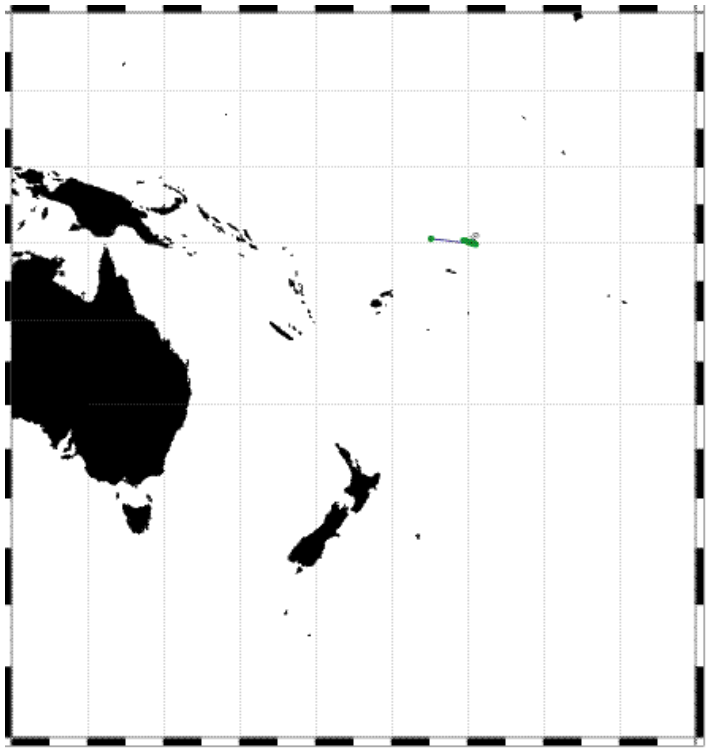
A. Cruise Narrative: PR23, PCM11 The Samoan Passage Experiment



A.1. Highlights

WHP Cruise Summary Information

WOCE section designation	**PR23, PCM11**
Expedition designation (EXPOCODE)	**316N138_8**
Chief Scientist(s) and their affiliation	R.D.Pillsbury/OSU, **Daniel L. Rudnick/UW**
Dates	1992.SEP.15 - 1992.SEP.27
Ship	R. V. Knorr
Number of stations	12
Floats and drifters deployed	6 ALACE floats
Moorings deployed or recovered	6

Scientific Goals

The central goal of the project is to determine the northward transport of abyssal water through the Samoan Passage, which appears to be the major pathway through which water deeper than 4000 m can go from the South Pacific to the North Pacific. An estimate of this transport is crucial to an understanding of abyssal circulation in the Pacific. Additional goals are to estimate the flux of heat, salt, oxygen and nutrients through the Samoan Passage, and to observe the low frequency variability in the transport.

Cruise Objectives

The main objective of the cruise was to deploy six subsurface moorings instrumented with current meters from 3000 m to the bottom. In support of this objective, twelve full-depth CTD casts were made to obtain the temperature-salinity characteristics of the abyssal water. In addition, six neutrally buoyant floats, called Autonomous Lagrangian Circulation Explorers (ALACE), were deployed. Bathymetry was collected while underway over the Robbie Ridge and Samoan Passage.

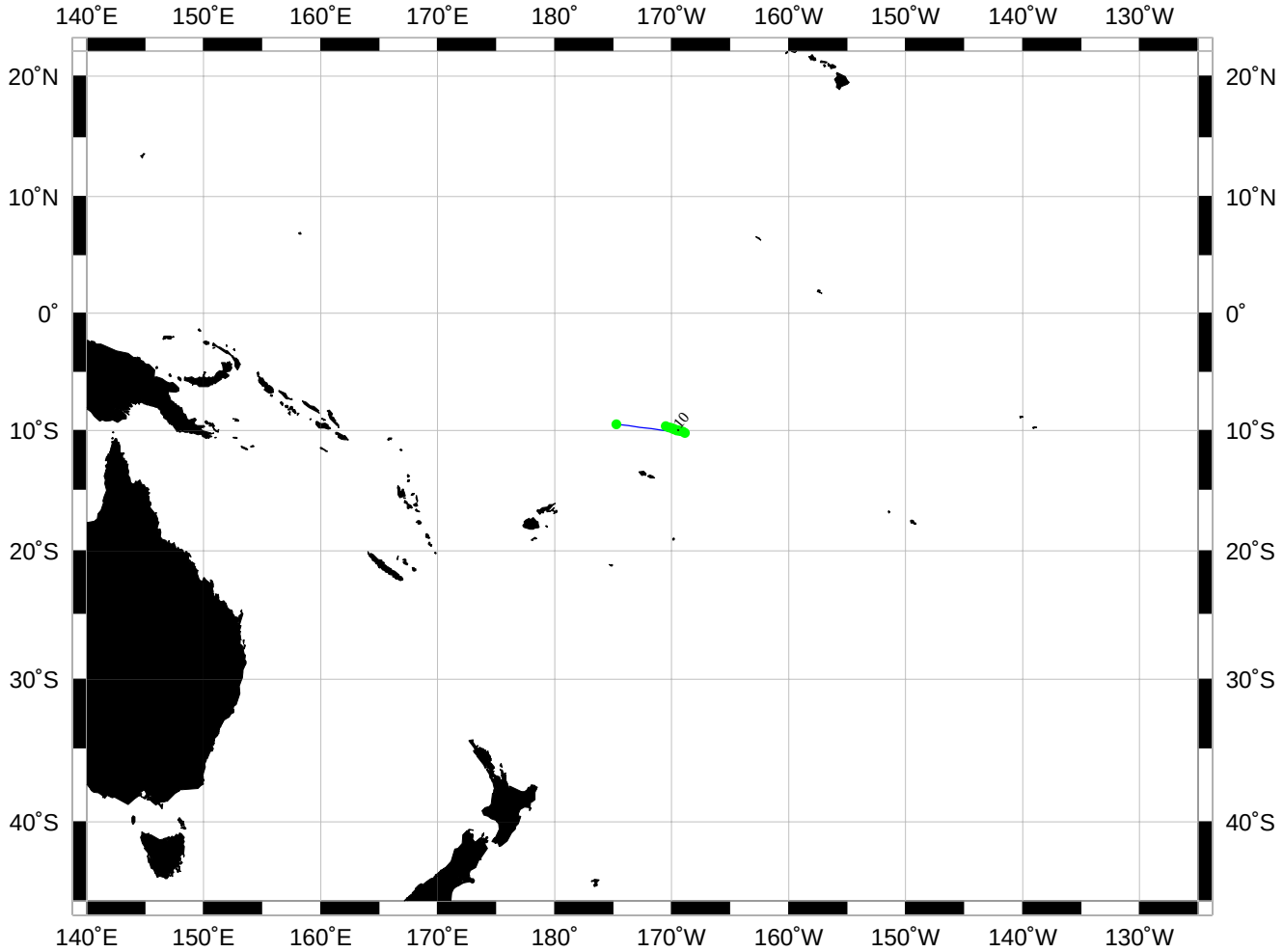
The six subsurface moorings were deployed along a transect in the Samoan Passage (Table 1, Figures 1-3). Each mooring had a radio buoy at the top, current meters, glass balls for flotation, an acoustic release, and an anchor. A total of 27 current meters were deployed, each measuring horizontal current and temperature. The upper two current meters on each mooring had pressure sensors. The moorings are due to be recovered in September 1994.

A total of 27 Aanderaa RCM8 current meters were employed, each measuring horizontal current and temperature, with the upper two meters on each mooring also measuring pressure. All instruments were recovered. There were some failures:

- Instrument 5872, the top meter of Mooring 2, experienced an electronic board failure after 5 days and stopped recording data. The data from this meter are not presented here.
- The pressure sensor on Instrument 4412 (2990 m on Mooring 1) showed abrupt depth changes several times. We believe these to be spurious, due to a sensor failure.
- The temperature sensor of Instrument 5856 (2970 m on Mooring 6) malfunctioned after 9 months.
- The compass of Instrument 7769 (4900 m on Mooring 3) failed its post-cruise calibration. It appears that the failure occured approximately one-fourth of the way through the experiment. Because the data are vector averages, both speed and direction are suspect.

The quality of the remaining records was excellent.

Station Locatons for PR32, PCM11: 1992



Produced from .sum file by WHPO-SIO

Table 1. Mooring positions.

Mooring	Latitude	Longitude
1	9°41.12'S	170°28.13'W
2	9°50.34'S	169°59.23'W
3	9°55.08'S	169°44.35'W
4	10°00.13'S	169°29.42'W
5	10°05.13'S	169°14.72'W
6	10°13.21'S	168°50.00'W

Of the twelve CTD casts, one was done north of a gap in the Robbie Ridge, and eleven were done in the Samoan Passage (Table 2). These casts provided measurements of temperature, conductivity, pressure, and oxygen from the bottom to the surface. Water samples were taken to calibrate the CTD conductivity sensor, although the oxygen sensor was not calibrated. The second component of the Samoan Passage Experiment is WOCE hydrographic line P31, from Fiji to Tahiti via the Robbie Ridge and Samoan Passage. This line is to be done by Dean Roemmich before the current meters are recovered, and is to include the full suite of WOCE hydrographic measurements.

Table 2. CTD stations.

Station	Latitude	Longitude
1	9°30.3'S	174°44.5'W
2	10°13.3'S	168°52.9'W
3	10°09.0'S	169°01.9'W
4	10°05.2'S	169°14.7'W
5	10°02.5'S	169°22.0'W
6	9°59.6'S	169°32.6'W
7	9°57.4'S	169°37.0'W
8	9°50.0'S	170°02.1'W
9	9°51.9'S	169°51.8'W
10	9°54.6'S	169°47.1'W
11	9°41.0'S	170°31.1'W
12	9°45.4'S	170°13.8'W

Six ALACEs were launched: one north of the Robbie Ridge, three in the Samoan Passage, and two east of the Manihiki Plateau (Table 3). The ALACEs, deployed for Russ Davis, were designed to float at 1500 m and to cycle to the surface every 26 days to report positions and temperature profiles. The ALACEs are expected to continue cycling for three to four years.

Table 3. ALACE deployments.

Serial Number	Latitude	Longitude
177	9°31.44'S	174°43.99W
178	10°12.77'S	168°53.04'W
181	9°54.64'S	169°44.38'W
171	9°40.80'S	170°30.94'W
172	13°55.44'S	159°46.09'W
173	15°46.92'S	154°56.63'W

Robbie Ridge

The original plan was to deploy five moorings in the Samoan Passage near 10°S, 170°W, and one mooring in a gap in the Robbie Ridge at 10°05'S, 174°10'W. Having departed Suva, Fiji at 050OZ 15 September, the first mooring deployment was to have been at the Robbie Ridge (Figures 1 and 2). A bathymetric survey was begun at 1645Z 17 September and terminated at 0718Z 18 September. The gap in the Robbie Ridge was approximately 4200 m deep and several miles wide amid very rough topography. Because the gap was so small, we determined that it could not be a major pathway for water colder than 1°C and did not deploy a mooring.

