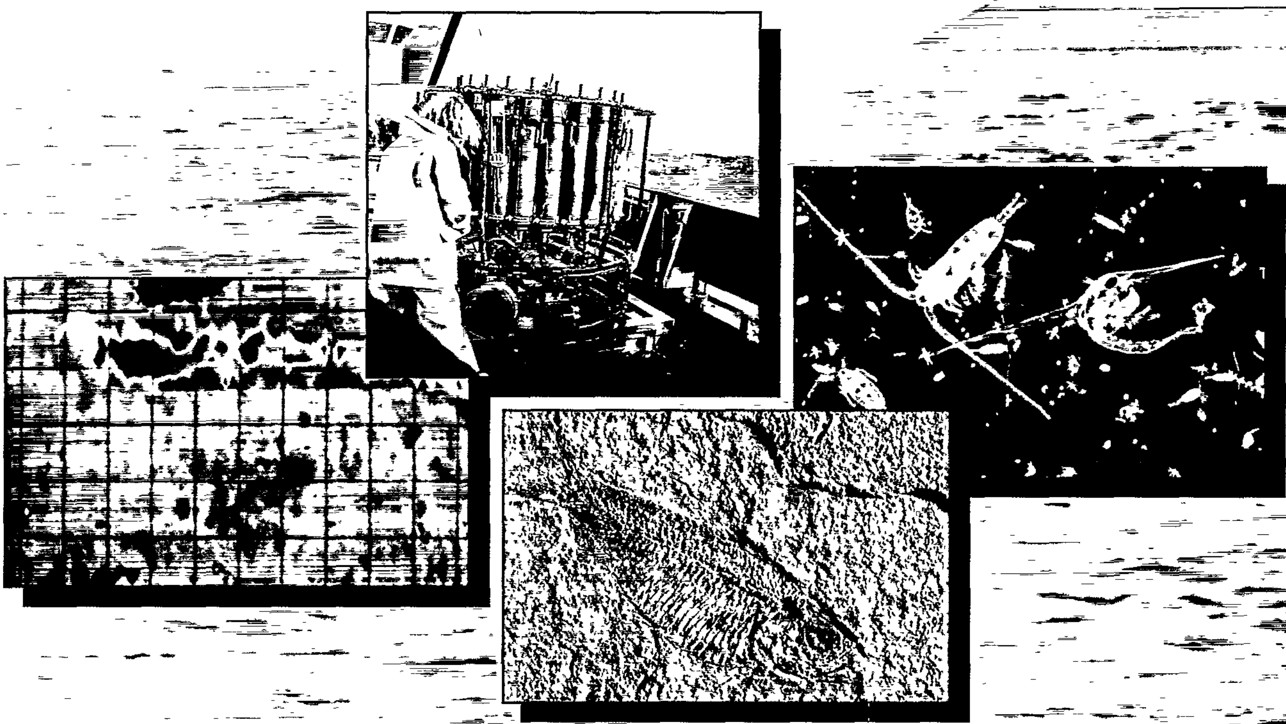
Southampton Oceanography Centre

Report



Natural Environment Research Council

University of Southampton

SOUTHAMPTON OCEANOGRAPHY CENTRE

REPORT

No. 1

SeaSoar operations and data collected on
Polarstern Cruise ANT-XIII/2
04 Dec 1995 - 24 Jan 1996

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ABSTRACT

Four SeaSoar surveys were carried out from FS *Polarstern* during the ANT XIII/2 cruise, to look at upper ocean dynamics in areas of high biological productivity. As well as the standard CTD (conductivity, temperature, depth) measurements, the SeaSoar was fitted with a fluorimeter and Optical Plankton Counter. This report describes the methods used to calibrate the SeaSoar CTD data, and presents the data as contour plots and profiles, section by section, without interpretation. A diary of operations is given. The computing macros used are listed in appendices.

KEYWORDS

CALIBRATION, CTD OBSERVATIONS, CRUISE XIII/2 1995, *POLARSTERN*, SEASOAR

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Abstract

Four SeaSoar surveys were carried out from FS *Polarstern* during the ANT XIII/2 cruise, to look at upper ocean dynamics in areas of high biological productivity. As well as the standard CTD (conductivity, temperature, depth) measurements, the SeaSoar was fitted with a fluorimeter and Optical Plankton Counter. This report describes the methods used to calibrate the SeaSoar CTD data, and presents the data as contour plots and profiles, section by section, without interpretation. A diary of operations is given. The computing macros used are listed in appendices.

Overview

Four distinct SeaSoar sections were undertaken, (plus an initial four hour run to test deployment and logging procedures) - see Tables 1 and 2. Runs 2 and 3 were consecutive (Figure 1) - separated by mooring site - and were used to identify the latitude of the polar front, and observe frontal features as far south as the ice limit. After an unsuccessful attempt to reach the Antarctic base at Neuymayer, *Polarstern* returned to the working area twelve days later. This time, after returning along the track of Run 3 as Run 6.1, a Course Scale Survey (CSS) comprising six north-south sections 75 km apart (Runs 6.2 to 6.7, Table 2, Figure 2) was carried out. After a few days of station work, the Fine Scale Survey (FSS) was undertaken (Run 8, Figure 3), comprising eleven north-south legs 13 km apart. Leg 8.1 duplicated leg 6.7, and leg 8.7 duplicated leg 6.6.

SeaSoar was fitted with a Neil Brown Instrument Systems Mk IIIb CTD, with dual conductivity cells; also fitted with oxygen sensor, PAR light meter, Chelsea Instruments Fluorimeter, and an Optical Plankton Counter. OPC data are presented in a separate report (Pollard *et al.*, 1996). Acoustic Doppler Current Profiler data collected at the same time (Allen *et al.*, 1996) and underway data (Read *et al.*, 1996) are also described in companion reports. Hardware and software supplied by NERC Research Vessel Services (RVS) were used to do the preliminary data logging, and the PEXEC software developed at IOS was used for all further processing.

Calibration

Every four hours, data were read in and processed. Extreme values of pressure, temperature and conductivity (1 and 2) were deleted from the raw data, before applying initial calibrations described below.

press = (praw*0.01)*0.998597 + (praw*0.01)2*1.767e-6 - 3.12281

temp = (traw*0.0005)*0.998877 + (traw*0.01)2*7.643e-6 - 0.11296

cond = (craw*0.001)*0.9936852 - 0.01566

cond2 = (craw*0.001)*0.9855667 - 0.03051

fluor = fraw*0.0012207

oxyc = (ocraw*0.001)*-.0100495 + (ocraw*0.001)2*0.124923 - 0.01249

light = (lraw*0.0012207)*4.854 - 11.65617

Note, the variables fluor, oxyc and light are from the multiplexed signal. This has a full scale value of 4096 equivalent to 5 volts. Hence, to convert to volts, these variables are multiplied by 0.0012207 .

Temperature

As the conductivity sensor has a faster response than the platinum thermometer, temperature data need to be accelerated to match salinity,(Crease, 1988). That is, temperatures, T, were replaced by T + τ x deltaT, where τ is 0.15 seconds and deltaT is the rate of change of temperature (calculated by the level A).

Salinity

The NBIS conductivity sensor consists of a small (4mm across), square tube, across which a small current is applied. The ratio of this current to the measured voltage gives the conductivity (the inverse of resistance). The small aperture often becomes clogged or fouled by bugs in the water. These foulings become apparent in the data as sharp drops in salinity, and the data must be edited. Either the sensor clears suddenly, in which case an offset may be applied to the fouled data; or (in a worse case), the bug is gradually washed away, giving rise to a gradual drift in salinity as it returns to the correct value. By using two conductivity sensors, it is often possible to use data from one cell, when the other is fouled. In the worst case scenario, when both sensors are clogged, it is up to the skill and experience of the data processor to apply an offset or delete the data altogether.

Once the salinity data have been 'cleaned up', it is possible to apply an overall offset to the data, to make it match the salinity data of lowered CTD casts (which were calibrated against the bottle salinities) when available. On this cruise, however, the underway thermosalinograph was used to provide to provide absolute calibration with the CTDs used later as final checks(Read *et al.*, 1996). After this procedure, salinities presented in this report are believed to be accurate within ±0.01.

Light

The irradiance meter was calibrated at Plymouth Marine Laboratory. The calibration provided was:

lnPAR = -7.051 + 0.004854(mV) (ln μWcm^{-2})

The calibration applied was:

light $= e^{(-11.65617+4.854 lraw)}$ (Wm^{-2})

where lraw is the raw light value in volts.

Light data for SeaSoar sections saps1002 to saps1018 were calibrated using the script light.cal; after that, shalctd.cal was updated, and an extra step added to ssexec1.

Oxygen

Oxygen data were calibrated against oxygen values measured at the CTD stations. The calibration was found to drift dramatically whilst the SeaSoar was in the water, and the data were considered unusable. They are not presented here.

Further processing

Once the four hourly sections were calibrated, they were appended to form a complete section. From these files the data were gridded using an un-weighted average of all data within cells 8m by 6km, and placed on a grid 8m by 6km. These data are presented in the figures as contour and profile plots section by section.

Data presentation

Tables 1-3 summarise the SeaSoar runs and legs. Figs 1-3 are track plots for the first section and the two surveys. Remaining figures present the data, section by section on two facing pages each. Each page contains plots of potential temperature, salinity and density σ_0. On the left hand page they are presented as contour plots, on the right hand page as profiles at intervals of 0.1° of latitude. The contour plots have the following contour intervals and bands shaded for clarity:

Temperature: Contour intervals are 0.5°C for T < 8°C and 1°C for T > 8°C. Shaded: -0.5°C to 0°C, 1.5°C to 2°C (to highlight the Polar Front), 4.5°C to 5°C (to highlight the SubAntarctic Front), and 7.5°C to 8°C.

Salinity: Contour intervals are 0.1 for 33.9 < S < 34.6 and 0.2 for S > 34.6 with an extra contour at S = 33.85. Shaded: less than 33.85 (to highlight the surface salinity minimum), and 34.3 to 34.4.

Density: Contour intervals are 0.05 kg m^{-3}. Shaded: 26.8 to 26.9, 27.1 to 27.2, and 27.55 to 27.65.

SeaSoar Diary - Polarstern Ant XIII/2

Monday 6 November 1995 - Wednesday 8 November

Most of the SeaSoar hardware and computing equipment was installed during *Polarstern*'s port call at Bremerhaven. This was exceptional, as equipment is usually not installed until the ship has sailed on the relevant leg, but was essential to ensure (a) that interface problems on a new ship were ironed out and (b) that we would be ready to begin SeaSoaring within a day of leaving Cape Town.

Sat 2 Dec Julian Day 336 - Sun 3 Dec Day 337

Polarstern docked in Cape Town at 0800 and we were on board by 0930. The boson had fixed the block on the winch and welded the winch to the deck during the passage from Bremerhaven. During the next two days the preparation continued. We

- installed multicore signal cable and winch strain sensor cable from the winch to the laboratory, approx. 60 metres,
    - connected electrical power to the winch,
    - assembled the Optical Plankton Counter (OPC) to theSeaSoar,
    - fixed the fluorimeter,CTD,PAR on SeaSoar,
    - terminated the sea cable and attached it to the vehicle,
    - applied power to the system and checked it out

Mon 4 Dec 1995 - Day 338

Sailed from Cape Town at 1100.

Tues 5 Dec - Day 339

Deployed SeaSoar for a trial run at 1350 (all further times are GMT). The block supplied was a disaster. It had a V-shaped cable slot, so when the fairing went in hanging down from the cable, the wire easily jumped out of the slot and jammed in the cheek plates. The very large stern A-frame made it impossible to guide the fairing by hand into the block. Also the block has become a little loose, leaving just enough space for the wire to force its way between the cheek plate and the wheel. After this had occurred three times, the block was abandoned and replaced by a ship's block that the Bosun produced. This was small, but had a wide, gently curved surface, and overhanging cheek plates. It worked excellently, and SeaSoar was deployed without further difficulty.

The SeaSoar winch was tucked well forward under the helicopter deck overhang, and the block was suspended on a wire that led over a block at the top of the A-frame to a side winch. By controlling the height of the block, and gradually raising it as the A-frame went outboard, it was possible to keep the wire lead from the winch at not too great an angle to the horizontal.

The winch still has a problem with tripping out two or three times per recovery or deployment. This is a safety feature to prevent overheating, but could do with adjustment. The winch controls are also course, making fine control difficult. This can be dangerous, such as dropping SeaSoar suddenly by 2m when it suspended above the deck and needs to be inched down.

After towing for 4.7 hours, SeaSoar was recovered at 1830. Conditions were calm and pendulum motion was reduced by side ropes attached to the block. As long as the winch driver maintains the SeaSoar close to the block, its height above deck for the final lowering is better controlled by the A-frame driver adjusting the height of the block.

Data from the first run were not processed. A CTD cast was made after recovery of SeaSoar, but the bottles on the multisampler did not fire, so no calibration of salinity was available.

<u>Wed 6 Dec - Day 340</u>

After CTD station 4 at 0817, the first major deployment, Run 2, was begun. However, the multisampler did not work, so no samples for salinity calibration were collected. The deployment went smoothly, and 700 m of cable were paid out. Various combinations of ship speed and up and down profiling rates were tried, but it proved impossible for the vehicle to reach the surface. This was believed to be caused by two factors, the wing angle, and the extra drag of the OPC. At 1900, therefore, the ship was slowed briefly while 150 m of cable were taken in. Thereafter, SeaSoar profiled between the surface and 370 m.

The Subtropical Front was crossed shortly after deployment, between 41.5°S and 42°S.

<u>Thurs 7 Dec - Day 341 and Fri 8 Dec - Day 342</u>

Run 2 continued on course 220° throughout both days on passage to Mooring 1 (50°11.1'S, 5°53.7'E). The major problem in analysing the data was that the second conductivity cell became very noisy on every down cast, spiking to high values with a mean offset, and thus unusable for cross-calibration at those times. However, the second cell appeared to foul less than the primary cell (the one paired with the Precision Reversing Thermometer), so was valuable in maintaining relative calibration. On the deck unit the spiking appeared to extend to the PRT also, but there was no sign of bad values on the scrolling data cycle print display, nor did any bad values come through to the 1-second averages output by the Level A.

<u>Sat 9 Dec - Day 343</u>

The SeaSoar run was ended at 0300 after passing through a waypoint 2 n.m. west of the mooring. The ship began turning into wind, course 259°, for recovery at 0235. *Polarstern* returned to the waypoint for CTD station 5 cast 2, to provide data for the salinity calibration and a multinet cast to calibrate the OPC. SeaSoar recovery proved difficult in heavy seas, which swept up the stern ramp and occasionally broke over the stern, swamping personnel. The SeaSoar was nearly dropped onto the deck because of lack of fine control of the SeaSoar winch. It would have been better to stop the SeaSoar winch for the final lowering and lower the block instead.

The mooring failed to release, so the mooring recovery, full depth CTD cast and subsequent mooring deployment were all cancelled. SeaSoar was not ready tdisassembled to tighten all internal boards, the most likely cause of the noisy cell. The wing angle was also changed to give more uplift. *Polarstern* therefore steamed on from 1000 until 1230, before stopping for a 500 m CTD station 6 cast 1 and multinet to calibrate the start of SeaSoar Run 3. After the casts ended at 1415, deployment was started 2 n.m northeast of the station position into wind on course 287°. Once the SeaSoar was fully deployed, *Polarstern* came up to 8 knots and turned onto course 240° towards Mooring 2 (54°20.6'S, 3°17.6'W), this manoever being completed by 1455.

The increased wing angle adjustment did indeed improve SeaSoar's ability to reach the surface, and the towing speed was increased to 9 knots. Maximum depth had to be limited to 360 m however, to avoid overhigh cable tensions.

Sun 10 Dec - Day 344

With a following wind and rough seas, the maximum depth had to be gradually reduced to 340 m over the next 24 hours. Shortly after 1700 it was decided that there was no possibility of recovering Mooring 2 on the following day because of inclement weather, so the course was changed to 195° towards Mooring 3 (59°27.5'S, 3°11.2'W).

Mon 11 Dec - Day 345

All noise in the second conductivity cell appeared to have been eliminated by the checks done between Runs 2 and 3. However, starting at 1000, the noise gradually returned. Thus just under 2 days of noise-free towing were achieved.

Forecasts and satellite images suggested that ice would be reached before the following morning, so it was decided to recover SeaSoar before darkness. At 2100 *Polarstern* turned into the wind course 284°, returning to the 2100 position after recovery for CTD station 7 cast 1. Passage towards the mooring was resumed thereafter.

Tues 12 Dec - Day 346 to Thurs 21 Dec - Day 355

After failing to recover Mooring 3 on 12 Dec, course was set for Neumayer, which was reached in the afternoon of Fri 15 Dec. During this passage it was possible to catch up with processing and calibrating SeaSoar and other data.

Salinity samples had been drawn every half hour from the 8 m deep clean supply during SeaSoar runs. These were analysed and used to correct offsets in the SeaSoar salinity calibration of as much as 0.1, and to correct the salinities to an absolute accuracy within 0.01. During this passage, progress was also made in processing data from the new Optical Plankton Counter (OPC) and in working up data from the Acoustic Doppler Current Profiler (ADCP). Details of the analysis will be found in data reports.

The shallow CTD was examined in detail and numerous improvements made. While there is a new shallow CTD (shallow meaning: fitted with a light pressure case and end caps suitable for SeaSoar) on board as backup, the double NBIS conductivity cell is fitted to an old CTD which has old boards and many patches. After this thorough overhaul, the following runs showed that the noise problems with the second cell had been eliminated. The cable termination was remade.

Weather and ice conditions prevented full relief of the Neumayer base, and it was decided to return to the vicinity of Mooring 1 then run a course survey to the east. It was felt that there would be value in repeating the section occupied on the southward passage, so course was set for 54°S, 0°E.

Fri 22 Dec - Day 356

SeaSoar was deployed at 1845 at 54°S for Run 6 Leg 6.1 and towed on course 007°, the reciprocal course to that occupied on the southward passage. There was a problem in flying SeaSoar to ensure that it reached the surface. Modification of the SeaSoar control unit cured the problem.

Sat 23 Dec - Day 357

On reaching 52°48'S course was altered to 053°, and Leg 6.1 continued throughout the day.

Sun 24 Dec - Day 358

When close to the Mooring 1 position, course was altered to the east for 14 km before turning south at 50.25°S, 6°E on Leg 6.2, the first of 6 parallel north-south runs approximately 75 km apart forming the course grid survey, Run 6. All legs extended to 52°S but the northern limits were gradually shifted northwards to extend past the front that was found at about 50°S. Leg 6.2 was completed running south and leg 6.3 begun returning north during the Christmas celebrations.

Mon 25 Dec - Day 359

High biomass was found near the northern end of leg 6.3, but tending to decrease at the northermost point. SeaSoar was therefore hauled to undertake CTD/net station 10 in high biomass conditions partway down leg 6.4. However, the southern limit of bloom conditions had moved northwards between legs 6.3 and 6.4 and the station was slightly too far south. SeaSoar was redeployed to continue leg 6.4 after a 4-hour break.

Tues 26 Dec - Day 360

Leg 6.4 southwards was completed and leg 6.5 northwards begun at 1300. By evening it was apparent from increased noise in the CTD data that the cable termination was weakening. This cannot be avoided where the cable works most, where it connects from the bridle of the SeaSoar vehicle to the vehicle itself. Conditions were unfavourable for recovery at nighttime with swell building up and Force 8 to 9 winds. The depth of profiling was therefore reduced from over 350 m to about 300 m and the rate of descent slowed in order to reduce the noise and avoid recovery before the next morning.

Wed 27 Dec - Day 361

By morning, the noise was still not excessive, so a station position 15 km down leg 6.6 was chosen for station work during the enforced break while the cable was reterminated. Recovery at 0930 was wet. Heading into 20 m/s winds with a strong swell, *Polarstern* pitches and waves run up the stern ramp and flood the working deck, occasionally breaking over the stern rails. This made the work wet and hazardous for personnel manning ropes and manhandling the vehicle during the last moments of recovery, but the operation was completed without accident.

Station 11 was attempted during repair of SeaSoar, but had to be abandoned after the CTD wire kinked. Nets were not possible in the high wind conditions, and waves breaking over the working deck were hazardous. The ship thereafter steamed at 1.5 knots on course 009°, nearly beam on to the swell, which minimised the water on the working deck, making it possible to move the SeaSoar vehicle into the lab where the wire could be reterminated in safety. By the time this was completed, the ship's position was north of 49.5°S. SeaSoar was redeployed at 1715 on the same course to keep the working deck dry during the operation. Despite the fact that the course was nearly beam on to the wind (by now moderated to 13 m/s) no problems were experienced with the wire angle, probably because of the good shieve.

After deployment was competed, *Polarstern* turned south to begin an extended Leg 6.6, during which the wind died completely then reversed from strong north-westerly to weak (6 m/s) north-easterly.

Thurs 28 Dec - Day 362

Southward leg 6.6 continued until 1110, and the final northward leg 6.7 was begun at 1530. During these legs there was still some noise in the data stream, which should not have been present with a newly made termination. It was surmised that strain during launch could be a contributing factor, as the large A-frame meant that the weight of SeaSoar is taken on the rather small diameter shieve for a few minutes during launch. However, the noise was not serious enough to merit termination of the run.

Fri 29 Dec - Day 363

Run 6 was terminated at the planned end of survey 6, at 49.5°S, 11.4°E at 0845. During the calibration Station 12, leg 6.7 was worked up to show the density and current structure. On the strength of this, a mooring was deployed at 49.9°S, 11.5°E near the core of the eastward frontal jet. This position was chosen to be a safe distance east of leg 6.7, itself chosen to be the easternmost leg of the fine-scale survey to follow after several days of station work.

Maintenance work on SeaSoar between runs included changing the fluorimeter and OPC cables, which were damaged. The cable was reterminated again. The state of fairing during recovery was noticeably deteriorating and several sections of up to a metre had to be cut off. This was particularly so for the upper length of the cable which spends a large proportion of its time near surface in the wave zone. Here, many of the small metal stoppers which separate the fairing sections had come unglued from the main cable. This allows fairing to slide along the cable fouling the next strip or seizing on the stopper, thus increasing drag (hence reducing fairing performance) and also speeding fairing wear. Both cable and fairing need replacement after this cruise.

Sat 30 Dec - Day 364 and Sun 31 Dec - Day 365

CTD and net stations 13-17 were worked over the next two days. Station 13 was at the mooring, stations 14 and 15 at 0.4° intervals south of 13, and Stations 16 and 17 along the longitude of leg 6.6, intended to be the central leg of the fine-scale survey. However, bad weather and the prospect of continuing high winds forced cancellation of the last station before the New Year's Eve break, with the likelihood that station work would not be possible the next day either. The decision was therefore taken to start the fine-scale survey as soon as work restarted on New Year's Day, conditions permitting.

Mon 1 January 1996 - Julian Day 1

By morning the wind had moderated from 20 m/s to under 15 m/s. Also *Polarstern* was running easily downwind towards the start position with the wind and swell from astern. SeaSoar was therefore launched at 0900 on that course, with no attempt to stop for an initial calibration cast. In order to reduce the strain on the cable during launch, SeaSoar was suspended from the bridle on a snatchblock from the A-frame and the cable kept loose. Once the SeaSoar was in the water, the snatchblock was released and deployment continued normally. *Polarstern* then turned south on the first leg of the finescale survey.

Early in the afternoon, SeaSoar recorded a very high strain and thereafter refused to dive or climb. The ship maintained its course beam on to the sea during recovery, which went smoothly. The problem was no more serious than fouling by kelp. A large holdfast of Macrocystis several metres long was wrapped around one of the wings. It was removed and SeaSoar redeployed in barely half an hour.

Tues 2 Jan - Day 2 to Thurs 4 Jan - Day 4

Run 8, the fine-scale survey, continued without further incident. The survey was planned to consist of 13 north-south parallel legs 13 km apart. While the course-scale survey legs were occupied from west to east, those for the finescale survey were worked from east to west, upstream against the prevailing current. Leg 8.1 coincided with Leg 6.7, and the fine-scale survey legs all ran from 49.7°S to 50.8°S. On the evening of 4 January it was decided to end the run after 11 legs instead of the planned 13 in order to give more time for station work before it became necessary to return to Neumayer. There was a prospect of strong winds, but more importantly, extra shallow stations were necessary along the pivotal transect of the fine-scale survey, Leg 8.7, itself a near repeat of Leg 6.6. These extra stations were needed for multinet/OPC casts to calibrate the SeaSoar OPC data and for rosette phytoplankton samples to be drawn at 10 m intervals in the vertical to aid calibration of the SeaSoar fluorimeter.

Wed 5 Jan - Day 5

SeaSoar was therefore recovered at 0600 at the end of Leg 8.11, ending survey 8 and SeaSoar operations for the cruise.

References

Allen J. T., H. Fischer, M. J. Griffiths, R. T. Pollard, J. F. Read and V. H. Strass (1996) *Acoustic Doppler Current Profiler data collected on Polarstern Cruise ANT XIII/2 4 December 1995 - 24 January 1996*. Southampton Oceanography Centre, Internal Document No. 8, 46 pp.

Crease J. (1988) *The acquisition, calibration and analysis of CTD data. A report of SCOR working group 51*. UNESCO Technical papers in marine science, 54, 92 pp.

Pollard R. T., M. J. Griffiths, T. J. P. Gwilliam and J. F. Read (1996) *Optical Plankton Counter SeaSoar data collected onPolarstern Cruise ANT XIII/2 4 Dec 1995 - 24 Jan 1996*. Southampton Oceanography Centre, Report No. 2, 92 pp.

Pollard R. T., J. F. Read and J. Smithers (1987) *CTD sections across the southwest Indian Ocean and Antarctic Circumpolar Current in southern summer 1986/7*. Institute of Oceanographic Sciences Deacon Laboratory, Report 243, 161 pp.

Read J. F., M. J. Griffiths and R. T. Pollard (1996) *Polarstern ANT XIII/2 4 December 1995 - 24 January 1996 Underway Data Report, comprising navigation, thermosalinograph, bathymetric and meteorological data*. Southampton Oceanography Centre, Internal Document No. 9, 49 pp.

Acknowledgements

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Appendix 1 - shalctd.cal file for ctdcal CTD calibration program

```
:CTD SHALLOW 1 - ANTXIII/2 (05/12/95)
:calibration file for shallow ctd
:From run 3 - added new light calibration.
press     .01      -3.12281  0.998597   0.000001767 0.   0.
temp      .0005    -0.11296  0.998877   0.000007643 0.   0.
deltat    .15       0.       1.         0.    0.   0.
cond      .001     -0.01566  0.9936852  0.    0    0.
cond2     .001     -0.03051  0.9855667  0.    0    0.
oxyc      .001     -0.01249  -.0100495  0.124923 0.   0.
oxyt      .128      0.       1.         0.    0.   0.
oxyfrac  -.046      0.       1.         0.    0.   0.
fvolts    1.        0.       0.0012207  0.    0.   0.
fluor     1.        0.       1.         0.    0.   0.
:light     1.        0.       0.0012207  0.    0.   0.
light     .0012207 -11.65617 4.854  0.    0.   0.
zvolts    1.        0.       0.0113     0.    0.   0.
```

Appendix 2 - Ship's Scientific clock

Details provided by Ed Cooper (RVS).

The scientific clock onboard *Polarstern* is manufactured by WEMPE; Message format is NMEA, (described below), 4800 baud, 8 data, 1 stop, no parity. Baud rate can be changed via jumper installation. There are RS-232 outputs in most labs.

$ZCZDA,hhmmss.ss,xx,xx,xxxx,xx,xx*hh<CR><LF>

ZC	- talker identifier
ZDA	- sentence format identifier
hhmmss.ss	- UTC
xx	- day, (01-31)
xx	- month, (01-12)
xxxx	- year, (1993-2092)
xx	- local time offset, (+/- hours)
xx	- local time offset, (+/- minutes)
*hh	- checksum

Example

$ZCZDA,085310.10,20,06,1995,02,00*56

Appendix 3 - Computing

SeaSoar Data Logging System

The critical stage of collecting and logging data from the CTD deck unit was done using hardware and software created and supplied by NERC Research Vessel Services (RVS). The system is commonly known as the ABC system, since conventionally it comprises three levels (one or more level A, one level B and one level C).

The CTD Level A is a dedicated microprocessor, and does the following processing:

- reads the data from CTD PC, arriving at 8 frames per second (12 bytes per frame)
- runs a median de-spiking routine
- averages data to 1 second values
- time stamps data, using ship's clock (see Appendix 2)
- calculates rate of change of temperature (deltaT) for each second (Pollard *et al.*, 1987).

Normally, the one second data would then be passed directly to the level B, using Ships Message Protocol (SMP). The level B monitors data arriving, raising an alarm if it interprets an error, and manages the (consistent) archiving of the data to tape. No level B was used during ANTXIII/2 - instead, the data from the level A were passed directly to the level C, (a Sun IPC workstation). At the level C, the data are stored in a binary format (known as RVS format) on hard disk, and it is from here that the data are made available to the users. (Note, the level C was also used to log the data from the ADCP, in the same RVS format).

The RVS level A used was a MkII. Data from the CTD PC were read at 9600 baud, with a clock input taken from the ship's NMEA clock at 4800 baud, to time stamp the data - see Appendix 2 for clock details. Note, this clock message was also passed to the OPC PC, allowing the datasets to be issued the same time stamp. Data were transferred to the level C (SOFAR) over the ship's Ethernet. A serial link between the level A and level C was also setup, as a backup for reading data. Finally, a serial link from the level A to one of the other Sun IPCs (SOSURVEY) was installed - running Kermit from this IPC, it was possible to monitor data from the level A, and also update/reset software parameters.

All channels from CTD were logged, including redundant variables from multiplexer.

Data Processing Hardware

Three Sun IPC workstations were used for logging, processing and archiving data. One IPC (SOFAR) acted as the RVS level C, and was used exclusively for this purpose. A one gigabyte disk was used. The two remaining workstations (SOSURVEY, SOCHEM) were used for the data processing. SOFAR was running SunOS 4.1.3U1; SOSURVEY and SOCHEM were both running SunOS 4.1.3. A four gigabyte disk attached to SOSURVEY held all packages (e.g. openwin, pexec), the pstar home directory, and the main data directories. A further one gigabyte disk was attached to SOCHEM, which acted as a holding area for data ready to be archived. K-Par ODSS (Optical Drive Support Software) Version 1.11 was installed on each workstation, just in case the SONY optical disk drive had to be moved from machine to another.

Each hard disk had two extra partitions - these held backup copies of the root (/) and usr (/usr) partitions of the disks host machine, and were created by restoring unix system dumps of the original partitions; e.g. (in single user mode)

- dump 0f /tmp/dump.root /dev/sd0a
- mount /dev/sd1a /mnt_root
- cd /mnt_root
- restore rf /tmp/dump.root
- /usr/mdec/installboot /mnt_root/boot /usr/kvm/mdec/bootsd /dev/rsd1a
- update /mnt_root/etc/fstab

Had the need arisen, each computer could have been rebooted from these alternative partitions - by using boot sd(0,1,0) at the monitor ROM prompt. Fortunately, the situation never arose.

Networking

Polarstern used a 10base2 Ethernet network, and supported the following protocols; Novell, TCP/IP and PCSA(DEC). Most labs had network outlet ports, which used non-interrupt style connectors.

Printing

Three printers were used; an Apple Personal LaserWriter, an HP Paintjet XL and an HP Deskjet 1600CM. Both the LaserWriter and Deskjet were capable of printing text and PostScript files; the Paintjet accepted HCPCL files. CAP60 (patch level 162) was installed on SOSURVEY, allowing the unix workstations to access the printers over the Ethernet. The scripts laser and pjet were used to send files; these use the scripts lprps.laser and lprps.jet respectively. There were no problems with any of the printers.

Software

Data from the CTD (and ADCP) were logged using the RVS level C software. When required, data would then be read into PSTAR data files, and then processed using the PEXEC suite of programs.

PEXEC and the PSTAR data format have been developed at IOSDL. The software has 20 years of oceanographic experience embedded in it. It has been used for a wide variety of tasks and data types, including CTD, ADCP, meteorological and model (e.g. FRAM) data. It has proved itself to be a versatile package that has been supplied to many institutes, including the Universities of East Anglia and Liverpool, BAS, BODC, Woods Hole Oceanographic Institute, Ifremer and Miami. At sea, its functionality complements that of the RVS Level ABC system, and shares a common data format.

Archiving and backups

Data were archived to optical disk, with a backup copy made to tape. Four 1.3Gbyte optical disks were used, with fifteen 150Mbyte QIC tapes and one DAT for the backup copies. The one gigabyte disk on SOCHEM acted as holding area for data before archiving (/archive).

Pstar data was copied (arch_cp) to the archive area and renamed to the format dataname.version, allowing files of the same filename to be archived throughout the cruise. A log file matched original filenames with the archived name. This file was maintained by arch_cp. The script rest_cp was written to help when restoring data, reading both the archive list and the optical/tape files.

