

CRUISE REPORT

R.R.S. CHARLES DARWIN CRUISE 134B

Victoria, Mahé to Victoria, Mahé

10 October – 17 October, 2001

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1. Cruise participants

R.B. Whitmarsh	Principal Scientist
J.S. Collier	Geophysicist
C.J. Paulson	Electronics Support/Technical Liaison Officer UKORS
J.B. Short	Computing Support UKORS
J.C. Zelia	Seychelles Hydrographic Brigade
K.O. Avery	Master
P.D. Gauld	Chief Officer
J.W. Mitchell	Second Officer
P.C.T. Reynolds	Third Officer
A.P. Adams	Chief Engineer
B.J. McDonald	Second Engineer
K.M. Connor	Third Engineer
J.G.L. Baker	Electrical Technical Officer
K.R.G. Luckhurst	Chief Petty Officer (Deck)
R. Johnson	Petty Officer (Deck)
M.S. Moore	Seaman.1.A
T.R. Edwards	Seaman.1.A
S.C. Cook	Seaman.1.A
K. Pringle	Petty Officer Motorman
R. Bell	Ship's Catering Manager
P.A. Lynch	Chef
A. Kujawiak	Mess Steward
J.A. Orsborn	Steward
P.W. Robinson	Steward

2. Cruise objectives

This cruise was arranged at short notice due to the cancellation of Cruise 134 which had been scheduled to take place in the Gulf of Oman where imminent military activity precluded oceanographic operations. In May 2001 Dr Collier, Prof. Kendall, Dr Minshull and Prof. Whitmarsh had been awarded funds by the NERC to carry out geophysical work off the northern continental margin of the Seychelles and over its conjugate margin in the northern Arabian Sea. This cruise was expected to take place in early 2003. However, the cancellation of Cruise 134 meant that the *RRS Charles Darwin* would be inactive in Victoria, Mahé for several weeks before Cruise 135 could be mobilised. The opportunity was therefore taken to mount a one week cruise over the northern margin of the Seychelles to conduct a background survey for the main 2003 experiment. Time constraints and freight logistics and cost meant that the equipment to be used could be little more than what was already available on board, principally the swath bathymetry system and precision echo-sounder. Thus, it was proposed, and the NERC agreed, that a swath bathymetry and magnetometer survey of the Seychelles margin would provide an extremely valuable opportunity to obtain base maps to aid and complement the mainly seismic work planned in 2003. Arrangements were therefore made to air freight two magnetometers to the Seychelles.

The Cruise was approved by NERC on Thursday 27th September, at which time Diplomatic Clearance was requested from the Seychelles Government via the Foreign and Commonwealth Office in London. The scientific party assembled in Victoria on 8th October, clearance was obtained the same day and the ship sailed on Wednesday 10th October.

The principal objectives were:

1. to obtain a swath bathymetric chart of the region to identify seafloor fabric over the continental margin,
2. to identify basement outcrops that could provide targets for dredging in 2003 to determine the nature of the acoustic basement,
3. to obtain magnetic profiles normal to the margin which could be interpreted in terms of the extensional history of the margin and fill gaps in the existing track coverage,
4. to delimit the trend of the oldest seafloor spreading anomaly (anomaly 27) in a region where it appears to be offset by a possible fracture zone.

3. Cruise narrative (all times are Local Times)

6th October: Mr Paulson flew to Victoria via Nairobi and stayed in a local hotel.

7th October: Dr Collier and Prof. Whitmarsh departed Heathrow via Paris for Victoria arriving 0800 8th October.

8th October: On arrival Dr Collier and Prof. Whitmarsh visited the Ship's Agent and learnt that the *RRS Charles Darwin* was due in port at 1500 contrary to earlier reports that it would arrive the next day. They then visited the Seychelles National Oil Company and discussed the cruise plans and future work in the area. On returning to the Agents it was confirmed that Diplomatic Clearance had been granted. The

majority of the magnetometer equipment arrived on the afternoon flight; however, the magnetometer sensors, having been classified as hazardous material, were delayed to a later flight. Dr Collier and Prof. Whitmarsh joined the ship.

