SOUTHAMPTON OCEANOGRAPHY CENTRE

CRUISE REPORT No. 57

RRS *CHARLES DARWIN* CRUISE CD168
02 FEB - 16 FEB 2005

Submarine landslides around
the Cape Verde Islands

Principal Scientist
D G Masson

2005

Challenger Division for Seafloor Processes
Southampton Oceanography Centre
University of Southampton
Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6568
Fax: +44 (0)23 8059 6554
Email: dgm@noc.soton.ac.uk

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AUTHOR
MASSON, D G et al

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ABSTRACT

Catastrophic large-scale landslides are a fundamental process in the formation of many oceanic islands. The main aim of cruise CD168 was to carry out a reconnaissance survey of the influence of landsliding on the Cape Verde islands, in the eastern central Atlantic, and to compare this with the known effects of landsliding on the Canary Islands. The data collected during RRS *Charles Darwin* Cruise, when combined with synthetic aperture radar imagery of the subaerial islands, show clear evidence for geologically young landslides off Fogo and Santo Antao, supporting the interpretation that these islands are the youngest and most active in the group. An extensive debris apron, covering an area of about 1000 km^3, occurs to the east of Fogo, confirming the onshore amphitheatre as a landslide scar. Debris avalanche deposits are recognised to the north and south of Santo Antao, with at least two phases of geologically recent landsliding recognised to the south. The slopes of many of the older islands are deeply incised by submarine canyons, making recognition of old landslides difficult. However, preliminary analysis of slope profiles suggests that some palaeo-landslide areas are still recognisable.

KEYWORDS

Cape Verde Islands, *Charles Darwin*, cruise 168 2005, multibeam bathymetry

ISSUING ORGANISATION

Southampton Oceanography Centre
Empress Dock
European Way
Southampton SO14 3ZH UK

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SCIENTIFIC PERSONNEL

MASSON, D.G. (Principal Scientist)	Southampton Oceanography Centre, UK
LE BAS, T.P.	Southampton Oceanography Centre, UK
HUVENNE, V.A.I.	Southampton Oceanography Centre, UK
SZUMAN, M.	Southampton Oceanography Centre, UK
LE BAS, M. J.	Southampton Oceanography Centre, UK
MICALLEF, A.	Southampton Oceanography Centre, UK
MOODY, M.	Seabird Observer

SHIP"S PERSONNEL

SARGEANT, P.	Master

ITINERARY

Departed	Las Palmas, Gran Canaria	2nd February, 2005
Arrived	Mindelo, San Vicente, Cape Verde Islands	16th February, 2005

CRUISE OBJECTIVES

Catastrophic large-scale landslides are a fundamental process in the formation of many oceanic islands. The main aim of cruise CD168 was to carry out an initial reconnaissance survey of the influence of landsliding on the Cape Verde islands, in the eastern central Atlantic, in an area where subaerial evidence suggests the occurrence of landslides but where limited previous offshore work had been undertaken. The main objectives of the study were to determine the extent of submarine landslides, the nature of the landslide processes, and the overall influence of landsliding on island evolution. A short survey of the distal part of the Cape Timiris Channel, at 20° 30' N and just outside the Mauritanian 200 mile limit, was carried out during the passage between Gran Canaria and the Cape Verdes.

NARRATIVE

31st January, 2005.

2000. Scientific party embarked on RRS *Charles Darwin*.

1st February, 2005.

0000-2400. Awaiting delivery of equipment containers required for CD169.

2nd February, 2005.

0800-1030. Loaded containers for CD 169.

1030-1200. Waiting for pilot

1200. Sailed from Gran Canaria

1200-2400. Passage towards Cape Verde Islands.

3rd February, 2005.

0000-2400. Passage towards Cape Verde Islands.

4th February, 2005.

0000-1200. Passage towards Cape Verde Islands.

1200-1205. Launch 3.5 kHz fish.

1208-2018. Multibeam survey of distal Cape Timiris Channel.

2018-2400. Passage towards Cape Verde Islands.

5th February 2005.

0000-1840. Passage towards Cape Verde Islands.

1900-2150. Complete sound velocity probe deployment.

2150-2320. Process and enter SVP data into EM12.

2320-2400. Run EM12 calibration lines.

6th February 2005.

0000-0400. Complete EM12 calibration lines.

0400-2400. Begin EM12 survey north of the western Cape Verde Islands

7th February 2005.