A seven day rolling backup schedule was used throughout the survey. Data from the working areas, plus the RVS data directories, were copied to DAT tape using the backup_pstar script (which uses the UNIX bar command).

df from sosurvey

```
Filesystem              kbytes    used    avail capacity  Mounted on
/dev/sd0a                 9031    7876      252    97%    /
/dev/sd0g               105991   91560     3832    96%    /usr
/dev/sd1d               457039  353622    57714    86%    /nerc
/dev/sd1e              1138701  138361   886470    14%    /data1
/dev/sd1f              1138701     814  1024017     0%    /data2
/dev/sd1h              1081058   27883   945070     3%    /data3
sofar:/rvs               26223     890    22711     4%    /rvs
sofar:/rvs/raw_data     643973   21881   557695     4%    /rvs/raw_data
sofar:/nerc/packages/rvs
                                 105783     73512     21693       77%
/nerc/packages/rvs
```

df from sochem

Filesystem	kbytes	used	avail	capacity	Mounted on
/dev/sd0a	18079	7705	8567	47%	/
/dev/sd0g	99043	77213	11926	87%	/usr
/dev/sd1d	777174	10	699447	0%	/archive
sosurvey:/data1	1138701	138361	886470	14%	/data1
sosurvey:/data2	1138701	814	1024017	0%	/data2
sosurvey:/data3	1081058	27883	945070	3%	/data3
sosurvey:/nerc	457039	353622	57714	86%	/nerc
sofar:/nerc/packages/rvs	105783	73512	21693	77%	/nerc/packages/rvs
sofar:/rvs	26223	890	22711	4%	/rvs
sofar:/rvs/raw_data	643973	21865	557711	4%	/rvs/raw_data

df from sofar

/dev/sd0a	18079	5296	10976	33%	/
/dev/sd0g	99043	80020	9119	90%	/usr
/dev/sd1d	26223	1028	22573	4%	/rvs
/dev/sd1f	643973	408819	170757	71%	/rvs/raw_data
/dev/sd1e	105783	73515	21690	77%	/nerc

Appendix 4 - C-shell script ssexec0 - read RVS data stream

```
##############################################################################
#
#  ssexec0
#
#  Description:
#  This is the first exec in a series to processes SeaSoar data at sea
#  ssexec0 reads in the data from the RVS file and converts it to Pstar
#  format.  It sets up the dataname and other header details.
#
#  Files produced:
#  saraw$num        Pstar format of RVS data; variables still in raw form.
#  saraw$num.arch   archive copy of saraw$num.
#
#  Main processing steps:
#  STEP_01     Read in RVS data using datapup
#  STEP_02     Reset raw flag for Pstar data using pcopya.
#  STEP_03     Setup dataname and other header details using pheadr
#
#  History:
#  Version Date     Author      Description
#  -1               RTP,FJR     Cruise 181 originals!
#  00               BAK,SGA,GXG Original version.
#  01      27/01/92 MJG         Added header; directory check; updated
#                               datapup to get variable names from
#                               $selected_vars; more output during runtime;
#                               archive copies to $arch_dir.
#  02      14/09/92 SGA         less output during runtime!
#                               use of shipdata removed
#  03      10/11/92 RTP         changes for Di198
#                               use rvs file ss_light & dont ask qu. in script
#                               this file has 16 light vars
#                               NB:NB:Revert to standard file and data names:
#                               sa: raw 4-hourly stuff
#                               ss: master 12-hourly files
#  04      10/01/95 MJG/RTP     D213 version.
#                               RVS stream is ctd_19 - IOS SeaSoar
#                               Use arch_cp
#  05      05/12/95 MJG/RTP     ANTXIII/2 version.
#                               RVS stream is ctd_12c - IOS SeaSoar
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
##############################################################################

######### Check these variables ##########################
#  These variables should be checked when setting up this  #
#  exec for the first time at sea.                         #

#  Default rvs file to read.
   set def_rvs_fil = "ctd_12c"

#  Variables to be copied from rvs file
#  note that datapup at 15/09/92 doesnt like subsets of vars
#  regardless of line above, better to read in all vars
   set selected_vars = "-"

######### Initialisation ##################################

#  Check directories
#  This exec looks at P_SS for a directory to run from and...
   if ($?P_SS) then
     echo " "
     echo " Changing directory to P_SS: $P_SS"
     cd $P_SS
   endif
```

```
#   ...P_ARCH for a directory to write archive copies to.
    if ($?P_ARCH) then
      set list = `echo $P_ARCH | tr ':' ' '`
      set arch_dir = $list[1]
      unset list
      echo "    Archive directory P_ARCH: $arch_dir"
      echo " "
    else
      set arch_dir = '.'
    endif

#   Set up variables and files
    /bin/rm -f sswork

##############################################################

########## Get information from the user ###################

    echo "> This exec will require the following information:"
    echo ">     seasoar file number"
#   echo ">     RVS datafile name"
    echo ">     start and end time of data"
    echo -n "> Continue (y/n)? "
    set ans = $<
    if ($ans != "y") exit

    echo -n "> enter seasoar file number : "
    set num = $<
    if ( -e ./saraw$num ) then
       echo -n "./saraw$num exists.  Overwrite? (y/n)"
       set ans = $<
       if ( $ans != "y" ) exit(1)
    endif


#   echo -n "> enter name of RVS datafile to read from (default = $def_rvs_fil): "
#   set rvs_fil = $<
#   if ($rvs_fil == "") set rvs_fil = $def_rvs_fil
    set rvs_fil=$def_rvs_fil

#   ask user for start and stop times
    echo -n "> enter start time in format yydddhhmm(ss) (0=start of file): "
    set start = $<
    echo -n "> enter stop  time in format yydddhhmm(ss) (0=end   of file): "
    set stop  = $<
    if ($stop  < $start) then
      echo " start > stop"
      exit
    endif

#   create start and stop flags for datapup and then execute
    if ($start != 0) then
      set start = "-s"$start
    else
      set start = ''
    endif
    if ($stop  != 0) then
      set stop  = '-e'$stop
    else
      set stop  = ''
    endif

    /bin/rm -f saraw$num
    /bin/rm -f ssexec0.talk
    touch ssexec0.talk

##############################################################

########## Main processing steps ###########################
```

```
################################################################
#  STEP_01 - Read in data from RVS
#            Read in from rvs format file - the variables to
#  read are setup in the initialisation in $selected_vars.
#

   echo "running datapup"
#  datapup $start $stop $rvs_fil ./sswork $selected_vars
   datapup $start $stop $rvs_fil ./saraw$num $selected_vars
   if ($status != 0) then
     echo "problem running datapup"
     exit
   endif

################################################################
#  STEP_02 - Reset raw data flag for Pstar data.
#
   echo "> Resetting raw data flag"
   cat << ! | sed 's/^   //' | pcopya >> ssexec0.talk
   saraw$num
   y
   /
   /
   /
!
   if ($status != 0) then
     echo "problem running pcopya - see ssexec0.talk"
     exit
   endif

################################################################
#  STEP_03 - Update the dataname and other header details.
#
   echo "> Running pheadr"
   cat << ! | sed 's/^   //' | pheadr >> ssexec0.talk
   saraw$num
   y
   1
   sa$CRUISE$num
   2
   seasoar
   ship
   $SHIPNAME
   $CRUISE
   /
   /
   /
   y
!
   if ($status != 0) then
     echo "problem running pheadr - see ssexec0.talk"
     exit
   endif
################################################################
#  STEP_04 - patch to change from 1995 to 1996 on Polarstern
#
   echo "> Running ptime"
   cat << ! | sed 's/^   //' | ptime >> ssexec0.talk
   saraw$num
   y
   1
   1
   1
   1900
   960101
   000000
   time
   seconds
```

```
!
   if ($status != 0) then
     echo "problem running ptime - see ssexec0.talk"
     exit
   endif
   echo "Time has been updated to start at 960101 000000"
   print_datnam saraw$num new

########## Archiving #######################################

#  Save a copy for archiving
#  cp -i saraw$num $arch_dir/saraw$num.arch
   arch_cp saraw$num

########## Keep directories tidy ###########################

   /bin/rm -f ssexec0.talk
   /bin/rm -f sswork

########## The End #########################################

   echo " "
   echo "> Files created:   saraw$num "
   echo "> End of ssexec0 for file $num"
   echo " "
   echo "> Next do editing with ssexec1"
   the_end:
   exit
```

Appendix 5 - C-shell script ssexec1 - initial calibration of data

```
################################################################################
#
#  ssexec1
#
#  Description:
#  This exec is number 2 in a series of SeaSoar processing execs.
#  It uses the output from ssexec0.
#  It performs simple editing and calibration of the data.
#  This special 10/11/92 is for rvs SS + 16 light channels
#
#  Processing steps:
#  STEP_01  Despike data for press,temp,cond,cond2 within course limits;
#           using pedita.
#  STEP_02  Interpolate press to remove absent data in pressure; using pintrp.
#  STEP_03  Calibrate data; using ctdcal.
#  STEP_04  Calibrate light channels using pcalib.
#  STEP_05  pheadr to set light channel units
#  STEP_06  pcopya usual SS data to proper file
#  STEP_07  pcopya light data to lt(CRUISE)num
#  STEP_08  pheadr light data to change datnam to lt(etc)
#  STEP_09  create .arch copies
#
#  History:
#  Version Date     Author      Description
#  -1               RTP,JFR     Cruise 181 original!
#  00               BAK,SGA,GXG Original version.
#  01      27/01/92 MJG         Added header; directory check;
#                               updated pedita/parith for use with vinput;
#                               updated input for new ctdcal - check variables;
#                               more output during runtime;
#                               archive copies to $arch_dir.
#  02      14/09/92 SGA         removed some of extra output during runtime
#                               made presence of 2nd cond optional, it assumes
#                               that if cond2 is present in calibration file
#                               it is present in data
#  03      11/11/92 RTP         This is a new version for 16 light channels
#                               Use with rvs SeaSoar CTD
#                               NB:NB:revert to RTP's standard names
#                               sa: raw 4-hourly stuff
#                               ss: final 12-hourly files
#  04      10/01/95 MJG/RTP     D213 version.
#                               2 conductivity cells
#  05      06/12/95 MJG/RTP     ANTXIII/2.
#                               2 NBIS conductivity cells.  Added an extra
#                               parith after ctdcal, to get difference
#                               between two salinities (sal1-2).
#                               After run 2, added section to calibrate
#                               light channel.  Could have added a new
#                               variable to ctdcal, but this would have
#                               meant changing variable name - would get messy.
#                               No arch_cp here - we archive ssraw???, then
#                               run arch_cp after all editing.
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
################################################################################

########## Initialisation ##################################

#  Check directories
#  This exec looks at P_SS for a directory to run from and...
   if ($?P_SS) then
     echo " "
     echo " Changing directory to P_SS: $P_SS"
     cd $P_SS
```

```
   endif
#  ...P_ARCH for a directory to write archive copies to.
   if ($?P_ARCH) then
     set list = `echo $P_ARCH | tr ':' ' '`
     set arch_dir = $list[1]
     unset list
     echo "    Archive directory P_ARCH: $arch_dir"
     echo " "
   else
     set arch_dir = '.'
   endif

#  set up variables and files

   set calfile = shalctd.cal
   if ( ! -e $calfile ) then
     echo " Calibration file $calfile not present"
     exit
   endif

   /bin/rm -f .editlist
   /bin/rm -f .editcomm
   /bin/rm -f ssexec1.talk
   touch ssexec1.talk

########## Get information from the user ###################

   echo "> This exec will require the following information:"
   echo ">    seasoar file number"
   echo -n "> Continue (y/n)? "
   set ans = $<
   if ($ans != "y") exit

   echo -n "> Enter seasoar file number : "
   set num = $<

   if (! -e saraw$num) then
     echo " File saraw$num does not exist"
     exit
   endif

   echo " "
   echo "> Making working copy of saraw$num - "
   /bin/cp saraw$num sstmp

############################################################
#  STEP_01 - Despike the data for the following:
#            2 pressure
#            3 temperature
#            4 conductivity
#            5 conductivity 2 for two cell SeaSoars
#  Results go to .editlist and displayed afterwards.

   print_datnam sstmp

   echo "sstmp"                >  .editcomm
   echo "/"                    >> .editcomm
   echo "/"                    >> .editcomm
   echo "press,-1000,65000"    >> .editcomm
   echo "y"                    >> .editcomm
   echo "temp,-8000,60000"     >> .editcomm
   echo "y"                    >> .editcomm
   echo "cond,20000,60000"     >> .editcomm
   echo "y"                    >> .editcomm
   echo "cond2,20000,60000"    >> .editcomm
   echo "y"                    >> .editcomm
   echo "/"                    >> .editcomm

   echo "> Despiking data - "
```

```
   pedita  < .editcomm > .editlist
   if ($status != 0) then
     echo "> ***problem running pedita. See .editlist***"
     exit
   endif

#  Report on how many variables were replaced.
   set edit = `awk '/values replaced/{print $7}' < .editlist`
   echo " "
   echo "> pedita summary:"
   echo "> $edit[1] datacycles replaced for pressure "
   echo "> $edit[2] datacycles replaced for temp "
   echo "> $edit[3] datacycles replaced for cond "
   echo "> $edit[4] datacycles replaced for cond2"

   print_datnam sstmp new

############################################################
#  STEP_02  Remove absent data in pressure.
#
   echo "> Running pintrp - "
   cat << ! | sed 's/^   //' | pintrp  >> ssexecl.talk
   sstmp
   /
   press/
!
   if ($status != 0) then
     echo "> ***problem running pintrp. See ssexecl.talk***"
     exit
   endif

   print_datnam sstmp new

############################################################
#  STEP_03  Calibrate data using ctdcal.F.
#  Set up variables for calibrations
#  D213 - check if file sa file exists - if so, warn user.
#
   if (-e sa${CRUISE}$num) then
     echo -n "sa${CRUISE}$num exists - overwrite ? (y/n) "
     set ans = $<
     if ( $ans != 'y' ) exit(1)
   endif

   echo "> Running ctdcal - "
   cat << ! | sed 's/^   //' | ctdcal  >> ssexecl.talk
   sstmp
   sa${CRUISE}$num
   shalctd.cal
   3
   n
   n
   n
   n
   n
   y
!
   if ($status != 0) then
     echo "> ***problem running ctdcal. See ssexecl.talk***"
     exit
   endif
print_datnam sa${CRUISE}$num new

#
#     New step for Polarstern (used previously on
#     cd5859).  Using two NBIS conductivity cells
#     so we can subtract one from other to compare
#     salinities.
#
```

```
/bin/cp sa$CRUISE$num sstmp
echo -n " Creating new variable sal1-2 - "
parith >! ssexec1.talk << !
sstmp
sa$CRUISE$num
/
subtract,salin,salin2/
/
sal1-2

!
if ($status != 0) then
  echo "problem running parith."
  cat ssexec1.talk
  exit
endif
echo "OK."
print_datnam sa$CRUISE$num new

  echo -n " Calibrating light - "
  psoup >! ssexec1.talk << !
sa$CRUISE$num
y
light 2
light
/
!
  if ($status != 0) then
    echo "problem running psoup."
    cat ssexec1.talk
    exit(1)
  endif
  echo "OK"
  print_datnam sa$CRUISE$num new
  echo -n " Updating units - "
  pheadr >! ssexec1.talk << !
sa$CRUISE$num
y
/
9
light
W/m2
/
/
!
  if ($status != 0) then
    echo "problem running pheadr."
    cat ssexec1.talk
    exit(1)
  endif
  echo "OK"
  print_datnam sa$CRUISE$num new

########## End of main processing steps ####################

########## Archiving #####################################

#  arch_cp sa$CRUISE$num
   cp sa$CRUISE$num  sa$CRUISE$num.bak
   echo " "
   echo -n "sa$CRUISE$num backed up to sa$CRUISE$num.bak, but "
   echo "not archived.  "
   echo -n "Remember to run arch_cp once all editing is complete"
#   cp lt$CRUISE$num $arch_dir/lt$CRUISE$num.arch

########## Keep directories tidy ###########################

   /bin/rm -f ssexec1.talk
   /bin/rm -f sstmp
```

```
#  /bin/rm -f sstmp2
   /bin/rm -f .editlist
   /bin/rm -f .editcomm


########## The End ########################################

   echo " "
   echo "> end of ssexec1"
   echo "> Next run ssexec2 to plot data"

   the_end:
   exit
```

Appendix 6 - C-shell script ssexec2 - plot data

```
##############################################################################
#
#  ssexec2
#
#  Description:
#  SeaSoar processing - plotting.
#
#  Processing steps:
#  STEP_01  run each requested plot; using plotxy.
#  STEP_01  run each requested plot; using plotpr.
#
#  History:
#  Version Date      Author      Description
#  00                BAK,SGA,GXG Original version.
#  01      27/01/92 MJG         Added header; directory check;
#                               more output during runtime;
#                               foreach loop for plotxy.
#  02      28-iii-93 JFR       Modified for Di201
#  03      12/01/95  MJG        D213 - copied from ctdexec3
#  04      06/12/95  MJG        ANTXIII/2 - timeF changes to time.pdf
#  NEXT    ??/??/?? ???         Please make a note of your changes here
#                               - using as many lines as necessary.  If
#                               the  changes are  substantial perhaps a
#                               new exec might be better?
#
##############################################################################

########## Check these variables ###########################
#  These variables should be checked when setting up this    #
#  exec for the first time at sea.                           #

#  Variables for available device drivers
   set devs = "mx11 ghp3630a4 pzeta8 hcposta4 mpost"

#  Default device driver
   set def_dev = "mx11"

#  pdfs for plots using plotxy
   set xy_pdf = (timeF)
   set xy_pdf = (time)
   set pr_pdf = (sp sp2 tp fp TS TS2 ip)

############################################################

########## Initialisation ##################################

#  Check directories
#  This exec looks at P_SS for a directory to run from.
   if ($?P_SS) then
     echo " Changing directory to P_SS: $P_SS"
     cd $P_SS
   endif

#  set up variables and files
   set xy_plot
   set pr_plot
   /bin/rm -f ssexec2.talk
   touch ssexec2.talk

############################################################

########## Get information from the user ##################

   echo "> This exec will require the following information:"
   echo ">    ss station number"
#  set ans = $<
#  echo $ans
```

```
#  if ($ans != "y") exit

   echo -n "> Enter SeaSoar station number - "
   set num = $<

   if (! -e sa$CRUISE$num ) then
     echo ">The file sa$CRUISE$num does not exist"
     exit
   endif

   echo " "
   echo "> Plots using plotxy..."
   echo "> Enter 'n'=no plot or 'y'=plot for each of the following pdf's"
   foreach i ($xy_pdf)
     echo -n "> "$i".pdf? "
     set ans = $<
     if( $ans == y ) set xy_plot = ( $xy_plot $i )
   end

   echo " "
   echo "> Plots using plotpr..."
   echo "> Enter 'n'=no plot or 'y'=plot for each of the following pdf's"
   foreach i ($pr_pdf)
     echo -n "> "$i".pdf? "
     set ans = $<
     if( $ans == y ) set pr_plot = ( $pr_plot $i )
   end

#  find users choice of plotting device.
   echo "> Available devices: $devs"
   echo -n "> Enter name of plotting device (default=$def_dev): "
   set devnam = $<
   if ($devnam == "") set devnam = $def_dev
   echo $devs | grep -s $devnam
   if ($status != 0) then
     echo " Device $devnam not known"
     exit
   endif

############################################################
#  STEP_01 - plots using plotxy
#
   if ($xy_plot[$#xy_plot] != '')then
         echo "enter start time in format JDAY HR MIN SEC "
         set start = $<
         echo "enter stop  time in format JDAY HR MIN SEC "
         set stop = $<
   endif
   foreach pdf ($xy_plot)

     echo " "
     if (! -e $pdf.pdf) then
       echo " $pdf.pdf does not exist"
     else
       echo "> Running plotxy with $pdf.pdf - "
       cat << ! | sed 's/^       //' | plotxy >> ssexec2.talk
       $pdf.pdf
       7
       ${start}/
       8
       ${stop}/
       3
       sa$CRUISE$num
       s $devnam;e


!
       if ($status != 0) then
         echo "> ***problem running plotxy. See ssexec2.talk***"
```

```
      exit
    endif
    send_plot $devnam - plot1
  endif

end

############################################################
#  STEP_02 - plots using plotpr
#
  foreach pdf ($pr_plot)

    echo " "
    if (! -e $pdf.pdf) then
      echo " $pdf.pdf does not exist"
    else
      echo "> Running plotpr with $pdf.pdf - "
      cat << ! | sed 's/^       //' | plotpr >> ssexec2.talk
      $pdf.pdf
      3
      sa$CRUISE$num
      s $devnam;e


!
      if ($status != 0) then
        echo "> ***problem running plotpr. See ssexec2.talk***"
        exit
      endif
      send_plot $devnam - plot1
    endif

  end

############################################################

########## Keep directories tidy ###########################

  /bin/rm -f ssexec2.talk
  /bin/rm -f HPGL1
  /bin/rm -f HCPCL
  /bin/rm -f unirast
  /bin/rm -f uniprnt

########## The End #########################################

  echo " "
  echo "> End of ssexec2"

  the_end:
  exit
```

Appendix 7 - C-shell script light.cal - calibrate light data

```
#!/bin/csh -f
#
# Script to calibrate light (PAR) variable in SeaSoar data
# files.
#
# Calibration is:
# ln(PAR) = -7.051 + 0.004854*raw_mV (ln uW/cm2)
#    PAR  = 0.01*EXP(  -7.051   + 4.854*raw_V) (W/m2)
#    PAR  =      EXP( -11.65617 + 4.854*raw_V) (W/m2)
#
# Input data is in volts.
#
   set file = sa$CRUISE$1
   if ( ! -e $file ) then
     echo "No file: $file"
     exit(1)
   endif
#
   pcalib << !
$file
y
light -11.65617 4.854 0
zvolts 0 0.0113 0
/
!
  psoup << !
$file
y
light 2
light
/
!
  pheadr << !
$file
y
/
9
light
W/m2
/
/
!
```

Appendix 8 - C-shell script ssPage - produce page of 3 SeaSoar plots

```
#!/bin/csh
#
#       Run ucontr a number of times and then run udisp to arrange
#       all plots on one page.
#
   set page_size = "190,240"
   set ratio     = "0.95,0.65"
   set DIR       = "/users/pstar/data/seasoar"
#
   if ( $#argv < 1 ) then
     echo "Usage: ssPage page_num [-u] [post]"
     exit(1)
   endif
   set page = $1
   if ( ! -e page$page ) then
     echo "No source file: page$page"
     exit(1)
   endif
#
#       Set variables for this page.  Form of this files is
#
#       #!/bin/csh
#       set title  = "Run 2"
#       set limits = "-41.5,-45.5"
#       set ticks  = 8
#       set file   = "run2-3.grall"
#       set start  = 0
#       set stop   = 0
#
   source page$page
#
#       if first argument is -u, miss out ucontr and go straight to udisp.
#
   if ( $1 == -u || $2 == -u ) goto udisp
#
#       colors - extension for colours file for each segment.
#       vars   - cdf variable number of each segment
#       limits - latitude limits for each page.
#
   set num_segs = 3
   set colors   = ( temp salin sigma )
   set vars     = ( 2 3 4 )
   set xvar     = gps_lat

   set seg = 1
   while ( $seg <= $num_segs )

     setenv PICT $seg
     setenv COLS colors.$colors[$seg]
#
#       ucontr with no file details (-fle), no axes labels (-lab),
#       no title (-ti) and no colour scale (-sc);  no need to press
#       return after display (-exit).
#
     ucontr -fle -lab -ti -sc -exit << !
plot.cdf
4
SeaSoar
1
1
$vars[$seg]
/
/
5
1
$xvar
$limits
```

```
7
$start/
8
$stop/
10
,,$ticks/
3
$DIR/$file
s mx11;e


!

     @ seg = $seg + 1

   end
#
#       Run udisp; if the last argument is 'post' setup
#       driver for postscript.
#
udisp:

   set driver = mx11
   if ( $argv[$#argv] == post ) set driver = hcposta4
   udisp << !
0
1,2,3/
3,1
2,1
1,1
3
2
s $driver;e
$page_size/
$ratio
97,251,3,0,1
SeaSoar $title
97,246,2.5,0,1
Potential Temperature (^218C)
12,210,2,90,1
Pressure (dbars)
97,172,2,0,1
Latitude (degrees)
-1/
$ratio
97,166,2.5,0,1
Salinity
12,130,2,90,1
Pressure (dbars)
97,92,2,0,1
Latitude (degrees)
-1/
$ratio
97,86,2.5,0,1
Sigma0 (kg/m>3)
12,50,2,90,1
Pressure (dbars)
97,12,2,0,1
Latitude (degrees)
-1/
!
```

Appendix 9 - SeaSoar Vehicle and Instruments

SeaSoar equipment, sensors and Instrumentation comprised

- horizontal drum Winch.
- SeaSoar vehicle Ser. no.001
- Hydraulic Unit Ser.no.01
- Shallow CTD Ser.no. 01 with twin cond cells.
- Fluorimeter CI Ser.no. 01
- PAR sensor Ser.no.01
- Plankton Counter Ser. no.TOW026.
- 486 PC - System 3.
- 486 PC - System 4.
- SeaSoar Control Unit Ser.no.02
- 1401 deck units - two off.
- Power supplies - Two off ATE150-0.7
- Windograf chart recorder.

Appendix 10 Raw data backup tapes

R.V. Polarstern SeaSoar Raw Data Backup Tape details

TAPE No.	CATALOGUE	PC SCREENS	RUN No.
1	CC51205A	PO13D001/D017	1&2
1	CC51207A		
1	CC51208A		
1	CC51209A		
2	CC51210A	PO13D018/D023	3
2	CC51211A	PO13D024/DO34	3
2	CC512224A	PO13D035/D045	6.1
2	CC51225A	PO13D044/D049	6.3
3	CC51225B	PO13D049/DO52	6.3
3	CC51226A	PO13DO53/DO54	6.4
3	CC51228A	PO13DO55/DO63	6.6
4	CC51229A	PO13D055/DO72	6
4	CC60102A	PO13D073/DO78	8.1
4	CC60103A	PO13DO79/DO84	8.6
5	CC60104A	PO13DO85/DO94	8.9
5	CC60105A	PO13DO85/DO98	8.10

Table 1 - SeaSoar deployments on AntXIII/2

Run	start	time (Z)	day/date	latitude	longitude	distance run (km)
001	start	1347	339/5xii95	39°05.9'S	14°43.9'E	679
	end	1834	339/5xii95	39°38.8'S	14°15.0'E	753
	duration	4h47m	mean speed 8.3 kt			74 km
Reason for recovery						End of trial
002	start	0931	340/6xii95	41°46.7'S	12°46.4'E	1036
	end	0300	343/9xii95	50°13.5'S	5°46.0'E	2127
	duration	2d17h29m	mean speed 8.9 kt			1091 km
Reason for recovery						End of run - mooring position reached
003	start	1427	343/9xii95	50°21.3'S	5°31.3'E	2195
	end	2117	345/11xii95	57°19.5'S	2°06.3'W	3185
	duration	2d6h50m	mean speed 9.7 kt			990 km
Reason for recovery						End of run - ice reached
6.1-3	start	1845	356/22xii95	54°00.6'S	0°05.8'W	6954
	end	1848	359/25xii95	50°28.2'S	8°05.3'E	8235
	duration	3d0h3m	mean speed 9.7 kt			1281 km
Reason for recovery						End of run - station position
6.4-5	start	2240	359/25xii95	50°29.1'S	8°07.8'E	8248
	end	0930	361/27xii95	49°54.9'S	10°15.3'E	8844
	duration	1d10h50m	mean speed 9.2 kt			596 km
Reason for recovery						Cable problem - need to reterminate
6.6-7	start	1715	361/27xii95	49°28.2'S	10°31.4'E	8903
	end	0845	363/29xii95	49°27.8'S	11°24.6'E	9555
	duration	1d15h34m	mean speed 8.8 kt			652 km
Reason for recovery						End of survey
8.1	start	0900	001/1i96	49°41.5'S	11°19.8'E	10292
	end	1430	001/1i96	50°25.0'S	11°23.1'E	10376
	duration	5h30m	mean speed 8.2 kt			84 km
Reason for recovery						Vehicle not flying - kelp holdfast around wing
8.1-11	start	1500	001/1i96	50°27.8'S	11°23.3'E	10381
	end	0627	005/5i96	50°48.6'S	9°30.0'E	11768
	duration	3d15h27m	mean speed 8.5 kt			1387 km
Reason for recovery						End of survey
Totals						
	duration	15d4h30m	mean speed 9.0 kt			6155 km

Table 2 - SeaSoar legs on AntXIII/2

Run	date	time(Z)	latitude	longitude	distrun (km)	course	
1	5xii95	1347	39°05.9'S	14°43.9'E	679	**211°**	
		1834	39°38.8'S	14°15.0'E	753	end	
2	6xii95	0931	**41°46.7'S**	12°46.4'E	1036	**211°**	
	9xii95	0300	50°13.5'S	5°46.0'E	2127	end	
3		1427	50°21.3'S	5°31.3'E	2195	**235°**	
	10xii95	1720	52°50.7'S	0°10.4'E	2663	**195°**	
	11xii95	2117	**57°19.5'S**	2°06.3'W	3185	end	
6.1	22xii95	1845	**54°00.6'S**	**0°5.8'W**	6954	**007°**	
	23xii95	0150	52°48.0'S	0°15.5'E	7093	053°	
	24xii95	0315	**50°14.6'S**	5°48.0'E	7570	090°	
6.2		0400	50°14.3'S	**6°0.5'E**	7584	**180°**	
		1505	**52°00.6'S**	6°00.8'E	7782	090°	
6.3		1940	51°59.6'S	**7°6.0'E**	7857	**000°**	
	25xii95	1005	**49°54.8'S**	7°06.1'E	8089	090°	
6.4		1415	49°54.7'S	**8°9.1'E**	8165	**180°**	
		1848	50°28.2'S	8°05.3'E	8235	end	st'n 10
		2240	50°29.1'S	8°07.8'E	8248	180°	restart
	26xii95	0855	**52°00.0'S**	8°09.4'E	8422	090°	
6.5		1300	51°59.9'S	**9°14.7'E**	8496	**000°**	
	27xii95	0345	**49°44.5'S**	9°15.5'E	8748	090°	
6.6		0755	49°45.2'S	10°17.5'E	8822	180°	
		0930	49°54.9'S	10°15.3'E	8844	end	cable
6.6a		1715	**49°28.2'S**	10°31.4'E	8903	**180°**	restart
	28xii95	1110	52°00.3'S	**10°17.7'E**	9197	090°	
6.7		1530	51°59.8'S	**11°23.1'E**	9273	**000°**	
	29xii95	0845	**49°27.8'S**	11°24.6'E	9555	end	

Table 2 - SeaSoar legs on AntXIII/2 (cont.)

Run	date	time(Z)	latitude	longitude	distrun (km)	course	
8.1	1i96	0900	**49°41.5'S**	**11°23.1'E**	10292	**180°**	
		1430	50°25.0'S	11°23.1'E	10376	end:	kelp
		1500	50°27.8'S	11°23.3'E	10381	180°	restart
		1725	**50°48.0'S**	11°23.3'E	10418	270°	
8.2		1820	50°48.0'S	**11°12.2'E**	10430	**000°**	
	2i96	0140	**49°42.0'S**	11°12.2'E	10551	270°	
8.3		0230	49°42.0'S	**11°01.3'E**	10565	**180°**	
		1000	**50°48.0'S**	11°01.6'E	10686	270°	
8.4		1050	50°48.0'S	**10°50.4'E**	10698	**000°**	
		1810	**49°42.0'S**	10°50.4'E	10820	270°	
8.5		1900	49°42.0'S	**10°39.5'E**	10834	**180°**	
	3i96	0255	**50°48.0'S**	10°39.5'E	10955	270°	
8.6		0345	50°48.0'S	**10°28.6'E**	10968	**000°**	
		1115	**49°42.0'S**	10°28.6'E	11090	270°	
8.7		1205	49°42.0'S	**10°17.7'E**	11102	**180°**	
		1945	**50°48.0'S**	10°17.7'E	11223	270°	
8.8		2035	50°48.0'S	**10°06.8'E**	11235	**000°**	
	4i96	0400	**49°42.0'S**	10°06.8'E	11357	270°	
8.9		0455	49°42.0'S	**9°55.9'E**	11370	**180°**	
		1255	**50°48.0'S**	9°55.9'E	11492	270°	
8.10		1340	50°48.0'S	**9°45.0'E**	11504	**000°**	
		2100	**49°42.0'S**	9°45.0'E	11626	270°	
8.11		2150	49°42.0'S	**9°34.1'E**	11639	**180°**	
	5i96	0545	**50°48.0'S**	9°34.1'E	11761	270°	
		0627	50°48.6'S	9°30.0'E	11768	end	