9th October: Mr Short flew into Victoria. He and Mr Paulson joined the ship. By early afternoon it was learnt that the magnetometer sensors had not arrived on the 1440 BA flight. The next (Air Seychelles) flight was due in Victoria at 0930 on Thursday 11th October but the chances of the sensors being aboard were judged to be slim. It was agreed therefore to sail next morning and to return to collect the sensors if and when they arrived in Victoria. Meanwhile Mr Paulson had set up the rest of the magnetometer equipment.

10th October (283): The ship sailed from Victoria at 0930 in excellent weather. Deployed echo-sounder fish at 1530. After emergency drill at 1615 we began surveying along roughly E-W margin-parallel tracks (Lines A-B). The PES and EM12-S systems were running and the ship steamed at full speed. Scientific watchkeeping started. At 1930 we learnt that the magnetometers had not been put on the Air Seychelles flight due to arrive on 11th October. First XBT deployed 1710. Weather deteriorated during the night with a stiff SE breeze and some pitching of the ship.

11th October (284): Survey continued over Lines C-E. It was decided to persevere with air freighting the magnetometers because useful work could still be done even with the 42 hours of survey time available if they arrived on the next Air Seychelles flight due 0930 15th October. Second XBT deployed at 0950. Just before midday we began a series of parallel NNE-SSW tracks out to the vicinity of anomaly 27. Third XBT deployed at 1850.

12th October (285): Survey continued over Lines E-H. A very fine, almost calm, day. Two more XBTs deployed morning and evening. Northern ends of Lines H and I, which lay over almost flat seabed, were truncated to save time.

13th October (286): Survey continued over Lines H-L. A fine but more windy day with winds up to 20 knots from the SE. Sixth XBT deployed at 0930 and seventh at 1840.

14th October (287): Survey continued over Lines L-O and tracks in the vicinity of a basement high first observed on a DSDP Leg 24 seismic reflection profile. The wind started quite fresh but fell away in the afternoon. Eighth and ninth XBTs deployed at 0915 and 1830, respectively. At 2230 we received a message saying that the two magnetometers were aboard the flight arriving Victoria next day and therefore we planned to finish the survey and return to Mahé next day.

15th October (288): Swath bathymetry survey finished with a track along the foot of the north slope of the Seychelles Plateau. By 0830 we were over the plateau and arrived at the Victoria Pilot Station at 1345 to meet the Agent's launch. By 1400 both magnetometers were aboard and we set course back to the north. During the afternoon the magnetometers were checked, the bottles filled with kerosene and terminations made. The planned magnetometer survey tracks were modified in the light of the swath bathymetry contours to cross a number of ridges revealed by the contours. The

PES fish and magnetometer were deployed at 1900 and the new survey, including swath bathymetry, begun at full speed. A calm day with light breezes from the SE.

16th October (289): Roll calibration experiment appeared to show that starboard depths are systematically deeper than port depths. Analysis suggests that a further correction of -0.16 degrees is required in addition to current settings consistent with the empirically determined sign of the error. XBT 10 deployed at 0825. At 1354 passed over a 500 m high seamount with a weak, effectively normal, magnetisation, therefore possibly consisting of continental crust. The ship's speed decreased during the afternoon as it headed into a swell from the SE.

17th October (290): The ship experienced some set during the night and lost some time. At the request of the Master the survey track was curtailed somewhat. During the night we passed over two further seamounts one which may have a reversed magnetisation and the other which appeared to be non-magnetic. At 0900 the magnetometer and PES fish were recovered. At 0930 2 XBTs were deployed (data from the first appeared suspect). The EM 12S swath system was closed down at 1055. The ship then steamed to the Pilot Station off Victoria and was alongside at 1825.

4. Navigation

The ship was navigated by Differential GPS, using a Trimble 4000DS receiver and Seastar Differential Receiver, and the positions were logged every second by the computer system. No problems were encountered with satellite orbits or with dithered signals in spite of the United States conducting bombing raids in Afghanistan during the cruise. The summary track is presented in Figure 1.

5. Swath bathymetry system

The Simrad EM12-S system was operated almost continuously during the cruise from 1640 on 10th October until 1050 on 17th October. Generally it operated without problems and minimal watchkeeping was required but the following defects were noted.