0000-2400. Continue EM12 survey north of the western Cape Verde Islands.

8th February 2005.

0000-2400. Continue EM12 survey north of the western Cape Verde Islands.

9th February, 2005.

0000-0800. Complete EM12 survey north of the western Cape Verde Islands.

0800-1000. Passage to east of Sao Nicolau Island to begin survey south of the western Cape Verde Islands.

1000-2400. Begin survey south of the western Cape Verde Islands.

10th February, 2005.

0000-2400. Continue survey south of the western Cape Verde Islands.

11th February, 2005.

0000-2400. Continue survey south of the western Cape Verde Islands.

12th February, 2005.

0000-2400. Continue survey south of the western Cape Verde Islands.

13th February, 2005.

0000-0400. Complete survey south of the western Cape Verde Islands.

0400-1400. Passage SE to vicinity of Island of Fogo.

1400-2400. Survey south and east of Fogo, filling gaps in swath coverage opportunistically obtained during RV *Meteor* cruise 62-3.

14th February, 2005.

0000-2400. Survey west flank of Santiago Island and continue filling of gaps in RV *Meteor* data between Santiago and Fogo.

15th February, 2005.

0000-0230. Complete survey of gaps in RV *Meteor* data between Santiago and Fogo.

0230-1015. Return passage to area south of San Vincente island.

1015-1715. Complete survey south of San Vincente island.

1715-1800. Recover 3.5 kHz fish.

1800-2100. Passage to Midelo, San Vincente island.

16th February, 2005.

0800-1100. Demobilisation.

1100. Science party leave vessel.

EQUIPMENT REPORTS

XBT

XBT type 5 were deployed on the following days. The temperature profiles were converted to sound velocity using a uniform salinity of 35.

Date	Time
07/02/05	14:05:04
09/02/05	10:59:40
10/02/05	12:10:29
11/02/05	13:11:27
12/02/05	12:41:30
14/02/05	13:03:38
15/02/05	14:14:04

Navigation

Differential corrected navigation was available throughout the cruise except for between 4th Feb 08:30:00 and 7th Feb. This was due to the ship traveling out of the European seastar coverage area. This was remedied by contacting Fugro, and having the range extended to cover the Cape Verde working area.

EM12

The EM12 swath was started up soon after leaving Las Palmas at 1300 on the 3rd Feb and logging started soon after. The first XBT was used to alter the existing sound velocity profile in the EM12. Upon reaching the Cape Verde working area, the sound velocity probe was lowered to near the sea bed. This sound velocity was used for the rest of the survey with daily XBTs to look for any major changes in the water column.

Neptune

The Neptune software was used to display a real time seabed image simultaneously to the main lab and bridge. The Neptune software was also used to display planned survey lines overlaid with coverage. The bridge display was connected as a mirrored display via a cat 5 extender.

Processing

It was agreed at the cruise planning meeting, that the swath processing would be carried out by the scientific party. Assistance was given to ensure that they were able to do this effectively.

3.5kHz Sub Bottom Profiler / Octopus

A new 3.5kHz data recorder named Octopus was used throughout the cruise. The data files *.seg were backup up to DVD media on a daily basis, at a rate of approximately one 4.3GB DVD per day. A paper copy was also produced in real time on the Raytheon recorder.

Swath

Filename format: LINE_DDMMYY_HHMMSS_raw.all

From mermaid:

	Raw files	*.all
	files in proc	*.depth, *.ind, *.para, *.pos, *.sfsvp, *.sidescan

From Aquavit:

	files in proc	*.depth, *.ind, *.para, *.pos, *.sfsvp, *.sidescan
	files in xyz	*.xyz, *.xyz.ascii

Octopus

Filename format: SB_YYMMDDHHMMSS.seg

Data Loss (Level B failure)

Several short data gaps occurred due to level B failure. These are listed as follows

12th Feb 18:04:55 to 18:11:27
12th Feb 18:13:09 to 18:15:06
12th Feb 18:18:48 to 18:24:35
14th Feb 19:41:02 to 19:44:20
14th Feb 19:44:48 to 19:47:35
14th Feb 19:48:03 to 19:49:23

SUMMARY OF RESULTS

The data collected during RRS *Charles Darwin* Cruise, when combined with synthetic aperture radar imagery of the subaerial islands, show clear evidence for geologically young landslides off Fogo and Santo Antao, supporting the interpretation that these islands are the youngest and most active in the group. An extensive debris apron, covering an area of about 1000 km^3, occurs to the east of Fogo, confirming the onshore amphitheatre as a landslide scar. Debris avalanche deposits

are recognised to the north and south of Santo Antao, with at least two phases of geologically recent landsliding recognised to the south. The slopes of many of the older islands are deeply incised by submarine canyons, making recognition of old landslides difficult. However, preliminary analysis of slope profiles suggests that some palaeo-landslide areas are still recognisable.