Figures

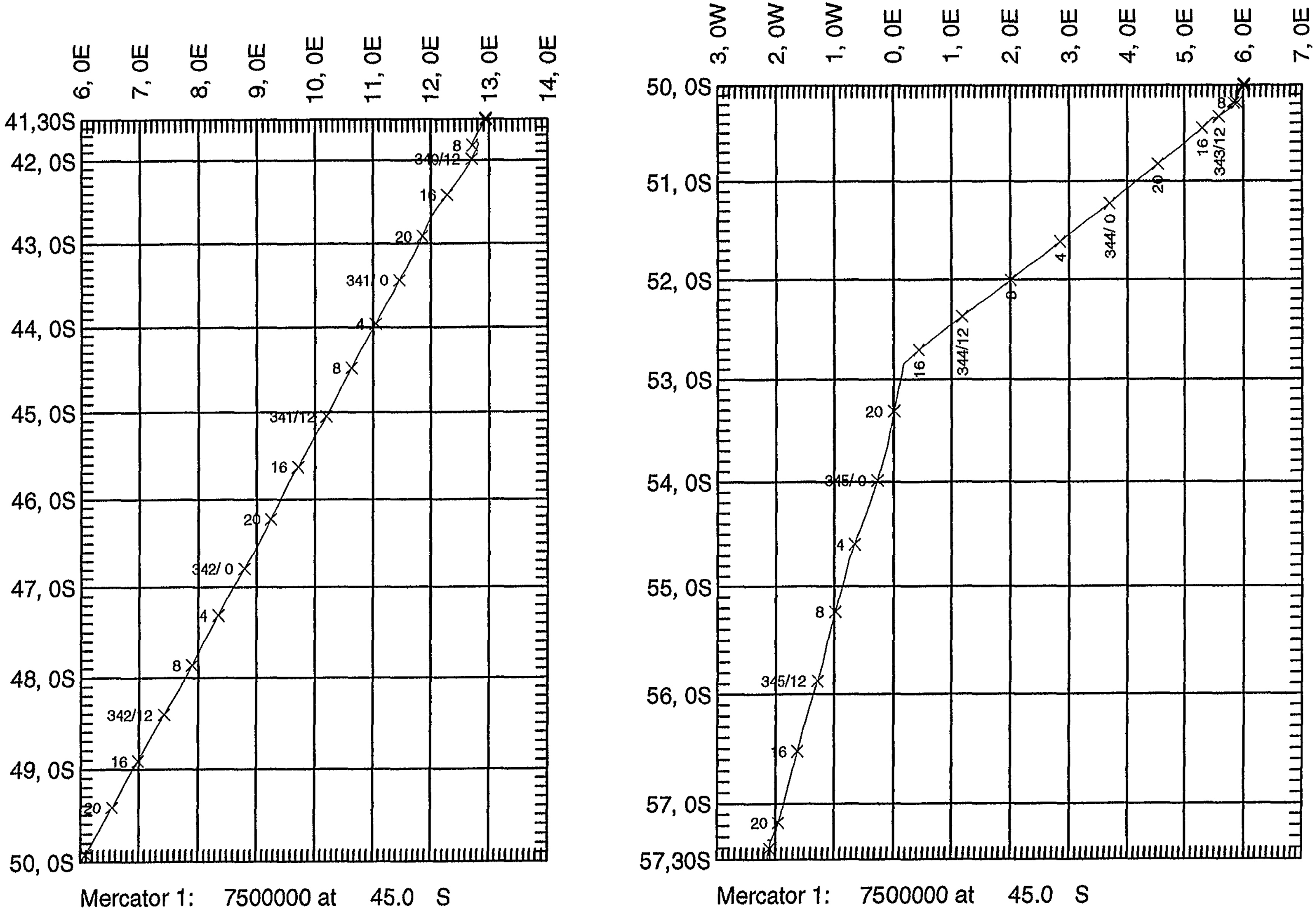


Figure 1 - SeaSoar Runs 2 and 3

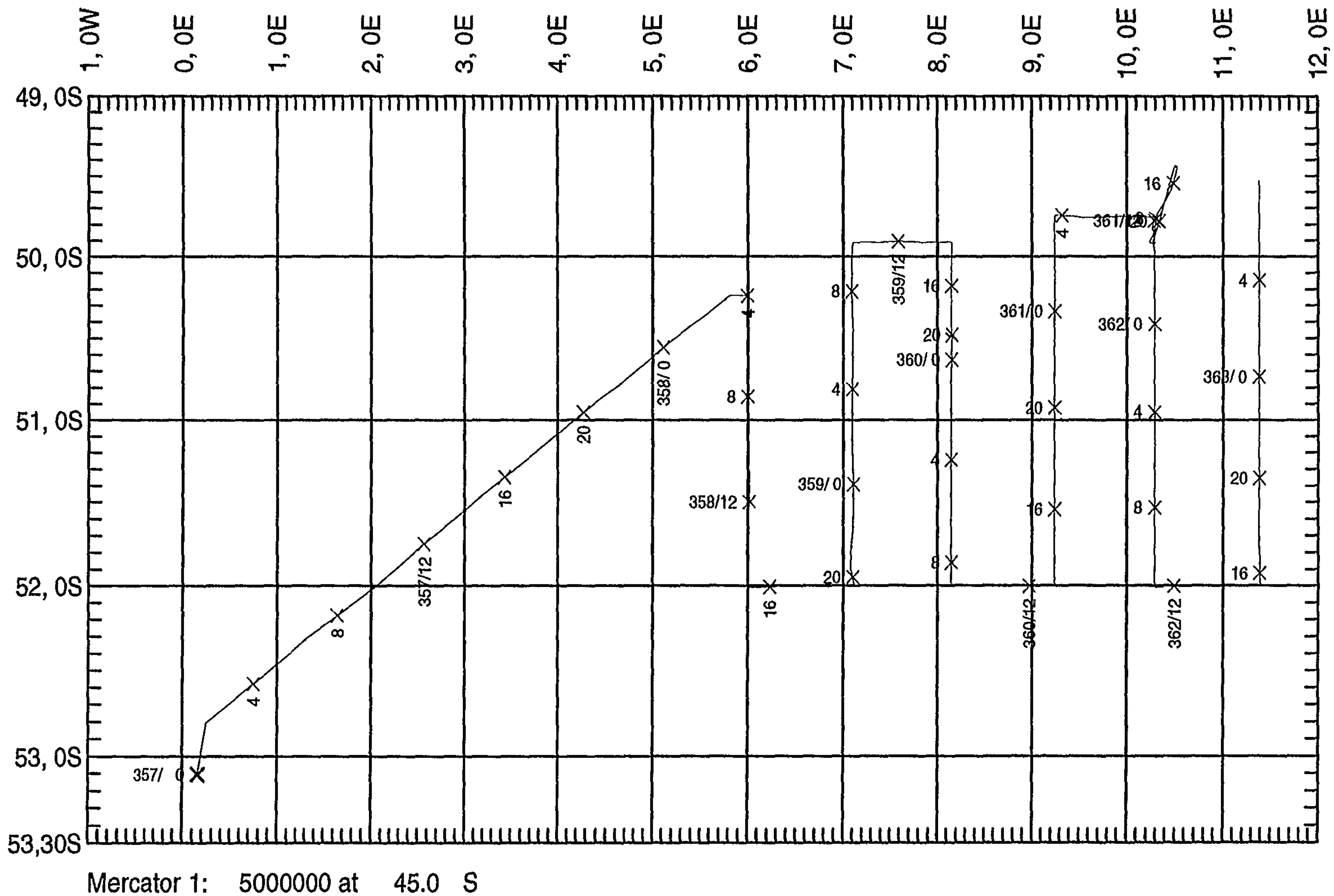


Figure 2 - SeaSoar Run 6

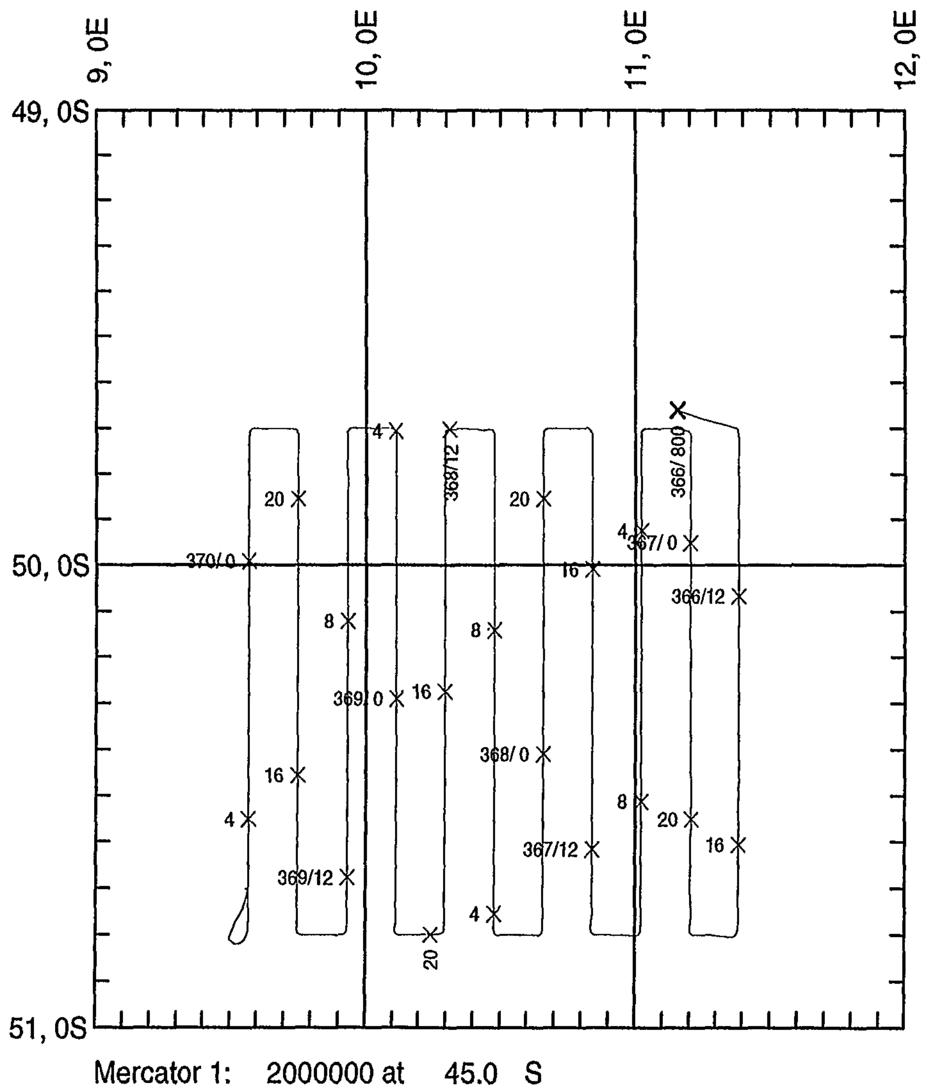
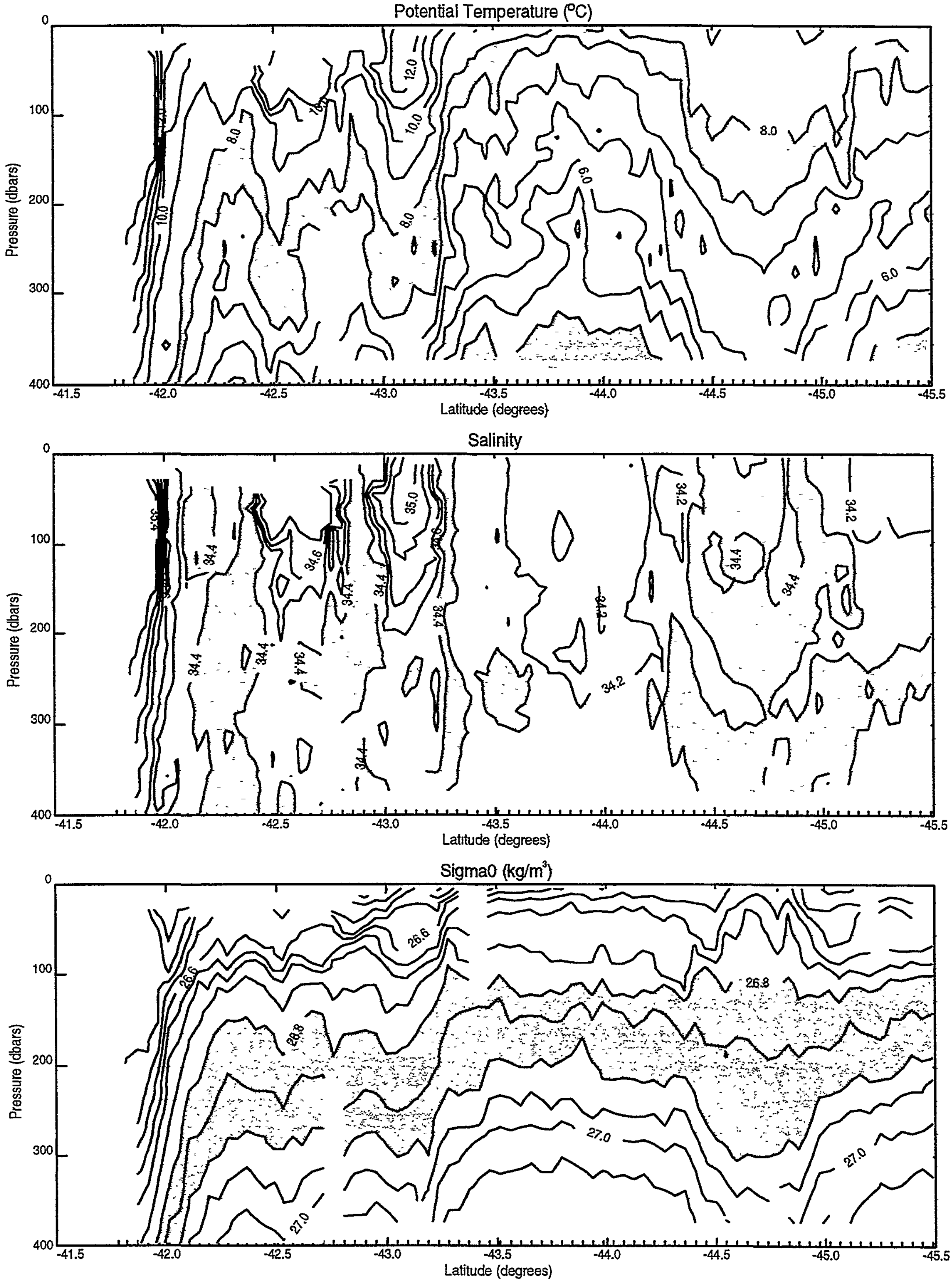


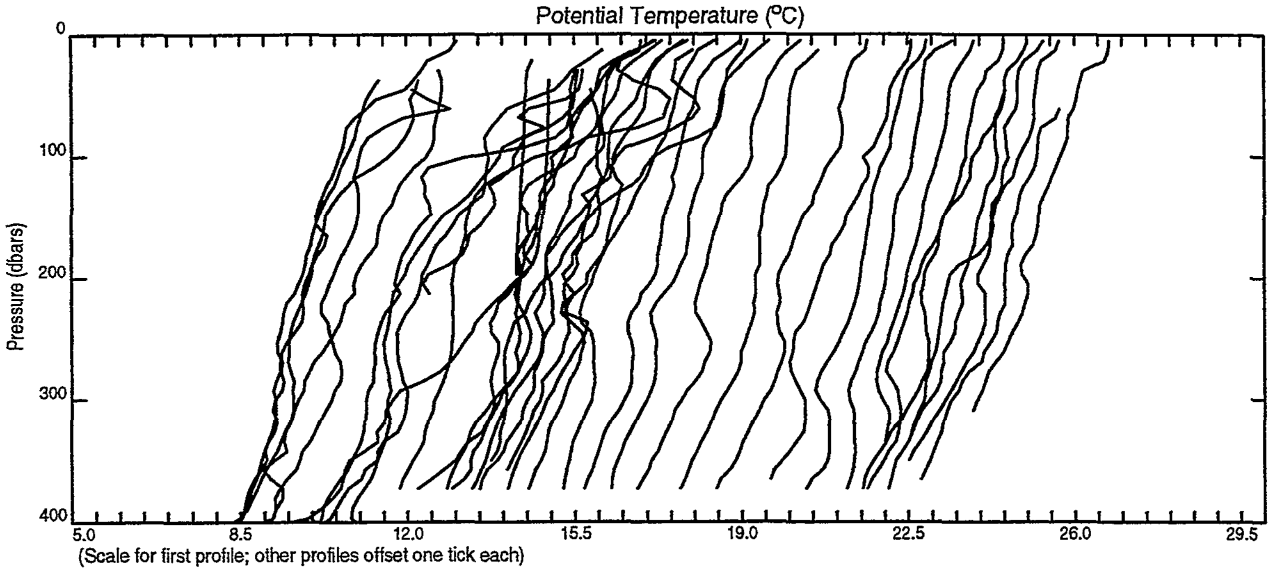
Figure 3 - SeaSoar Run 8

SeaSoar Run 2

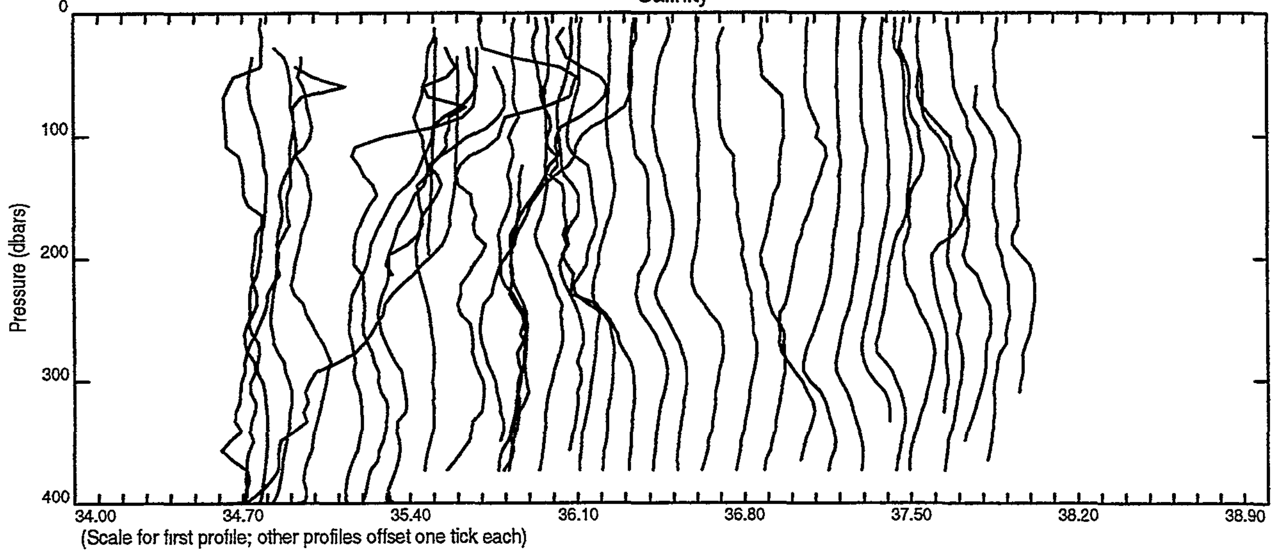


SeaSoar Run 2

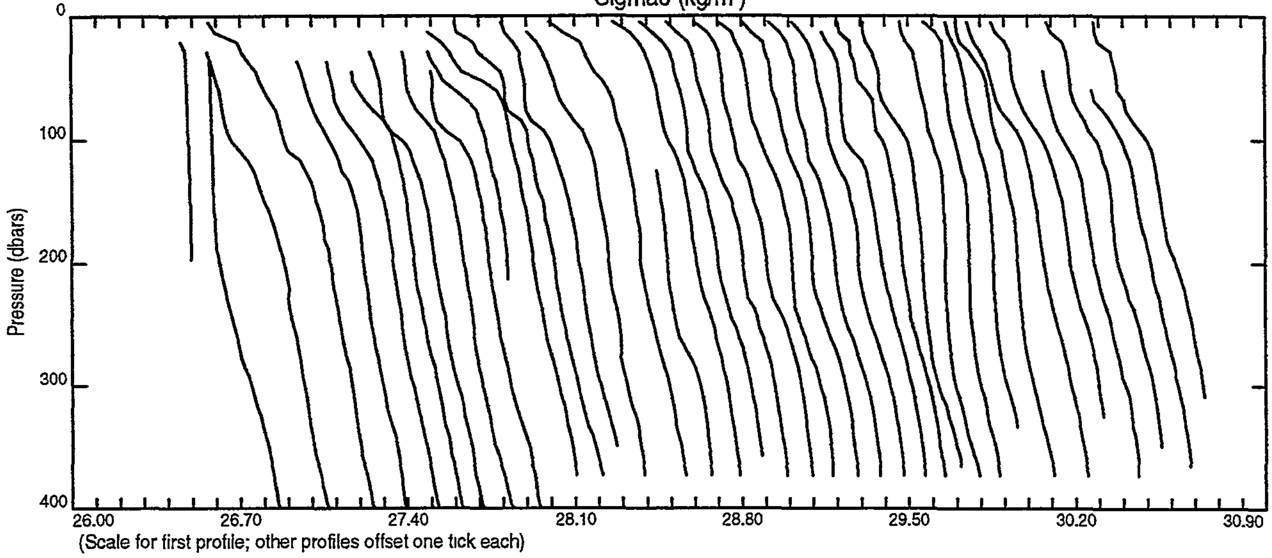
Potential Temperature (°C)



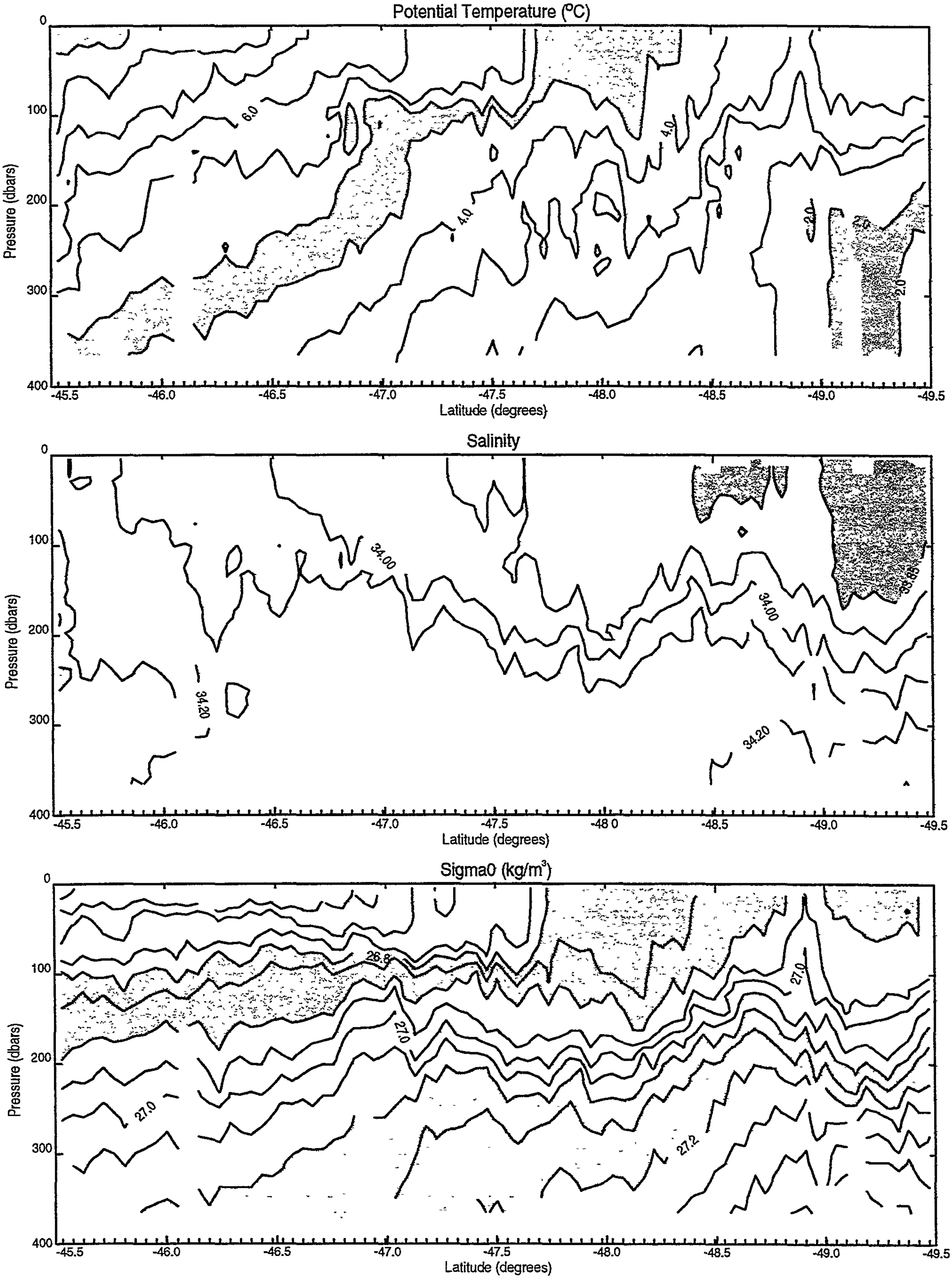
Salinity



Sigma0 (kg/m³)

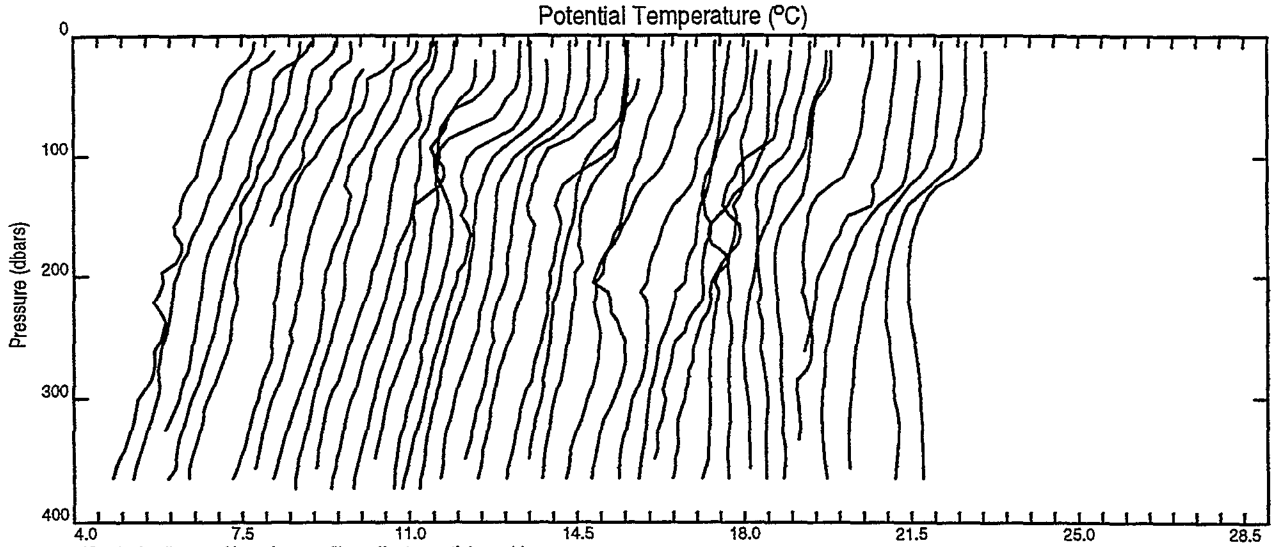


SeaSoar Run 2



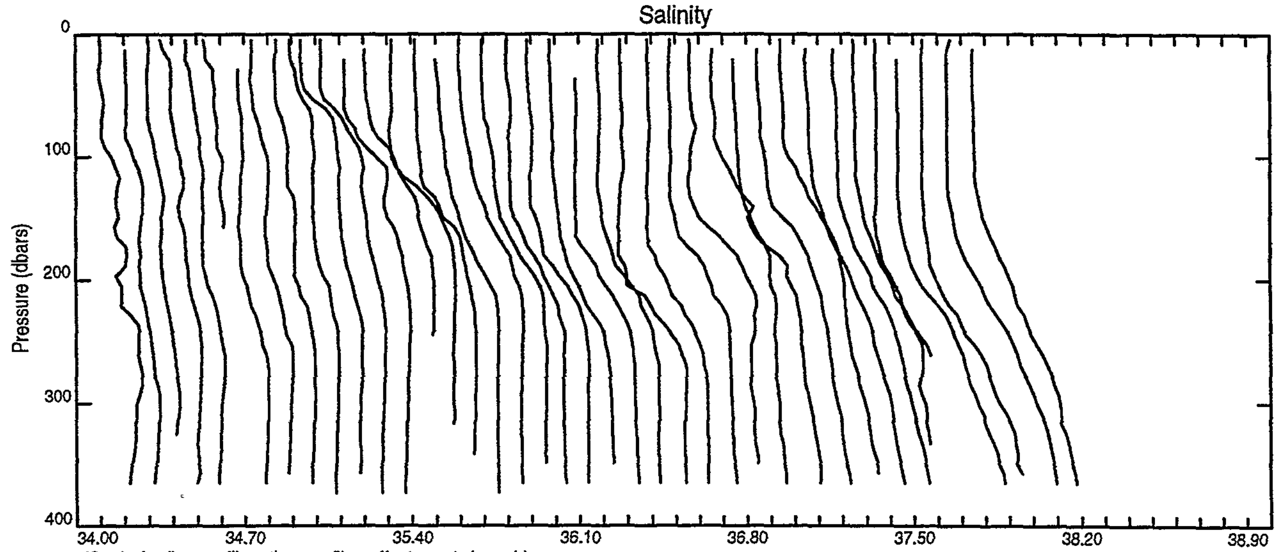
SeaSoar Run 2

Potential Temperature (°C)



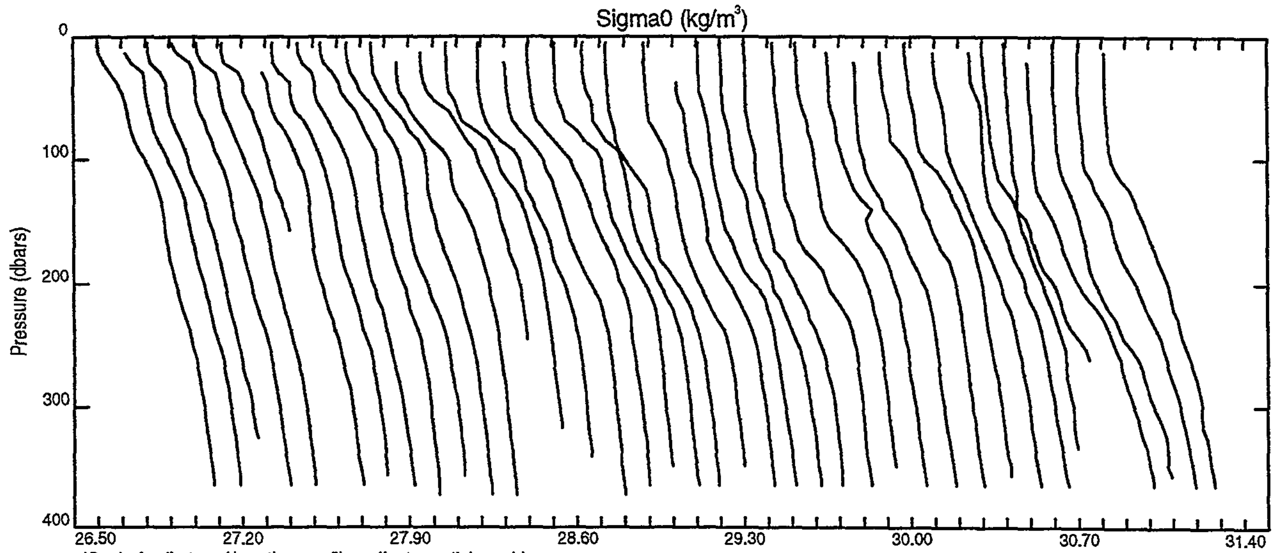
(Scale for first profile; other profiles offset one tick each)

Salinity



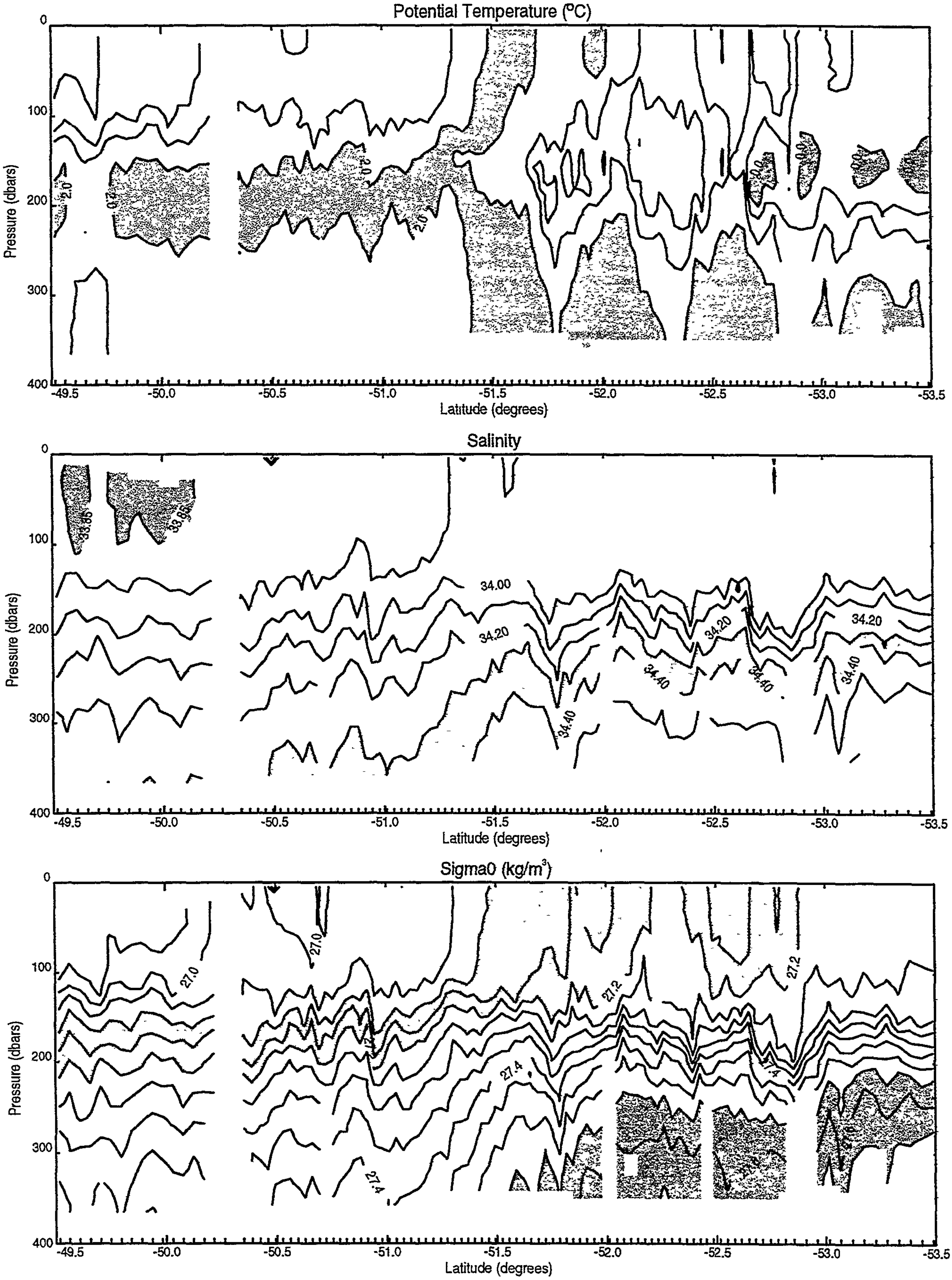
(Scale for first profile; other profiles offset one tick each)

Sigma0 (kg/m³)

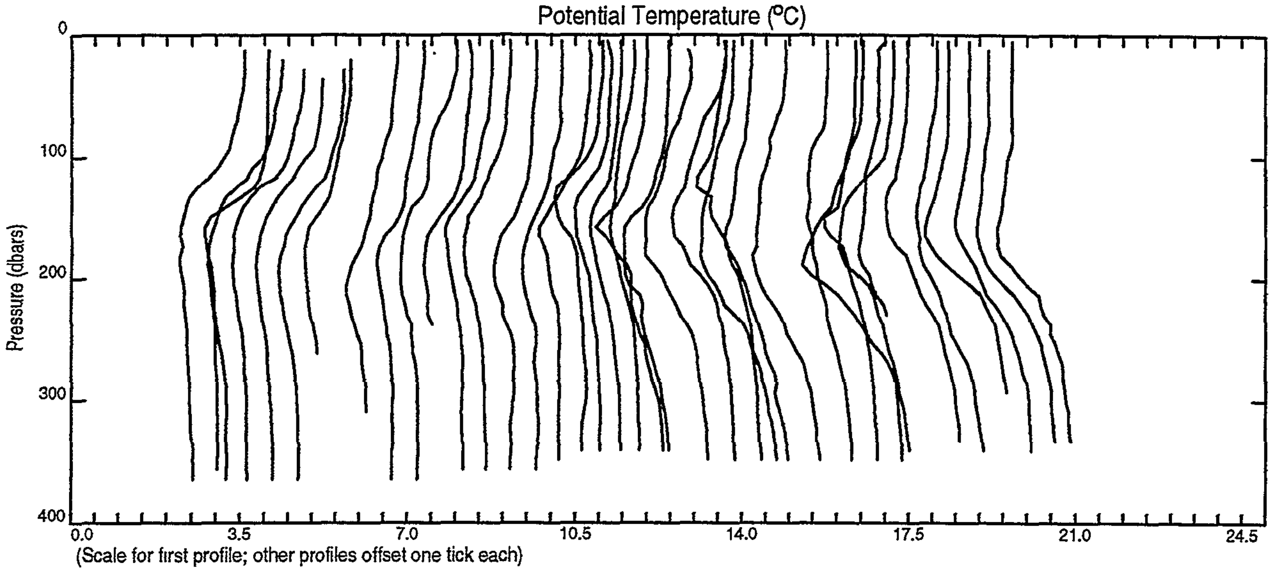


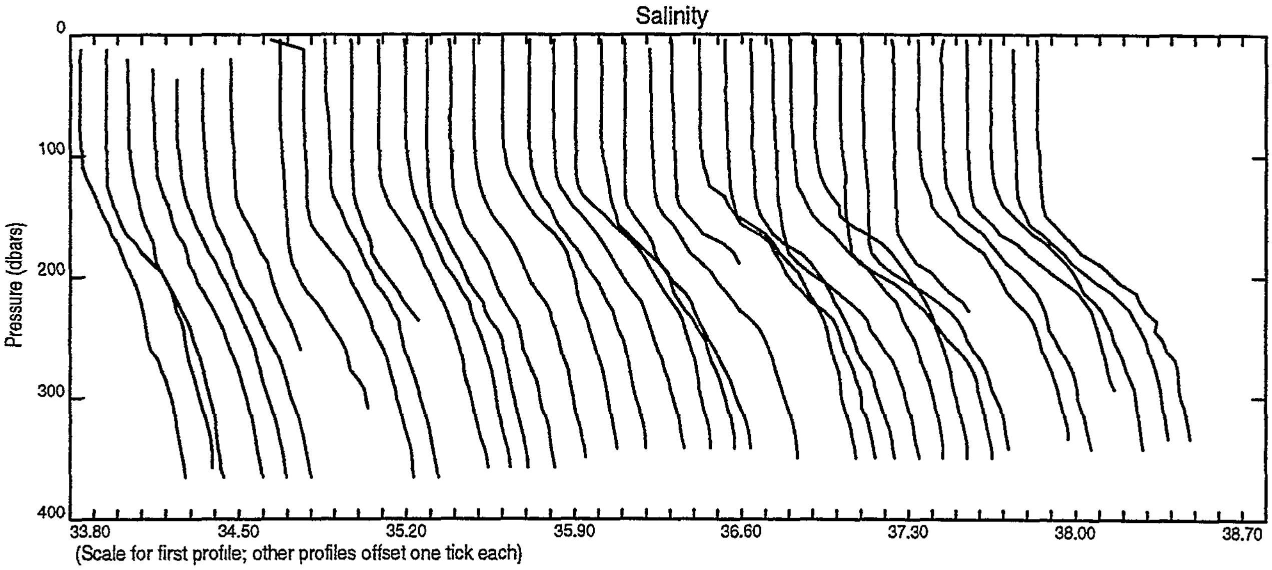
(Scale for first profile; other profiles offset one tick each)