- The print head on the sidescan display appears damaged (it produces a continuous white strip at far range on the port side).
- Several outer beams (probably beams 9-12 and 68-71 inclusive) on the port and starboard sides occasionally lose signal producing a stripe on the contour print and screen monitors.
- The starboard side of the swath appears to be too deep; this manifests itself as a mismatch of contours when two starboard swath edges are merged. On flat areas a distinct 'valley' about 50 m deep, co-axial with the edges of the swaths, appears in the contours. The effect can be seen, but is less marked, when the seafloor is less flat. Re-calibrating the roll factor did not appear to improve the contours.
- No means was provided for interfacing the results of XBT deployments with the EM12-S acquisition system. Soundspeeds had to be computed and entered semi-manually after each XBT cast.

The coloured QA plots of depth contours were mosaiced more or less in real time. Preliminary processing was conducted on board using the Neptune system which led to the generation of contour plots. A calibration experiment to check the roll

calibration, and possibly remove the problem with the starboard edge matching, was carried out on 15th October revealed the need for a minor correction of -0.16° (equivalent to 34 m over a swath width of 12 km).

Extensive further processing ashore, both in the University of Bristol and at the Scott Polar Institute, University of Cambridge, failed to significantly improve on the contours produced at sea. This was very disappointing and resulted in spite of seeking the advice of Simrad on several occasions. Therefore the bathymetry presented on Figure 2 must continue to be regarded as preliminary.

6. Precision echo-sounder

The Simrad echo-sounder was operated continuously without problems throughout the cruise. Depths were logged by the computer system and profiles were also displayed on the HP PaintJet printer. As usual during swath acquisition the towed fish was used at 10 kHz in preference to the hull transducers. The slant depth of the fish when underway at full speed was equivalent to 3 fairing lengths.

7. Expendable bathythermographs

Sippican T-5 and T-7 XBTs were deployed twice a day, morning and evening (Table 1). Results were logged on the hard disk of the Hydrographic Office PC in the Scientific Plot aft of the Bridge. After each deployment a *.dat ASCII file was then transcribed to a floppy disk and the file transferred to a Unix machine in the Computer Room. Salinities estimated from historical observations were then merged with the list of inflexion points that defined each temperature profile and soundspeeds were calculated using Wilson's formula for a latitude of 2.5 degrees. Finally the soundspeed profile was plotted for comparison with other collected profiles (Figure 3) and the depth/soundspeed table was printed to enable it to be entered manually into the EM12-S system.

8. Magnetometers

Two proton precession magnetometer bottles and outboard cables were shipped to Victoria during the cruise and collected during a boat transfer at 1400 on 15th October. Measurements began once a bottle had been filled with jet fuel and connected to the outboard end of a tow cable. A magnetometer was towed continuously from 1700 on 15th October until 0900 on 17th October. The length of overside cable was 700 feet. Measurements were both displayed on a chart recorder, at 1000 nT full scale to monitor the shape and amplitude of anomalies, and logged by the Level C system.

For future occasions when magnetometer bottles are air freighted it would be useful to work out a method of flushing all traces of combustible vapour from the bottles. The packers employed to pack the bottles, which were classed as hazardous cargo, did no more than pack them loosely in cardboard boxes filled with polystyrene granules and stick 'Hazard' labels on the outside!

9. Acknowledgements

We acknowledge the NERC for granting permission for this cruise at short notice and we thank the Foreign and Commonwealth Office, London and the Seychelles Ministry of Foreign Affairs, respectively, for quickly processing and granting our request for diplomatic clearance. We also thank Colm O’Cofaigh, formerly of University of Bristol, now at the Scott Polar Institute, University of Cambridge for his unstinting assistance in trying to improve the processed swath bathymetry chart.