TABLES

Table 1. Waypoints for multibeam survey of Cape Timiris Channel

Way point number	Latitude	Longitude
1	20° 36.0'N	20°40.0'W
2	20° 31.0'N	20° 48.0'W
3	20° 36.0'N	20° 46.0'W
4	20° 21.5'N	20° 34.0'W

Table 2. Waypoints for multibeam calibration lines

Way point number	Latitude	Longitude
1	17° 30.0'N	23° 30.0'W
2	17° 30.0'N	23° 35.0'W
3	17° 30.0'N	23° 35.0'W
4	17° 30.0'N	23° 30.0'W
5	17° 32.0'N	23° 32.5'W
6	17° 28.0'N	23° 32.5'W

Table 4. Waypoints for multibeam survey of the Cape Verde Islands

Way point number	Latitude	Longitude
1	17° 23.5'N	23° 30.5'W
2	16° 31.5'N	23° 42.2'W
3	16° 40.0'N	24° 10.0'W
4	16° 44.2'N	24° 27.5'W
5	16° 54.7'N	24° 43.0'W
6	17° 13.4'N	25° 02.2'W
7	17° 14.4'N	25° 26.3'W
8	17° 16.8'N	25° 26.3'W
9	17° 15.5'N	25° 00.1'W
10	16° 56.4'N	24° 40.5'W
11	16° 46.2'N	24° 23.5'W
12	16° 41.8'N	24° 24.5'W
13	16° 42.1'N	24° 29.0'W
14	16° 50.3'N	24° 39.3'W
15	16° 54.0'N	24° 45.7'W
16	17° 04.0'N	24° 55.5'W
17	17° 03.0'N	24° 56.5'W
18	16° 52.0'N	24° 45.8'W
19	16° 49.5'N	24° 40.0'W
20	16° 42.4'N	24° 33.4'W
21	16° 40.5'N	24° 28.2'W
22	16° 40.7'N	24° 25.8'W
23	16° 47.3'N	24° 26,5'W
24	16° 44.8'N	24°.22.6'W
25	16° 36.2'N	23° 49.8'W
29	17° 23.0'N	25° 22.7'W

30	17° 22.4’N	25° 07.0’W
31	17° 22.2’N	24° 56.5’W
32	17° 01.1’N	24° 34.3’W
33	16° 51.6’N	24° 18.0’W
37	16° 43.2’N	23° 47.9’W
38	16° 43.1’N	24° 00.3’W
39	16° 47.3’N	24° 14.9’W
40	16° 50.7’N	24° 15.2’W
41	16° 47.6’N	23° 38.6’W
42	16° 47.6’N	23° 47.0’W
43	16° 36.0’N	23° 49.6’W
44	16° 28.0’N	23° 54.0’W
45	16° 28.1’N	24° 10.0’W
46	16° 22.0’N	24° 18.6’W
47	16° 15.5’N	23° 56.2’W
48	16° 20.5’N	23° 55.0’W
49	16° 23.6’N	24° 13.3’W
50	16° 22.3’N	24° 16.4’W
51	16° 26.5’N	24° 25.0’W
52	16° 31.0’N	24° 28.8’W
53	16° 31.5’N	24° 26.8’W
54	16° 22.0’N	24° 18.6’W
55	16° 34.5’N	24° 43.0’W
56	16° 38.4’N	24° 45.3’W
57	16° 40.8’N	24° 53.0’W
58	16° 42.3’N	24° 51.1’W
59	16° 41.2’N	24° 46.2’W
60	16° 39.3’N	24° 43.8’W
61	16° 34.5’N	24° 40.5’W
62	16° 35.0’N	24° 44.8’W
63	16° 43.0’N	25° 05.5’W
64	16° 54.8’N	25° 22.2’W
65	17° 02.7’N	25° 25.8’W
66	17° 03.5’N	25° 24.0’W
67	16° 53.5’N	25° 20.0’W
68	16° 54.9’N	25° 23.8’W
69	17° 09.5’N	25° 34.8’W
70	17° 20.0’N	25° 25.0’W
71	17° 22.4’N	25° 26.8’W
72	17° 18.4’N	25° 33.0’W
73	17° 17.6’N	25° 31.9’W
74	17° 18.2’N	25° 30.2’W
75	17° 20.3’N	25° 28.1’W
76	17° 17.8’N	25° 33.3’W
77	17° 13.4’N	25° 39.4’W
78	17° 04.5’N	25° 33.4’W
79	17° 00.9’N	25° 27.3’W
80	16° 56.8’N	25° 25.3’W
81	16° 02.9’N	25° 36.5’W
82	17° 14.7’N	25° 42.5’W

