UNOLS
Rev. 4/83

CRUISE REPORT

SHIP UTILIZATION DATA

SHIP NAME	R/V CONRAD
CRUISE (LEG) NO.	27-11
AREA OF OPERATIONS:	Mid-ocean ridge 26°S, 14°W and 27°S, 26°W
DAYS AT SEA	29 (86) / 1 (87)
DAYS IN PORT	3 (86) / 1 (87)
OPERATING INST.	LDGO
DATES	Dec. 3, 1986 = Jan.2,87

PORT CALLS:

PLACE	DATES
Capetown	11-30-86/ 12-03-86
Rio di Janeiro	01-02-87/ 01-06-87

PARTICIPATING PERSONNEL

CODE	NAME	TITLE	AFFILIATION
1.	Cande, Steven C.	Ch. Sci.	LDGO
2.	Vogt, Peter R.	Co-Ch. Sci.	NRL
3.	Gilbert, Lewis E.	Scientist	LDGO
4.	Miller, Joyce E.	Scientist	URI

(over)

Use Reverse If Additional Space Required.

WAS RESEARCH CONDUCTED IN FOREIGN WATERS? NO COUNTRY: ______

PRIMARY PROJECTS (those which govern the principal operations, area and movements of the ship)

PROJECT TITLE AND PRINCIPAL INVESTIGATOR	SPONSORING ACTIVITY	GRANT OR CONTRACT NUMBER	PARTICIPATING PERSONNEL (AS CODED ABOVE)
Systematic Variations in Basement Morphology in the South Atlantic	ONR	N00014-84-C-0132	
DISCIPLINE			

ANCILLARY PROJECTS (which are accomplished on a not-to-interfere basis and contribute to the overall effectiveness of the cruise)

PROJECT TITLE AND PRINCIPAL INVESTIGATOR	SPONSORING ACTIVITY	GRANT OR CONTRACT NUMBER	PARTICIPATING PERSONNEL (AS CODED ABOVE)

SIGNATURE ______ DATE ______
CHIEF SCIENTIST

TOTAL SCIENTISTS 11 TOTAL TECHNICIANS 5
TOTAL GRAD STUDENTS 1 TOTAL STUDENTS/OBSERVERS ______

ATTACH PAGE SIZE CRUISE TRACK

COST ALLOCATION DATA

DAYS CHARGED	AGENCY OR ACTIVITY CHARGED	GRANT OR CONTRACT NO.
32 (1986)	NAVY	5-60844
2 (1987)	NAVY	5-60844

SIGNATURE Steven C. Cande

	NAME	TITLE	AFFILIATION
5.	Perram, Laura J.	Scientist	UC
6.	Abrams, Lewis J.	Scientist	URI
7.	Reynolds, Jennifer R.	Scientist	URI
8.	Blackman, Donna K.	Scientist	Brown U.
9.	Grindlay, Nancy R.	Scientist	URI
10.	O'Connor, John	Scientist	Oregon State U.
11.	Chayes, Daniel A.	Scientist	NRL
12.	Stennett, Joseph	Sci. Officer	LDGO
13.	Caplan, David M.	Tech. - Elec.	LDGO
14.	Robinson, Frank	Tech..- Air Gun	LDGO
15.	Iltzsche, Martin W.	Tech. - Compressor	LDGO
16.	LaBrecque, Steve P.	Tech.	LDGO

July 16, 1987

TO:

Barbee, W.D.	- UNOLS
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Raleigh, B.	- LDGO
Ruddiman, W.	- LDGO
Ryan, W.F.B.	- LDGO
Sykes, L.R.	- LDGO
Takahashi, T.	- LDGO
Science Officer	- CONRAD
Captain	- CONRAD

RESEARCH CRUISE REPORT

R/V ROBERT D. CONRAD 27-11

Attached is a copy of a cruise report for the above CONRAD cruise.

Ann Burns
Ann Burns
Marine Office

Enc.

FINAL CRUISE REPORT
RC2711

Introduction

Conrad 27-11 left Capetown on December 3, 1986 and arrived in Rio de Janeiro on January 2, 1987. The cruise was devoted almost entirely to underway geophysical data acquisition: Seabeam, magnetics, gravity, 3.5 kHz bathymetry, and single-channel seismics. Approximately 7000 n.m. of underway data were collected. There was one unsuccessful dredge station. About three dozen XBT's were dropped in the Benguela Current area. A plot of the track is shown in figure 1. The operations can be divided into 6 parts.

