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RRS JAMES CLARK ROSS
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GRACE Evaluation Experiment

G.W. Hargreaves

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ABSTRACT

GRACE is a USA/German experiment consisting of two polar orbiting satellites, 220km apart, connected by a microwave link that measures their separation to one hundredth of a millimetre. As the gravitational pull of a mass on the earth attracts first one satellite, then the other, a characteristic change in their separation occurs, which allows the earth's gravity field to be mapped. Changes in the gravity field allow mapping of changes in the earth's surface mass distribution. Over the ocean, this is equivalent to bottom pressure.

To provide in-situ data to calibrate computer models, three BPRs were deployed in the Argentine basin around the Zapiola Ridge where a significant signal is expected.

The Sea Level Recorder at Stanley, Falkland Islands was also serviced.

ISSUING ORGANISATION	TELEPHONE: **(0151) 653 8633**
Proudman Oceanographic Laboratory **Bidston Observatory** **Bidston** **Prenton** **CH43 7RA** **UK** **Director: Dr A.E Hill**	FAX: **(0151) 653 6269** TELEX: **628591 OCEAN BG**

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CRUISE PERSONNEL

POL Personnel

Principal Scientist	Geoff Hargreaves
Higher Scientific Officer	Mike Smithson

Ship Personnel

Captain	Christopher Elliot
Chief Officer	Robert Patterson
Second Officer	Kim Cooling
Third Officer	Mike Golding
Chief Engineer	Dave Cutting
Second Engineer	Bill Kerswell
Third Engineer	Gerard Armour
Fourth Engineer	Steve Eadie
Deck Engineer	Simon Wright
Radio Officer	Charlie Waddicor
Bosun	George Stewart

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OVERVIEW

GRACE is a joint US/German satellite gravity mission launched on 17th March 2002, which promises to be capable of detecting changes in ocean bottom pressure over a five-year period. It consists of a pair of satellites, 220 km apart and 500 km above the earth, with a microwave link measuring their separation to a precision of one hundredth of a millimetre. As the gravitational pull of a mass on the earth attracts first one, then the other satellite, a characteristic change in their separation occurs, which allows the earth's gravity field to be mapped. Changes in the gravity field allow mapping of changes in the earth's surface mass distribution. Over the ocean, this is equivalent to bottom pressure.

The potential of this new observing system as the only method of monitoring global changes in the abyssal ocean circulation is enormous. There is, however, one major obstacle. The satellite will complete enough measurements for a global solution over a period of about 30 days. Any bottom pressure changes with shorter periods will alias into that solution unless they can be modelled and subtracted out.

In order to see whether the models are accurate enough, and to check whether the resulting satellite pressure measurements agree with the actual pressure signal, in-situ pressure measurements are required in a region where a significant signal is expected. The largest bottom pressure signals in models are in three areas in the Southern Ocean - the SE Pacific, SE Indian, and SW Atlantic (Argentine basin). The Argentine basin is also of interest because of a high frequency (about 25 day period) barotropic signal which has been detected using altimetry. It has only recently been recognised that such barotropic signals, other than tides, are a cause of significant aliassing in altimetry measurements, and an unambiguous, temporally resolved confirmation of this inference would be of great interest to the altimetry community.

In order to unambiguously identify the spatial structure of the 25 day signal, and to provide an estimate of the spatial coherence of this and other bottom pressure signals for comparison with GRACE results, a set of three bottom pressure recorders is to be deployed in the Argentine basin, in a triangle centred on the amphidrome of the 25 day wave as inferred from altimetry, and wide enough to sample the amplitude maximum of the wave. This configuration also approximately matches the spatial resolution of GRACE, permitting validation of satellite measurements and models.

POL CRUISE OBJECTIVES

1) To service the Sea Level Recorder at Port Stanley, Falkland Islands.
2) To deploy three BPRs around the Zapiola Ridge.

SHIP PREPARATION

POL personnel, Geoff Hargreaves and Mike Smithson, joined RRS James Clark Ross at Port Stanley, Falkland Islands on May 5, 2002. The equipment was quickly located, unpacked and stowed safely.