A CTD station was occupied north of the Robbie Ridge at 09°30.3'S, 174°44.5'W to look for evidence of abyssal water flowing over the ridge. The coldest water at this 4525 m deep station had a potential temperature of 0.87°C, so little abyssal water was flowing through the gap. After deploying ALACE 177 we headed for the Samoan Passage.

Samoan Passage

We arrived at the Samoan Passage at 0838Z 19 September and began a bathymetric survey consisting of a transect of the passage. After the transect was completed at 2220Z, we determined mooring positions on the basis of the bathymetry (Table 1, Figure 3). The horizontal spacing of the array in the center of the Passage was about 28 km.

During the four days on station in the Samoan Passage, our general plan was to deploy moorings during the day and to do CTD casts at night. This plan took advantage of the daylight for mooring operations, and allowed time for eleven CTD casts: six casts next to the moorings, and five between the moorings. Three ALACEs were deployed in the passage.

The moorings were designated 1 through 6 from west to east. Since the bathymetric survey left us on the east side of the passage, we began with mooring 6. Prior to each mooring deployment a small-scale bathymetric survey consisting of a box, one mile on a side, was done around each mooring site. Fine adjustments in mooring positions were made using the results of these surveys. Following each deployment, a survey was done to determine the position of the acoustic release.

Deployment of mooring 6 began at 0145Z and concluded at 0326Z 20 September (1626LT). CTD stations 2-4 were done during the evening: CTD 2 was three miles off (to avoid tangling) from mooring 6, CTD 3 was between moorings 5 and 6, and CTD 4 was at mooring site 5. ALACE 178 was launched upon the conclusion of CTD station 2.

Mooring 5 was deployed during 1806Z-1952Z 20 September, and mooring 4 was deployed during 011OZ-0309Z 21 September. CTD stations 5-7 were done during the evening: CTD 5 was between moorings 4 and 5, CTD 6 was three miles off from mooring 4, and CTD 7 was between moorings 3 and 4.

Mooring 3 was deployed during 1931Z-2154Z 21 September, and mooring 2 was deployed during 0152Z-0348Z 22 September. ALACE 181 was deployed after mooring 3. The evening's CTD stations were 8-10: CTD 8 was three miles off from mooring 2, CTD 9 was between moorings 2 and 3, and CTD 10 was three miles off from mooring 3.

Mooring 1 was deployed from 2341Z 22 September to 0046Z 23 September. CTD station 11 was three miles off from mooring 1, and CTD 12 was between moorings 1 and 2. ALACE 171 was launched after CTD 11.

Having finished all the mooring deployments and CTD casts, we headed back along the transect and resurveyed the acoustic releases on moorings 3 and 6. These additional surveys were necessary because of intermittent failures in the acoustic release deck box.

At 2044Z 23 September the resurvey of mooring 6 was completed and we were underway to Papeete, Tahiti. ALACEs 172 and 173 were launched on the way.

We arrived in Papeete at 0235Z 28 September.

Personnel

Daniel Rudnick	University of Washington
Dennis Root	Oregon State University
Robert Still	Oregon State University
John Simkins	Oregon State University
Dennis Barstow	Oregon State University
Mary Johnson	Scripps Institution of Oceanography
Scott Hiller	Scripps Institution of Oceanography
Wendi Eastman	University of Washington
Christine Halas	University of Washington

Acknowledgments

I would like to thank Captain Chiljean and the crew of the R/V Knorr for their help, especially during mooring deployments. It was a pleasure to sail with such an able and professional science party. This cruise was sponsored by the National Science Foundation under grant OCE-9104161.

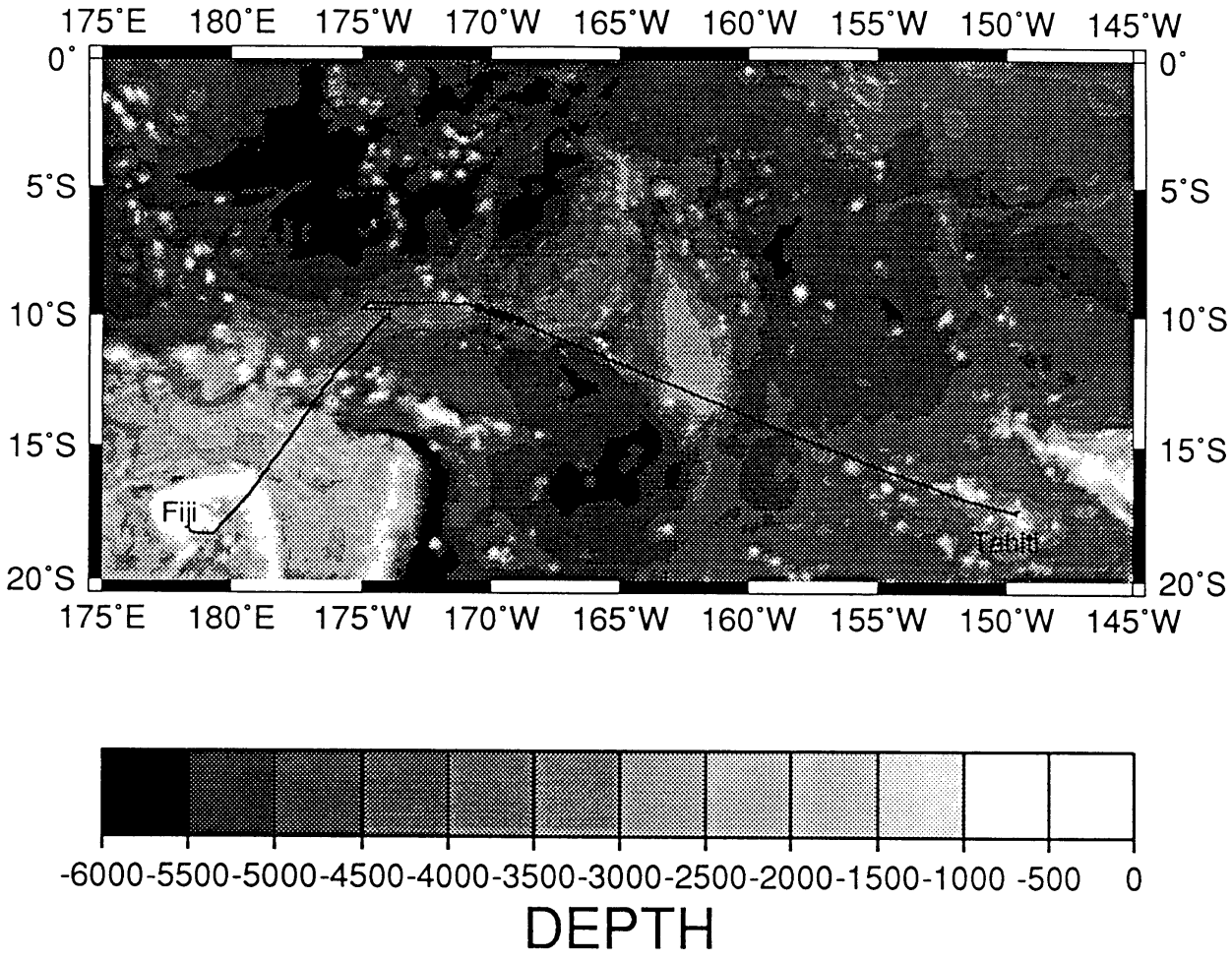


Figure 1. Ship track superimposed on ETOPO5 bathymetry. The cruise went from Fiji to Tahiti via the Robbie Ridge and the Samoan Passage. The circles are moorings in the Samoan Passage. The Manihiki Plateau is the shallow feature at about 9°S, 162°W.

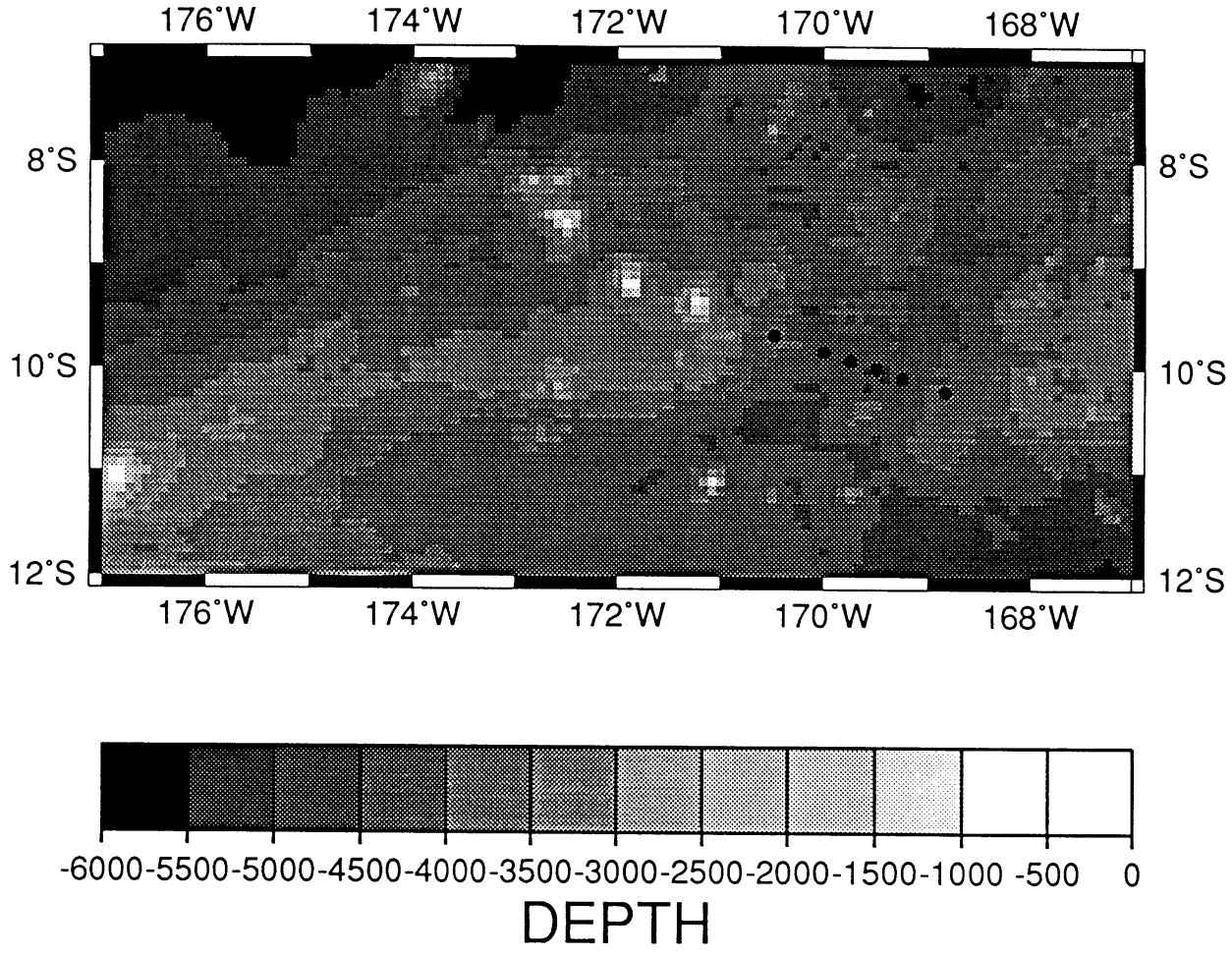


Figure 2. The ETOPO5 bathymetry in the region of the Robbie Ridge and Samoan Passage. The moorings are indicated by circles.