1. An E-W transit across the Cape Basin with Seabeam surveys of two seamounts, including the Vema Seamount.

2. A N-S transit of the Walvis Ridge following a Seasat/Geosat repeat track.

3. Data were collected along a flowline just south of and parallel to the Rio Grande Fracture Zone from anomaly 34 on the east flank to anomaly 34 on the west flank.

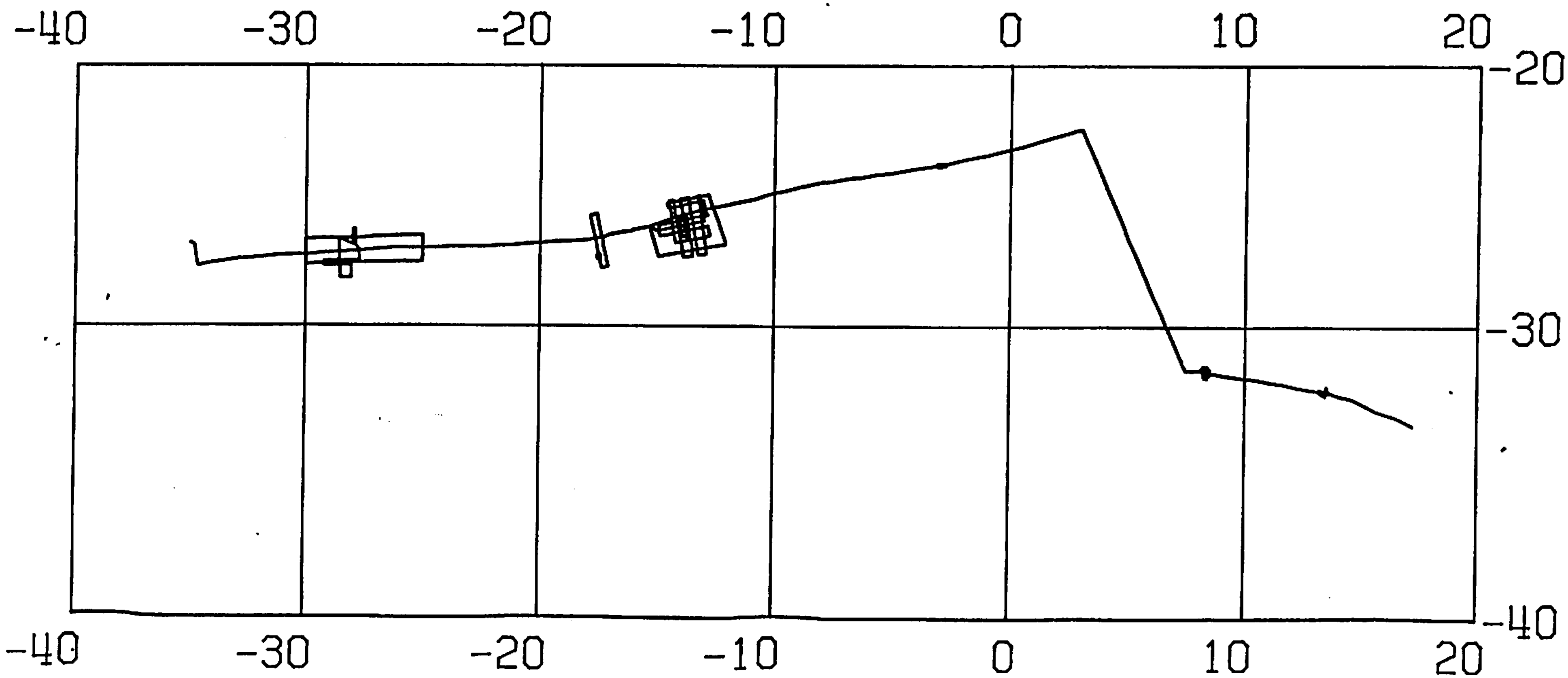
4. A detailed survey of the MAR between 25 and 28 degrees South, outlining the location and character of the rift valley sections and the location and offsets on the bounding Moore and Rio Grande fracture zones.