Table 1. Expendable bathythermograph deployments

XBT no.	Time (GMT)	Date	Julian Day	Latitude (degrees, minutes)	Longitude (degrees, minutes)	Type	Depth reached (m)
1	1311	10/10/01	283	-3 31.6	55 31.5	T-7	836
2	0550	11/10/01	284	-3 21.7	55 37.0	T-5	1290
3	1451	11/10/01	284	-2 14.4	55 57.4	T-7	836
4	0456	12/10/01	285	-2 47.2	55 46.9	T-5	2013
5	1424	12/10/01	285	-2 47.0	55 54.1	T-7	836
6	0526	13/10/01	286	-3 01.5	56 00.3	T-5	2013
7	1438	13/10/01	286	-2 32.6	56 32.0	T-7	836
8	0515	14/10/01	287	-3 07.1	56 27.7	T-5	2013
9	1428	14/10/01	287	-3 13.5	56 39.4	T-7	836
10	0425	16/10/01	289	-2 13.4	56 33.5	T-5	2013
11	1535	16/10/01	289	-2 53.3	56 34.3	T-7	789
12	0521	17/10/01	290	-3 31.1	55 48.8	T-5	1005
13	0531	17/10/01	290	-3 32.1	55 47.7	T-5	1950

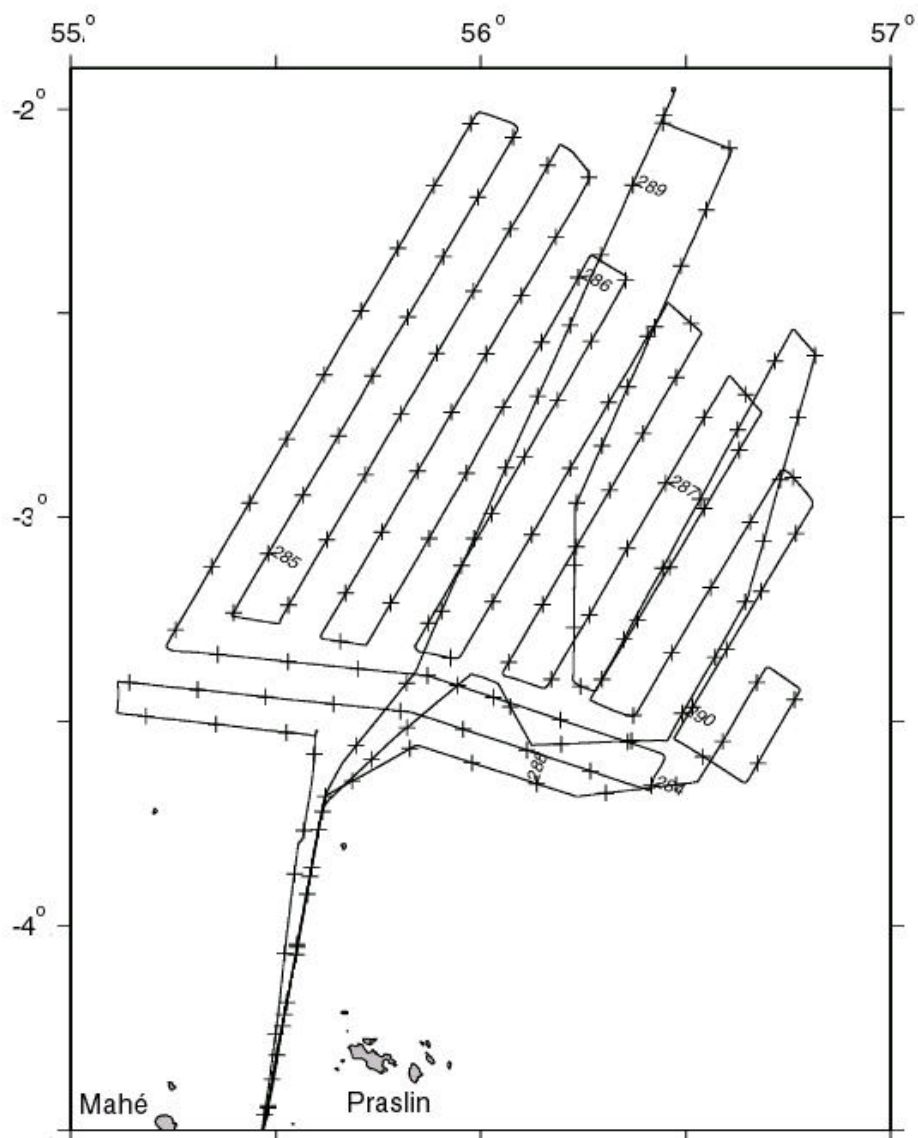


Figure 1. Track chart of the whole cruise with Julian Day Numbers at midnight.