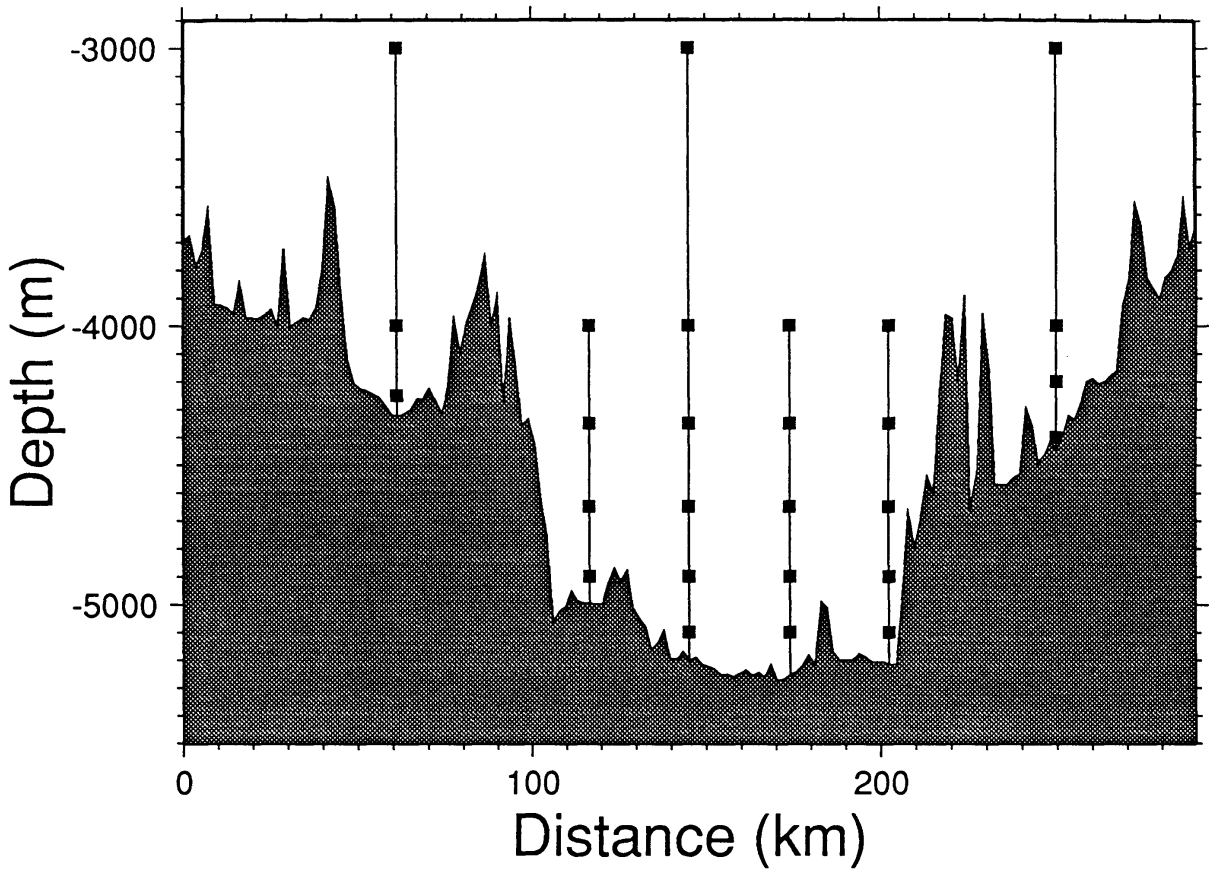


Figure 3. The mooring array in the Samoan Passage and underway bathymetry. The perspective is looking northward, so mooring 1 is on the left and mooring 6 is on the right. The squares indicate the locations of current meters.

Log

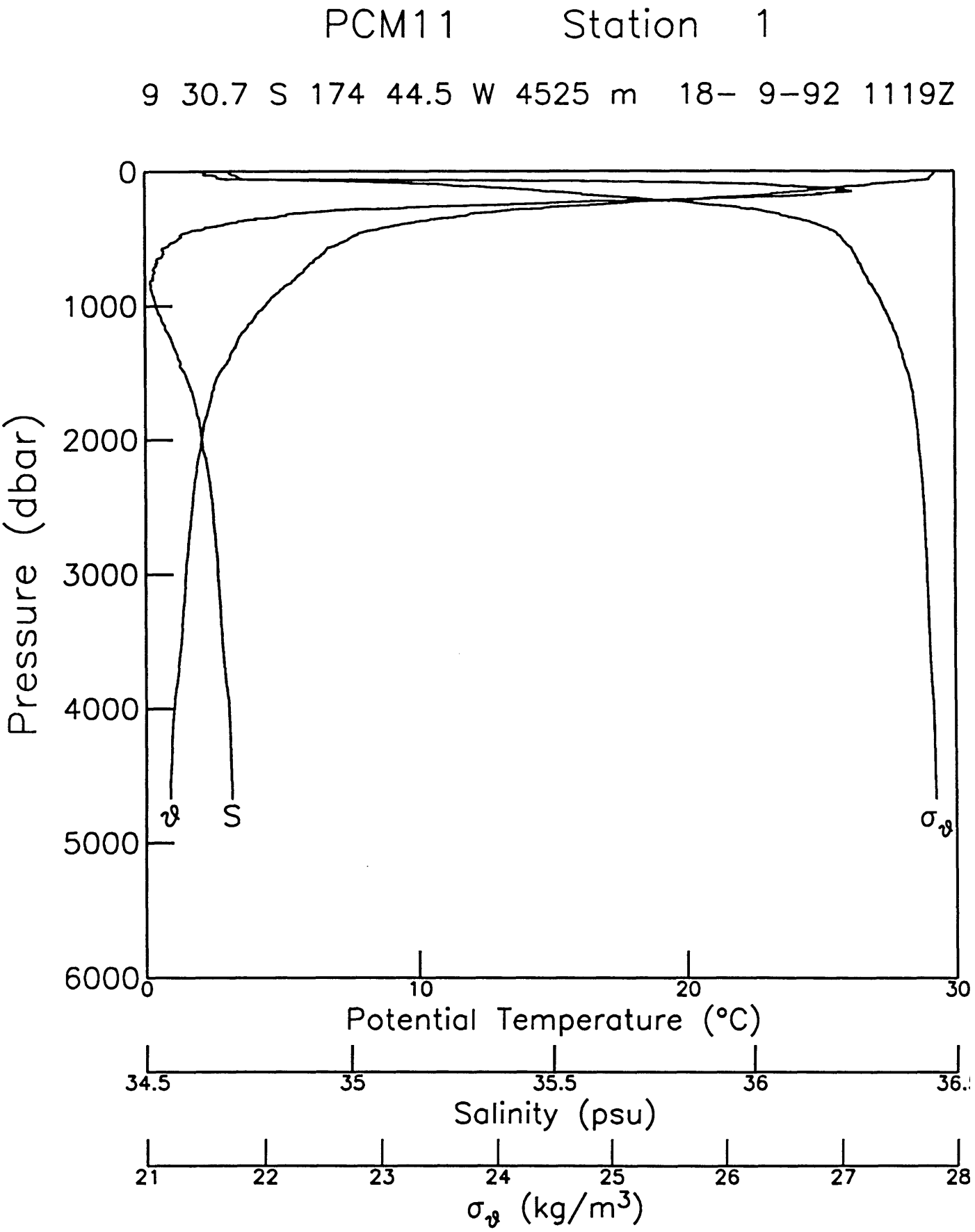
Date	Time (Z)	Latitude	Longitude	Event
15 Sep	0500	18°07.86'S	178'24.83'E	Depart Suva
17 Sep	1645	10°34.88'S	174°36.23'W	Begin bathymetric survey at Robbie Ridge
18 Sep	0718	09°44.61'S	175°00.28'W	Terminate bathymetric survey
	0950	09°30.04'S	174°44.07'W	Start CTD station #1
	1233	09°31.39'S	174°44.31'W	End CTD station #1
	1243	09°31.44'S	174°43.99'W	Launch ALACE #177
19 Sep	0838	09°30.09'S	171°00.00'W	Begin bathymetric survey at Samoan Passage
	2220	10°20.81'S	168°28.71'W	End bathymetric survey
20 Sep	0145	10°12.96'S	168°51.35'W	Begin deployment of mooring #6
	0326	10°13.38'S	168°49.93'W	Anchor away for mooring #6
	0533	10°13.50'S	168°52.96'W	Start CTD station #2
	0817	10°12.98'S	168°53.09'W	End CTD station #2
	0829	10°12.77'S	168°53.04'W	Launch ALACE #178
	0934	10°09.10'S	169°02.19'W	Start CTD station #3
	1212	10°09.06'S	169°02.18'W	End CTD station #3
	1336	10°05.23'S	169°14.70'W	Start CTD station #4
	1631	10°05.22'S	169°14.61'W	End CTD station #4
	1806	10°04.94'S	169°17.68'W	Start deployment of mooring #5
	1952	10°05.12'S	169°14.62'W	Anchor away for mooring #5
21 Sep	0110	09°59.13'S	169°32.82'W	Start deployment of mooring #4
	0309	10°00.21'S	169°29.38'W	Anchor away for mooring #4
	0610	10°02.94'S	169°21.91'W	Start CTD station #5
	0902	10°02.25'S	169°22.34'W	End CTD station #5
	1016	10°00.08'S	169°32.34'W	Start CTD station #6
	1331	09°59.01'S	169°32.87'W	End CTD station #6
	1420	09°57.46'S	169°37.00'W	Start CTD station #7
	1714	09°57.56'S	169°37.58'W	End CTD station #7
	1931	09°55.15'S	169°48.41'W	Start deployment of mooring #3
	2154	09°55.15'S	169°44.28'W	Anchor away for mooring #3
	2313	09°54.64'S	169°44.38'W	Launch ALACE #181
22 Sep	0152	09°50.40'S	170°02.68'W	Start deployment of mooring #2
	0348	09°50.41'S	169°59.22'W	Anchor away for mooring #2
	0643	09°50.35'S	170°02.17'W	Start CTD station #8
	0929	09°49.19'S	170°01.86'W	End CTD, station #8
	1042	09°52.82'S	169°52.15'W	Start CTD station #9
	1336	09°51.18'S	169°51.56'W	End CTD station #9
	1425	09°55.17'S	169°47.04'W	Start CTD station # 10
22 Sep	1722	09°53.99'S	169°46.80'W	End CTD station 410
	2341	09°41.13'S	170°30.08'W	Start deployment of mooring #1
23 Sep	0046	09°41.10'S	170°30.08'W	Anchor away for mooring #1
	0331	09°41.10'S	170°31.12'W	Start CTD station #11
	0554	09°40.80'S	170°31.18'W	End CTD station #11
	0605	09°40.80'S	170°30.94'W	Launch ALACE #171
	0755	09°45.30'S	170°13.59'W	Start CTD station #12
	1015	09°45.46'S	170°14.03'W	End CTD station #12
25 Sep	1821	13°55.44'S	159°46.09'W	Launch ALACE #172
26 Sep	1817	15°46.92'S	159°56.63'W	Launch ALACE #173
28 Sep	0235	17°27.84'S	149°36.52'W	Arrive Papeete