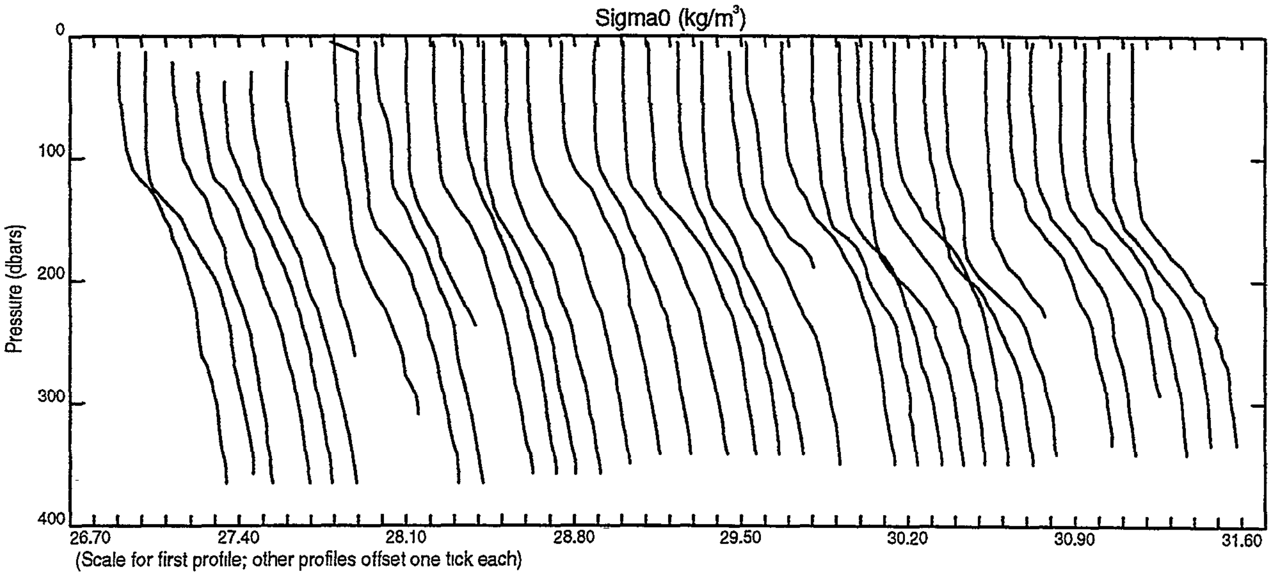
SeaSoar Runs 2 & 3



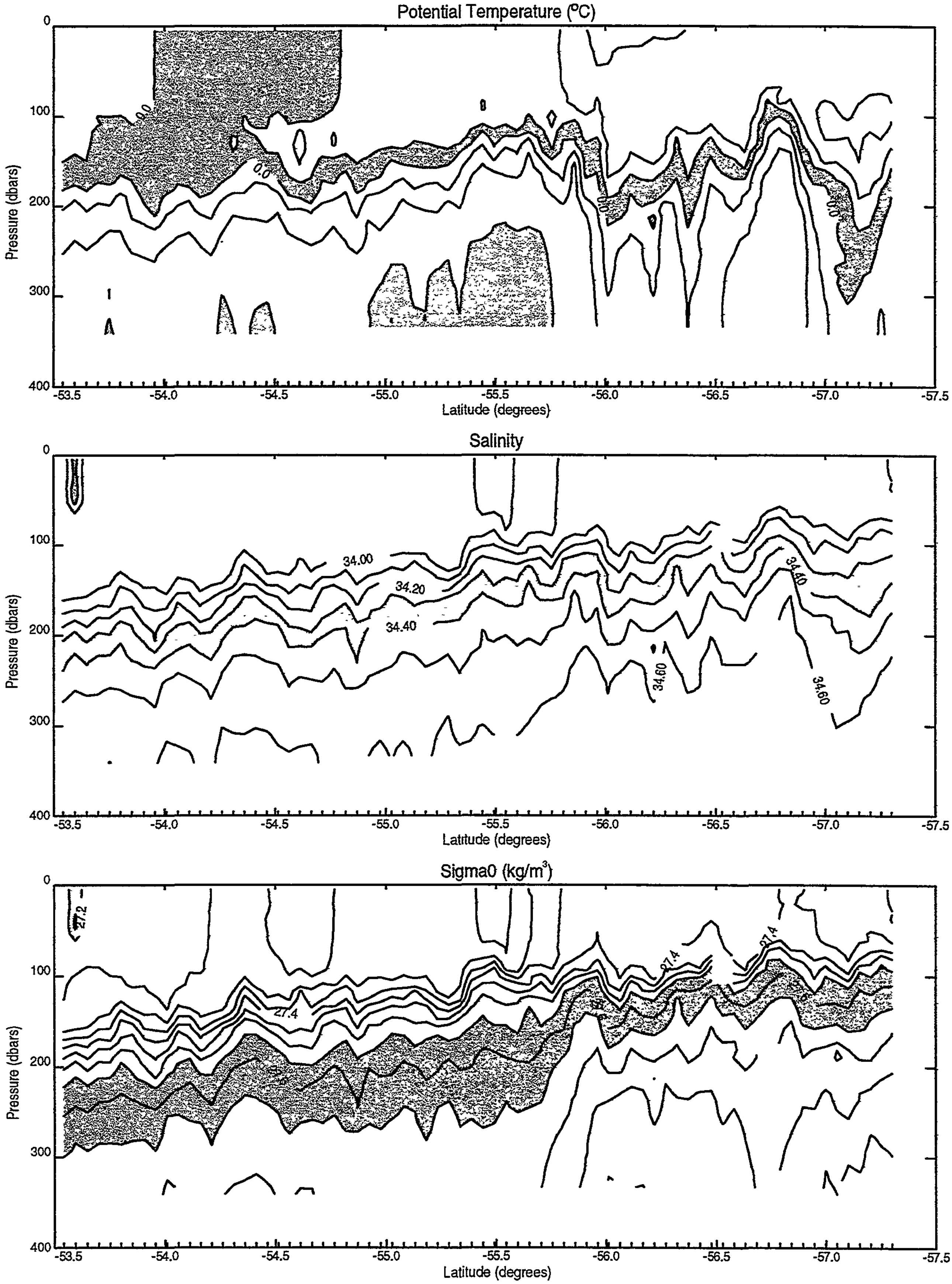
SeaSoar Runs 2 & 3



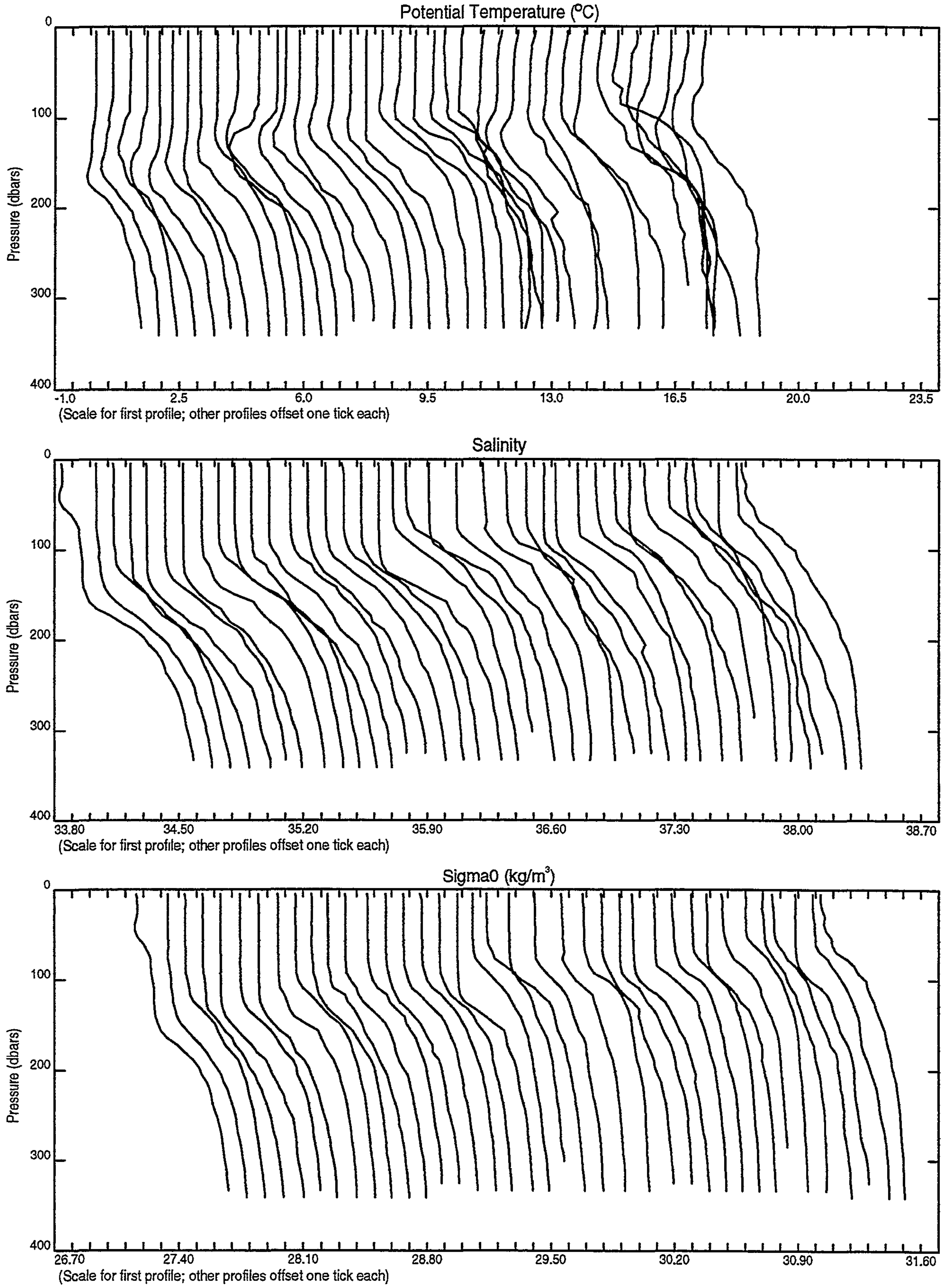


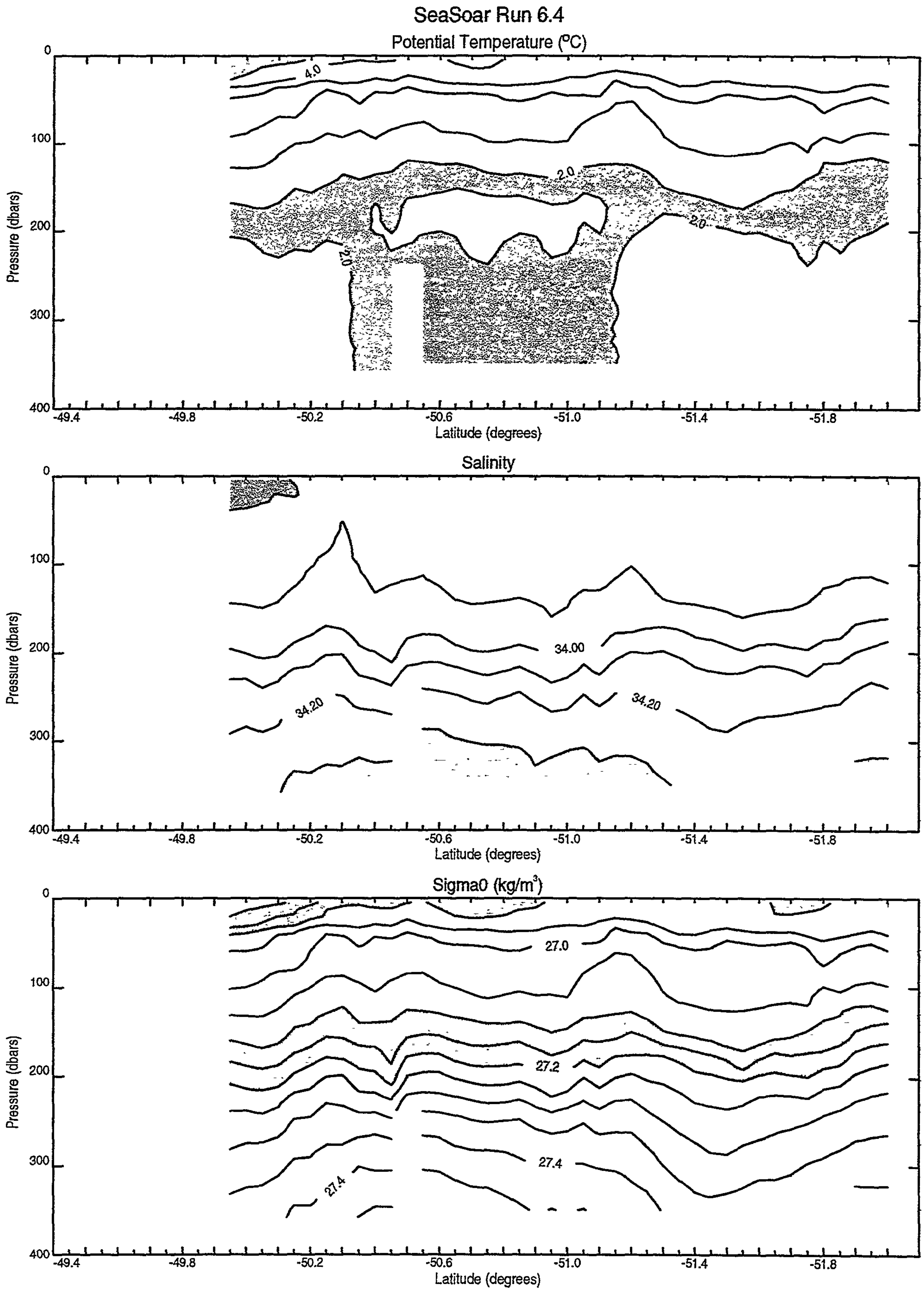


SeaSoar Run 3



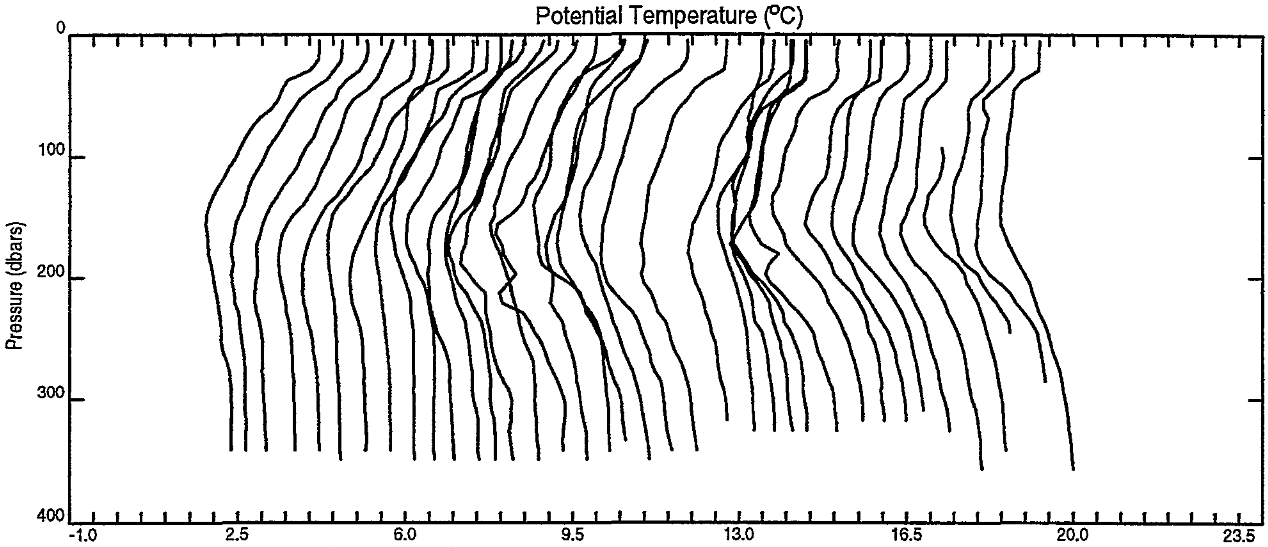
SeaSoar Run 3




SeaSoar Run 6.4
Potential Temperature (°C)
4.0
2.0
2.0
2.0
Salinity
34.00
34.20
34.20
Sigma0 (kg/m³)
27.0
27.2
27.4
27.4
Pressure (dbars)
0
100
200
300
400
Latitude (degrees)
-49.4
-49.8
-50.2
-50.6
-51.0
-51.4
-51.8

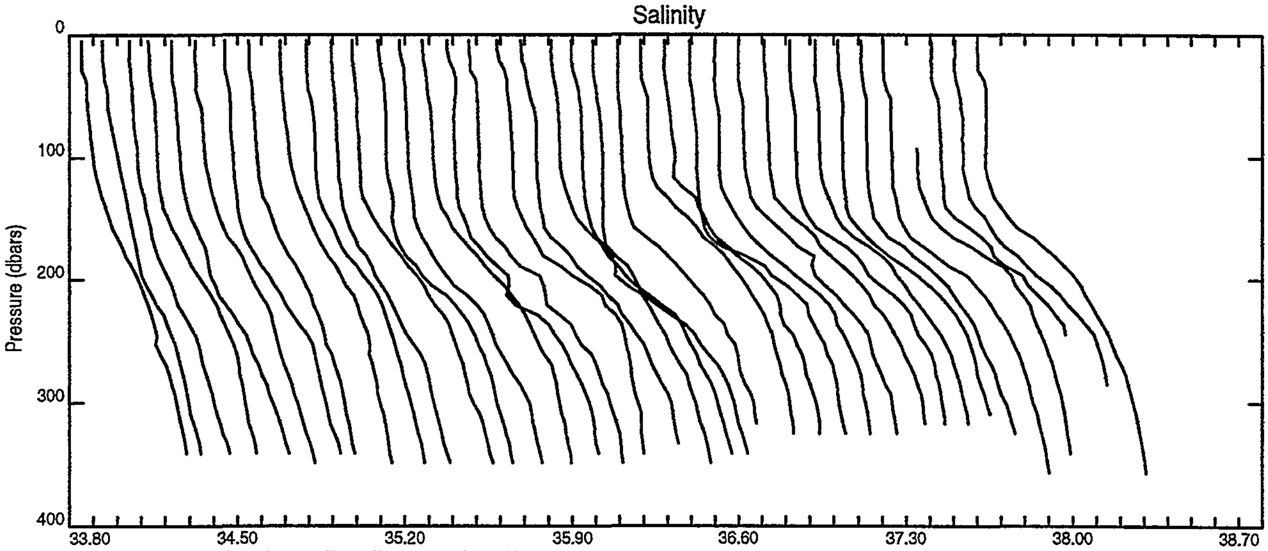
SeaSoar Run 6.1

Potential Temperature (°C)



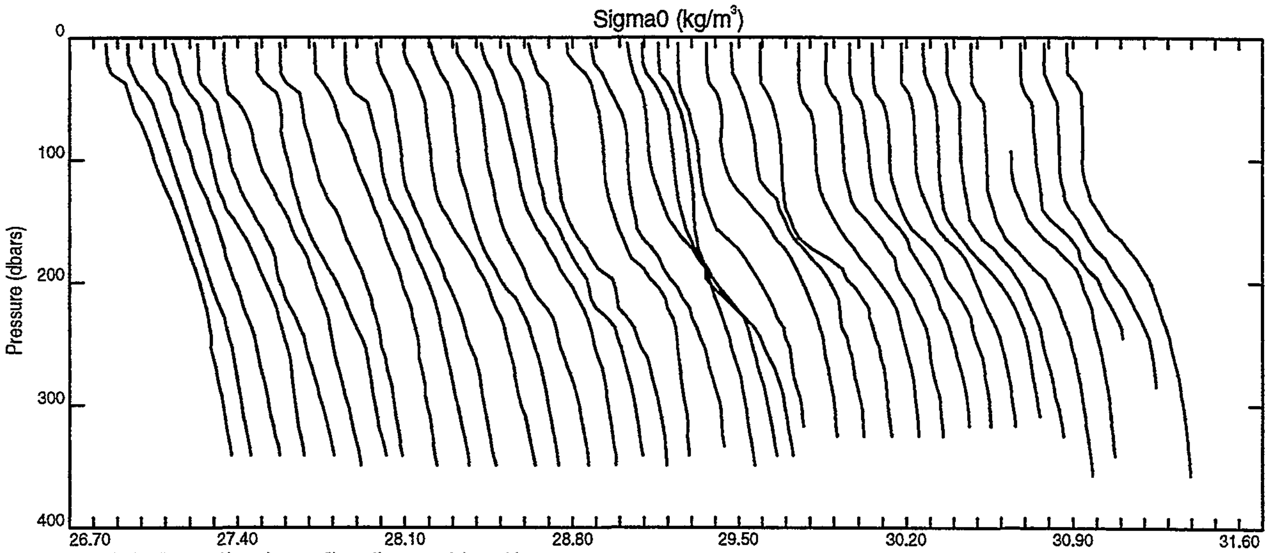
(Scale for first profile; other profiles offset one tick each)

Salinity

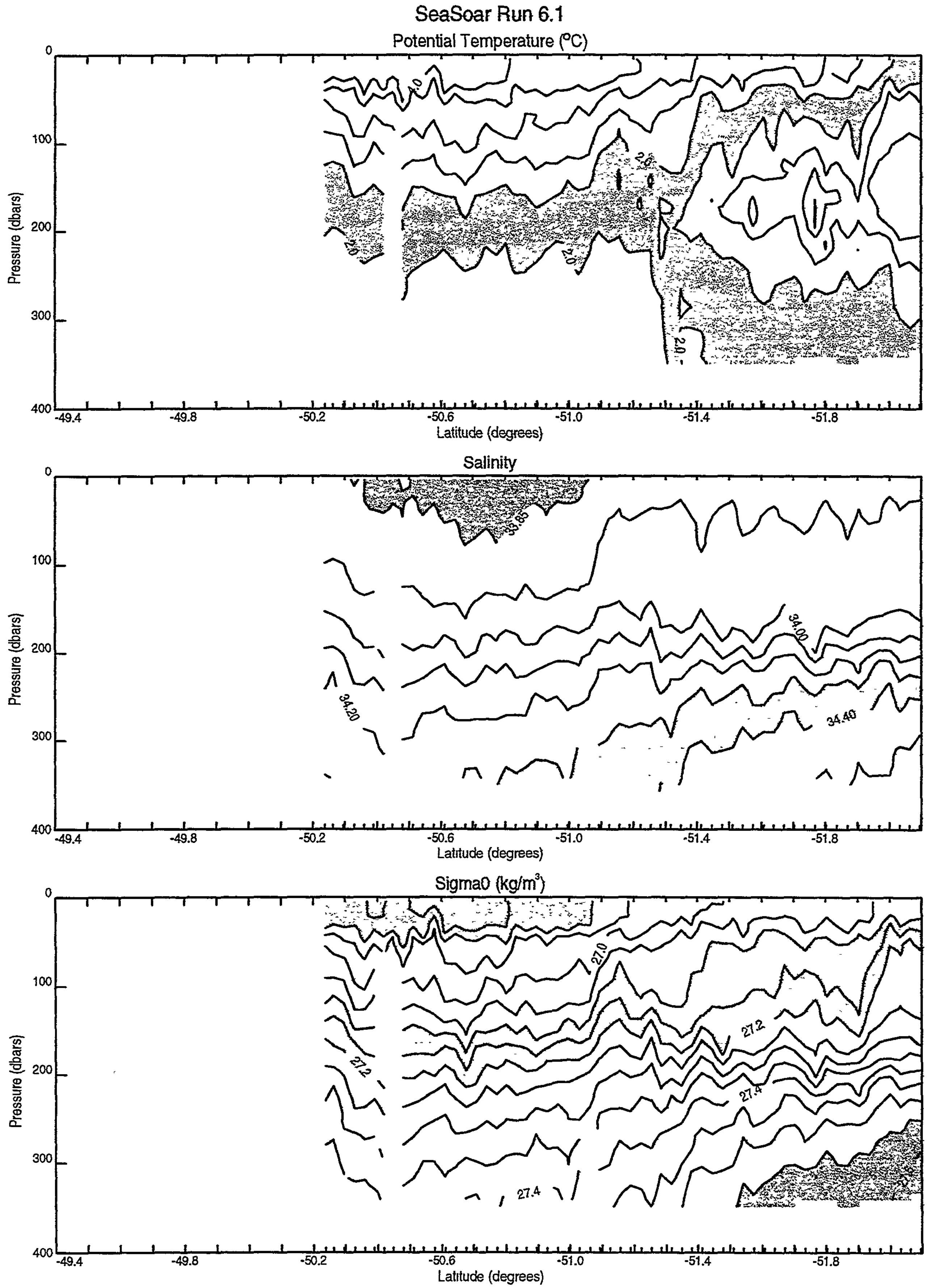


(Scale for first profile; other profiles offset one tick each)

Sigma0 (kg/m^3)

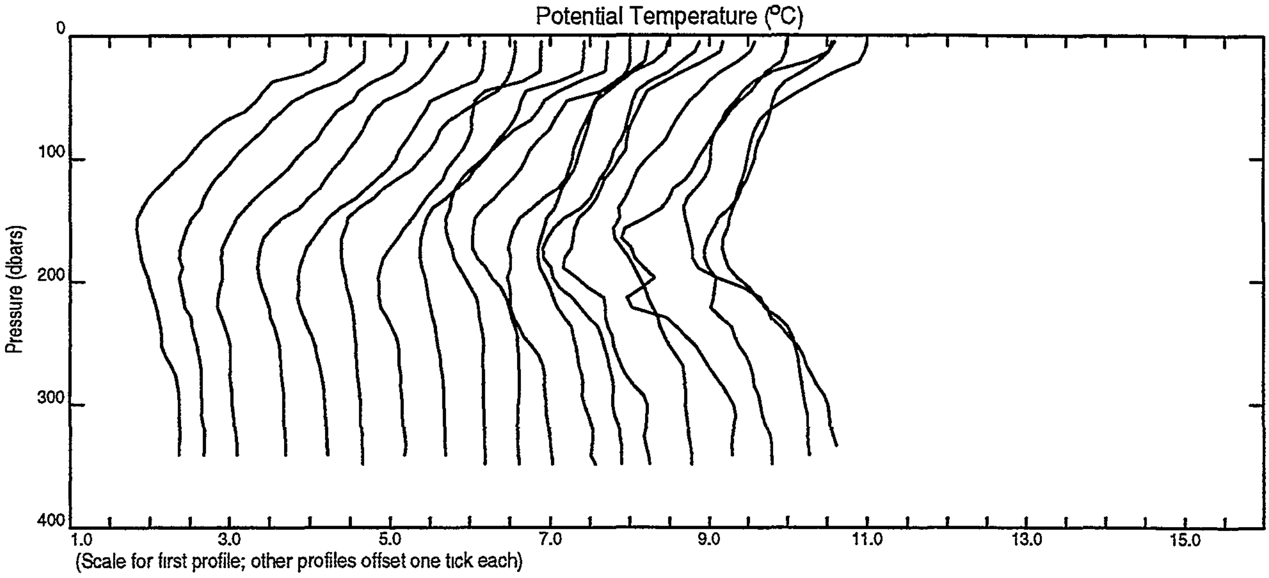


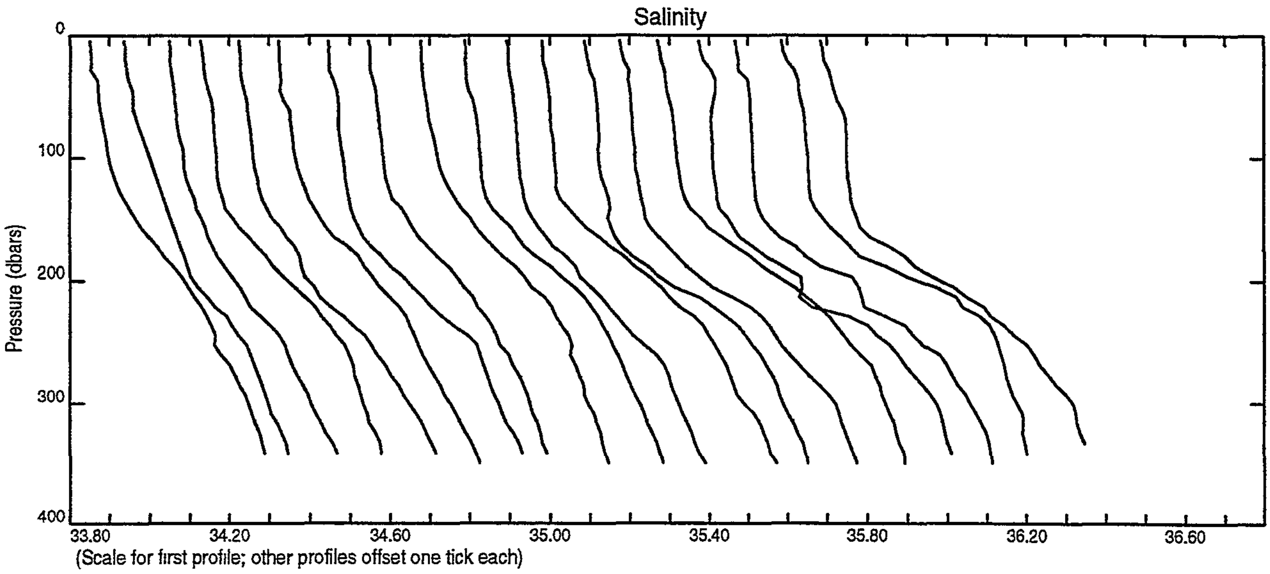
(Scale for first profile; other profiles offset one tick each)

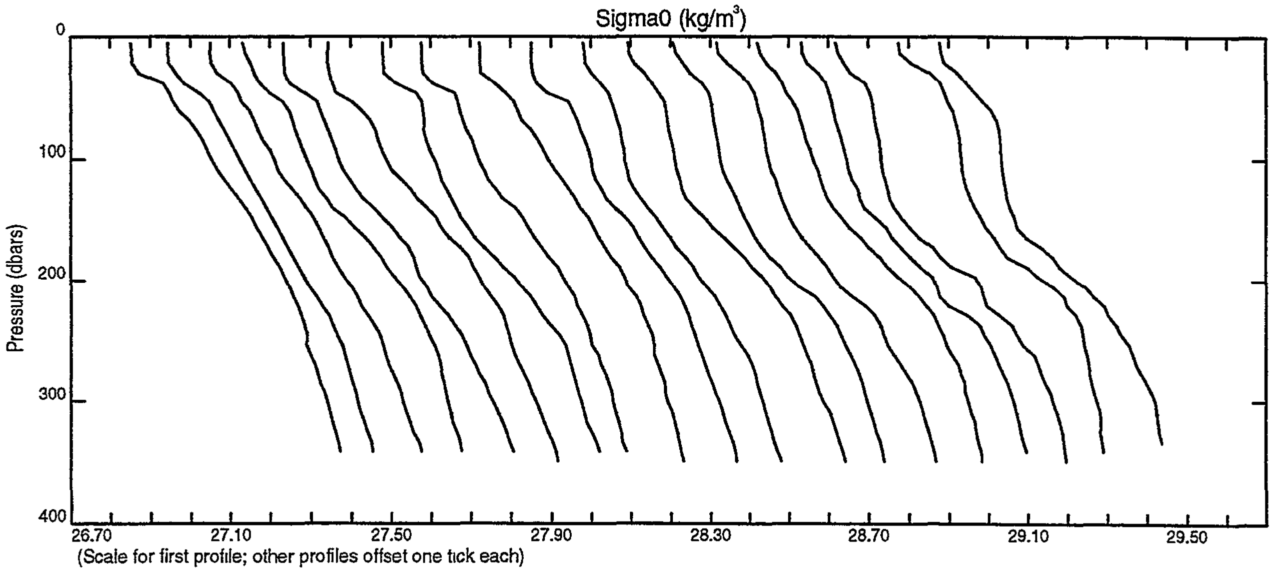


SeaSoar Run 6.1
Potential Temperature (°C)
Pressure (dbars)
Latitude (degrees)
2.0
Salinity
33.85
34.00
34.20
34.40
Sigma0 (kg/m³)
27.0
27.2
27.4
0
100
200
300
400
-49.4
-49.8
-50.2
-50.6
-51.0
-51.4
-51.8