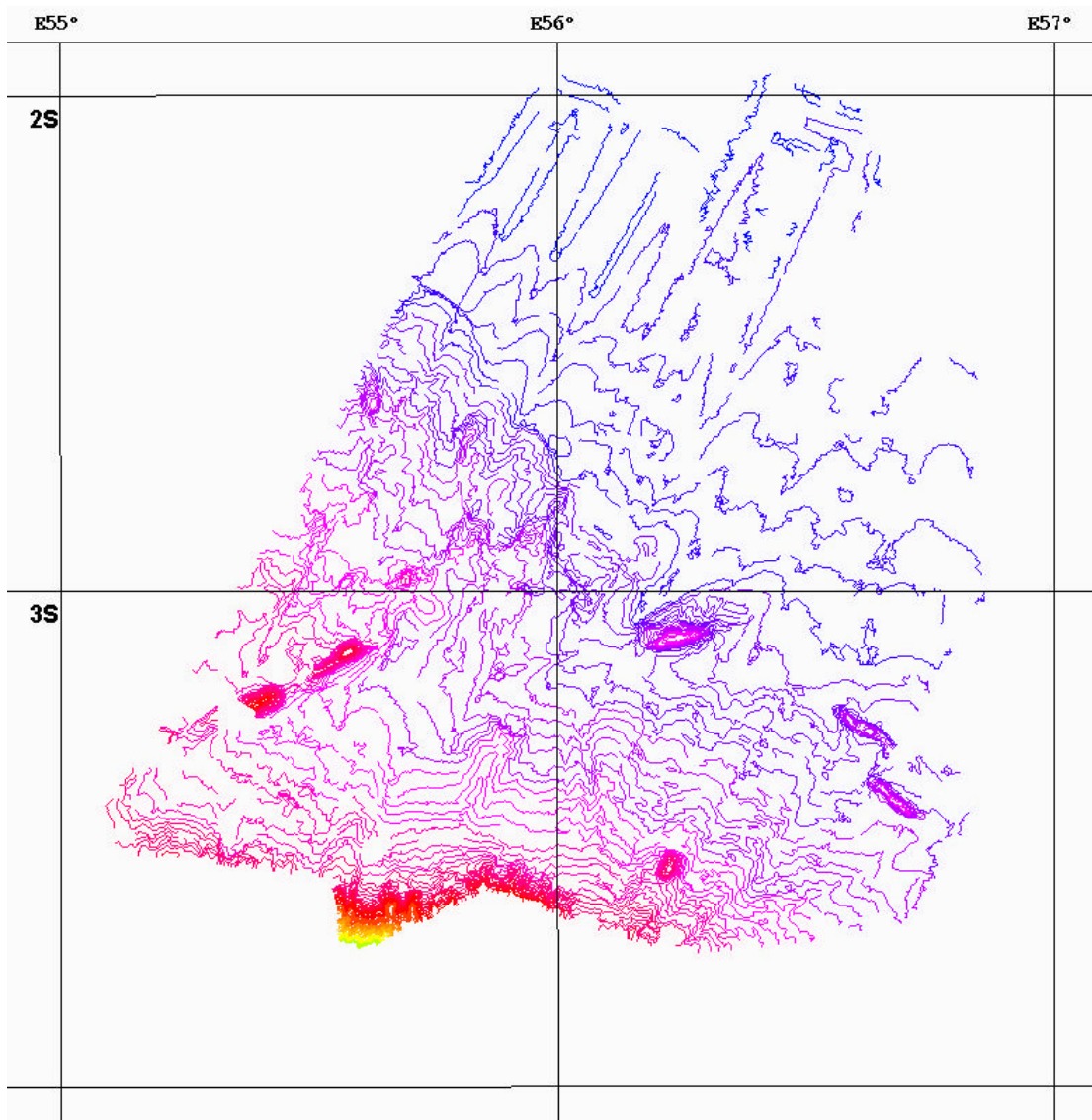


Figure 2. Preliminary swath bathymetry with 50 m contours after re-processing at the University of Bristol. The NE-SW 'valleys' are artefacts of the acquisition or post-processing which currently cannot be explained. The absolute depths may be too deep by upto 80 m.