CTD Data

Potential temperature, salinity, and potential density for each of the twelve CTD stations are shown in the following plots. The location, bottom depth and time are given for each station.

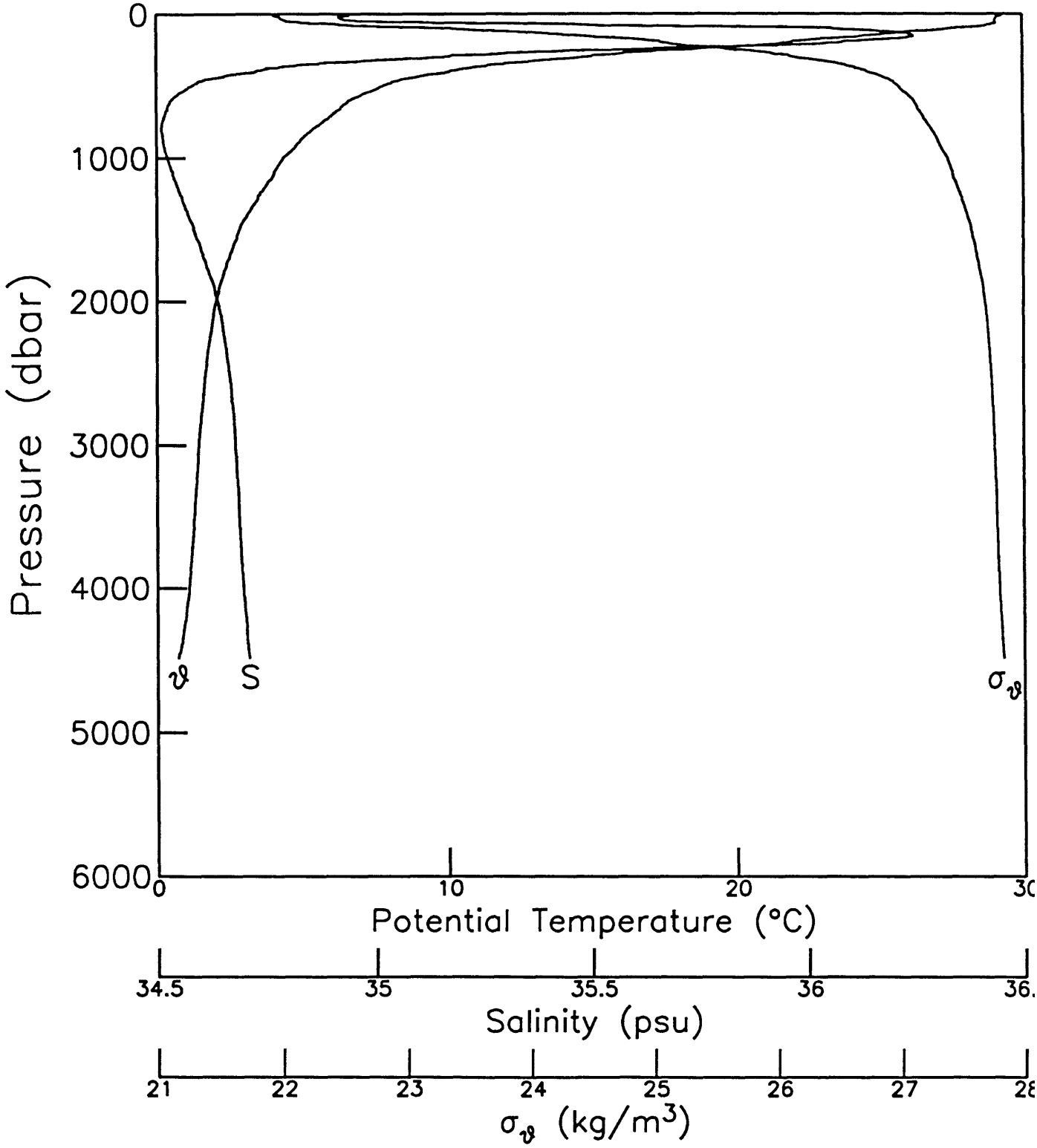
PCM11	discrete salts comments
001/01	bottle 24: lanyard hung up, no sample
002/01	bottle 20: lanyard hung up, no sample
002/01	ALL differences +.01 compared to ctd; only cast this high; not rerun
003/01	end standard drift +.00023
004/01	huge end drift (+160) - RERUN looks fine
005/01	ok
006/01	bottle 20: lanyard hung up, no sample
007/01	ok
008/01	ok
009/01	see station 10 - not rerun
010/01	bottle 20: lanyard hung up, no sample
010/01	run back to back with 9; large drift (+53) - RERUN looks fine
011/01	bottle 116 salt looks low
012/01	ok

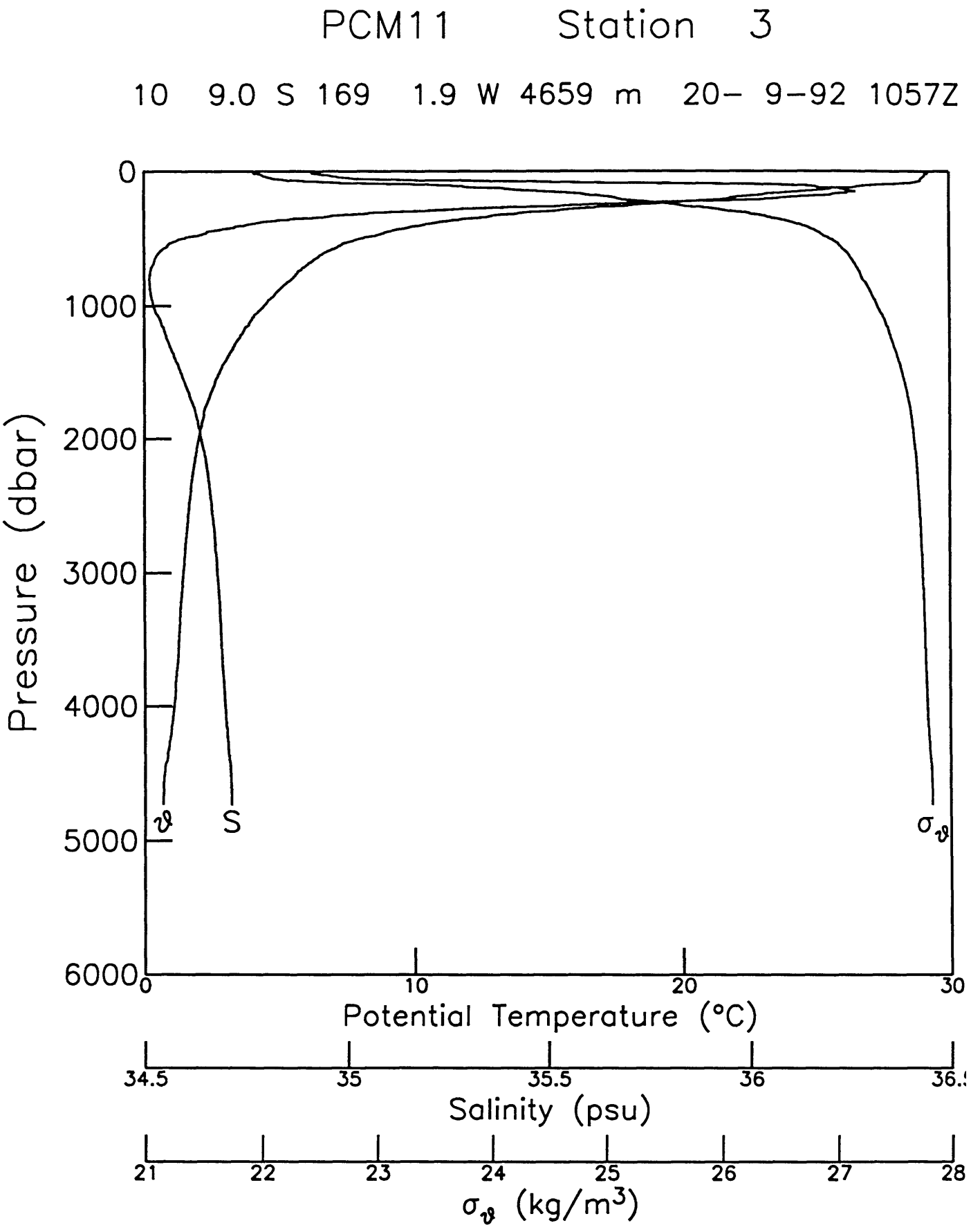
A "D" in the differences report next to bottle salinity means the salinity value is the CTD salinity - no difference will be reported. These bottles were mis-trips and came back with no water. All data values were included in the report, even if they were questioned or not used for ctd calibration.