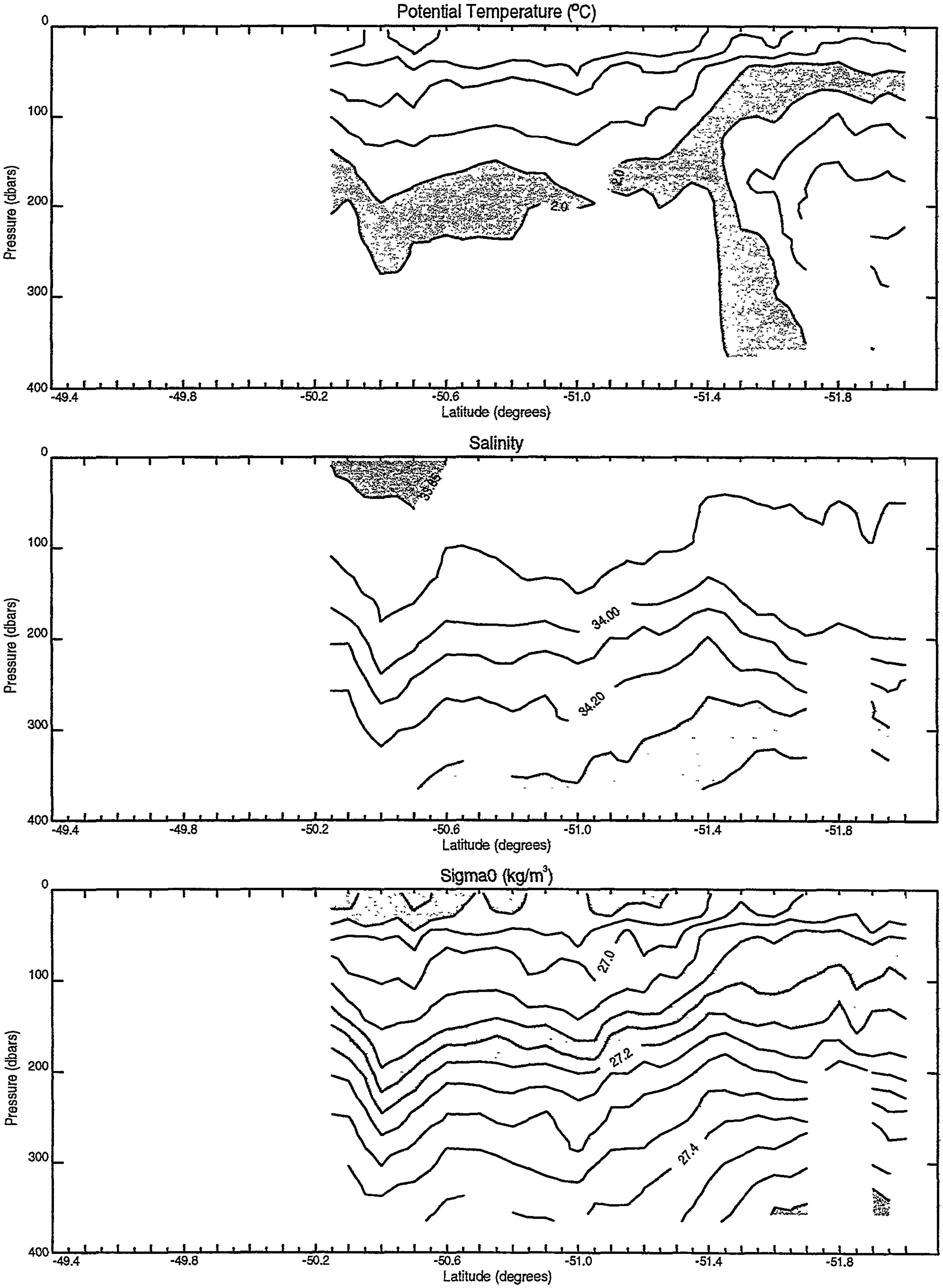
SeaSoar Run 6.1



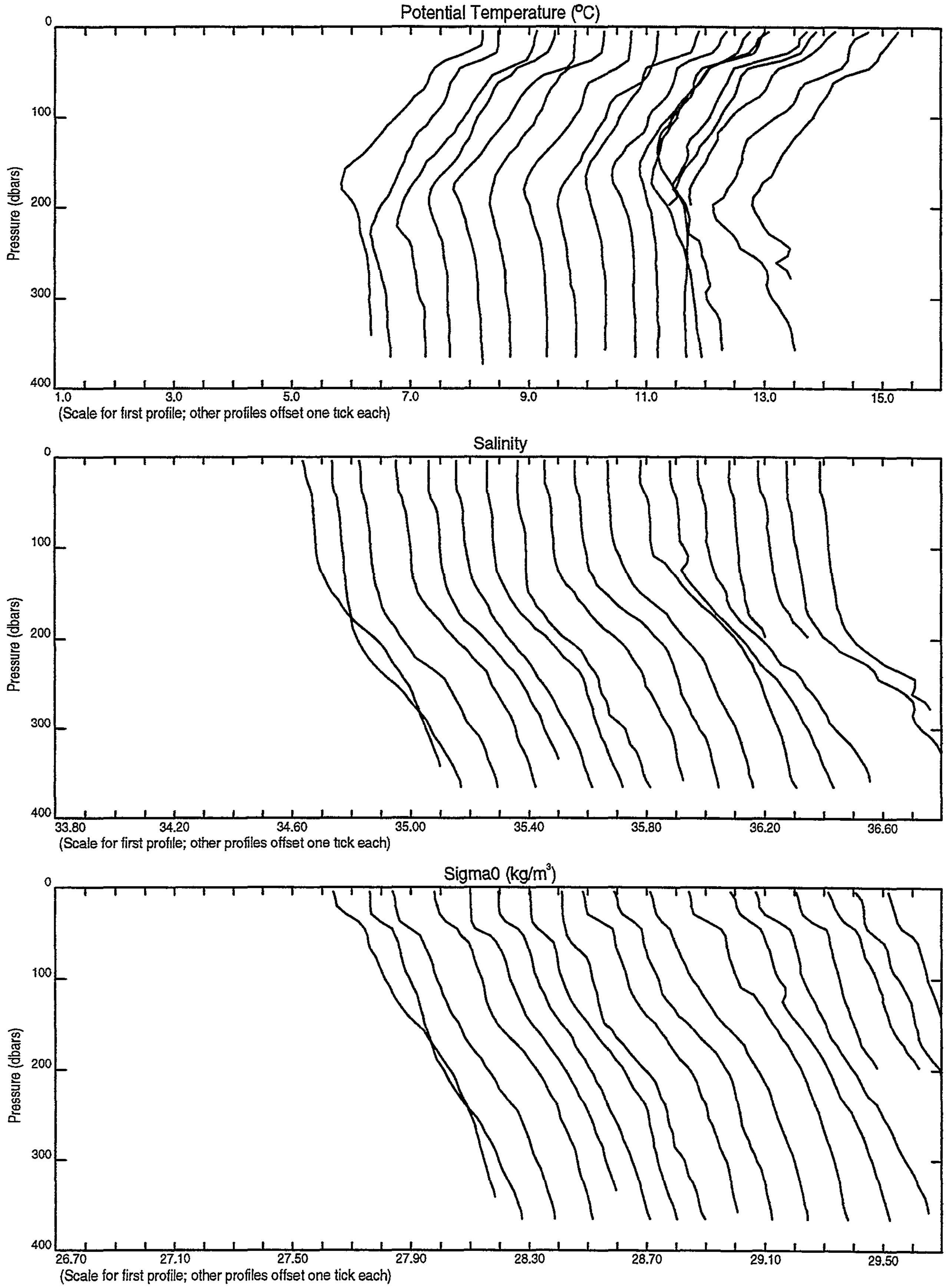




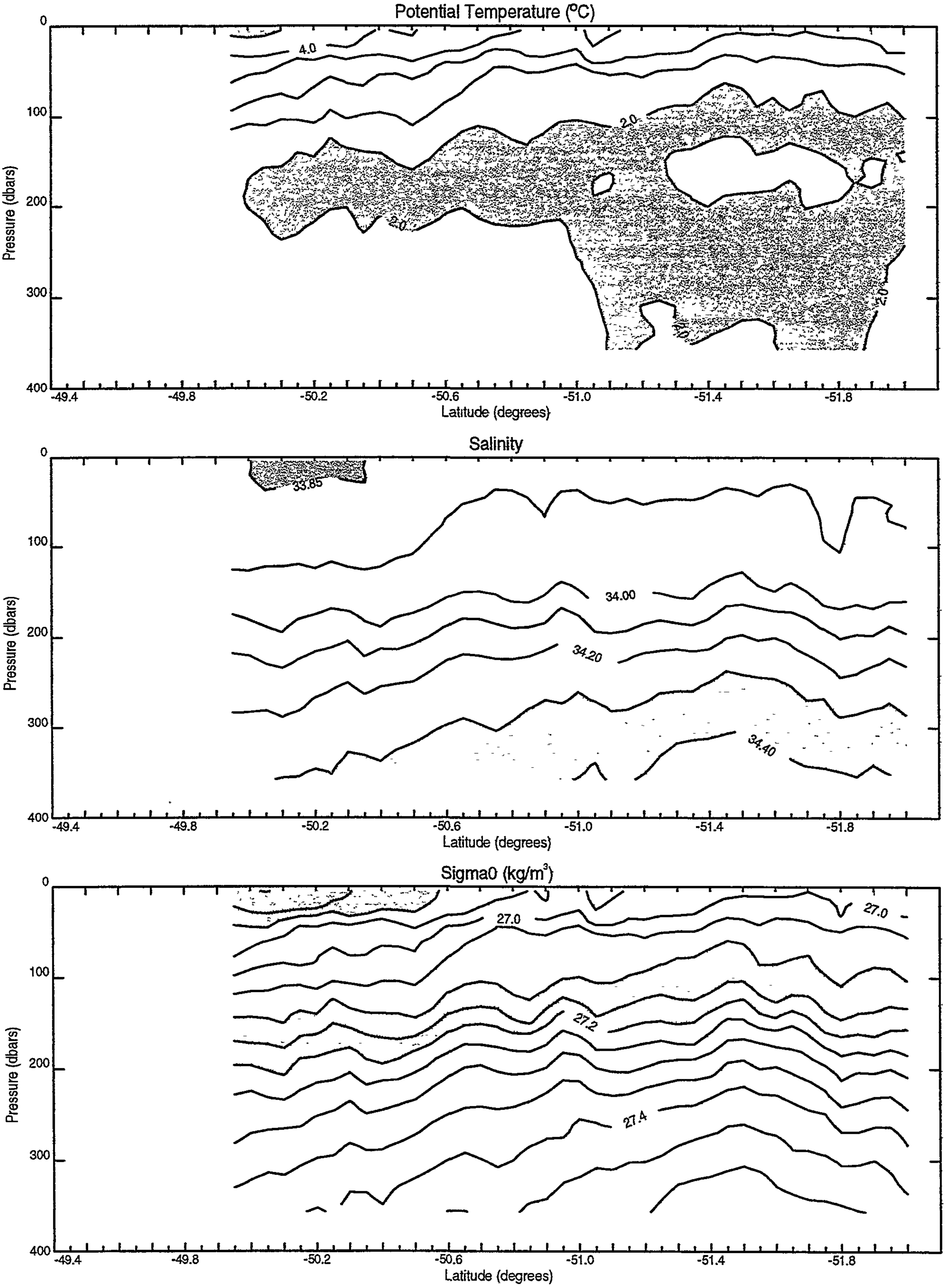
SeaSoar Run 6.2



SeaSoar Run 6.2

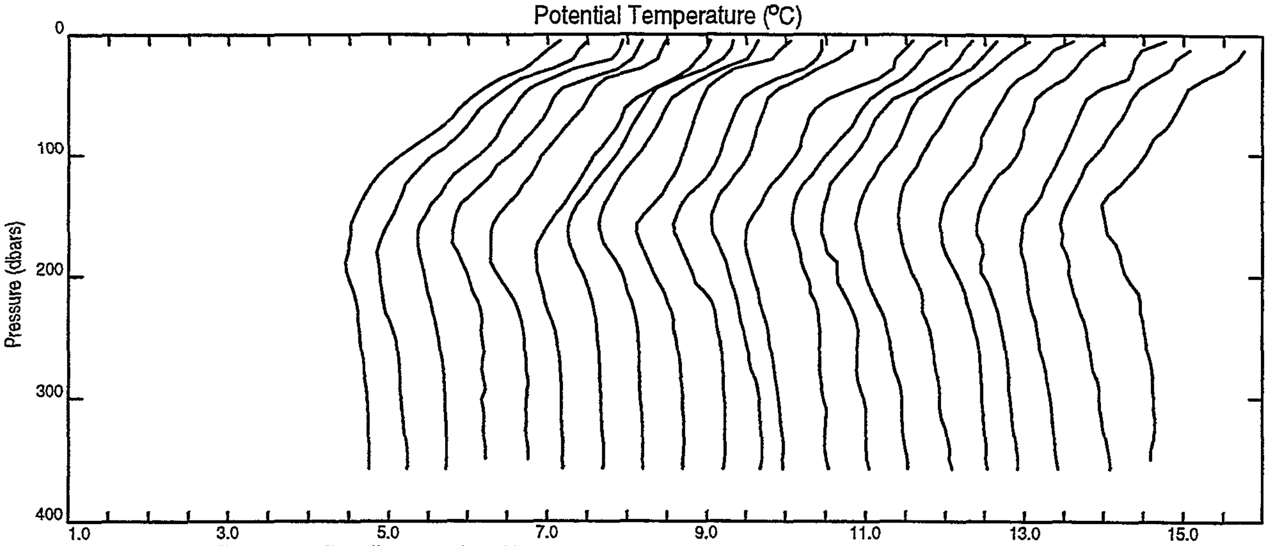


SeaSoar Run 6.3



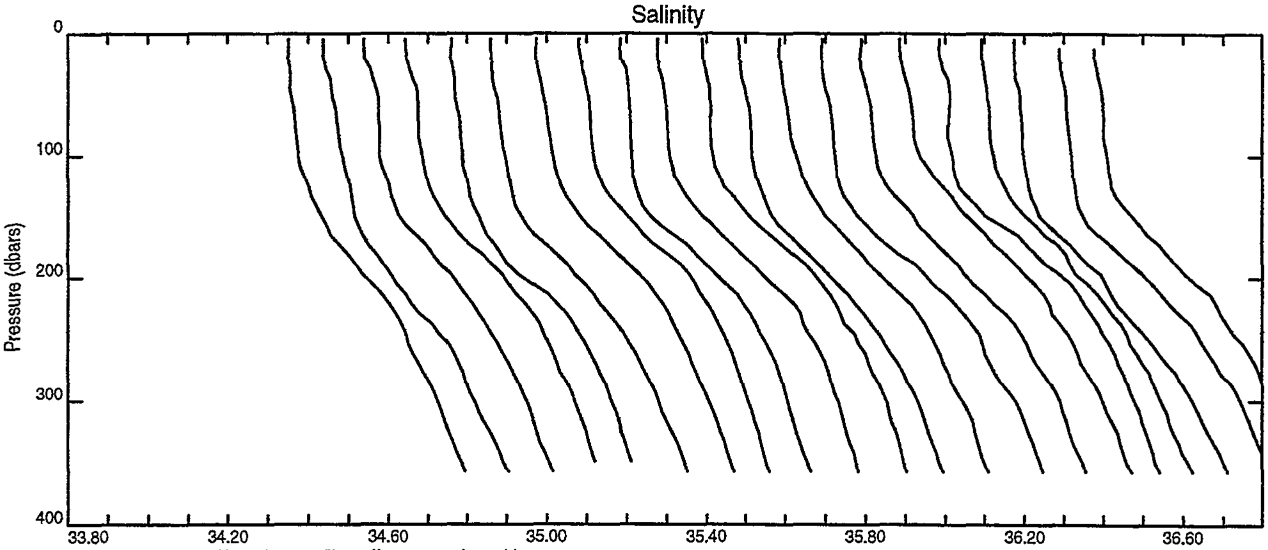
SeaSoar Run 6.3

Potential Temperature (°C)



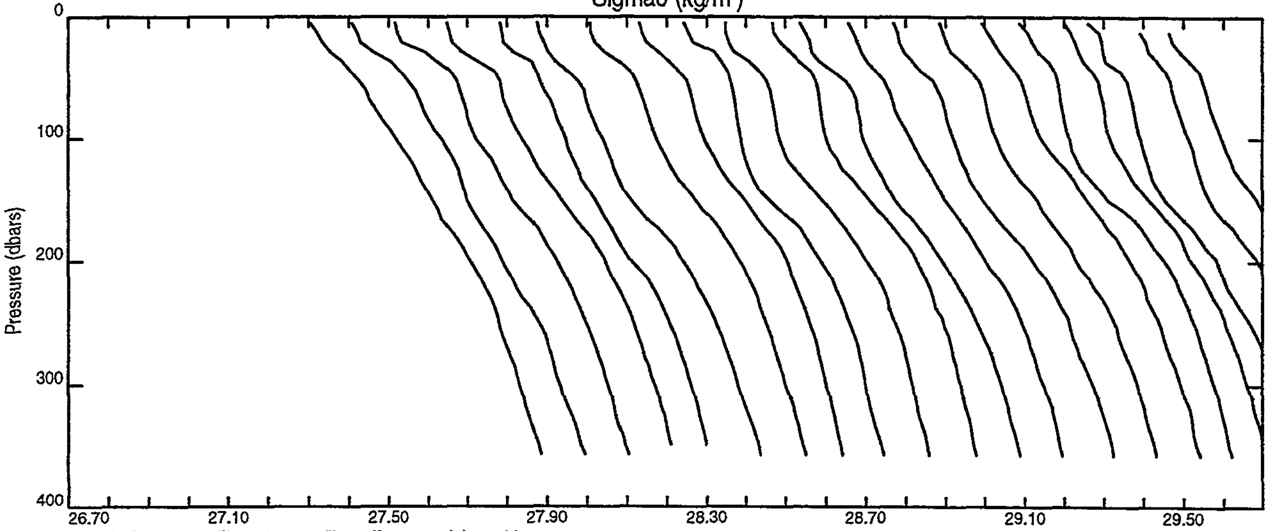
(Scale for first profile; other profiles offset one tick each)

Salinity



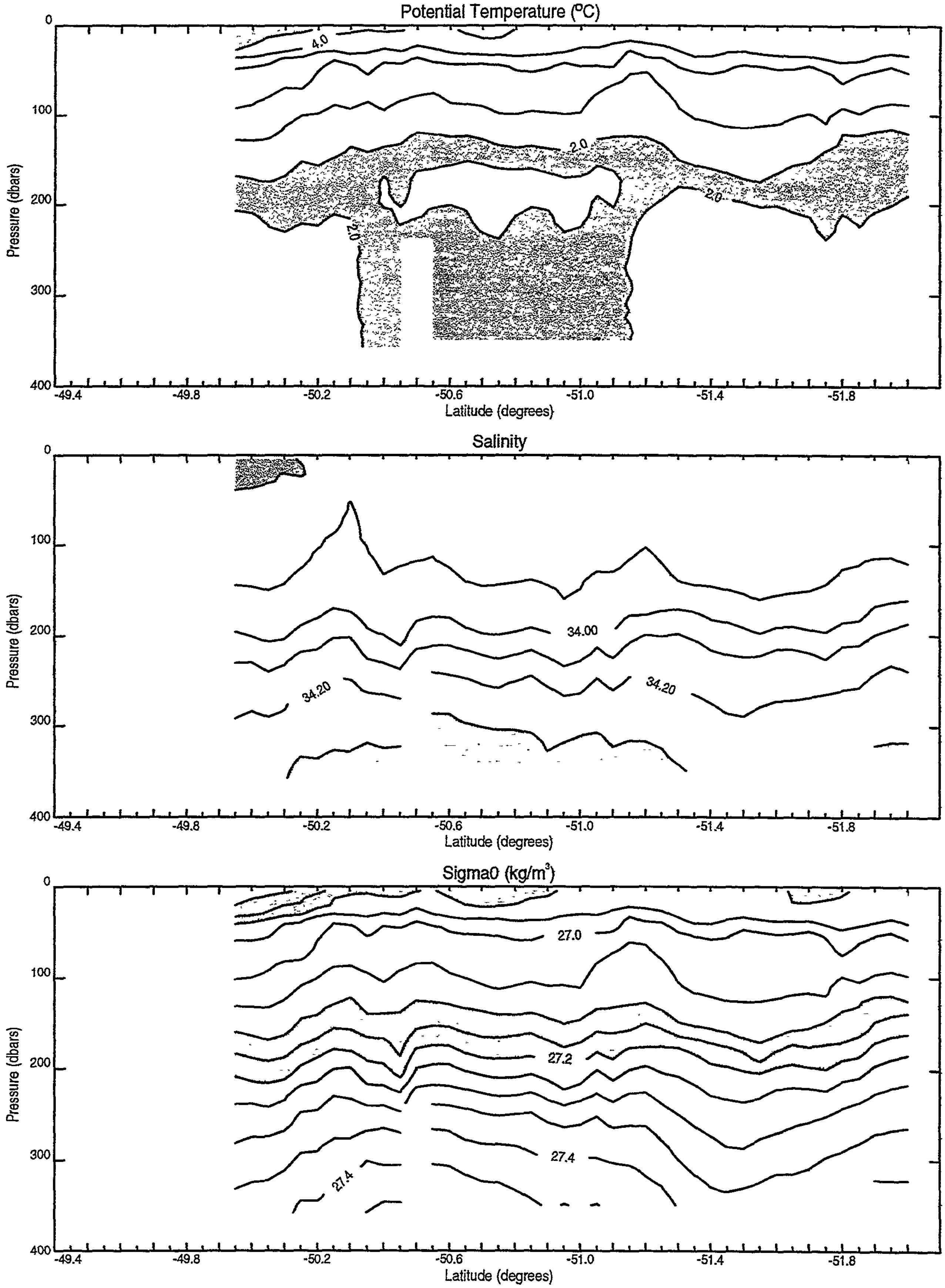
(Scale for first profile; other profiles offset one tick each)

Sigma0 (kg/m^3)

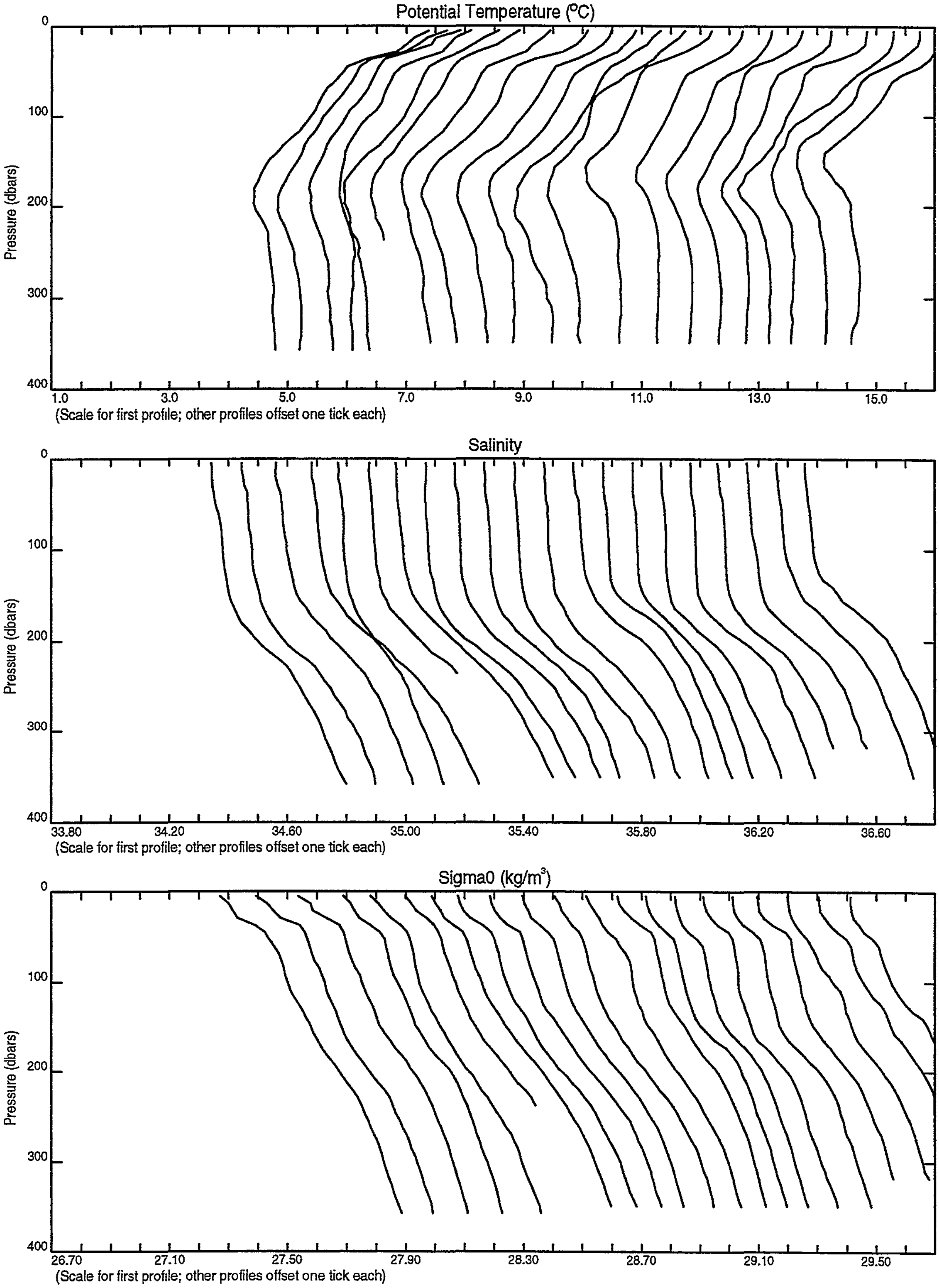


(Scale for first profile; other profiles offset one tick each)

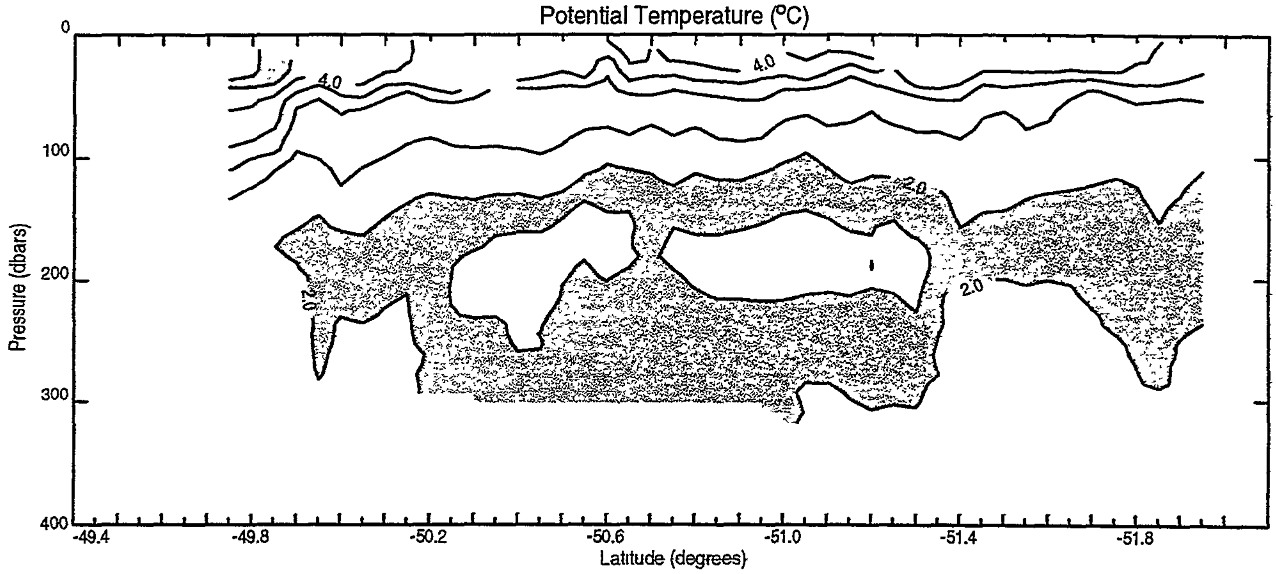
SeaSoar Run 6.4

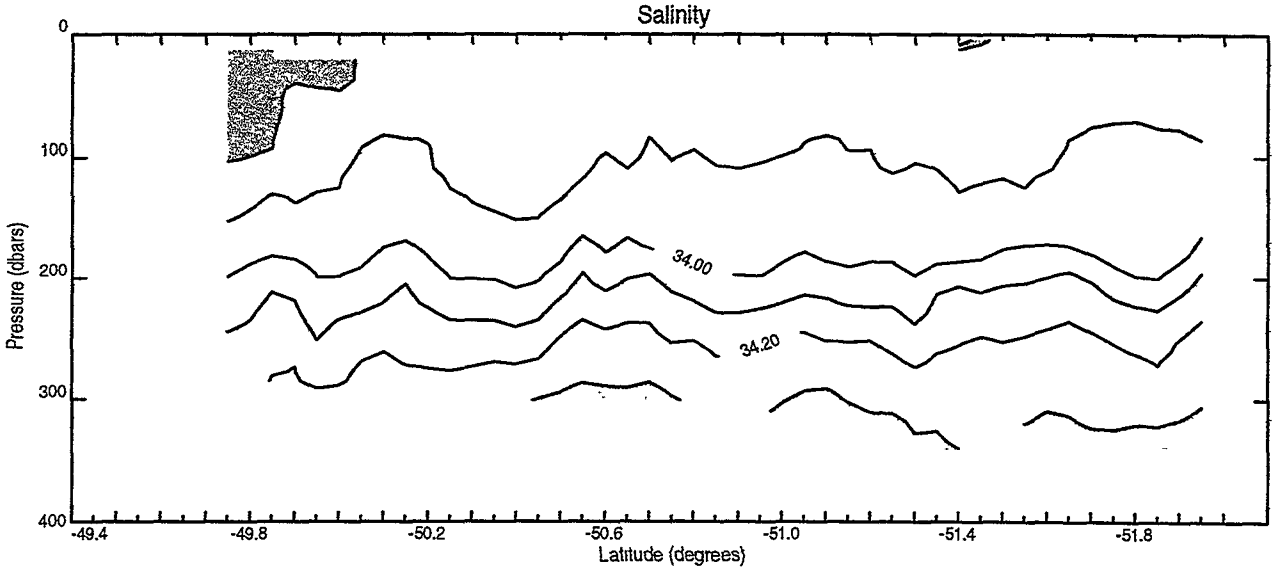


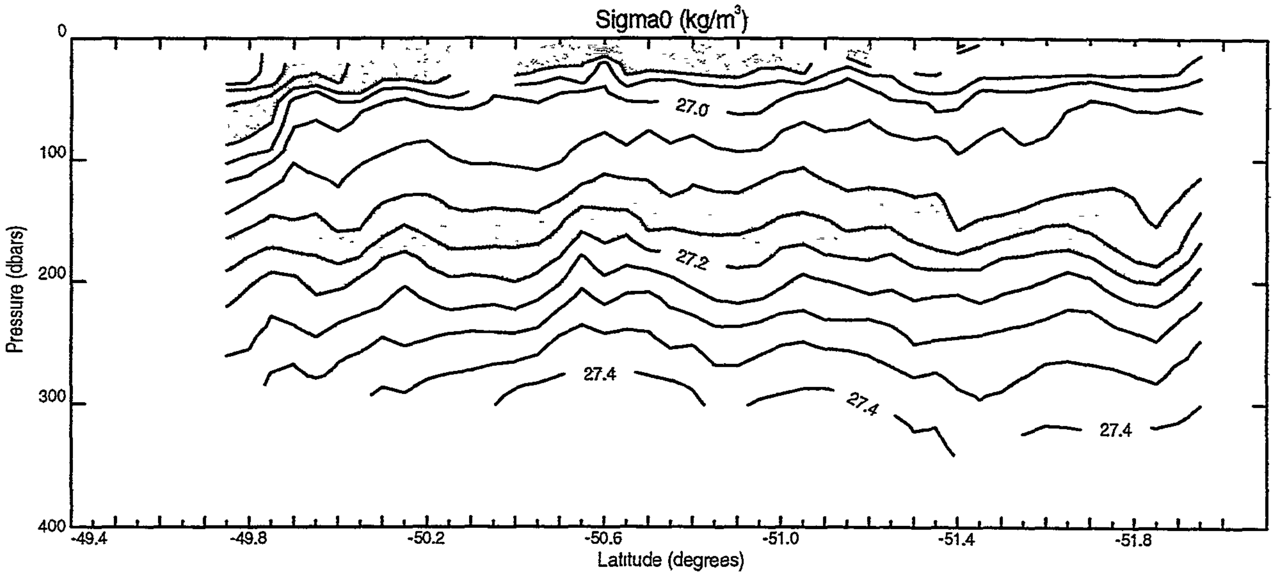
SeaSoar Run 6.4



SeaSoar Run 6.5

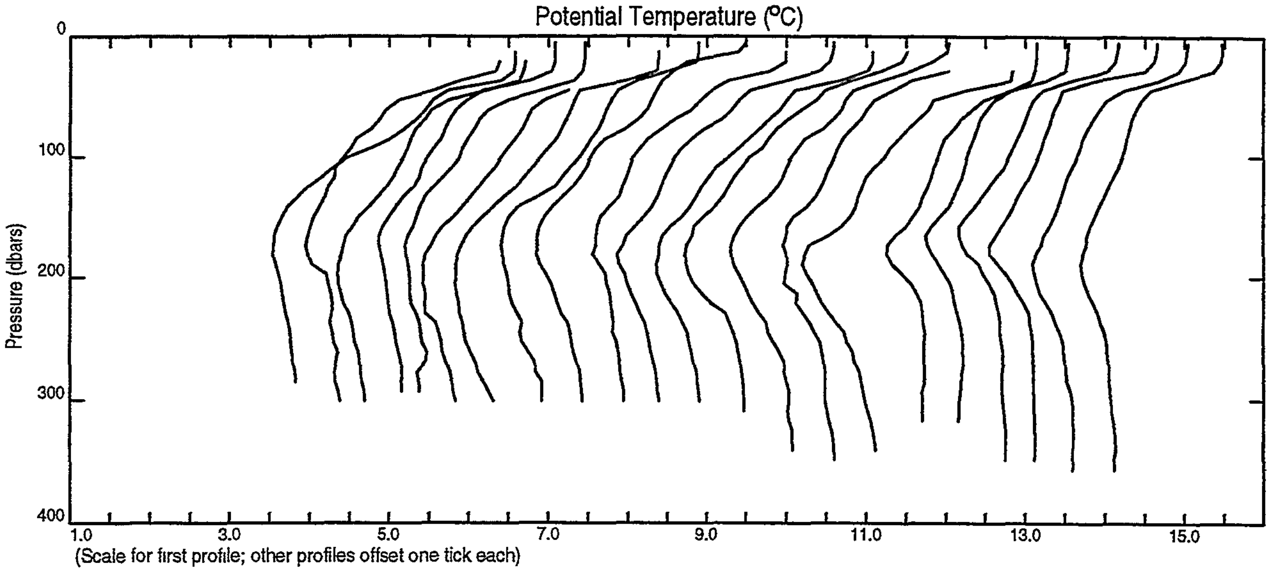




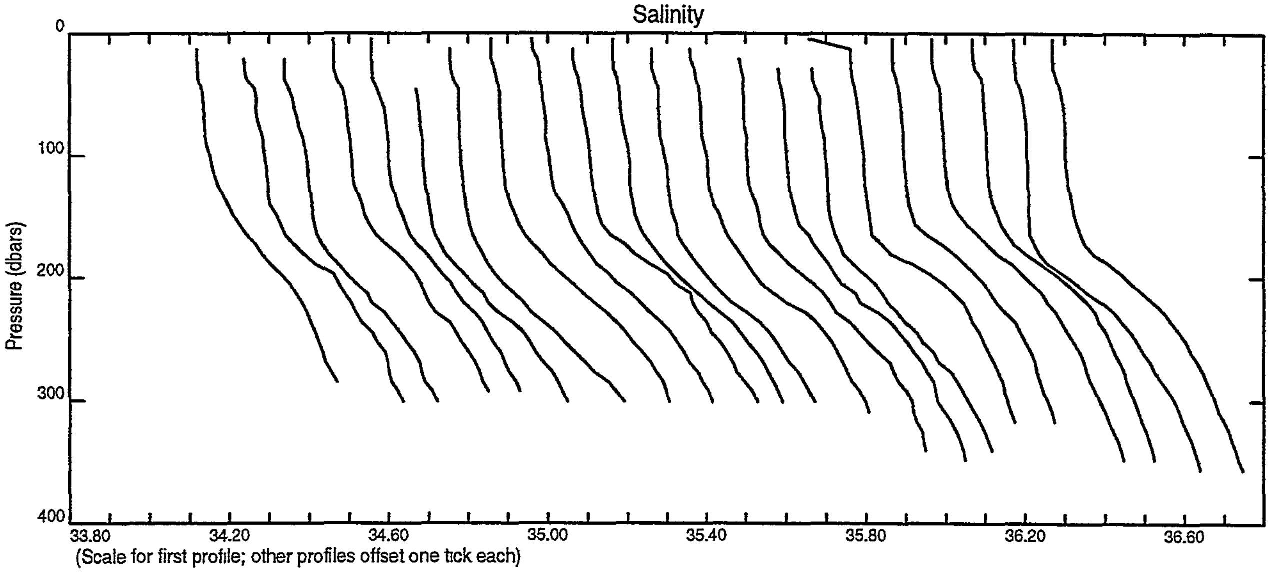


SeaSoar Run 6.5

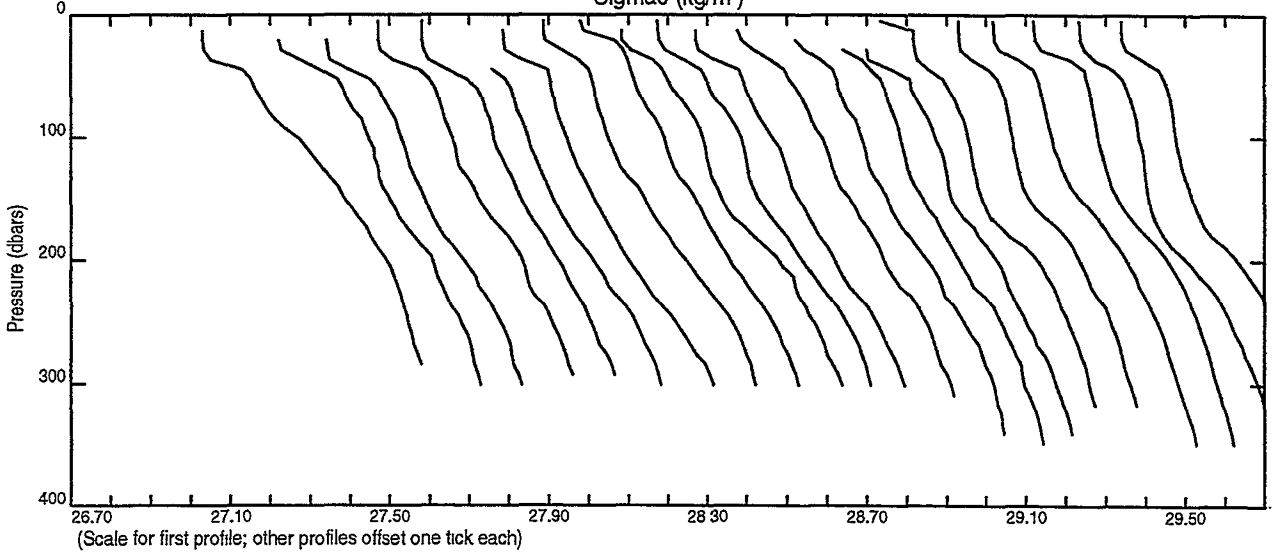
Potential Temperature (°C)