SERVICING STANLEY SEA LEVEL RECORDER 5/5/2002

The Stanley Sea Level Recorder (SLR) consists of two logging systems, one measuring tidal information and the other measuring wave information. The tide logger samples data every 15 minutes and transmits the data via a satellite link to the UK four times a day. The wave logger samples data every one second and is connected to the telephone network via a modem.

Both tide and wave loggers were operating well. The data stored locally on the tide logger was downloaded and timing errors were noted. The logger was then re-started. No servicing was performed to the wave logger.

Stanley Sea Level Recorder Servicing Summary

Servicing the tide logger went smoothly and the data was successfully recovered.

DEPLOYMENT OF BPR (GRACE 1) 15/5/2002

EVENTS

03.20 GMT	Vessel on station
03.30 GMT	Released into the water
04.52 GMT	On the seabed

Total time on station: 1 hour 32 minutes

BPR (GRACE 1) Deployment Summary

The BPR was monitored to the seabed using the acoustic release. Reception was difficult beyond a depth of 4500m but was re-established again at the seabed. Acoustic conditions were excellent with absolutely no noise being generated by the ship. This meant a high gain setting could be used on the deck unit.

DEPLOYMENT OF BPR (GRACE 2) 15/5/2002

19.17 GMT	Vessel on station
19.25 GMT	Released into the water
20.41 GMT	On the seabed

Total time on station: 1 hour 24 minutes

BPR (GRACE 2) Deployment Summary

The deployment went smoothly. The acoustic transponder performed well to 4500m and then it became difficult to receive any signals. Communication was regained when the unit was on the seabed.

DEPLOYMENT OF BPR (GRACE 3) 16/5/2002

EVENTS

16.47 GMT	Vessel on station
16.52 GMT	Released into the water
18.15 GMT	On the seabed

Total time on station: 1 hour 23 minutes

BPR (GRACE 3) Deployment Summary

The deployment went smoothly. The unit was monitored on its descent using the acoustic release. It was difficult to communicate with the unit below 3500m. Only one reading was obtained when the unit was thought to be on the seabed.

CONCLUSIONS

All of the objectives were achieved.

APPENDIX 1 - BPR TECHNICAL INFORMATION

STANLEY SEA LEVEL RECORDER INFORMATION

The system at Stanley is situated at the floating quay of FIPAS. It consists of two separate logging systems: a tide logger storing samples every fifteen minutes to a memory card (SRAM) and also a wave/tide recorder that is sampling every one second and is storing data to a CompactFlash card. The wave/tide logger is also connected to a telephone line via a modem and can be contacted from the UK.

The tide logger was serviced and the data recovered.

Timebase scan

Expected	Actual
17.45.00 GMT on 5/5/2002	17.44.16 GMT on 5/5/2002

The raw data were downloaded from the memory card and stored as stan2002.raw

The SRAM memory card was replaced with another card fitted with a new backup lithium battery.

Sensors fitted.

Full Tide	DQ 47594
Half Tide	DQ 47598
Barometer	DQ 39239

Tide logger (TDS) timebase started at 19.00.00 GMT on 5/5/2002
First scan at 19.15.00 GMT on 5/5/2002

BPR (GRACE 1) DEPLOYMENT INFORMATION

Location details	-	***Latitude 46°46.24' S***
		Longitude 043°26.89' W
		Depth 5587m
On station	-	03.20 GMT on 15/5/2002
Release into the water	-	03.30 GMT
On the seabed	-	04.52 GMT

The BPR is fully contained within a 17” glass sphere and mounted in a tripod ballast frame.
The deployment went very smoothly and it was possible to monitor the acoustic release to the seabed. Communication became dificult below 4500m but was regained at the seabed.

Acoustic Information

Benthos XT6000 67000	-	Rx 11.0 kHz, Tx 12.0 kHz, Release C	

The release is a burnwire mechanism that gives a four ping acknowledgement once the burn command has been received.