5. A detailed survey of the flowline between roughly anomalies 24 and 31 on the west flank, documenting the fracture zone offsets and locating the time (crustal age) of changes in basement relief.

6. A transit of the Brazil Basin crossing the Vema Channel and a basement high of unknown origin north of the flowline .

East-West Transit of the Cape Basin

The track out of Capetown crossed over two seamounts. The first seamount, unnamed on the charts and here dubbed the Phantom Seamount, was present on some charts and absent on others. The position of the seamount falls on a recently proposed hot spot track that terminates in a series of seamounts recognized by Chris Hartnady and his colleagues at the University of Capetown . These seamounts were observed on Haxby's Seasat derived free-air gravity map and their existence was documented by a recent cruise of the South African research vessel Proteus. The Phantom seamount is located roughly 500 km to the northeast of these seamounts and offered a chance to calibrate the age of this hotspot track. After a short underway survey of the seamount, a


-40
-30
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-20
-30
-40

dredge station was attempted, but no rocks were recovered.

A peculiar feature of the Phantom Seamount is that it has virtually no magnetic signature. The seamount may either be non-magnetic or else it may have formed during a period of rapid reversals.

The transit line then crossed the Vema seamount where we carried out a 16 hour reconnaisance survey of this classic seamount that rises from over 5000m to within 30 meters of the sea-surface. The Seabeam swaths revealed details of the struture of the seamount including a series of small cones on the flanks and possible rib-like structures on the sides. Contrary to rumours overheard in Capetown, we discovered that Vema seamount lobsters are not extinct: the Conrad officers deployed the Zodiac and rendezvouzed with one of two trawlers fishing the summit plateau. Rock lobsters sufficient for the next fantail barbeque were obtained in trade.

Xbt's were collected every four hours along the transit line between Capetown and the start of the Walvis Ridge transit. These had been requested by Arnold Gordon of LDGO.

North-South Transit of the Walvis Ridge

The track followed a Seasat/Geosat repeat track across the Walvis Ridge. This is the first time that shipboard gravity, magnetics, Seabeam bathymetry, seismics, and temperature/depth profiles have been collected at the same time satellite altimeter measurements were being made along the same track. Twenty-eight model T-7 Xbt's were dropped, one every two hours. The line crossed the Walvis Ridge at a point where it strikes nearly East-West and should provide good constraints on the structure of the Ridge.

A flowline south of the Rio Grande Fracture Zone

The track followed a flowline from anomaly 34 on the east flank to anomaly 34 on the west flank. This is the first track that follows a normal flowline from ridge flank to ridge flank in the South Atlantic. Peter Barker followed a flowline south of the Aghulas/Falkland Fracture Zone several years ago, but his flowline was characterized by several large ridge jumps. Because of good fracture zone control from Seasat, conjugate points on the flowline followed on Conrad 2711 were probably formed within 10 n.m. of each other on the ridge. This is apparent from the frequency with which topographic and magnetic features are seen in mirror image on the conjugate flanks.

The data along the flowline document a progression of changes, some abrupt and others more gradual, in basement roughness and magnetic anomaly amplitudes, and also constrain periods of asymmetric spreading. The data from the flowline will also provide a check on the recent revisions to the finite rotation poles for South Atlantic spreading.

This profile sets the stage for what we hope will be a continuing set of future studies centered on this flowline and adjacent fracture zones.

At two points along the flowline we conducted small surveys. On the east flank, we examined some particularly odd looking topography (characterized as having a "spiny backbone") between anomalies 27 and 26. On the west flank we made two N-S transverse crossings of the corridor near anomaly 6 in order to determine the spacing and character of the Rio Grande and Moore fracture zones and the cross-sectional shape of the crustal swath between the fracture zones. The westernmost of these transverse lines crossed the site of the first successful deep sea sounding, made by James Ross (who also discovered the North Magnetic Pole and was on his way south looking for the South Magnetic Pole) on the Erebus in 1840. We conducted a small survey of this site and located the most likely area of Ross' 4435m measurement.

Mid-Atlantic Ridge Survey

The ridge survey focused on a corridor between anomaly 3a on both flanks of the ridge and straddled the Rio Grande and Moore fracture zones. The survey documented several features of the region.