83	17° 24.9’N	25° 29.2’W
84	17° 27.9’N	25° 31.5’W
85	17° 16.3’N	25° 46.4’W
86	16° 59.6’N	25° 40.7’W
87	16° 53.2’N	25° 23.8’W
88	16° 41.8’N	25° 08.6’W
89	16° 33.4’N	24° 47.2’W
90	16° 29.4’N	24° 38.7’W
91	16° 23.0’N	24° 28.0’W
92	16° 18.8’N	24° 20.3’W
93	16° 20.3’N	24° 19.5’W
94	16° 22.3’N	24° 21.6’W
95	16° 23.2’N	24° 26.1’W
96	16° 21.2’N	24° 22.0’W
97	16° 18.6’N	24° 19.7’W
98	16° 10.0’N	23° 57.6’W
99	16° 04.4’N	23° 59.6’W
100	16° 23.0’N	24° 37.1’W
101	16° 30.9’N	24° 52.1’W
102	16° 41.3’N	25° 14.1’W
103	16° 50.3’N	25° 24.8’W
104	16° 54.0’N	25° 41.9’W
105	16° 49.6’N	25° 44.0’W
106	16° 47.4’N	25° 25.7’W
107	16° 42.7’N	25° 20.8’W
108	16° 42.3’N	25° 40.1’W
109	16° 36.1’N	25° 40.1’W
110	16° 37.9’N	25° 12.2’W
111	15° 10.5’N	24° 25.3’W
112	15° 10.5’N	24° 19.8’W
113	15° 06.0’N	24° 16.8’W
114	14° 59.0’N	24° 16.8’W
115	14° 52.8’N	24° 16.0’W
116	14° 48.6’N	24° 18.5’W
117	14° 47.2’N	24° 22.0’W
118	14° 40.0’N	24° 15.0’W
119	14° 39.5’N	24° 30.0’W
120	14° 33.0’N	24° 41.8’W
121	14° 32.0’N	24° 40.5’W
122	14° 32.0’N	23° 59.4’W
123	14° 36.6’N	23° 56.5’W
124	14° 55.0’N	23° 53.8’W
125	15° 04.7’N	23° 53.3’W
126	15° 25.0’N	23° 47.4’W
127	15° 25.0’N	23° 45.0’W
128	15° 19.2’N	23° 47.5’W
129	15° 15.3’N	23° 47.6’W
130	15° 04.2’N	23° 51.5’W
131	15° 01.3’N	23° 51.8’W
132	14° 58.0’N	23° 50.6’W

133	14° 58.0’N	23° 58.6’W
134	15° 28.0’N	23° 52.2’W
135	15° 28.0’N	24° 00.0’W
136	15° 20.7’N	24° 02.5’W
137	15° 14.0’N	24° 07.8’W
138	15° 09.5’N	24° 09.0’W
139	15° 14.0’N	24° 17.7’W
140	15° 14.0’N	24° 24.0’W
141	15° 17.6’N	24° 37.0’W
142	15° 45.4’N	24° 52.3’W
143	16° 17.1’N	25° 08.4’W
144	16° 28.7’N	25° 13.3’W
145	16° 25.7’N	25° 25.6’W
146	16° 30.1’N	25° 28.4’W
147	16° 32.8’N	25° 12.6’W
148	16° 40.9’N	25° 24.7’W
149	16° 41.5’N	25° 17.5’W
150	16° 43.0’N	25° 14.2’W
151	16° 47.2’N	25° 12.5’W
152	16°47.5’N	25° 10.9’W
153	16° 48.2’N	25° 10.4’W
154	16° 50.6’N	25° 12.4’W
155	16° 52.9’N	25° 15.9’W