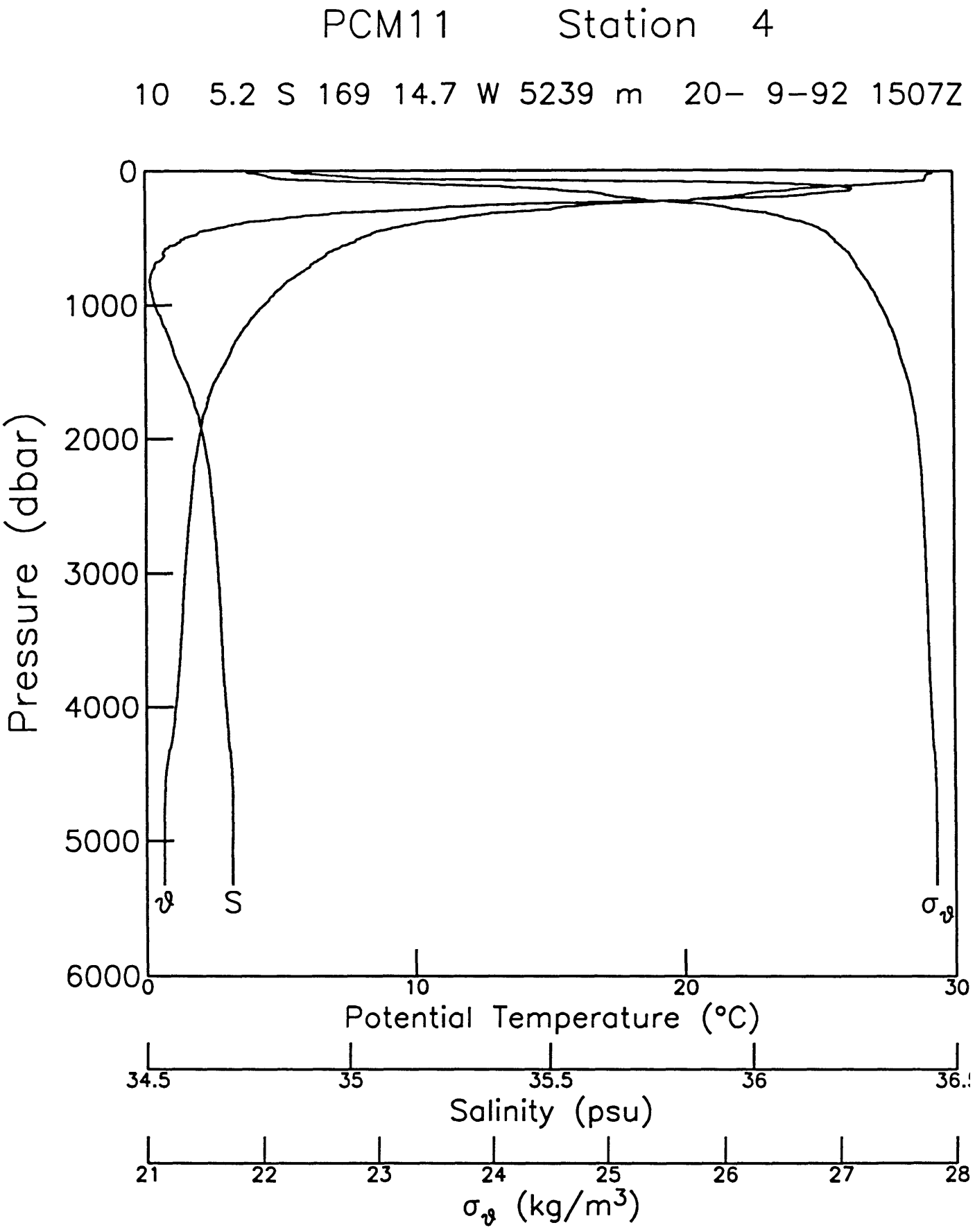

PCM11 Station 1
9 30.7 S 174 44.5 W 4525 m 18- 9-92 1119Z
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
ϑ
S
σϑ
0
10
20
30
Potential Temperature (°C)
34.5
35
35.5
36
Salinity (psu)
21
22
23
24
25
26
27
28
σϑ (kg/m3)

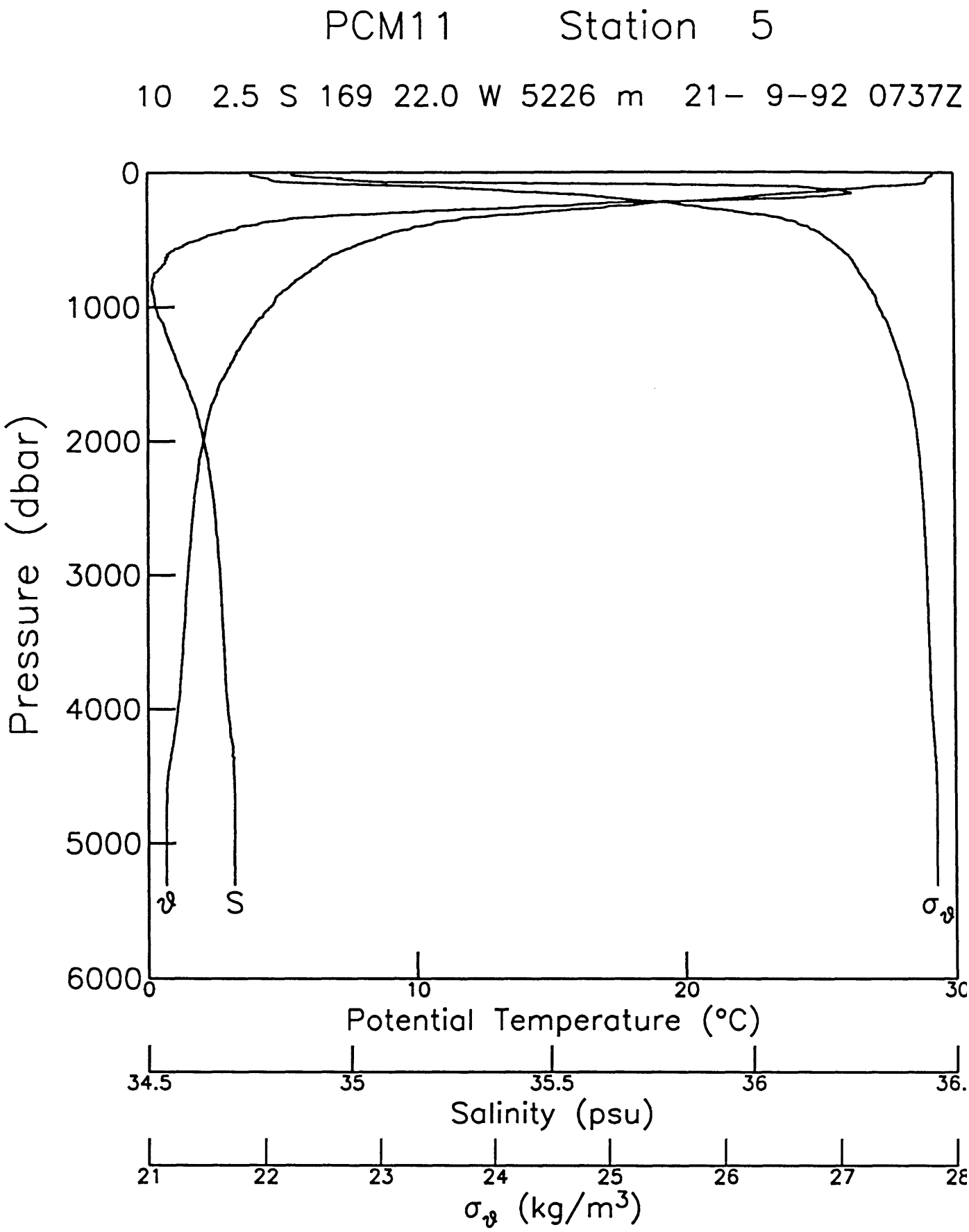
PCM11 Station 2

10 13.3 S 168 52.9 W 4432 m 20- 9-92 0649Z



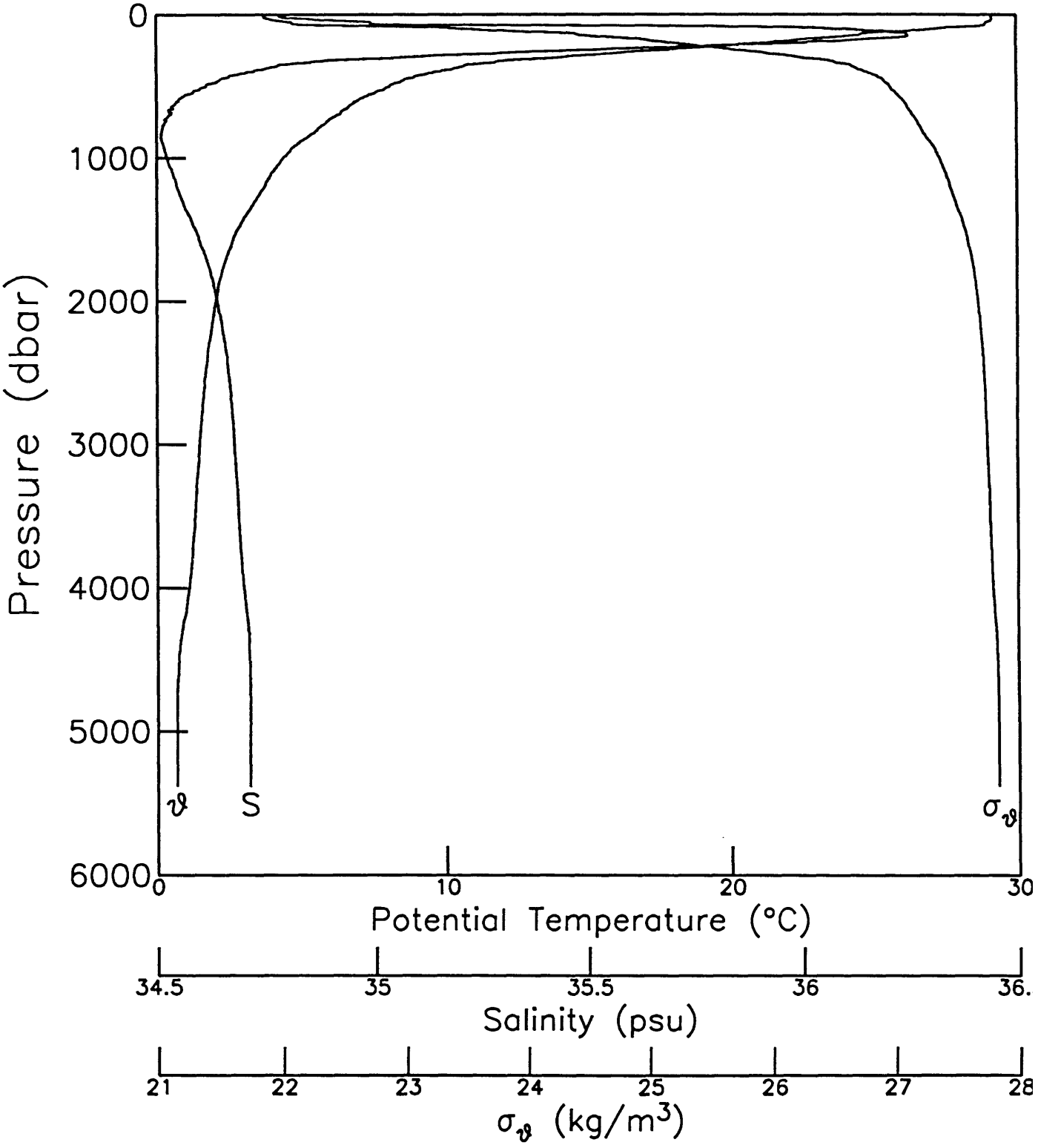

PCM11 Station 3
10 9.0 S 169 1.9 W 4659 m 20- 9-92 1057Z
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
ϑ
S
σϑ
0
10
20
30
Potential Temperature (°C)
34.5
35
35.5
36
Salinity (psu)
21
22
23
24
25
26
27
28
σϑ (kg/m3)