The present day offsets of both the Rio Grande and Moore transform faults are quite small. The Rio Grande F.Z. has roughly a 30 km right-lateral offset and the Moore F.Z. has about a 10 km left-lateral offset. At least for crust younger than anomaly 3a, there is no evidence for any transform-type feature midway between the Rio Grande and Moore fracture zones corresponding to the major (140 km offset) fracture zone observed in the area of the ridge flank survey. The offset at the Moore Transform Fault appears to be in the process of disappearing entirely and the rift valley segment to the south may be starting to propagate northwards, either joining or passing the rift valley north of the Moore F.Z. If the rift valleys are joined by a short oblique segment, then the present Moore F.Z. resembles the Kurchatov F.Z. and similar "ridge axis discontinuities." The rift valley south of the Moore F.Z. is narrower than the one north of the F.Z.

The magnetic anomalies indicate that the offset of the Moore F.Z. has been decreasing rapidly (by faster spreading on the east flank) and possibly irregularly within the last 3 m.y.; if the average rate is extrapolated into the future, the offset will have disappeared entirely within 1 m.y. There is a lesser amount of asymmetric spreading (also faster on the east flank) north of the Rio Grande F.Z. which also tends to decrease the offset on this transform fault, although at a slower rate.

A profile along the axis of the rift valley revealed two prominent seamounts, Hump and Halfway seamounts, straddling the axis. The seamount in the section between the Moore and Rio Grande fracture zones , which we refer to as the The Hump, with a summit depth of 2550m, has about 1000 m of relief and, above 3200 m, is cylindrically symmetrical in appearance. It is located closer to the Rio Grande fracture zone than to the Moore F.Z., but the along-axis profile indicates that it influences the entire section of the rift valley. The Seabeam lines show what may be the split remnants of an older volcanic feature now preserved as highs on the crest of the rift valley walls a few miles south of the center of The Hump. It appears that the axial seamount along the rift valley section north of the Rio Grande F.Z. is not as symmetrical in shape and is smaller, although this conclusion is based on only a single crossing. The association of axial seamounts with wide rift valleys (the narrow rift valley south of the Moore F.Z. lacks such seamounts) may be significant in terms of rift valley evolution. From our incomplete mapping of the two axial seamounts it appears that neither is significantly divided by faulting and therefore both must be geologically very young. Both seamounts are relatively weakly magnetized and in fact appear to be associated with weakly magnetized (reheated?) crust.

We note that the Moore F.Z. appears to be similar to the small offset transform mapped between the Easter and Christmas fracture zones at 33 degrees South. Both fracture zones have similar present day offsets and both exhibit much larger offsets on the ridge flanks.

No obvious off-axial seamounts were discovered in the region of the ridge crest survey.

West Flank Survey

A regional survey of the corridor was undertaken between 25 and 30 degrees west, corresponding rougly to Paleocene and early Eocene age crust. The objective of this survey was to determine the amount of offset on the various fracture zones (along this section of the cooridor there is a prominent fracture zone midway between the Moore and Rio Grande fracture zones, which we refer to as the Midway F.Z.) and to look for systematic variations in basement topography.

Three longish east-west lines determined the basic offsets on the fracture zones as being 100km right lateral on the Rio Grande F.Z., 140 km left-lateral on the Midway F.Z. and 100 km left-lateral on the Moore F.Z. Another 100 km of right-lateral offset is taken up on the next fracture zone north of the Rio Grande F.Z.

The east-west line along the swath between the Midway and Moore fracture zones revealed a strikingly fracture zone parallel grain and suggested that there was a secondary shear zone within this swath. Two additional east-west lines were run within this swath, straddling the original line, in an effort to determine the amount of offset from the magnetics. Unfortunately, the magnetic anomaly pattern is ambiguous, although the favored interpretation would give about 70 km of left-lateral offset.

The east-west lines also revealed some systematic changes in basement relief. To some extent , the basement relief on crust older than anomaly 30 can be characterized as smooth, while the basement topography between anomalies 28 and 24 can be characterized as rough. There is an abrupt transition between these two zones around anomaly 29. This transition zone shows up best on the northernmost swath between Rio Grande and Midway fracture zones, The transition zone and onset of the rougher topography is temporally related to the time of an abrupt change in the path of the stage poles (i.e. the hairpin loop) and to the time of the slowdown in spreading rates. It may prove to be a major tectonic marker in the South Atlantic. Before leaving the area, we just had time to start a more detailed survey of the transition zone on the northern swath.