Logger

Logger PG1 fitted with DQ87200 and DQ 87202

DQ 87200	-	Temperature frequency	171.733 kHz
		Pressure frequency	32.855 kHz
DQ 87202	-	Temperature frequency	170.889 kHz
		Pressure frequency	33.045 kHz

Timebase started at 18.00.00 GMT on 7/5/2002
First scan at 18.15.00 GMT on 7/5/2002

Recovery Equipment

Benthos radio beacon	-	154.585 MHz, Channel A

Battery Information

Acoustic	-	Red	14.52V
		Orange	14.52V
Burnwire	-	28.8V	
Logger	-	Red	14.50V
		Orange	14.50V

BPR (GRACE 2) DEPLOYMENT INFORMATION

Location details	-	***Latitude***	***44°25.197' S***
		Longitude	***040°22.185 ' W***
		Depth	***5114m***
On station	-	19.17 GMT on 15/5/2002	
Released into the water	-	19.25 GMT	
On seabed	-	20.41 GMT	

The BPR is fully contained within a 17” glass sphere and mounted in a tripod ballast frame.
The deployment went very smoothly and it was possible to monitor the acoustic release to the seabed. Communication became dificult below 4500m but was regained at the seabed.

Acoustic Information

Benthos XT6000 (67021)	-	Rx 11.5 kHz, Tx 12.0 kHz, Release C	

The release is a burnwire mechanism that gives a four ping acknowledgement once the burn command has been received.

Logger

Logger PG2 with sensors DQ 87195 and DQ 87198

DQ 87195	-	Temperature frequency	171.571 kHz
		Pressure frequency	33.014 kHz
DQ 87198	-	Temperature frequency	170.331 kHz
		Pressure frequency	33.048 kHz

Timebase started at 18.45.00 GMT on 7/5/2002
First scan at 19.00.00 GMT

Recovery Equipment

Benthos radio beacon	-	154.585MHz Channel A

Battery Information

Acoustic battery	-	Red	14.46V
		Orange	14.46V
Burnwire battery	-	28.5V	
Logger battery	-	Red	14.47V
		Orange	14.46V

BPR (GRACE 3) DEPLOYMENT INFORMATION

Location details	-	***Latitude***	***43°11.90' S***
		Longitude	***045°18.10' W***
		Depth	***5141m***
On station	-	16.47 GMT on 16/5/2002	
Release into the water	-	16.52 GMT	
On the seabed	-	18.15 GMT	

The BPR is fully contained within a 17” glass sphere and mounted in a tripod ballast frame.
The deployment went very smoothly and it was possible to monitor the acoustic release to the seabed. Communication became dificult below 3500m and only one reading was obtained when the unit was on the seabed.

Acoustic Information

Benthos XT6000 67012 - Rx 10.5kHz, Tx 12.0kHz, Release C

The release is a burnwire mechanism that gives a four ping acknowledgement once the burn command has been received.

Logger

Logger PG3 with sensors DQ 87193 and DQ 87194

DQ 87193	-	Temperature frequency	172.022 kHz
		Pressure frequency	33.079 kHz
DQ 87194	-	Temperature frequency	170.022 kHz
		Pressure frequency	33.038 kHz

Timebase started at 00.15.00 GMT on 7/5/2002

First scan at 00.30.00 GMT on 7/5/2002

Recovery Equipment

Benthos radio beacon - 154.585 MHz, Channel A.

Battery Information

Acoustic release	-	Red	14.47V
		Orange	14.48V
Burnwire	-	28.5V	
Logger	-	Red	14.47V
		Orange	14.46V

GLOSSARY

ACCLAIM	-	Antarctic Circumpolar Current levels from Altimeter and Island Measurements
BPR	-	Bottom Pressure Recorder
EPROM	-	Erasable Programmable Memory
FIPASS	-	Falkland Islands Passenger and Sea Service
GMT	-	Greenwich Mean Time
GRACE	-	Gravity Recovery And Climate Experiment
POL	-	Proudman Oceanographic Laboratory
SLR	-	Sea Level Recorder
SRAM	-	Static Random Access Memory
TDS	-	Triangle Digital Services