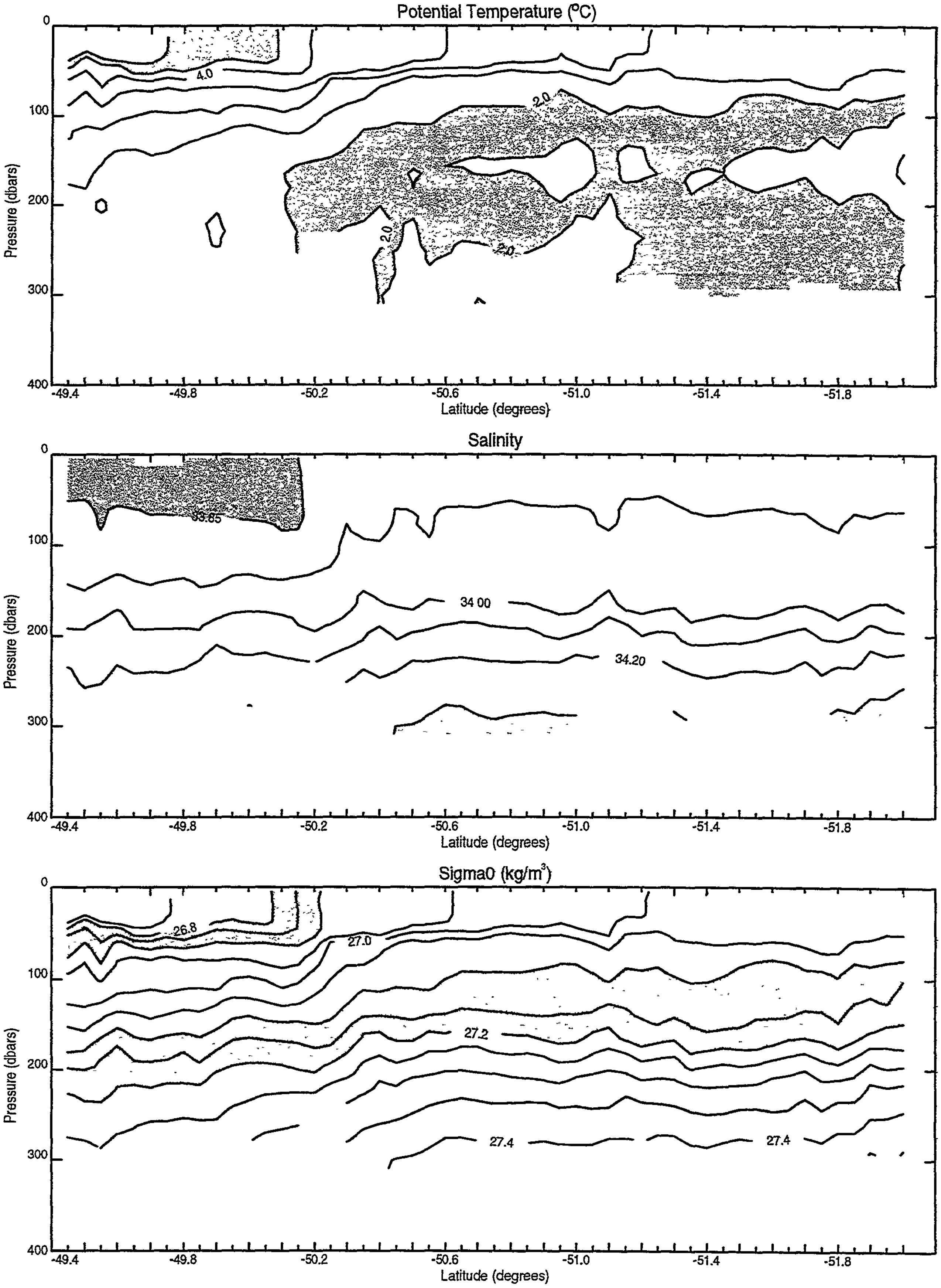
Salinity



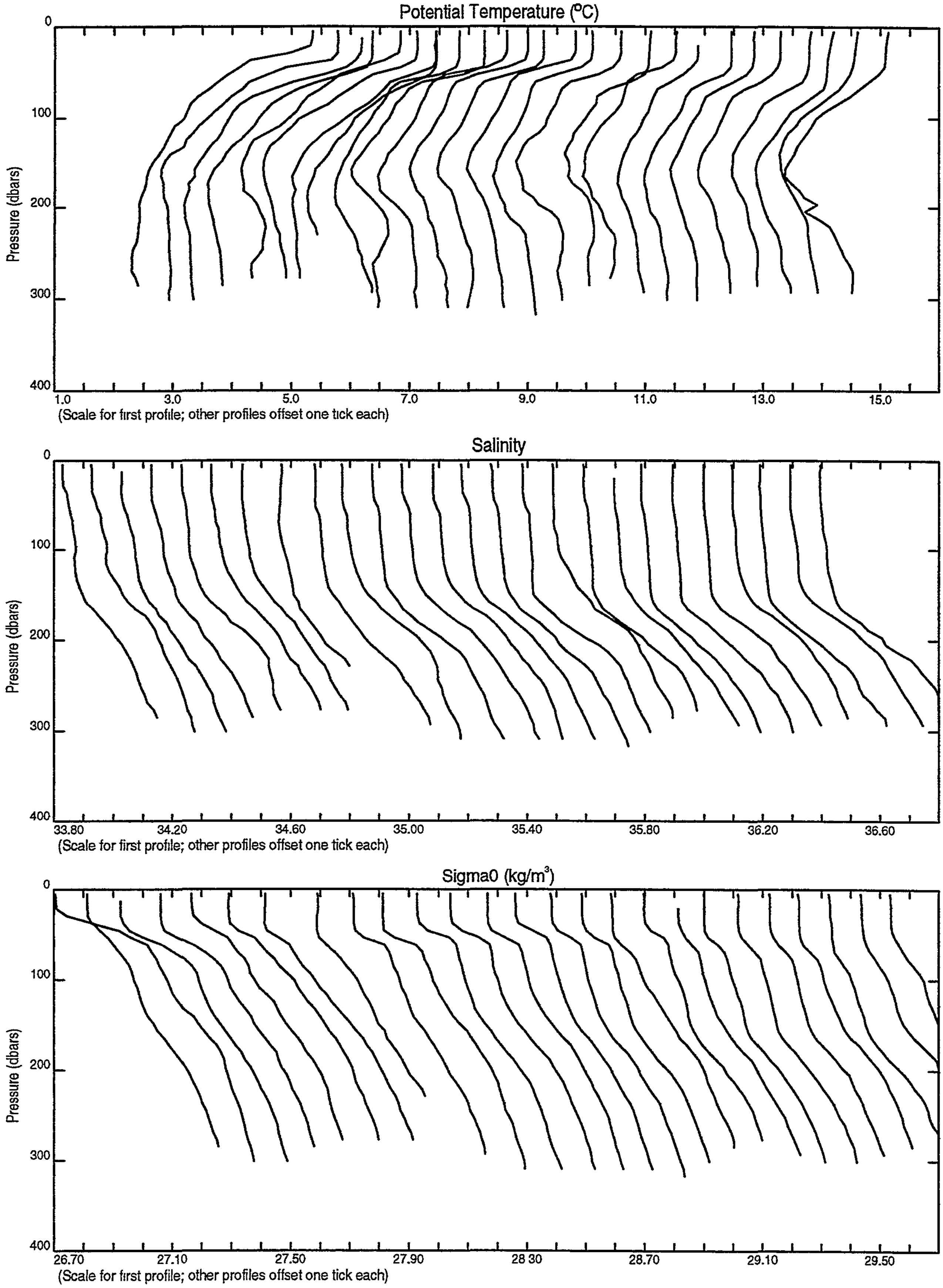
Sigma0 (kg/m^3)



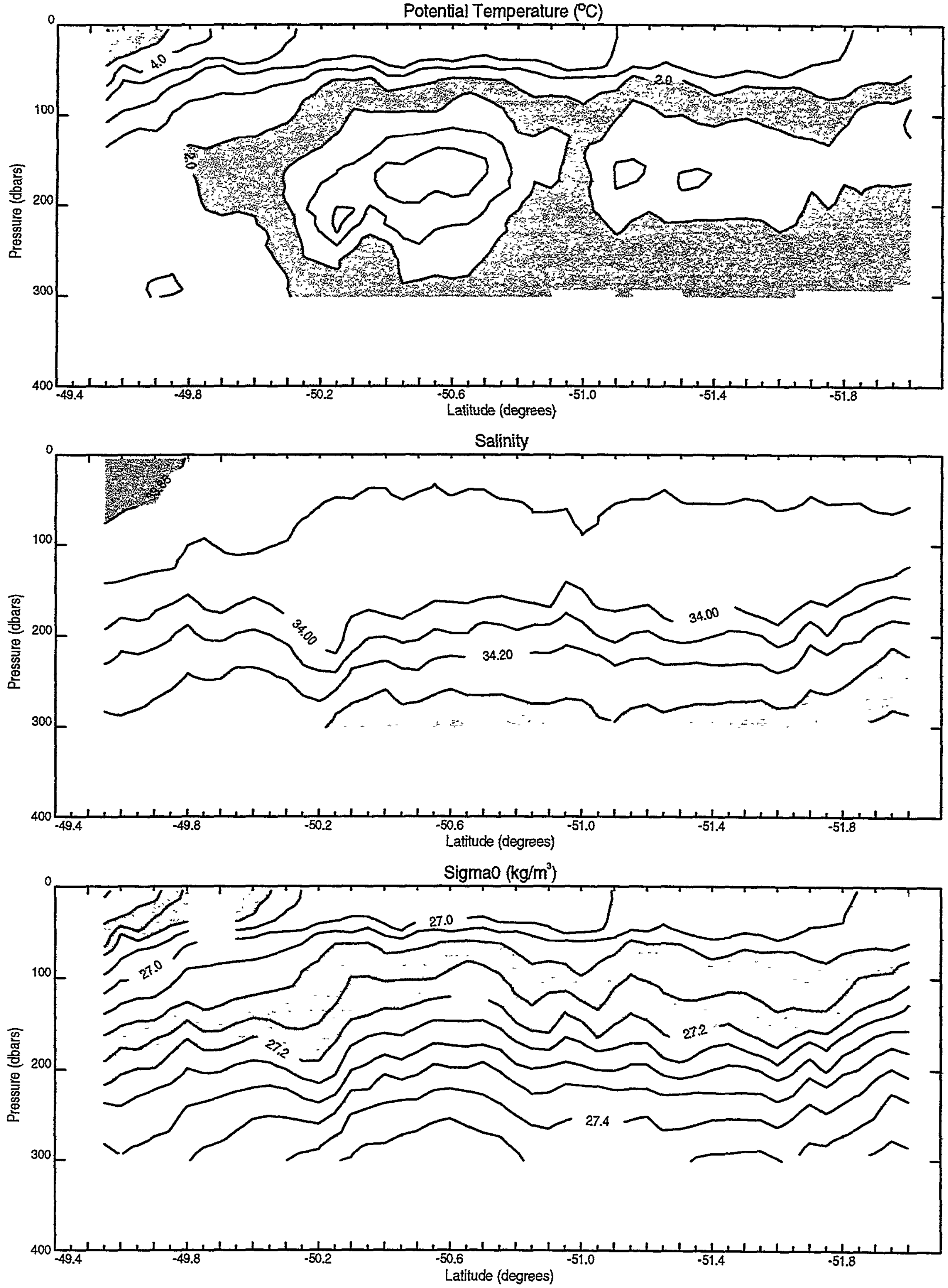
SeaSoar Run 6.6



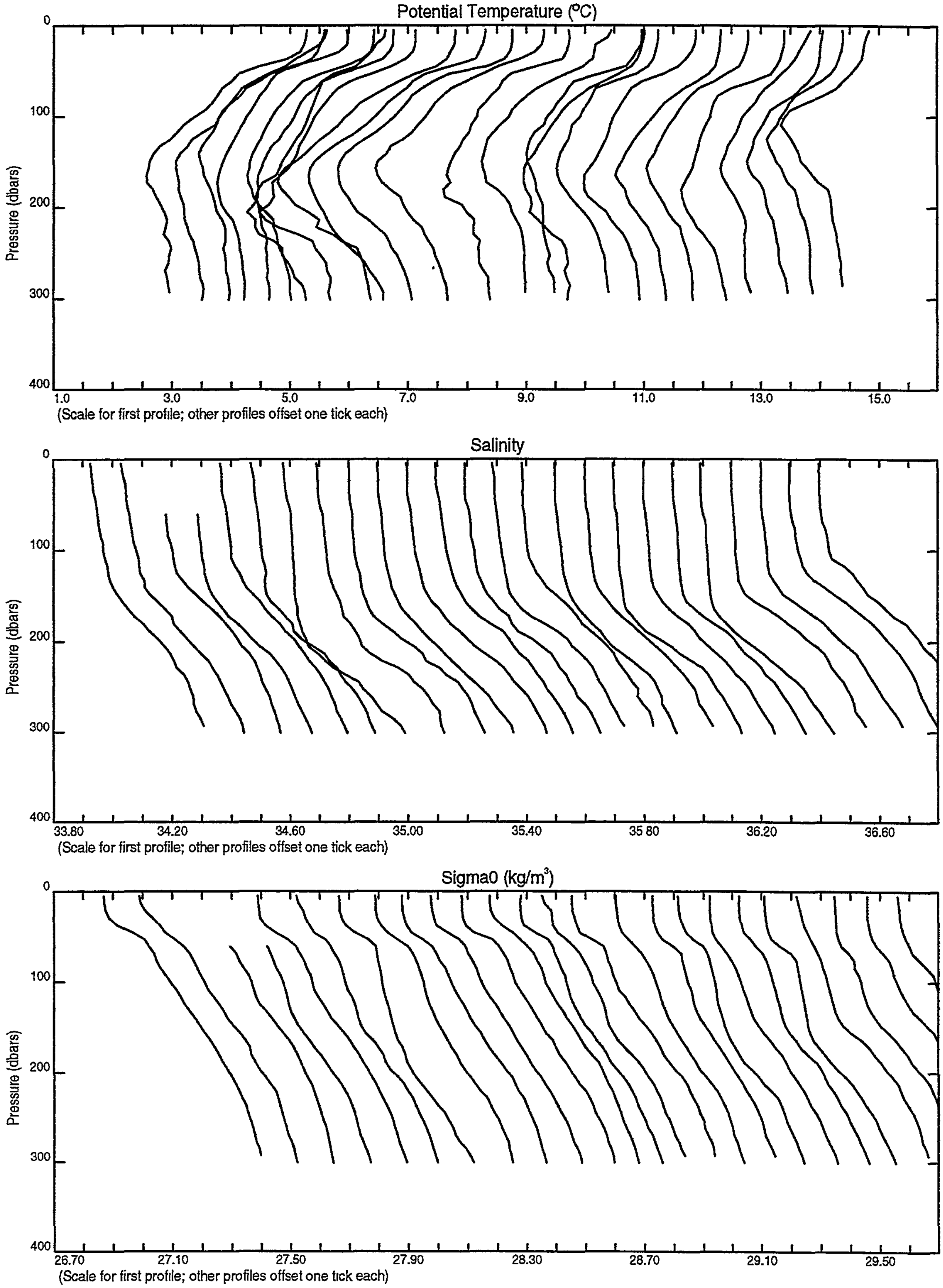
SeaSoar Run 6.6



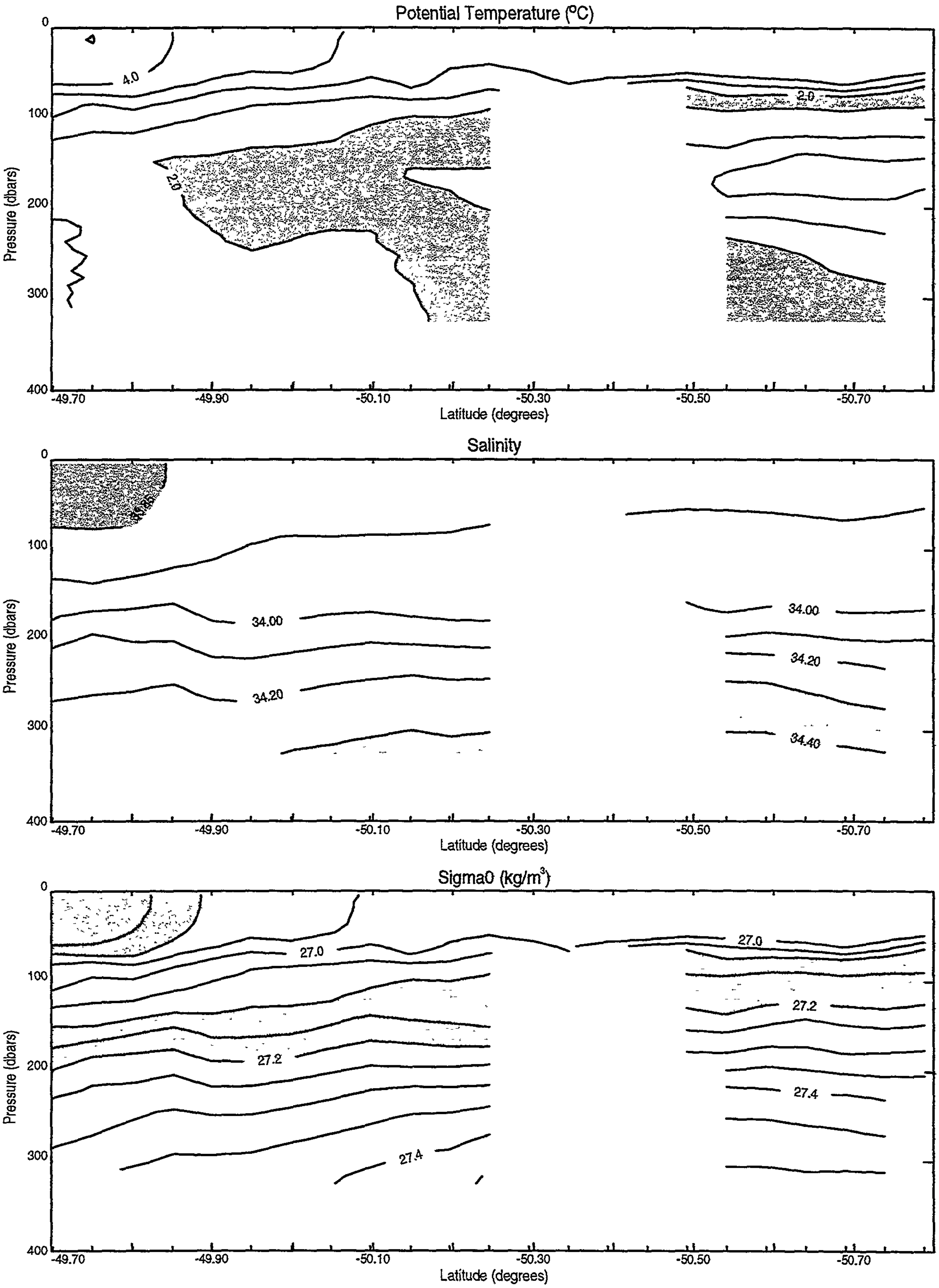
SeaSoar Run 6.7



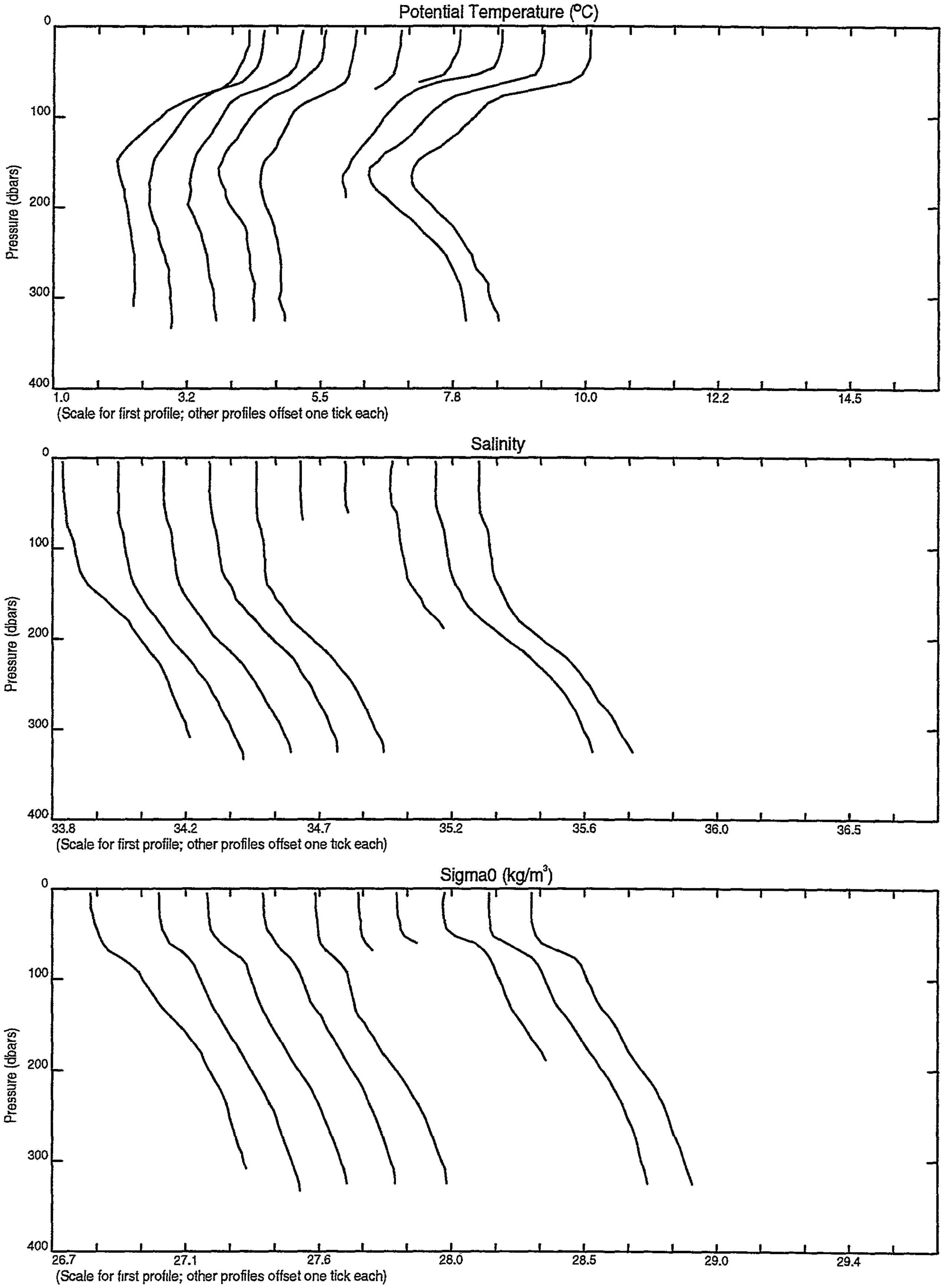
SeaSoar Run 6.7



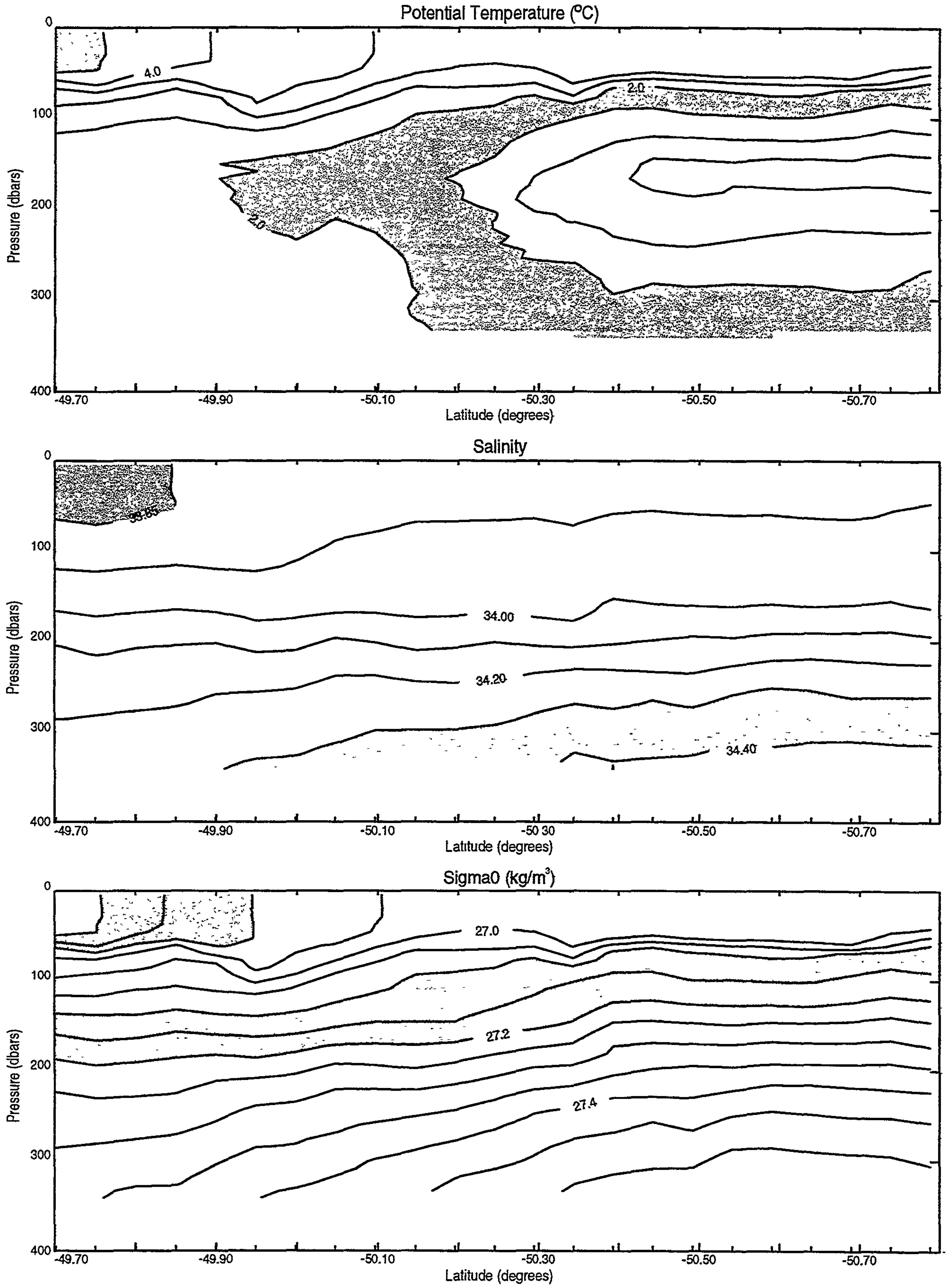
SeaSoar Fine Scale Survey - Run 8.1



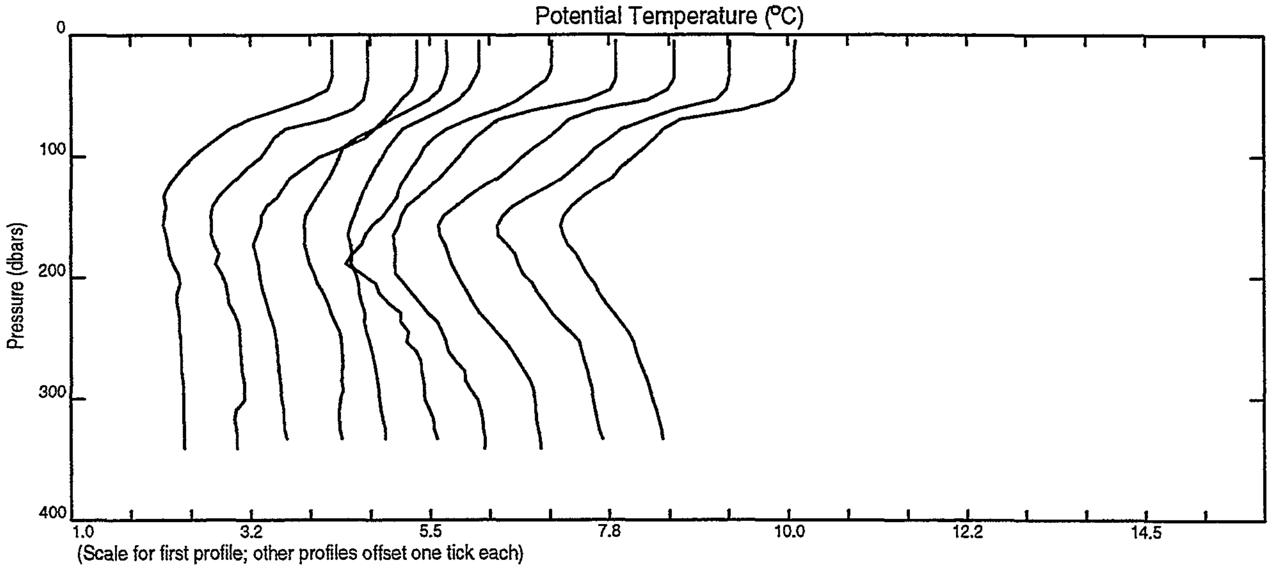
SeaSoar Fine Scale Survey - Run 8.1

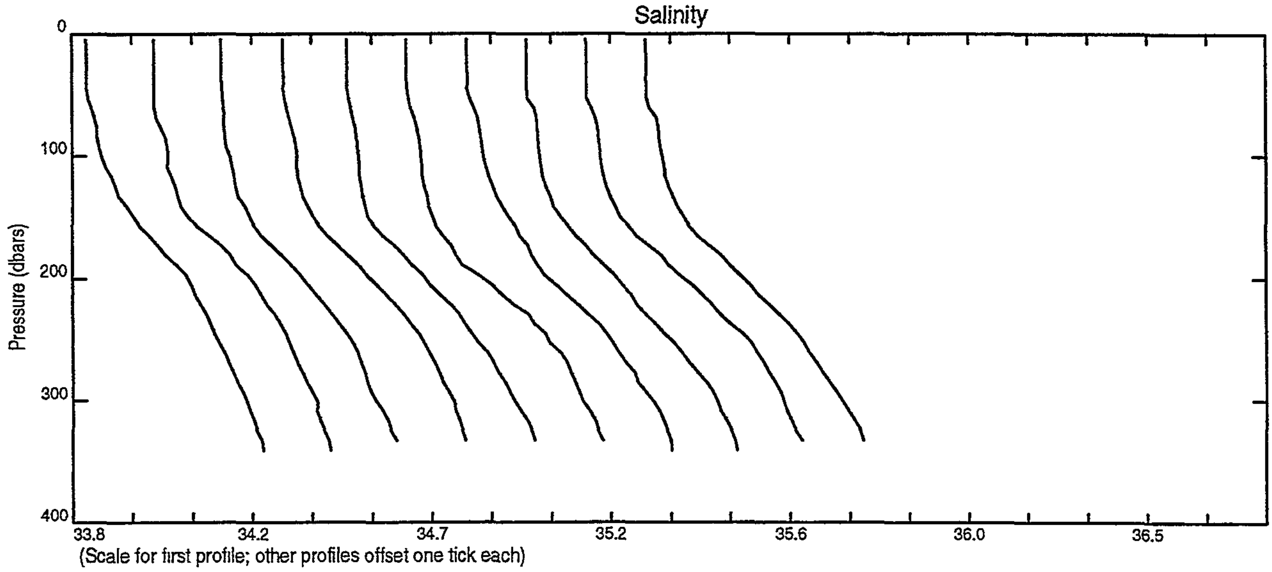


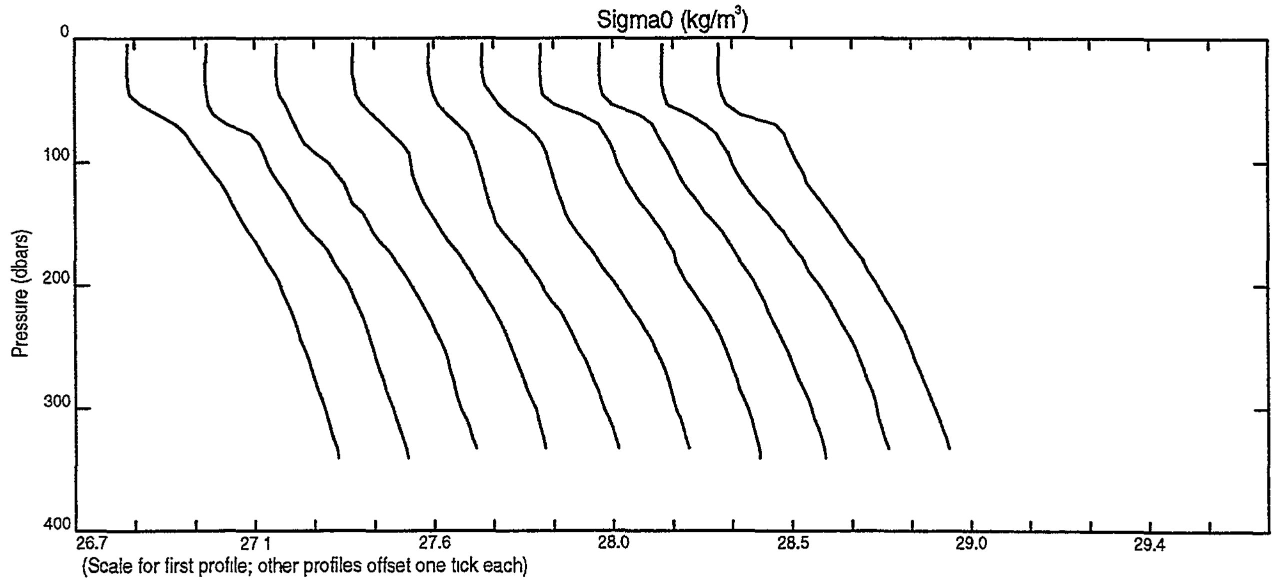
SeaSoar Fine Scale Survey - Run 8.2



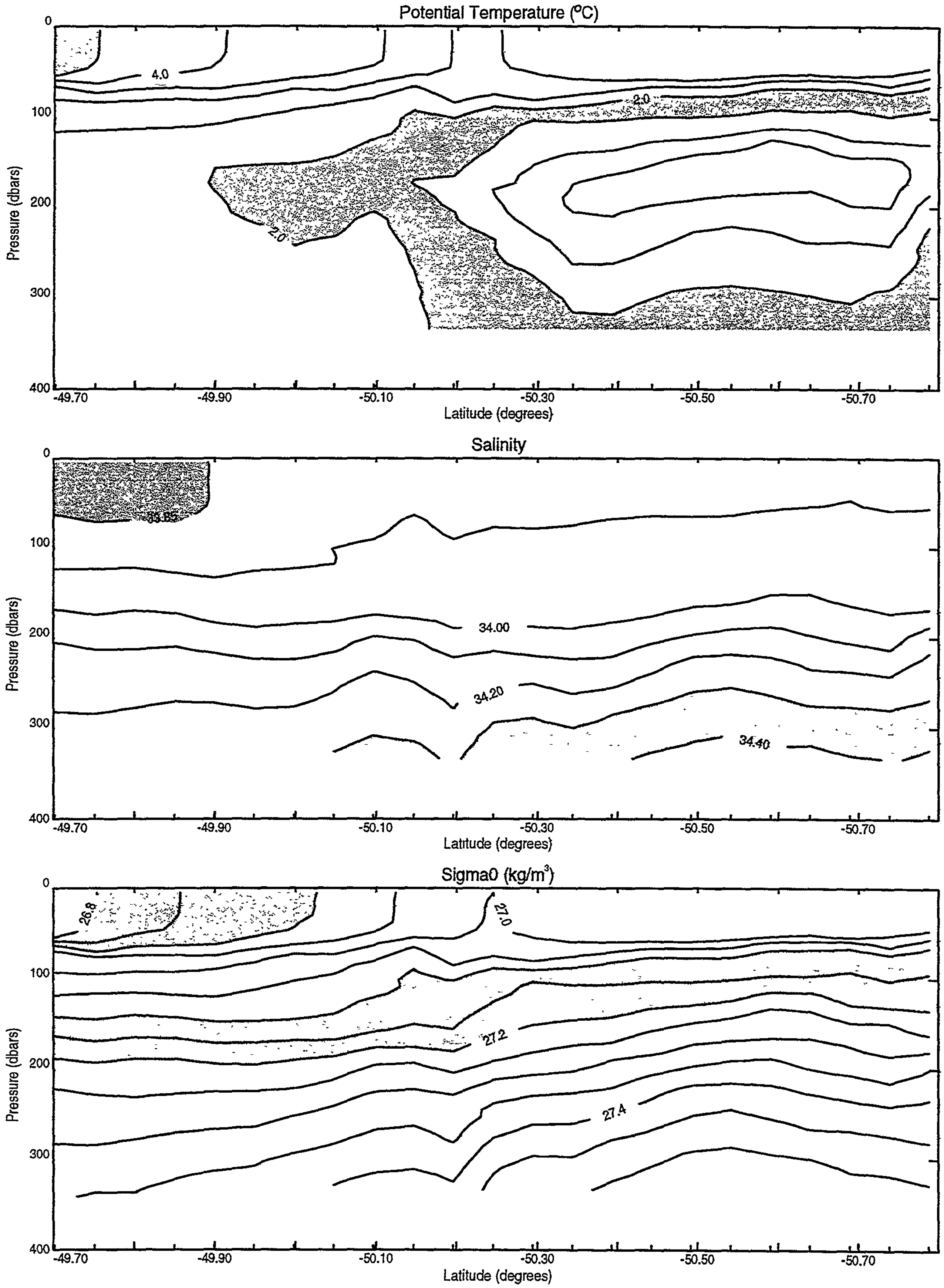
SeaSoar Fine Scale Survey - Run 8.2





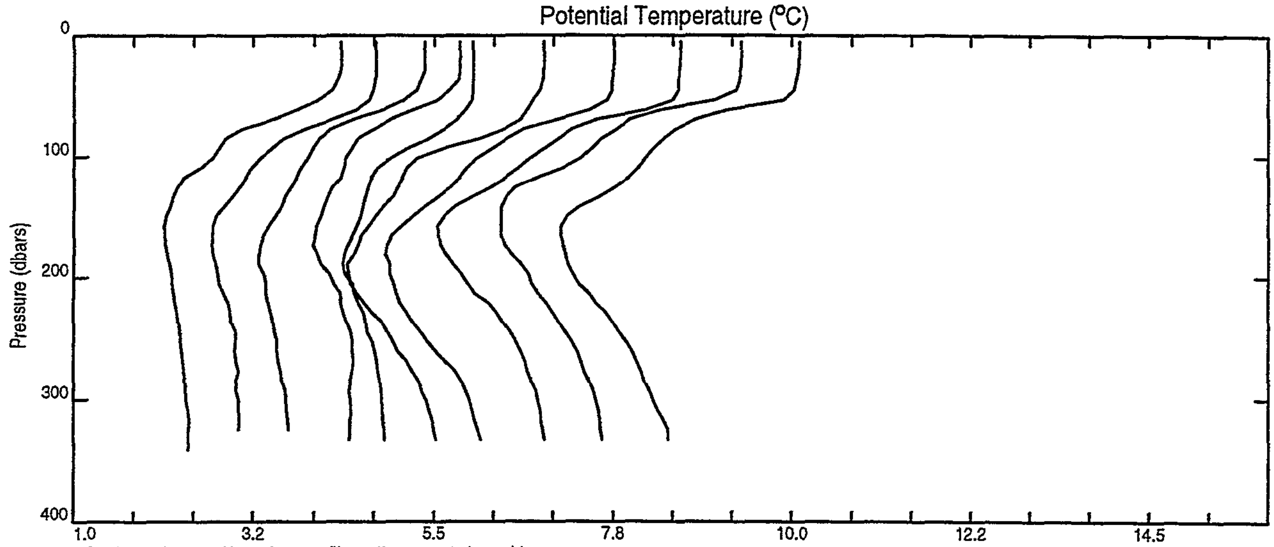


SeaSoar Fine Scale Survey - Run 8.3



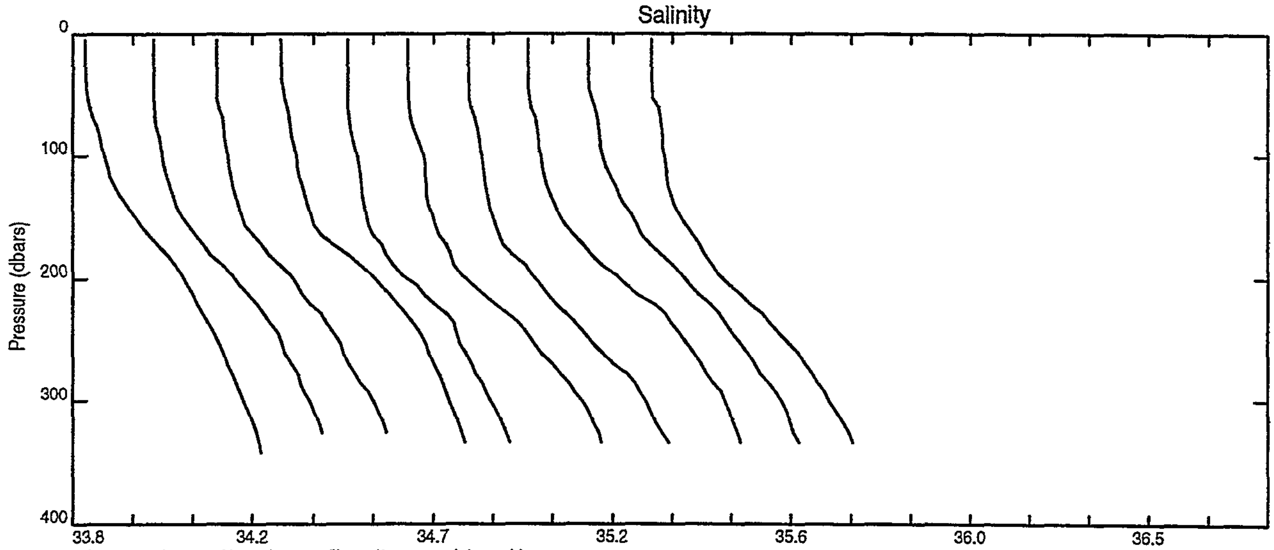
SeaSoar Fine Scale Survey - Run 8.3

Potential Temperature (°C)