PCM11 Station 4
10 5.2 S 169 14.7 W 5239 m 20- 9-92 1507Z
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
ϑ
S
σϑ
0
10
20
30
Potential Temperature (°C)
34.5
35
35.5
36
Salinity (psu)
21
22
23
24
25
26
27
28
σϑ (kg/m3)


PCM11 Station 5
10 2.5 S 169 22.0 W 5226 m 21- 9-92 0737Z
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
ϑ
S
σϑ
0
10
20
30
Potential Temperature (°C)
34.5
35
35.5
36
36.
Salinity (psu)
21
22
23
24
25
26
27
28
σϑ (kg/m3)

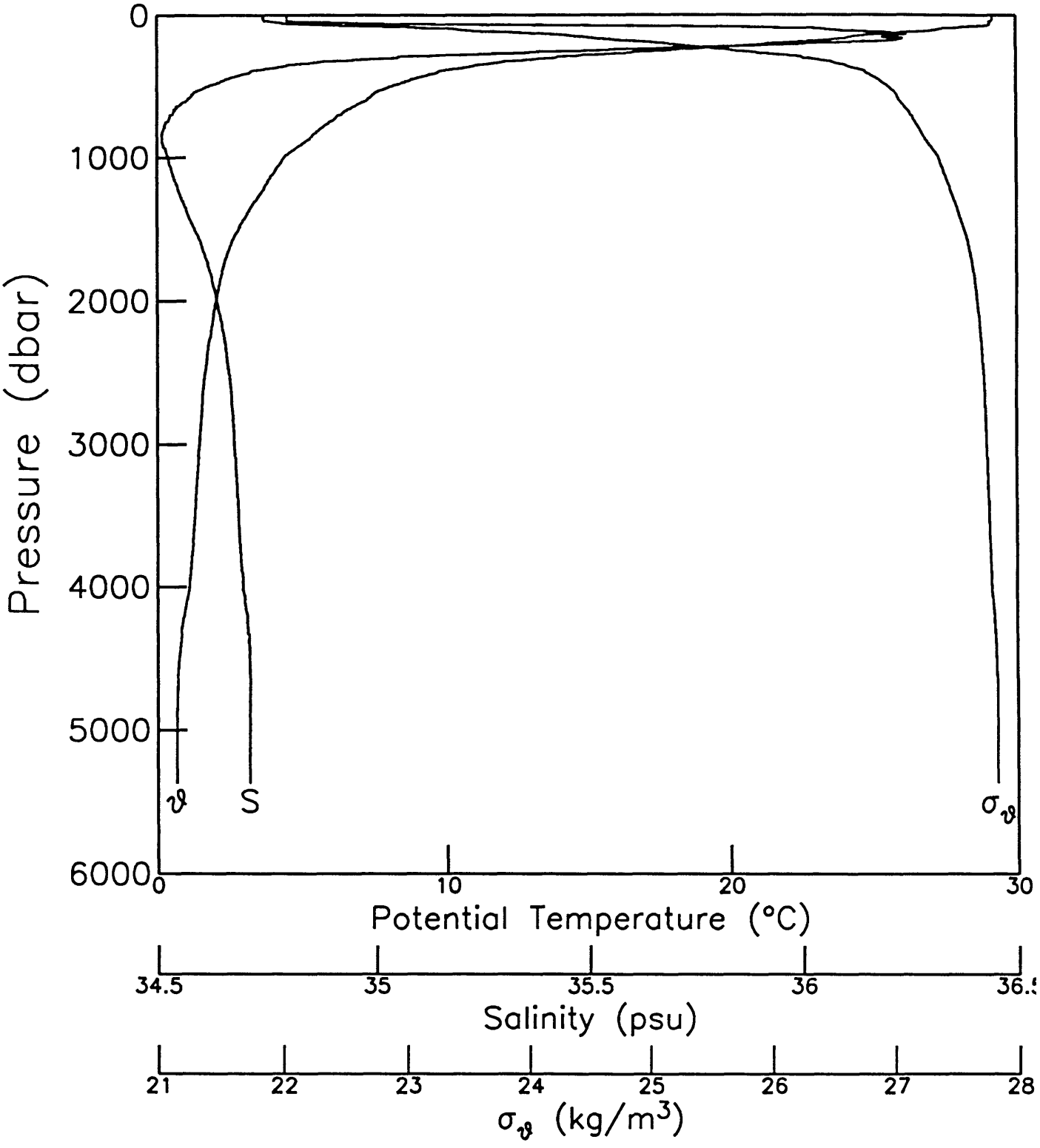
PCM11 Station 6

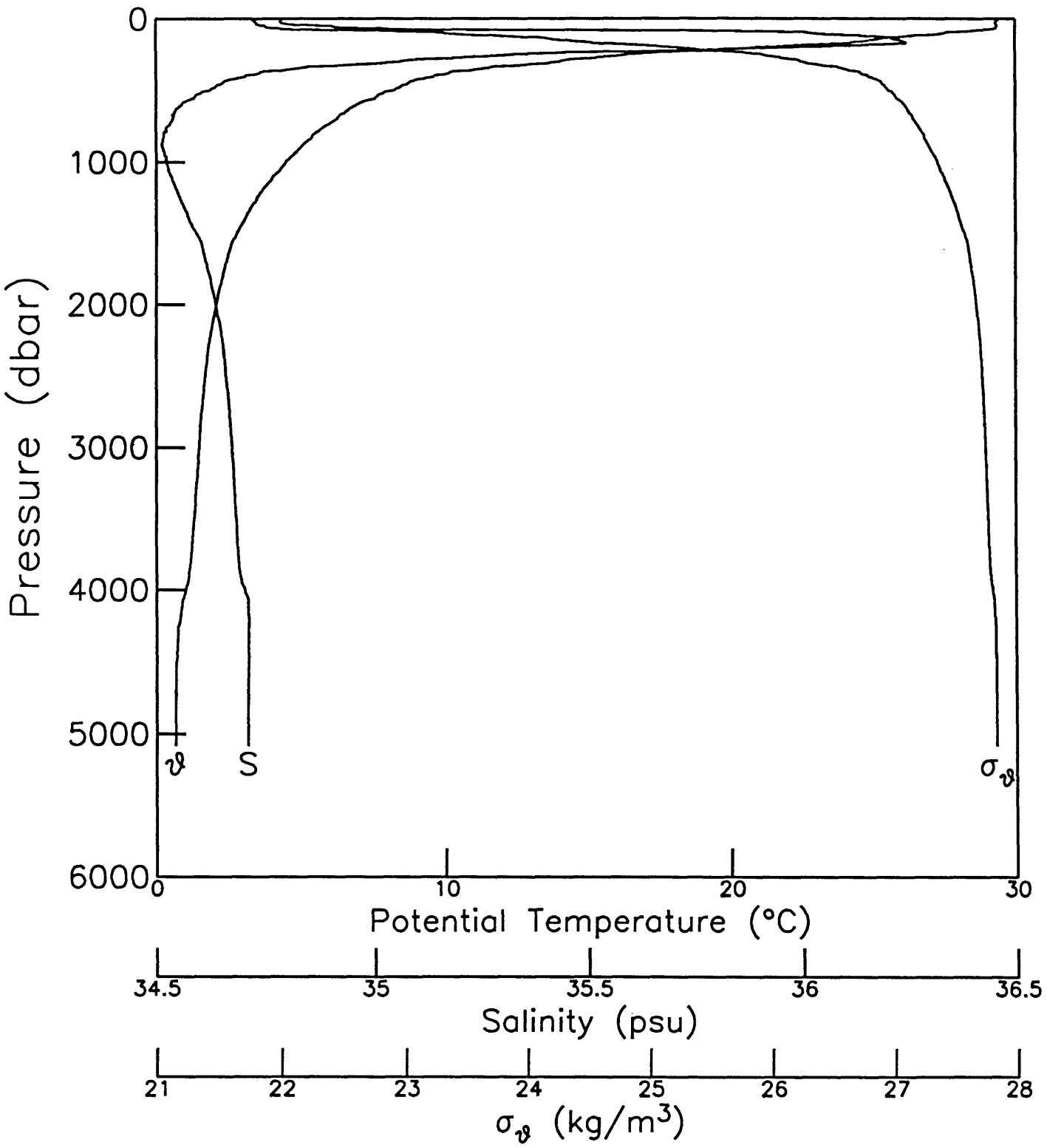
9 59.6 S 169 32.6 W 5299 m 21- 9-92 1144Z



