not seem to be characteristic of ocean floor weathering and may possibly indicate deep tropical subaerial conditions.

The type and degree of vesiculation indicates eruption at a shallower depth than the flank varieties; the filling of the vesicles implies burial to a substantial depth (identification of the zeolite mineralogy may help to quantify this) and the state of alteration and shape of the lava blocks indicates considerable weathering followed by active erosional stripping and transport.

All these features would be consistent with the seamount building up by submarine volcanism continuing to subaerial activity to expose the upper part to a substantial elevation, which was then planated by erosion which was followed by subsidence to the present depth of c. 600-800 m. There appears to have been no further major volcanism following subsidence and the only deposit covering the erosion products is the calcareous sand which is largely of organic origin.

SUMMARY AND CONCLUSIONS

Throughout the cruise the scientific programme was at the mercy of the logistic arrangements for the ship. Some of the logistic problems were obviously associated with the industrial dispute between R.V.S. and N.U.S. Others were rather more avoidable. The following points are suggested in the light of our experiences.

1. It would be very useful for Masters and P.S.O.s to know more about the preceding and following cruises. This would facilitate co-operation betwee cruises and be of great benefit when sudden programme changes occur.

2. It would be even more useful if P.S.O.s and technicians (or at least the senior technician) for each cruise could meet at least a month before each cruise. Technicians would benefit by being more aware of the likely equipment usage during the cruise. P.S.O.s would benefit by becoming aware of the latest modifications and new acquisitions to the equipment li

3. There should be a more organised system for stock-keeping on board ship. Especially when there is no hand-over period among the technicians, there can be great confusion about what is stored where. On this cruise we had to be informed by radio from Barry that there was a spare PES on board. Also the stock of swivels and weak links was totally inadequate for a scientific cruise involving dredging and coring.

4. Communication between ship and R.V.S. is inadequate, most of the problem lying within R.V.S. On this cruise messages for spares for airguns and tape decks were acknowledged by Chris Adams but did not reach the departmental heads for action.

5. On the second leg the technicians on board were all rather specialised and this led to considerable strain on individuals during certain parts of the cruise. If it is to be a deliberate policy to encourage technicians to restrict themselves to particular specialities, then the total number of technicians carried on any cruise will have to be increased.