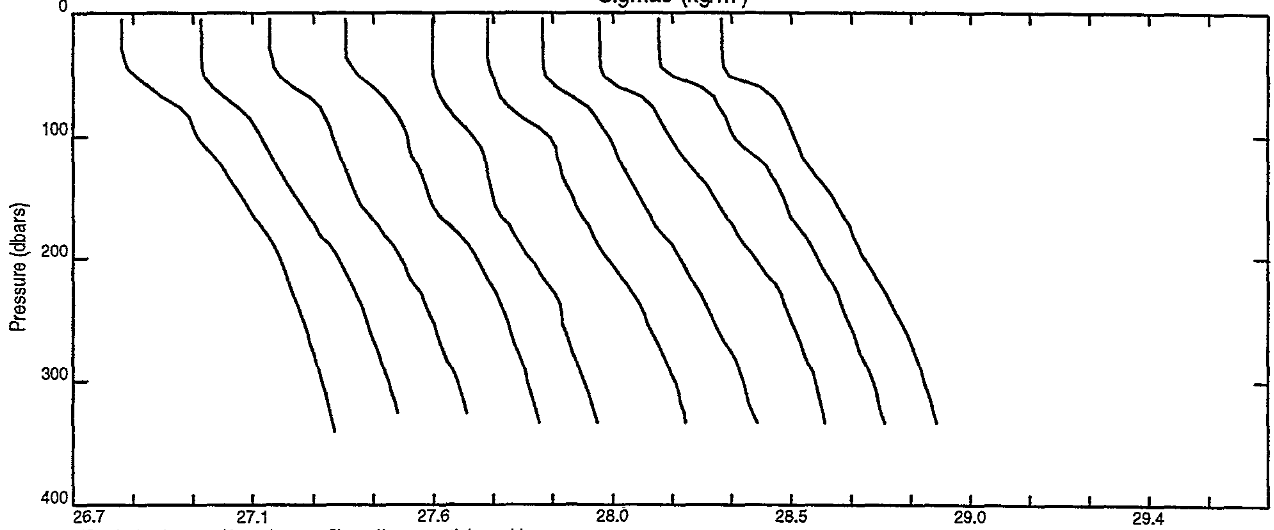
(Scale for first profile; other profiles offset one tick each)

Salinity



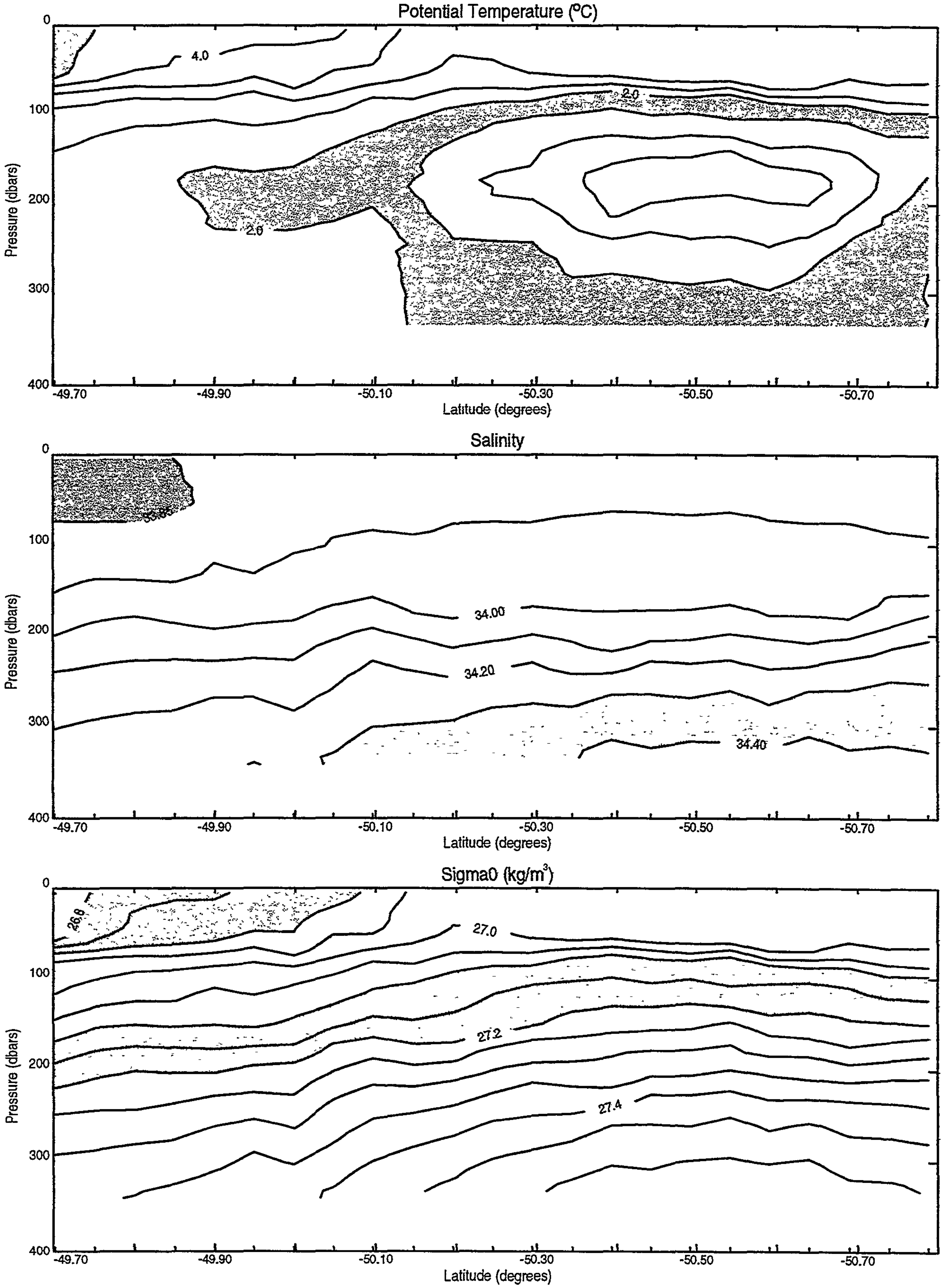
(Scale for first profile; other profiles offset one tick each)

Sigma0 (kg/m³)



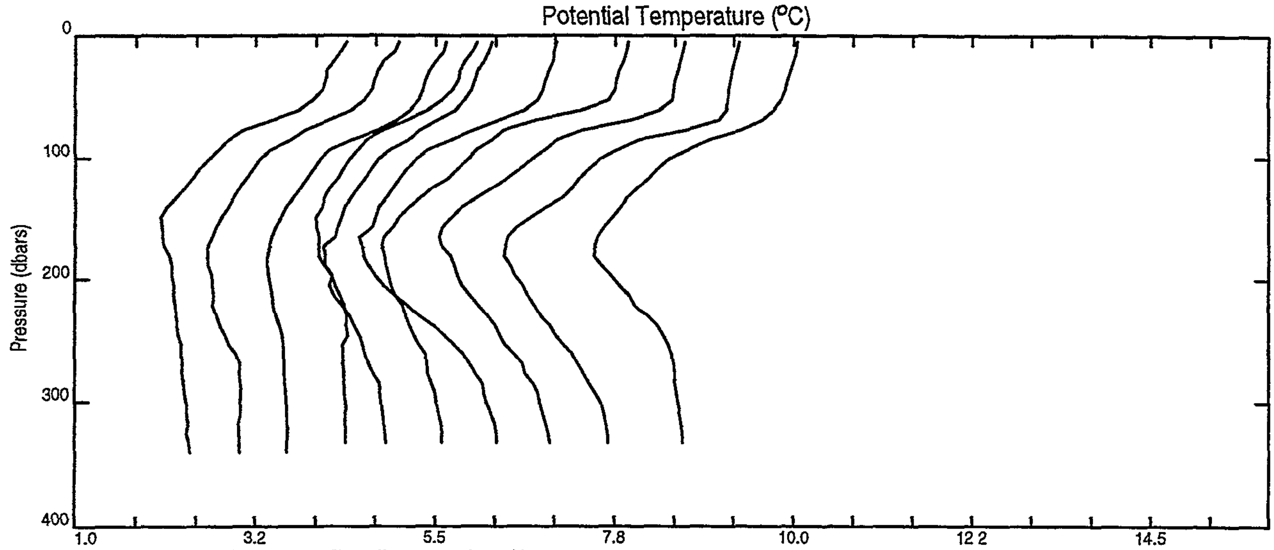
(Scale for first profile; other profiles offset one tick each)

SeaSoar Fine Scale Survey - Run 8.4



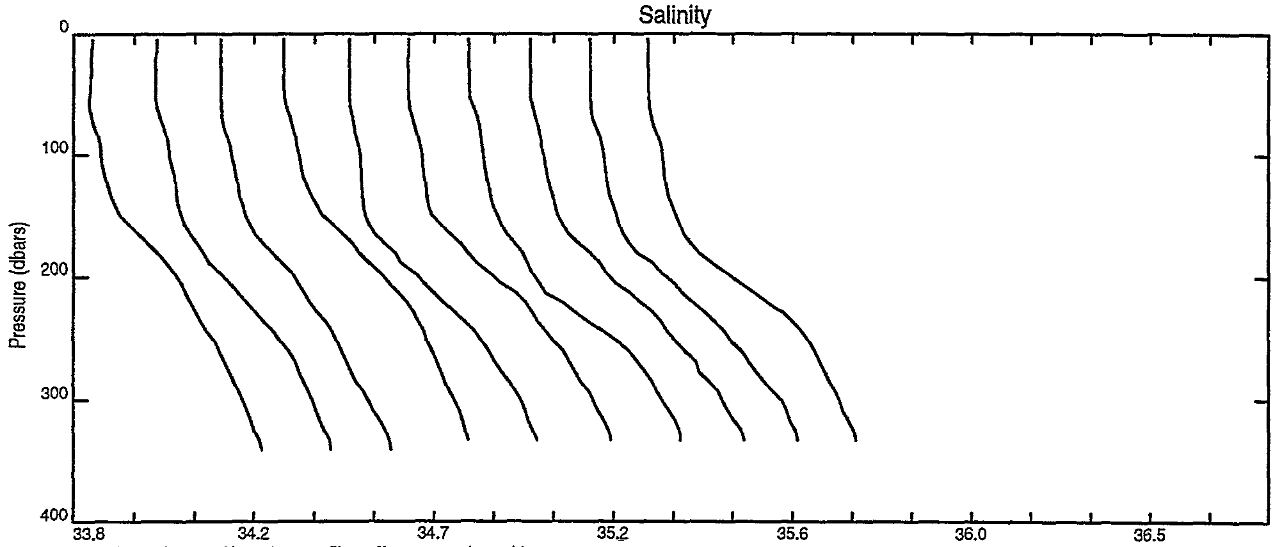
SeaSoar Fine Scale Survey - Run 8.4

Potential Temperature (°C)



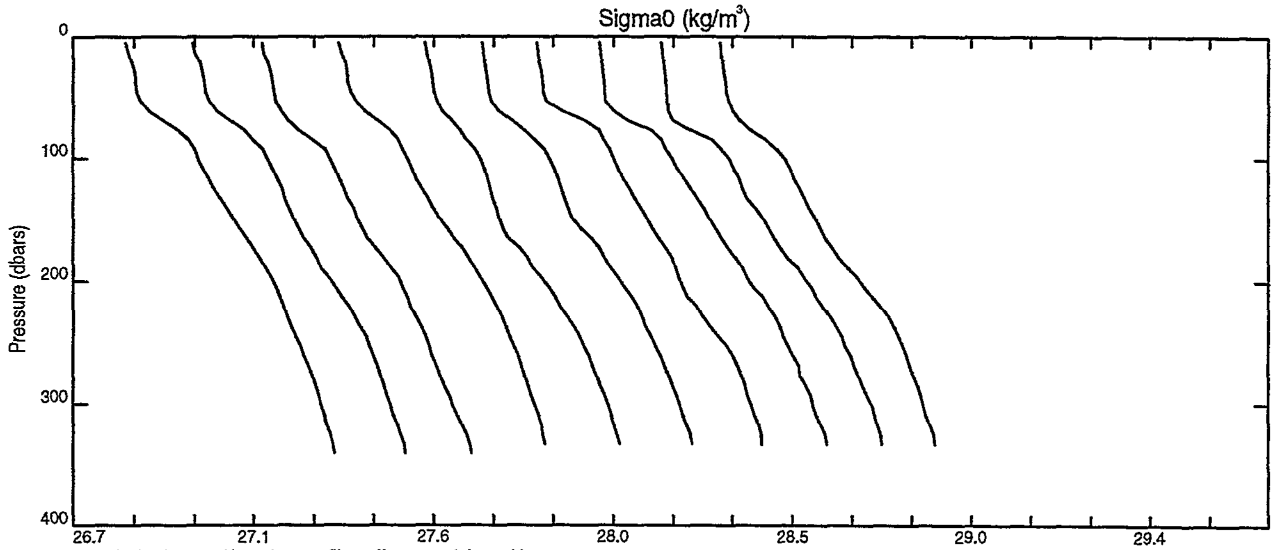
(Scale for first profile; other profiles offset one tick each)

Salinity

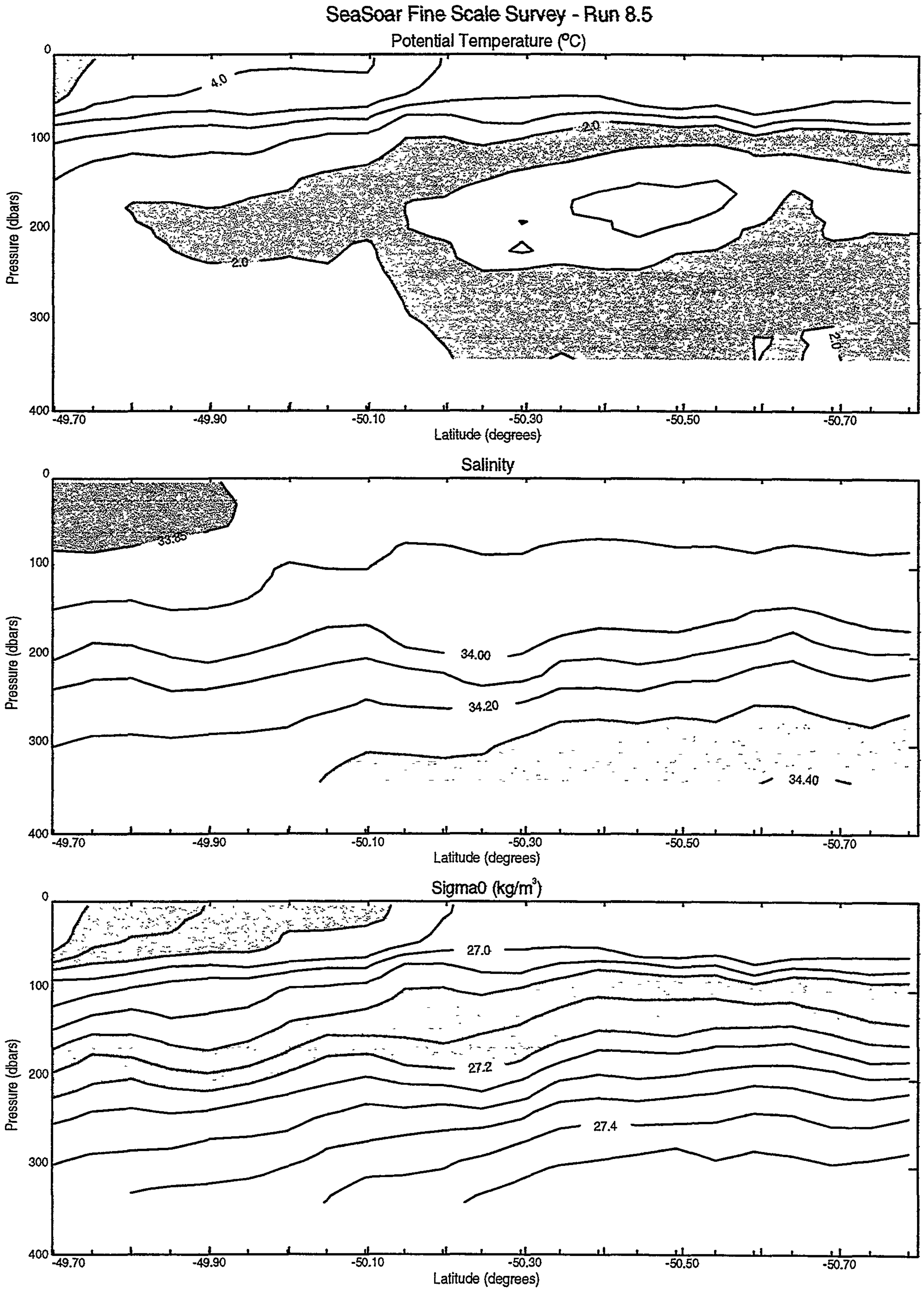


(Scale for first profile; other profiles offset one tick each)

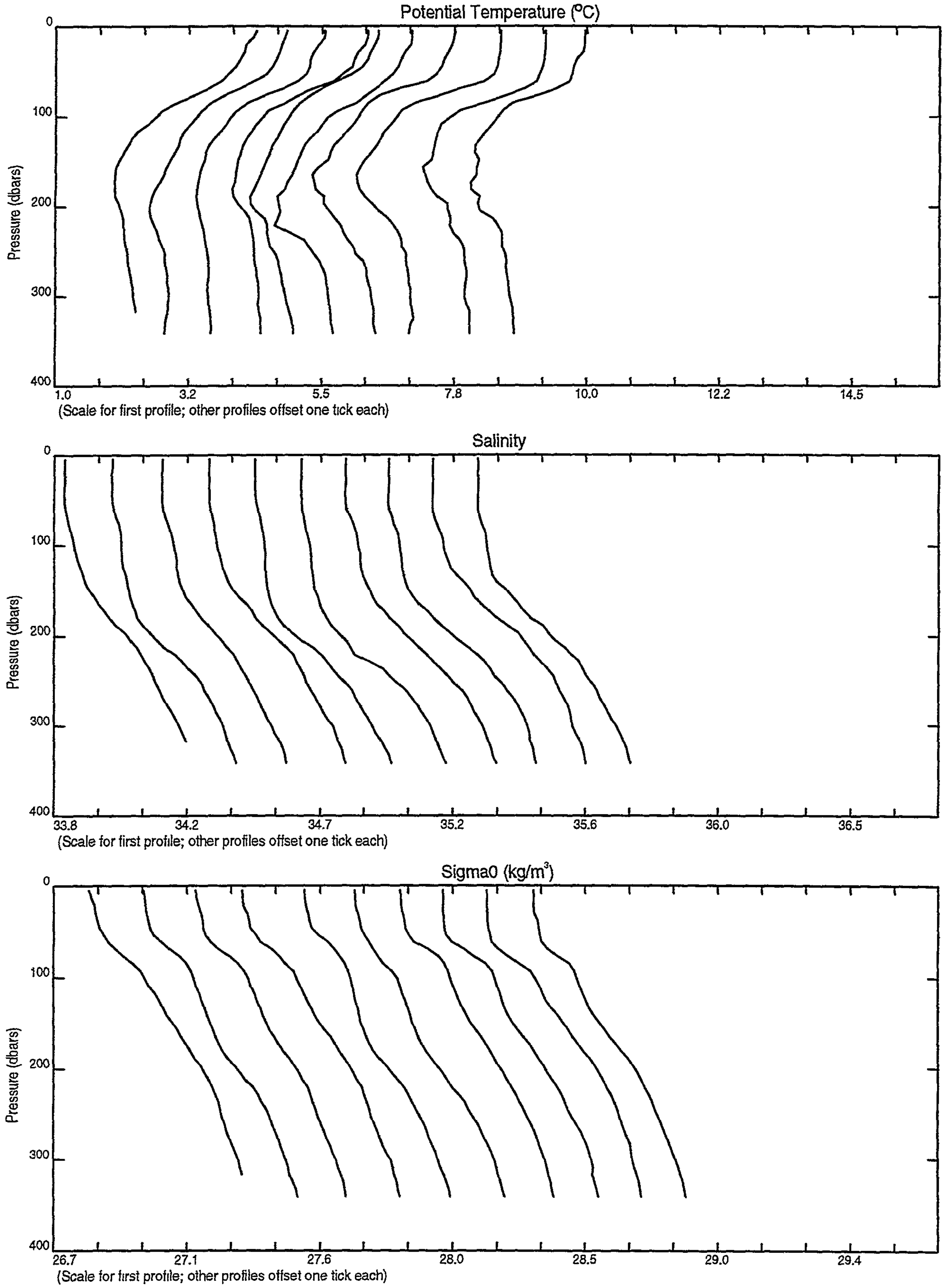
Sigma0 (kg/m³)



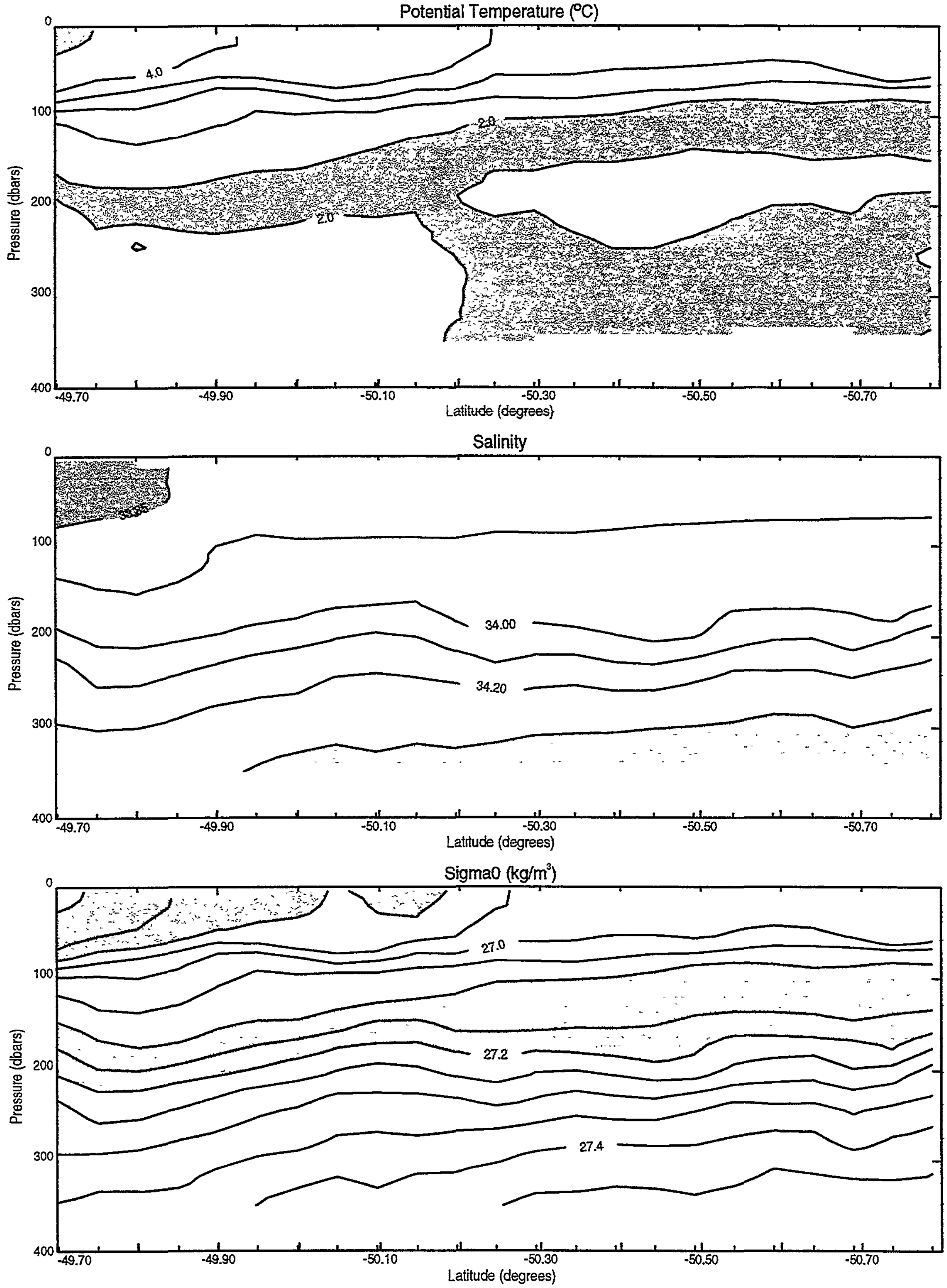
(Scale for first profile; other profiles offset one tick each)


SeaSoar Fine Scale Survey - Run 8.5
Potential Temperature (°C)
Pressure (dbars)
0
100
200
300
400
4.0
2.0
2.0
2.0
-49.70
-49.90
-50.10
-50.30
-50.50
-50.70
Latitude (degrees)
Salinity
Pressure (dbars)
33.85
34.00
34.20
34.40
Latitude (degrees)
Sigma0 (kg/m³)
Pressure (dbars)
27.0
27.2
27.4
Latitude (degrees)

SeaSoar Fine Scale Survey - Run 8.5

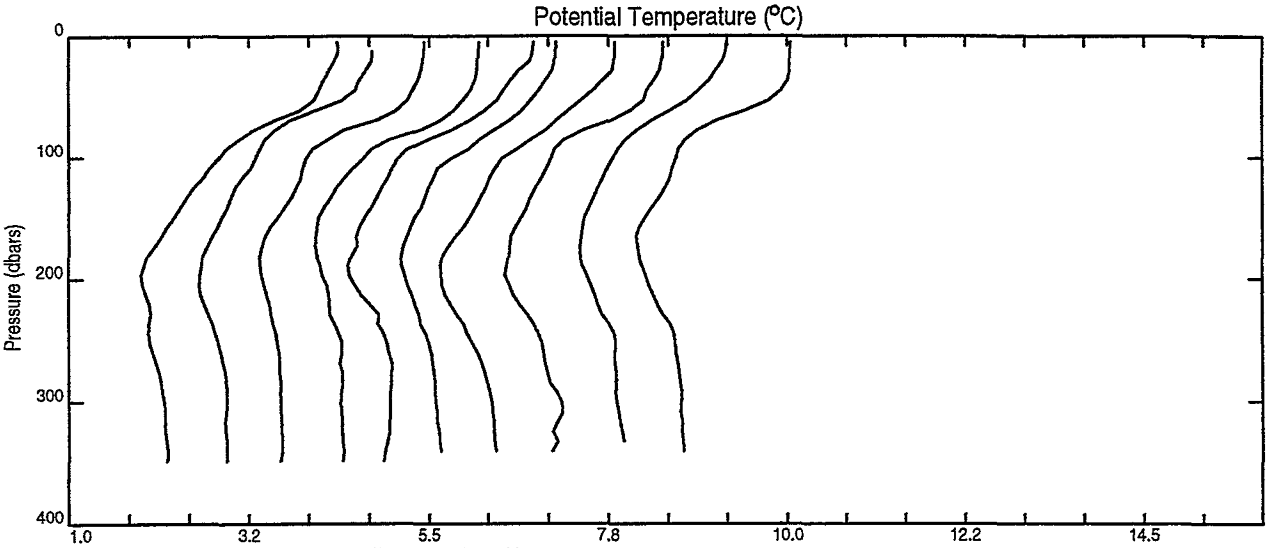


SeaSoar Fine Scale Survey - Run 8.6



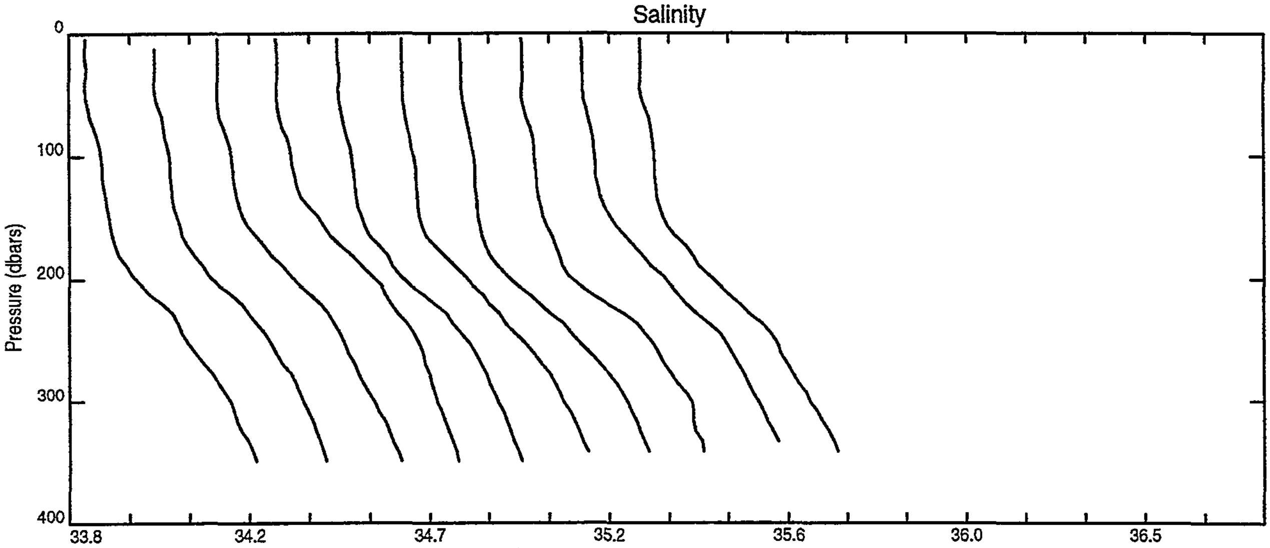
SeaSoar Fine Scale Survey - Run 8.6

Potential Temperature (°C)



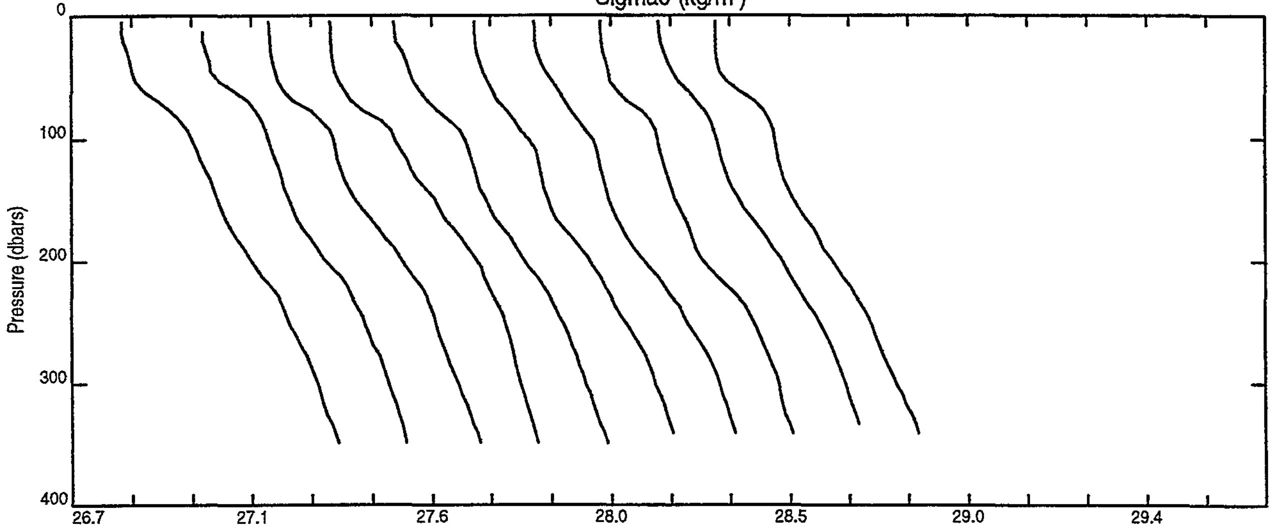
(Scale for first profile; other profiles offset one tick each)