Table 5. Summary of cruise activities

Date	**Mobilisation (hr)**	**Multibeam survey (hr)**	**Downtime (hr)**	**Calibration (hr)**	**Passage (hr)**
1 Feb	24				
2 Feb	12				12
3 Feb					24
4 Feb		8.3			15.7
5 Feb				5.4	18.6
6 Feb		20		4	
7 Feb		24			
8 Feb		24			
9 Feb		24			
10 Feb		24			
11 Feb		24			
12 Feb		24			
13 Feb		24			
14 Feb		24			
15 Feb	3	18			3
16 Feb	11				
Totals (days)	**2.1**	**9.9**	**()**	**().4**	**3.1**

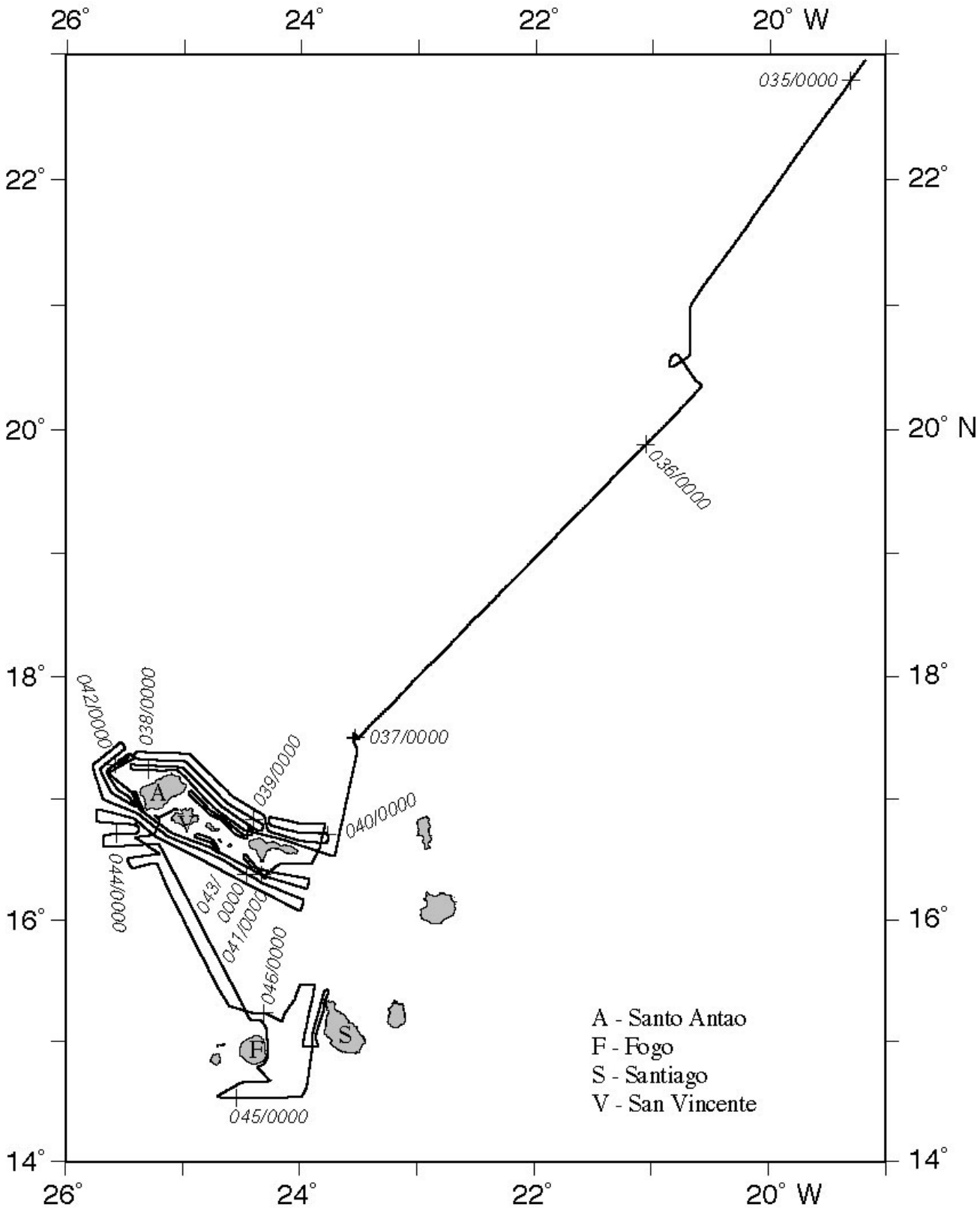

Figure 1. Track chart for RRS *Charles Darwin* cruise 168. Annotations are Julian day/ time.