PCM11 Station 7

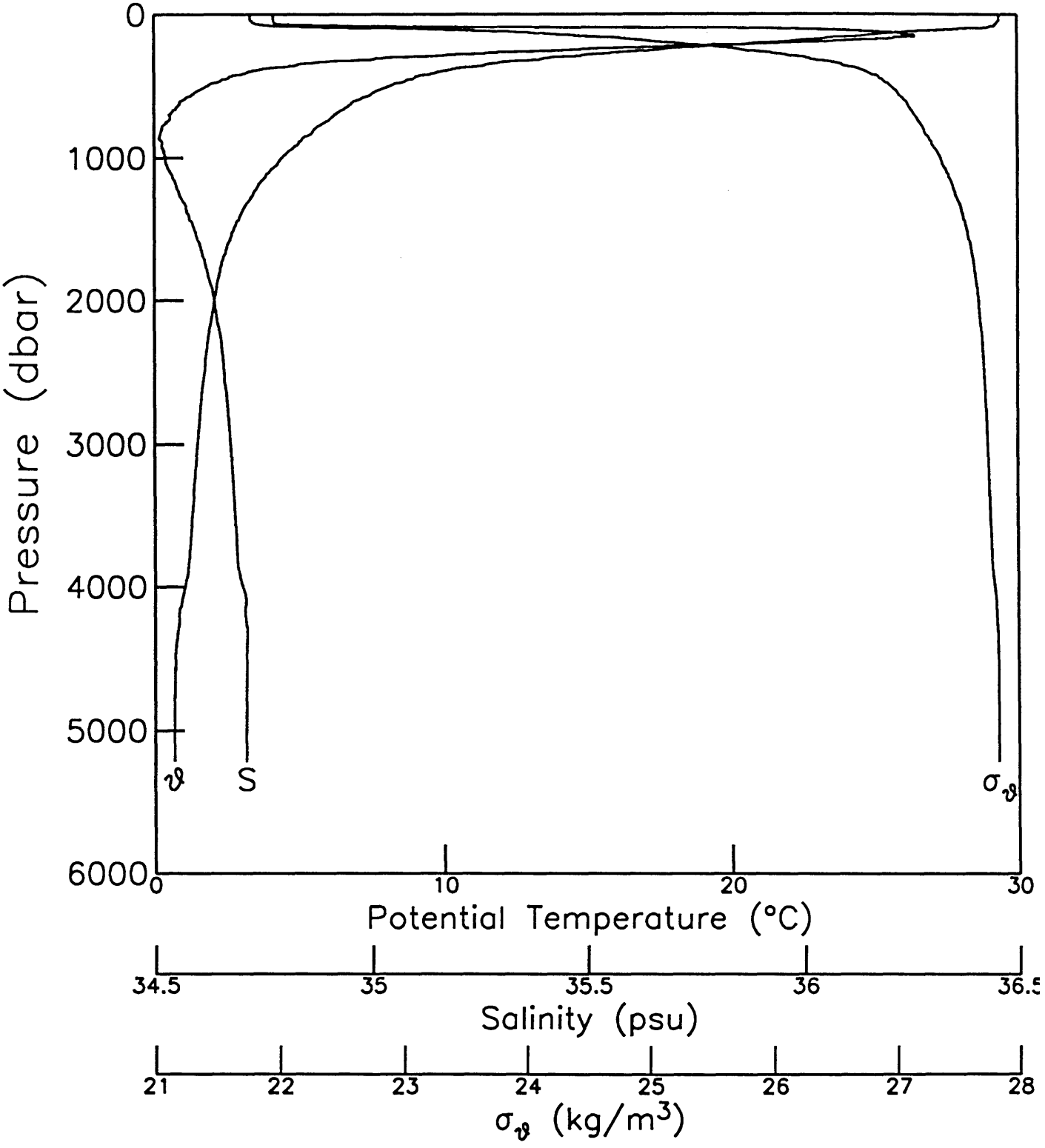
9 57.4 S 169 37.0 W 5281 m 21- 9-92 1419Z




PCM11 Station 8
9 50.0 S 170 2.1 W 5011 m 22- 9-92 0810Z
Pressure (dbar)
0
1000
2000
3000
4000
5000
6000
ϑ
S
σϑ
0
10
20
30
Potential Temperature (°C)
34.5
35
35.5
36
36.5
Salinity (psu)
21
22
23
24
25
26
27
28
σϑ (kg/m3)