Seismic profiles show sediments to be rather thin (less than a few hundred meters) and conformable throughout the west flank survey except within the fracture zone valleys. Thus seafloor topography mapped by Seabeam closely reflects the basement topography of primary interest to this cruise.

Recommendations for the second leg

Both the ridge flank and ridge axis surveys revealed interesting targets that can be the focus of more detailed surveys on the second leg. Both areas need more regional type lines to fill in the broader tectonic picture.

1) The ridge crest area

The Moore Fracture Zone seems to have the most interesting tectonic story. This seems to be a transfom fault heading towards extinction and even now the rift valleys may be joined together by an oblique valley. A detailed survey of the Moore Transform Fault and the adjacent rift valleys will reveal the present state of connectivity between the rifts. Following the fracture zones out onto the ridge flanks will show what happened during the dying phase of the fracture zone. However, careful mapping of the magnetic lineations on both sides of the fracture zone out to anomaly 5 will be required to establish the offset history.

The second target of interest is the Hump and Halfway seamounts, situated squarely on the rift valley axis without any indication of rift structures on the summit. These seamounts are considerably larger than the axial volcanoes previously observed in the Central Atlantic (e.g. Mount Pluto and Venus in the FAMOUS area). It is not clear whether central volcano development has recurred at the site of The Hump, thereby leaving a topographic trail on the ridge flanks.

The Rio Grande F.Z. appears to be a more typical fracture zone, although of shorter offset than the Easter and Christmas fracture zones. The structures here may form the small-offset end of a continuum of structures already observed along larger-offset fracture zones.

There is also a need for a few long east-west lines continuing the magnetic anomaly sequence out to anomaly 5 on both flanks, both north and south of the Moore F.Z.

2) The west flank survey

The topographic transition zone between anomalies 28 and 29 presents a natural target for detailed work. Near this transition on the various swaths can be obserevd several of the major types of bathymetric relief that have been observed in the area. A detailed survey that straddles the transition on two swaths would reveal the type of variation that occurs on independent recordings of this tectonic event.

Several long north-south lines cutting all of the fracture zones are needed to better characterize the cross-sectional shape of the corridor. The few north-south lines that we collected revealed interesting profiles and more are needed.

3) The transit lines

The most useful flowlines to be followed would be along the swath between the Midway and Moore fracture zones and returning along a flowline south of the Moore F.Z. The age offset north of the Rio Grande F.Z. is already fairly well constrained by a long Glomar Challenger line, while there are considerable gaps in our knowledge of the spreading history straddling the Moore F.Z.

Equipment, Etc.

The underway geophysical gear worked almost flawlessly thanks to the relentless efforts of the technical staff. We started shooting seismics after passing 200 n.m. from South Africa, using initially 2 waterguns. At the end of the Walvis Ridge transit, we dropped to 1 watergun. After the initial pass through the ridge crest area, we stopped shooting seismics for about six days. Seismics were resumed along the transit out to the west flank area and used during the entire flank survey. Two guns were deployed for the final run up to the Brazil 200 mile limit. The 3.5 kHz Profiler, in operation for most of the cruise, was secured for most of the MAR crestal survey and in some other areas because interference produced artifacts in the Seabeam data.

Data reduction was a multi-group effort. The Seabeam group provided navigation and seabeam plots and generated raw files of time versus magnetics,gravity and center beam values. Both the

Lamont group and the NRL group processed and plotted the previous day's magnetics,gravity and center beam values. Watchstanders in the Main Lab maintained a continuous real-time plot of magnetics and bathymetry versus time at 5 minute intervals.

Personnel

Steven Cande	Chief Scientist	LDGO
Peter Vogt	Co-Chief Scientist	NRL
Daniel Chayes	Observer	NRL
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Laura Ferram	Student-observer	UCSB
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Lew Abrams	Student-observer	URI
John O'Conner	Student-observer	Oregon State
Jennifer Reynolds	Technician	URI
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James Ferguson	SeaBeam Technician	URI
Joseph Stennett	Science Officer	LDGO
Steve LaBrecque	Electronics Tech.	LDGO
Frank Robinson	Deck Technician	LDGO
David Caplan	Programmer	LDGO
Martin Iltzsche	Air Gunner	LDGO

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