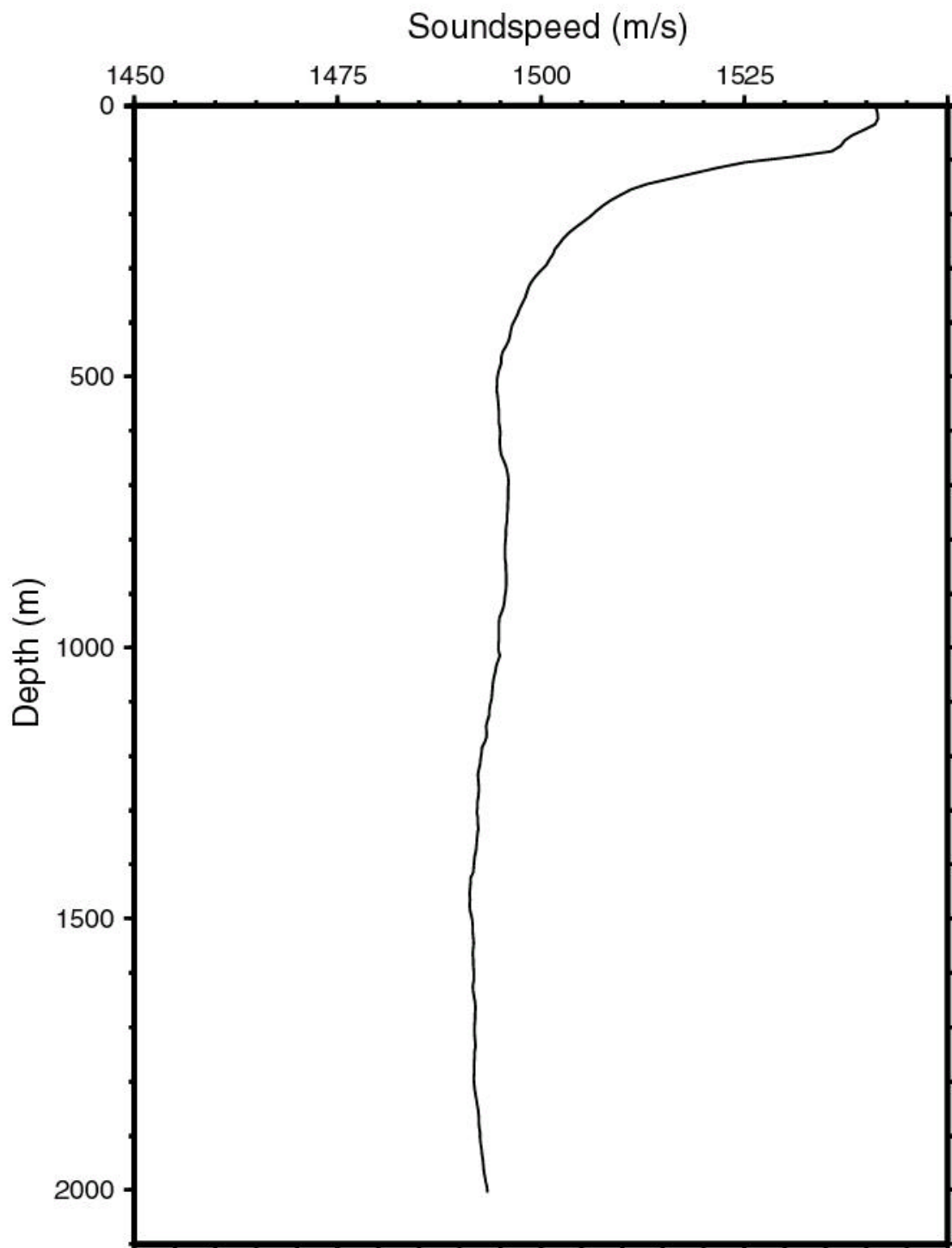


Figure 3. Averaged soundspeed profile computed from XBT profiles 3, 4, 5, 6, 7 and 10 with a 10 m running average.