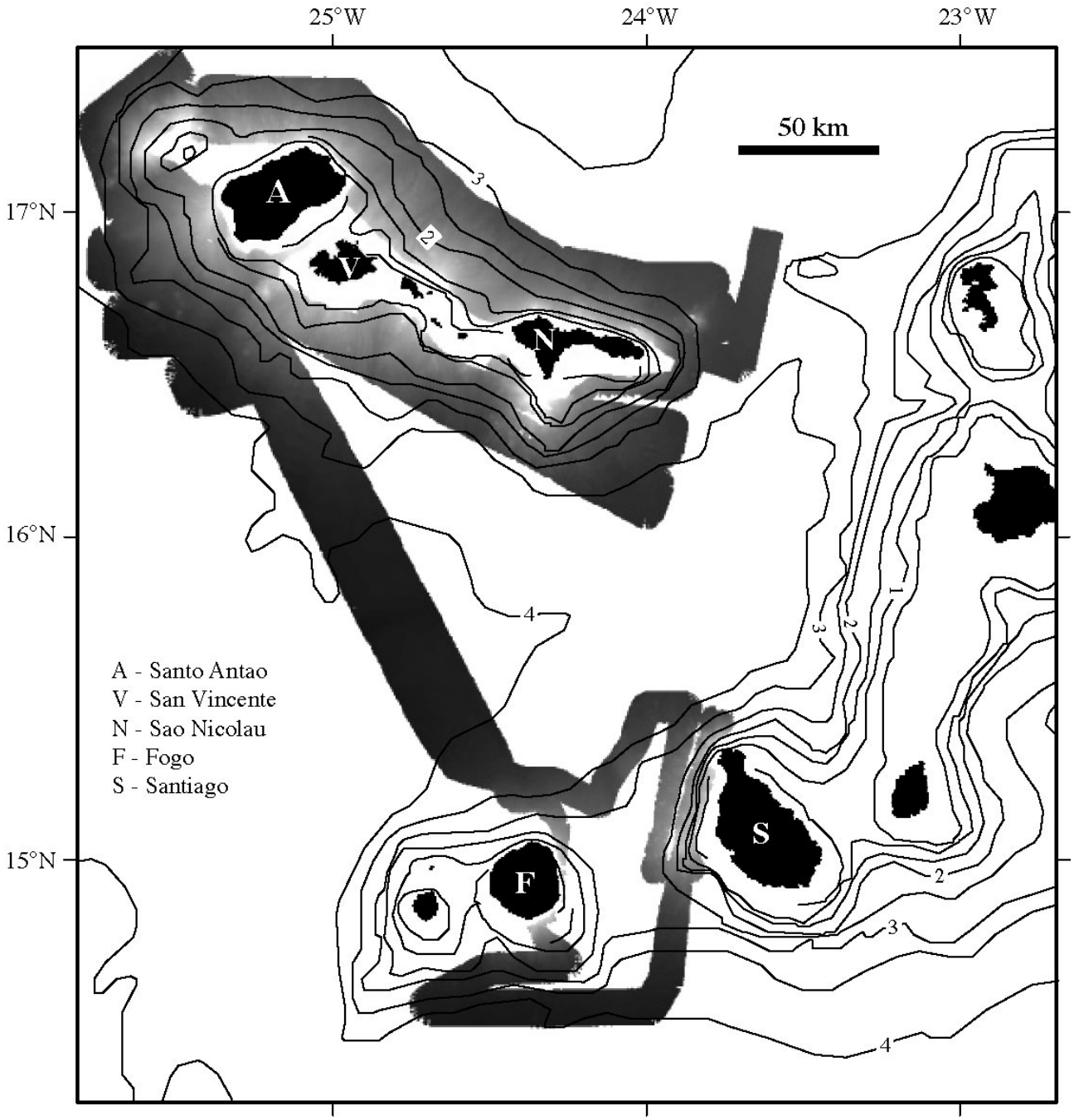

Figure 2. Multibeam coverage (shaded) around the Cape Verde islands obtained during RRS *Charles Darwin* cruise 168. Contour interval 500 m.