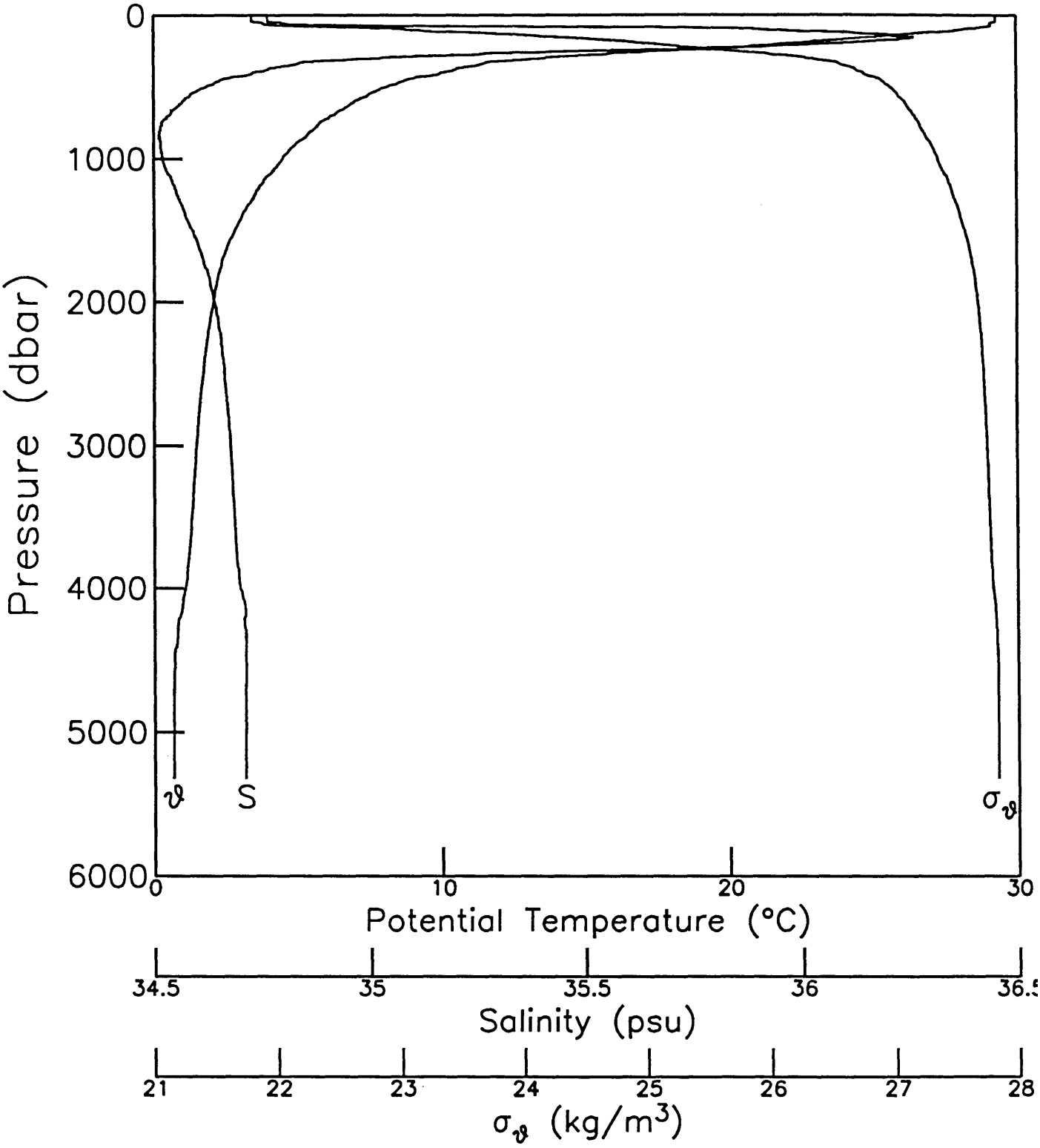
PCM11 Station 9

9 51.9 S 169 51.8 W 5159 m 22- 9-92 1213Z



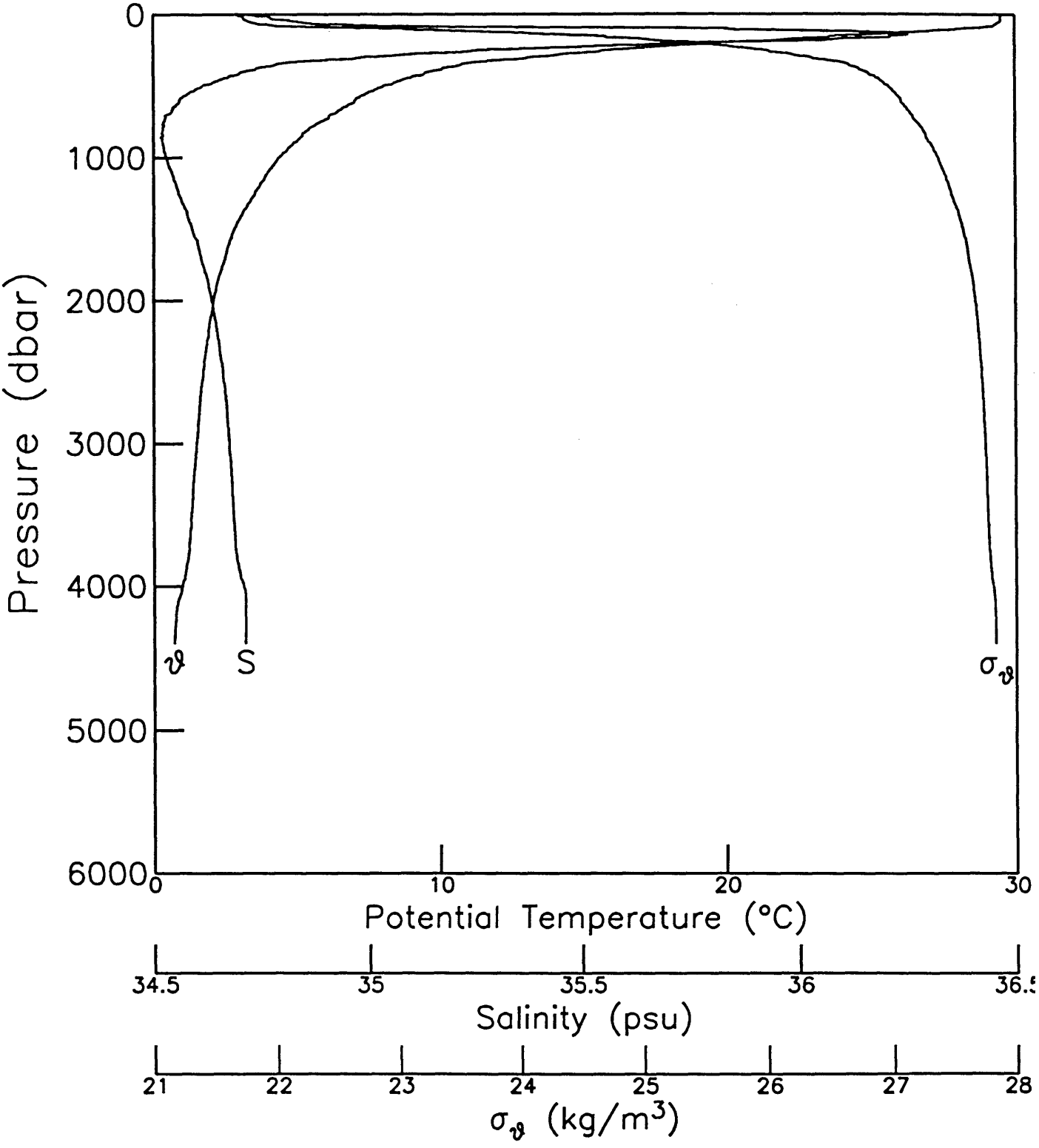
PCM11 Station 10

9 54.6 S 169 47.1 W 5227 m 22- 9-92 1557Z



PCM11 Station 11

9 41.0 S 170 31.1 W 4339 m 23- 9-92 0444Z



PCM11 Station 12

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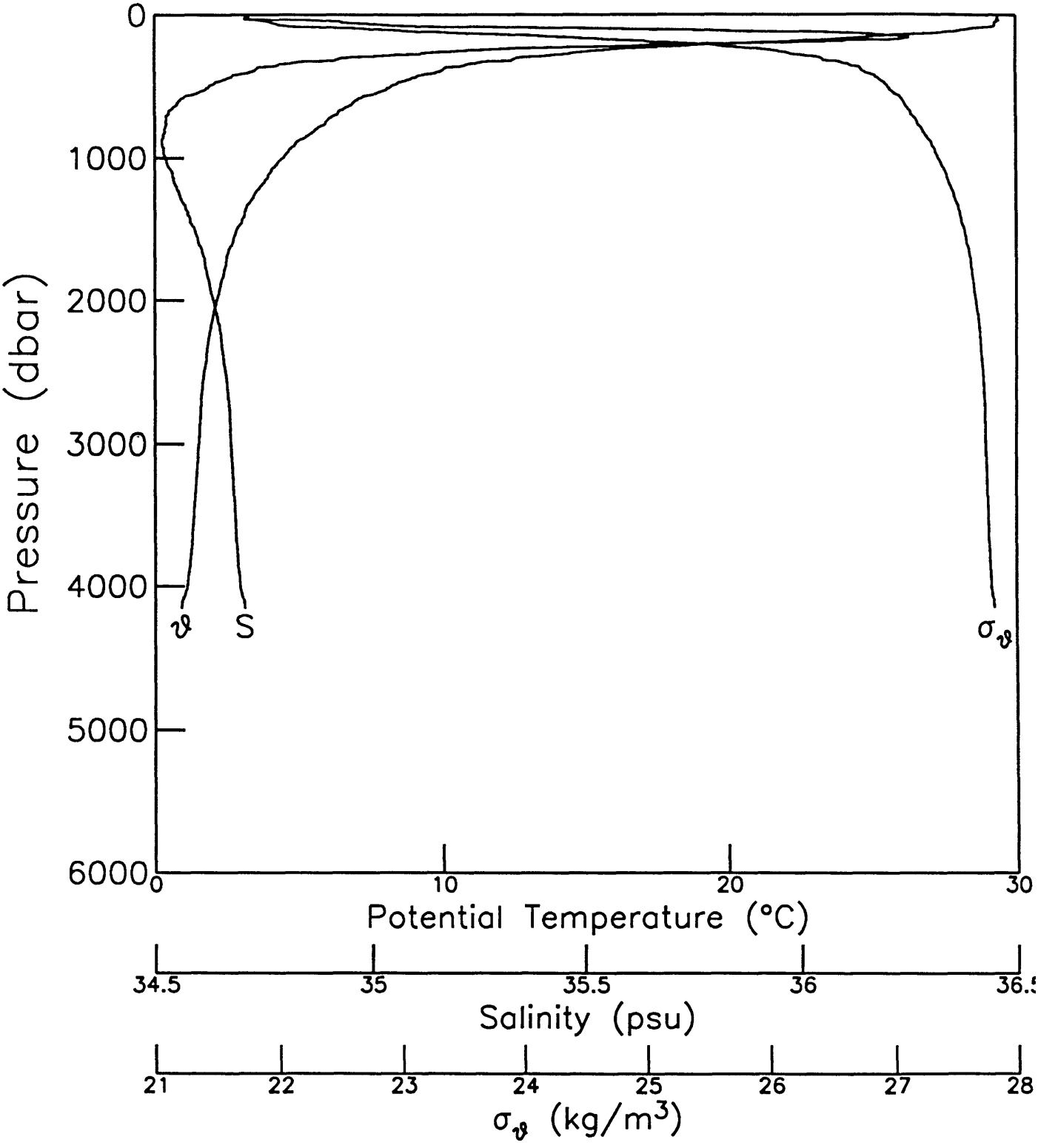

June 2001

ODF has discovered a small error in the algorithm used to convert ITS90 temperature calibration data to IPTS68. This error affects reported Mark III CTD temperature data for most cruises that occurred in 1992-1999. A complete list of affected data sets appears below.

ODF temperature calibrations are reported on the ITS90 temperature scale. ODF internally maintains these calibrations for CTD data processing on the IPTS68 scale. The error involved converting ITS90 calibrations to IPTS68. The amount of error is close to linear with temperature: approximately -0.00024 degC/degC, with a -0.00036 degC offset at 0 degC. Previously reported data were low by 0.00756 degC at 30 degC, decreasing to 0.00036 degC low at 0 degC. Data reported as ITS90 were also affected by a similar amount. CTD conductivity calibrations have been recalculated to account for the temperature change. Reported CTD salinity and oxygen data were not significantly affected.

Revised final data sets have been prepared and will be available soon from ODF (ftp://odf.ucsd.edu/pub/HydroData). The data will eventually be updated on the whpo.ucsd.edu website as well.

IPTS68 temperatures are reported for PCM11 and Antarktis X/5, as originally submitted to their chief scientists. ITS90 temperatures are reported for all other cruises.

Changes in the final data vs. previous release (other than temperature and negligible differences in salinity/oxygen):

S04P: 694/03 CTD data were not reported, but CTD values were reported with the bottle data. No conductivity correction was applied to these values in the original .sea file. This release uses the same conductivity correction as the two nearest casts to correct salinity.

AO94: Eight CTD casts were fit for ctdoxy (previously uncalibrated) and resubmitted to the P.I. since the original release. The WHP-format bottle file was not regenerated. The CTDOXY for the following stations should be significantly different than the original .sea file values: 009/01 013/02 017/01 018/01 026/04 033/01 036/01 036/02

I09N: The 243/01 original CTD data file was not rewritten after updating the ctdoxy fit. This release uses the correct ctdoxy data for the .ctd file. The original .sea file was written after the update occurred, so the ctdoxy values reported with bottle data should be minimally different.

DATA SETS AFFECTED:

WOCE Final Data - NEW RELEASE AVAILABLE:

WOCE Section ID	P.I.	Cruise Dates
S04P	(Koshlyakov/Richman)	Feb.-Apr. 1992
P14C	(Roemmich)	Sept. 1992
PCM11	(Rudnick)	Sept. 1992
P16A/P17A (JUNO1)	(Reid)	Oct.-Nov. 1992
P17E/P19S (JUNO2)	(Swift)	Dec. 1992 - Jan. 1993
P19C	(Talley)	Feb.-Apr. 1993
P17N	(Musgrave)	May-June 1993
P14N	(Roden)	July-Aug. 1993
P31	(Roemmich)	Jan.-Feb. 1994
A15/AR15	(Smethie)	Apr.-May 1994
I09N	(Gordon)	Jan.-Mar. 1995
I08N/I05E	(Talley)	Mar.-Apr. 1995
I03	(Nowlin)	Apr.-June 1995
I04/I05W/I07C	(Toole)	June-July 1995
I07N	(Olson)	July-Aug. 1995
I10	(Bray/Sprintall)	Nov. 1995
ICM03	(Whitworth)	Jan.-Feb. 1997

non-WOCE Final Data - NEW RELEASE AVAILABLE:

Cruise Name	P.I.	Cruise Dates
Antarktis X/5	(Peterson)	Aug.-Sept. 1992
Arctic Ocean 94	(Swift)	July-Sept. 1994

Preliminary Data - WILL BE CORRECTED FOR FINAL RELEASE ONLY NOT YET AVAILABLE:

Cruise Name	P.I.	Cruise Dates
WOCE-S04I	(Whitworth)	May-July 1996
Arctic Ocean 97	(Swift)	Sept.-Oct. 1997
HNRO7	(Talley)	June-July 1999
KH36	(Talley)	July-Sept. 1999

"Final" Data from cruise dates prior to 1992, or cruises which did not use NBIS CTDs, are NOT AFFECTED.

post-1991 Preliminary Data NOT AFFECTED:

Cruise Name	P.I.	Cruise Dates
Arctic Ocean 96	(Swift)	July-Sept. 1996
WOCE-A24 (ACCE)	(Talley)	May-July 1997
XP99	(Talley)	Aug.-Sept. 1999
KH38	(Talley)	Feb.-Mar. 2000
XP00	(Talley)	June-July 2000

REVISED FINAL quality-coded WHP-format CTDO + Bottle Data release for WOCE92-PCM11

These data were revised to correct a temperature conversion error. Please see the file DOC/README.Jun2001 for more information regarding this error and its correction. This is the first release of these data in WHP standard format.

The CTD data in this release have been corrected using pre- and post-cruise laboratory calibrations for pressure and temperature, and bottle salt vs CTD comparisons to calibrate conductivity/salinity. Interpolated/extrapolated data records are identified by a quality code of "6666". Only surface (0-decibar) levels may have been extrapolated in this data set. The default quality code of "2" (acceptable) was used for CTD Pressure, Temperature and Salinity.

CTD oxygen data are quality-coded "1" (uncalibrated) because no bottle oxygen samples were drawn or analyzed. CTD oxygens cannot be corrected without check sample data taken during the casts. The shipboard oxygen corrections from P14C/station 37, during the leg which preceded this cruise, were used for all casts in order to provide some idea of approximate maxima and minima only. These CTD oxygen data should in no way be used to draw any conclusions about oxygen for these casts.

The only bottle data collected during PCM11 were salinity check-samples for the purpose of calibrating CTD salinity. A WOCE-format ".sea" file with bottle salinities and standard CTDO values is included with this release. Further documentation, including data processing details and problems or tables of correction coefficients, will not be produced for this cruise. Wilf Gardner at TAMU (wgardner@tamu.edu) should be contacted regarding any transmissometer data collected with PCM11 CTD casts.

QUESTIONS:

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