Salinity



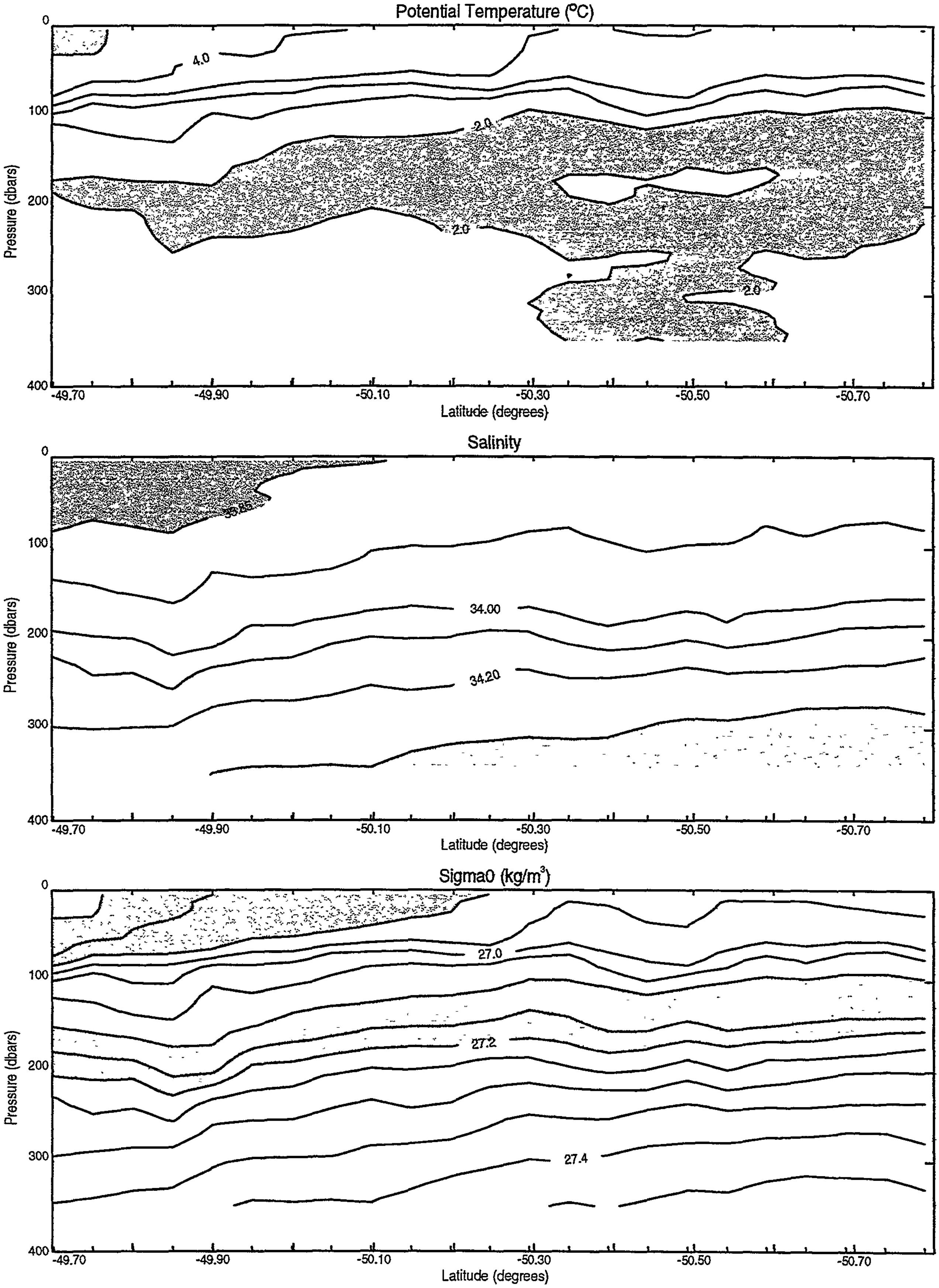
(Scale for first profile; other profiles offset one tick each)

Sigma0 (kg/m³)

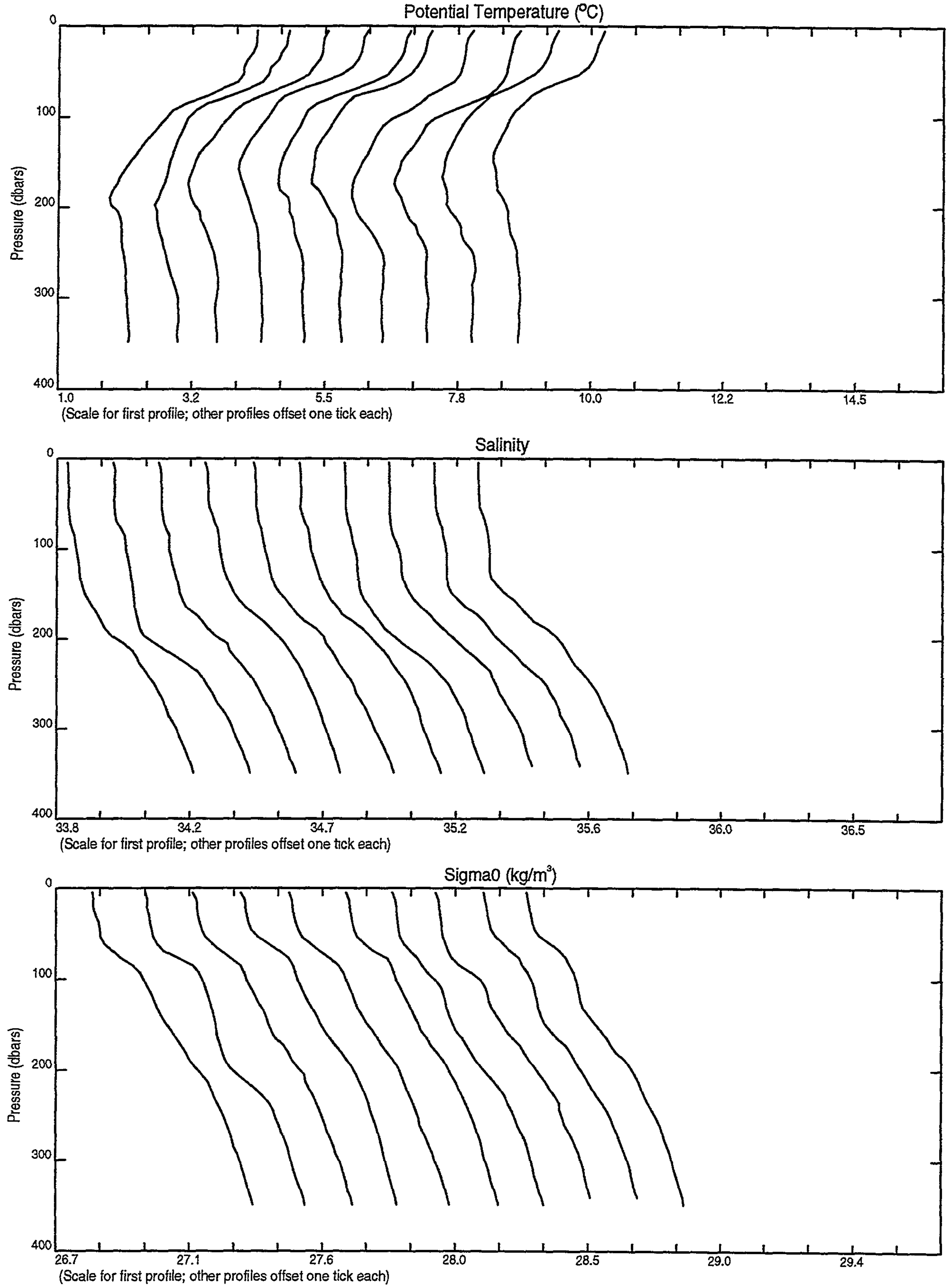


(Scale for first profile; other profiles offset one tick each)

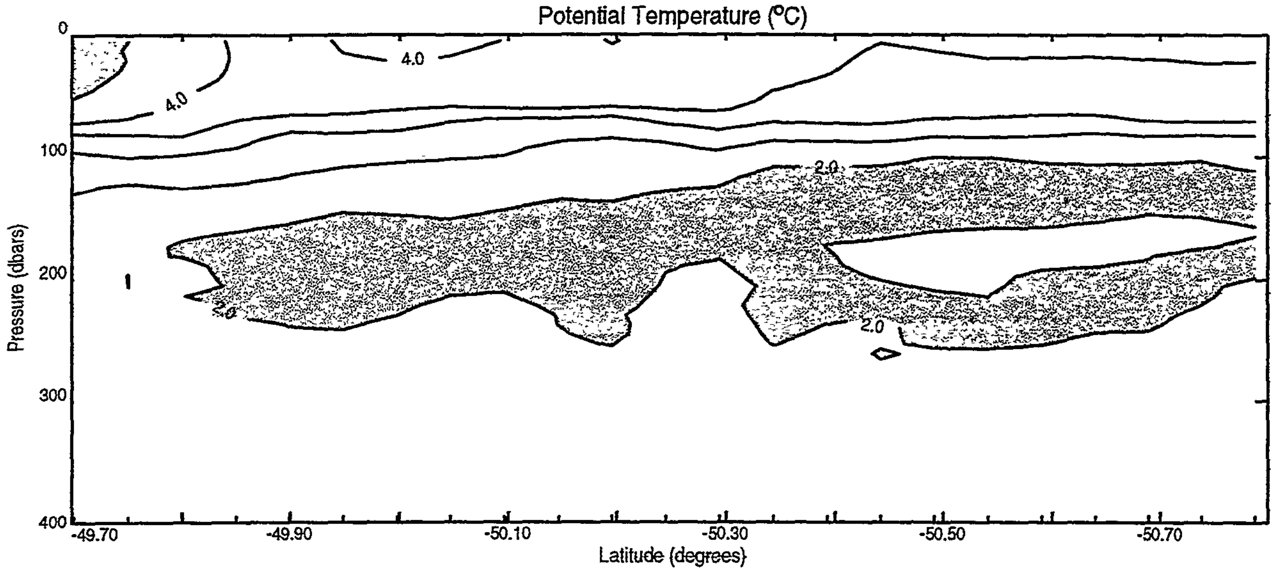
SeaSoar Fine Scale Survey - Run 8.7

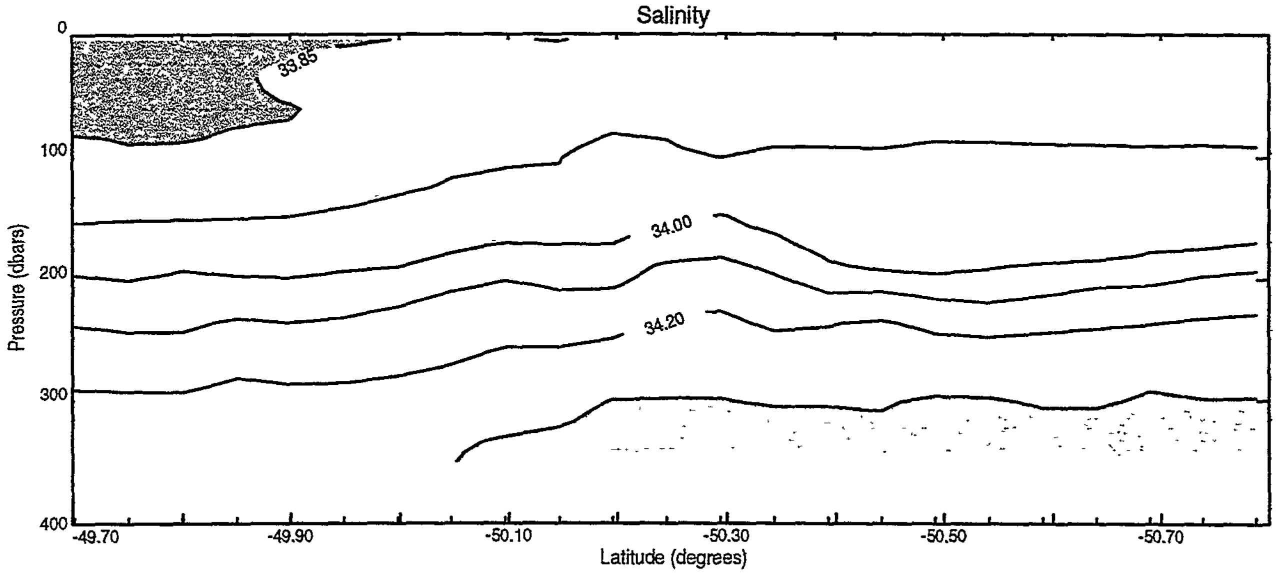


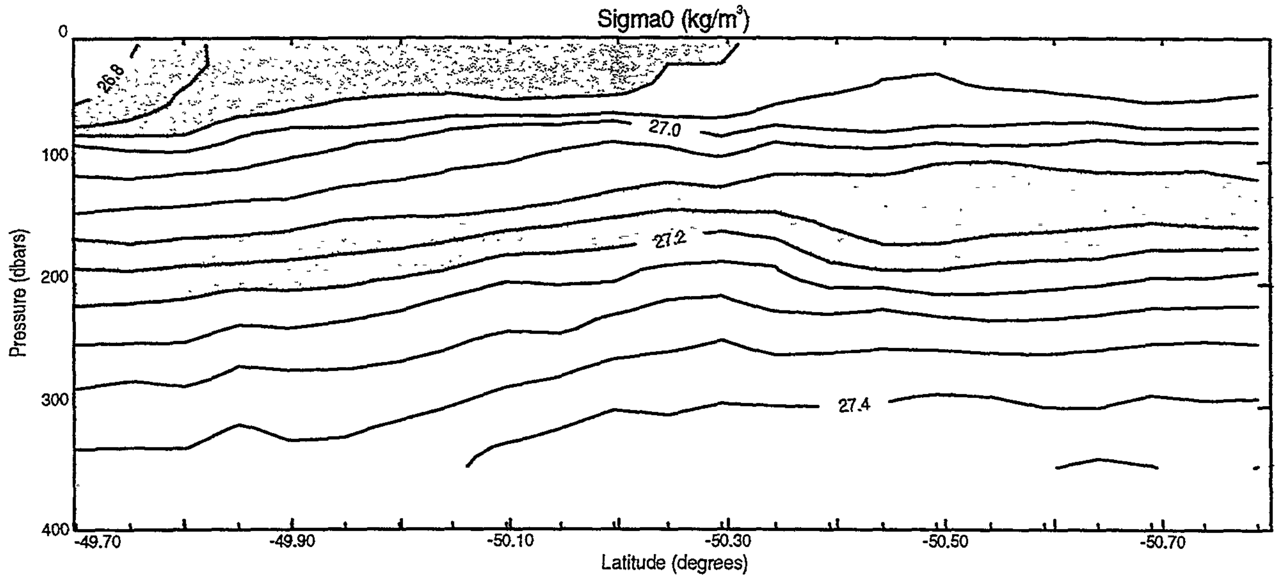
SeaSoar Fine Scale Survey - Run 8.7



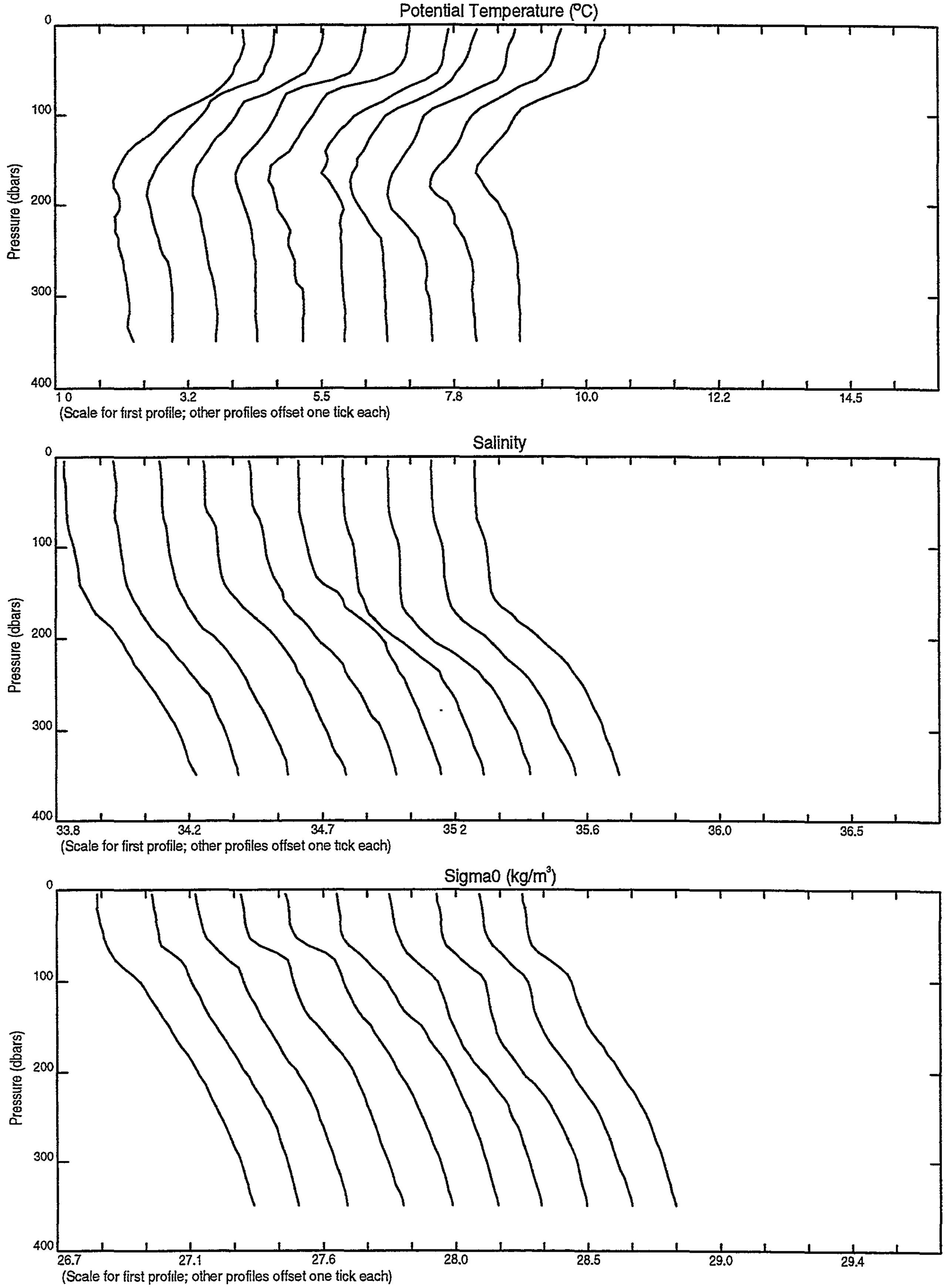
SeaSoar Fine Scale Survey - Run 8.8



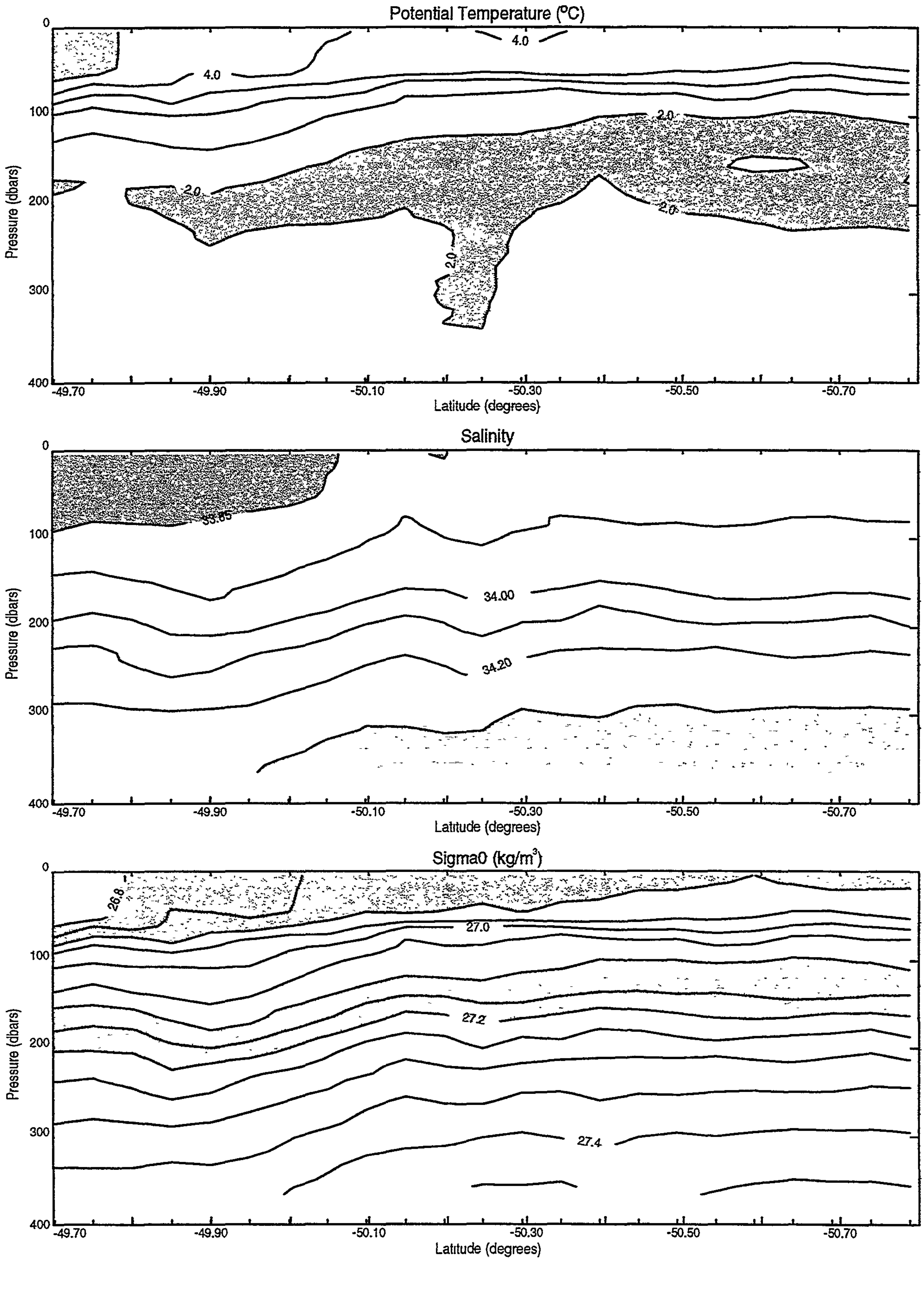




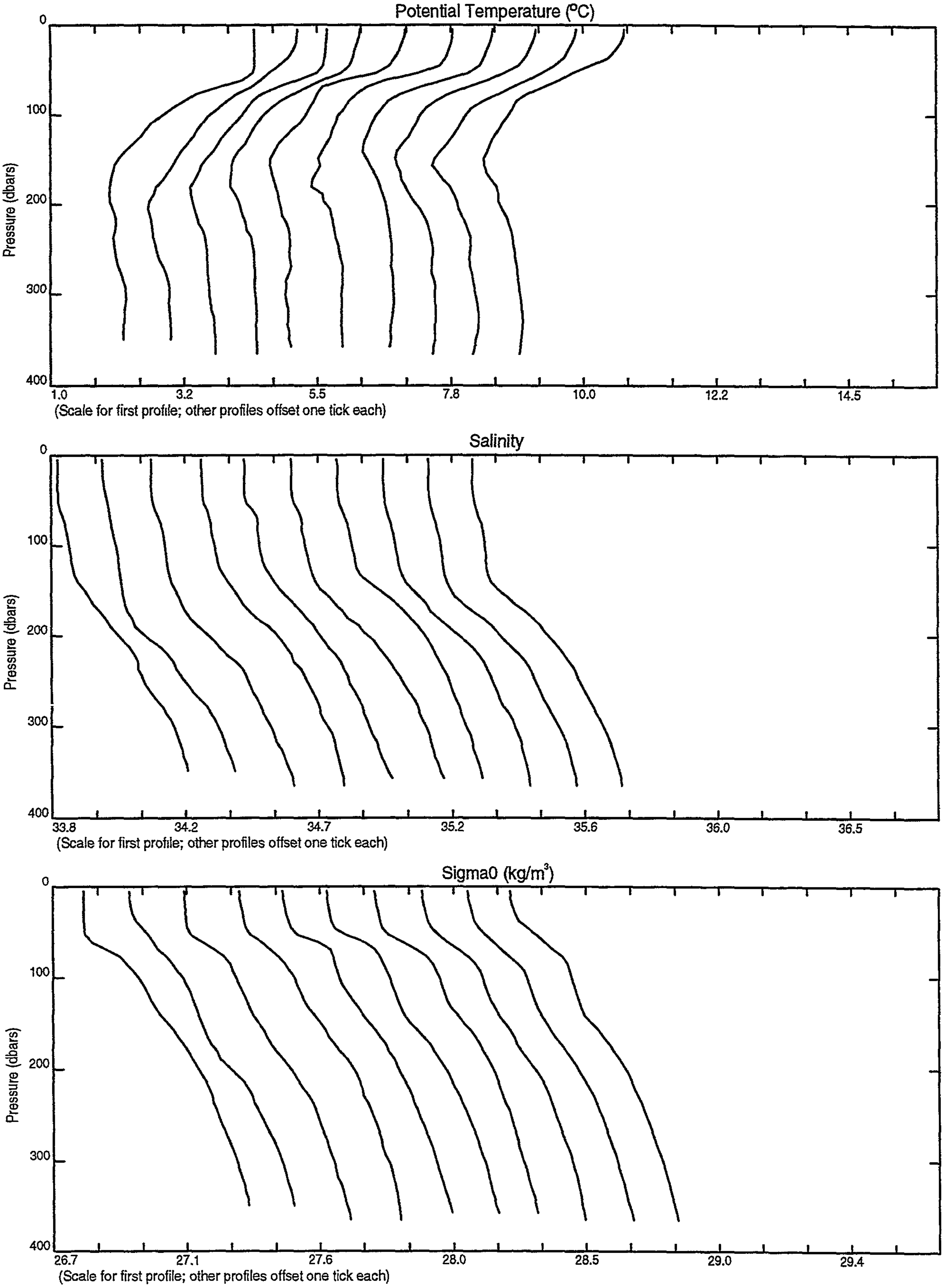
SeaSoar Fine Scale Survey - Run 8.8



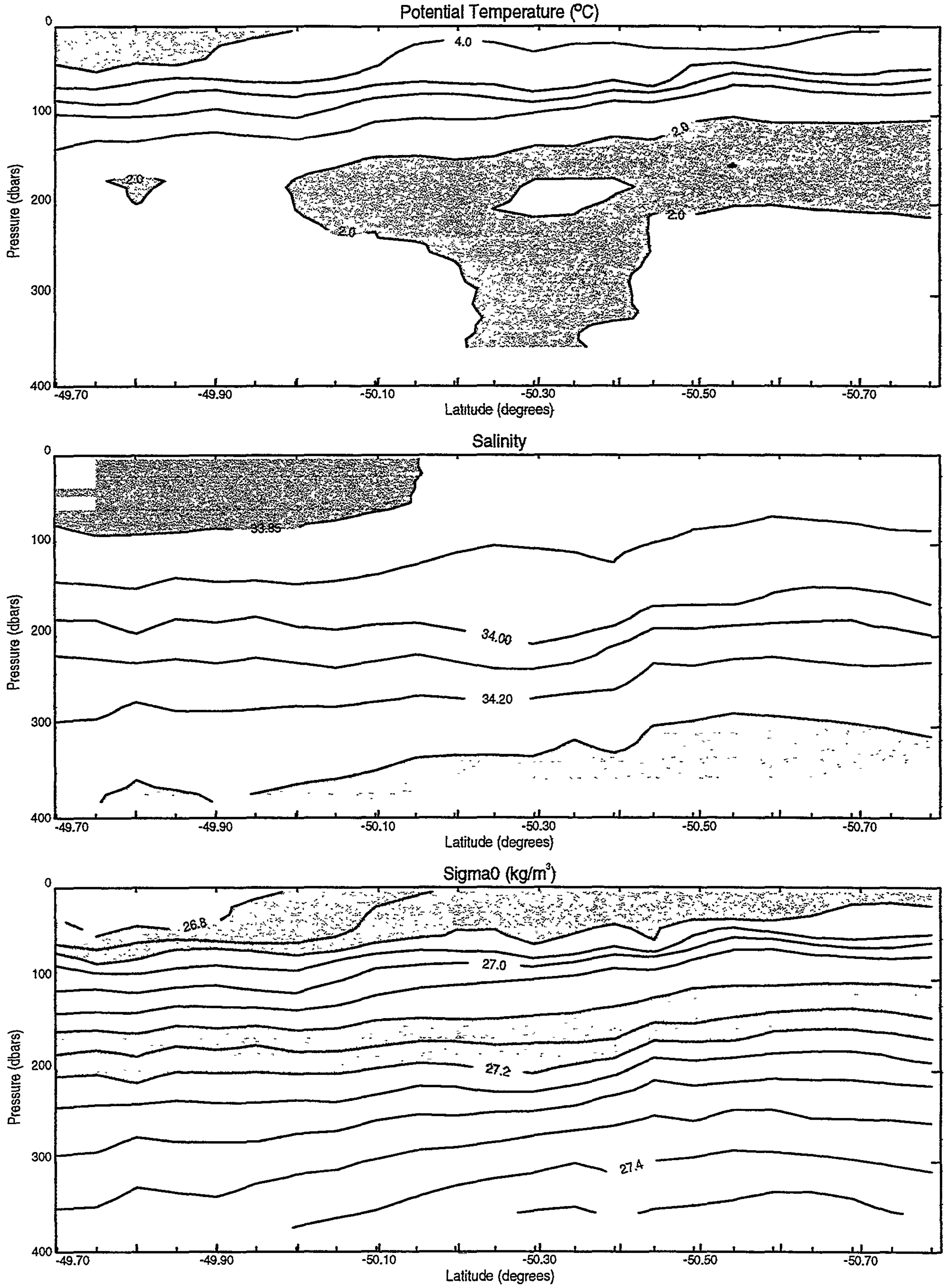
SeaSoar Fine Scale Survey - Run 8.9



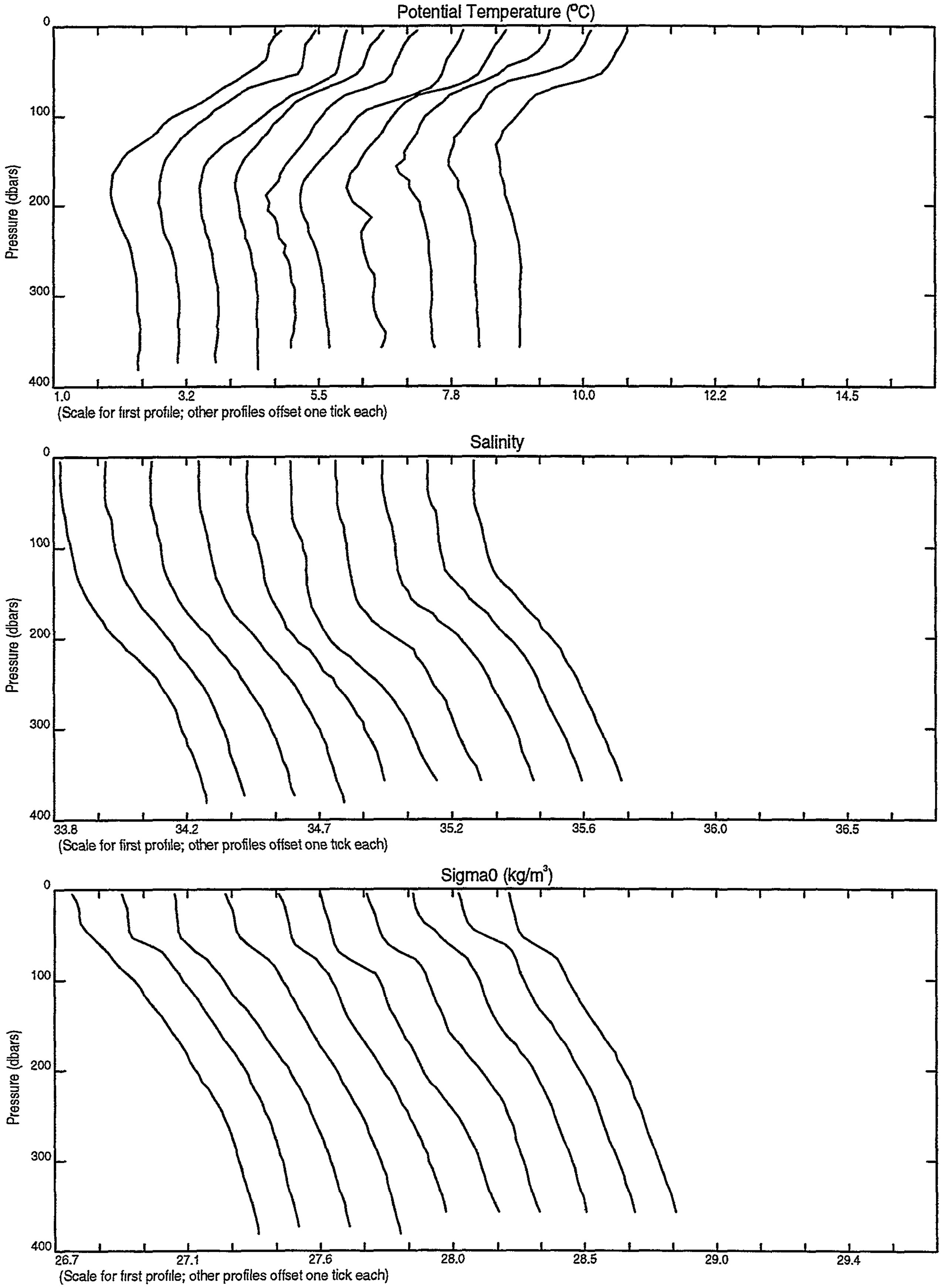
SeaSoar Fine Scale Survey - Run 8.9



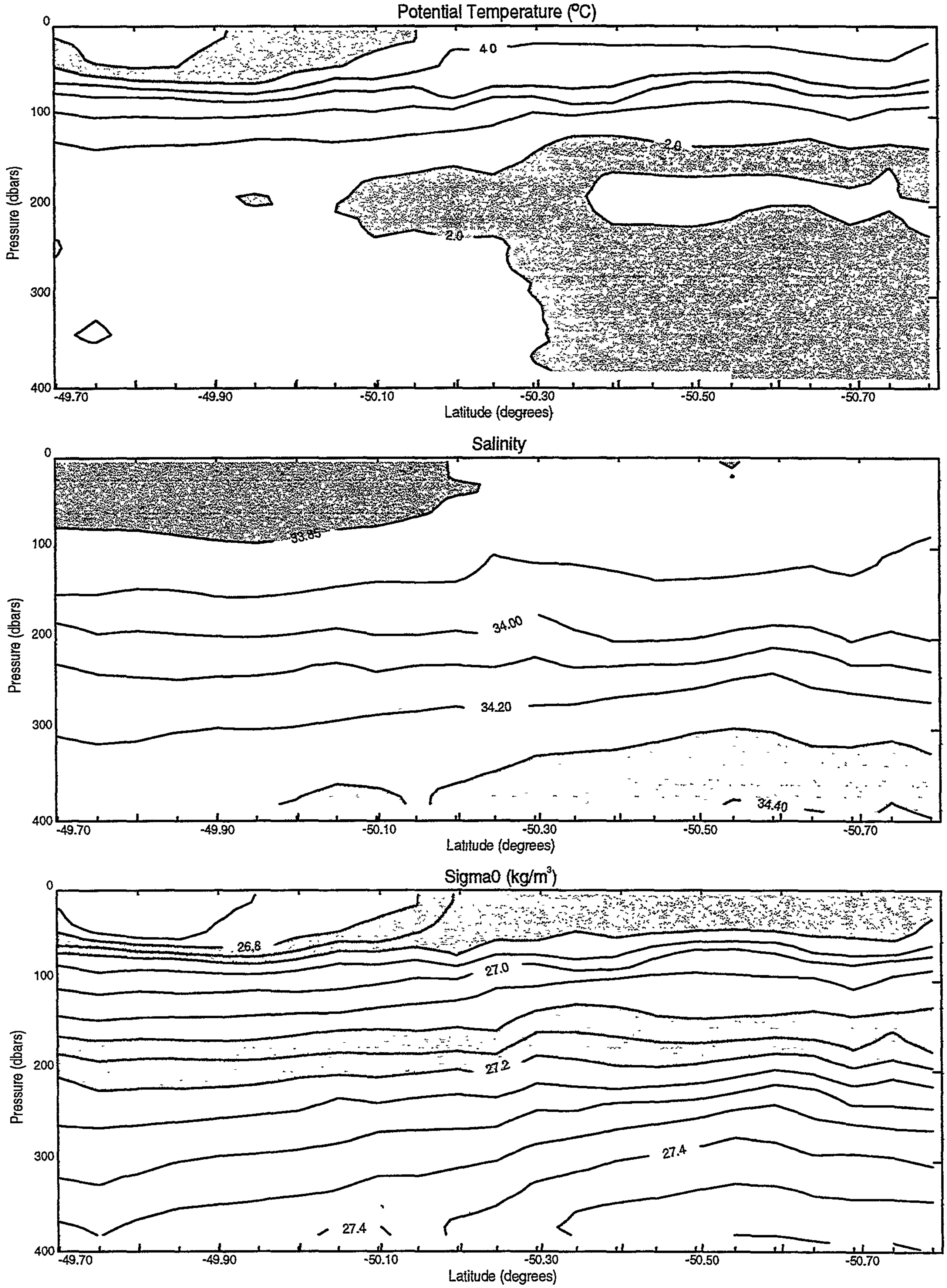
SeaSoar Fine Scale Survey - Run 8.10



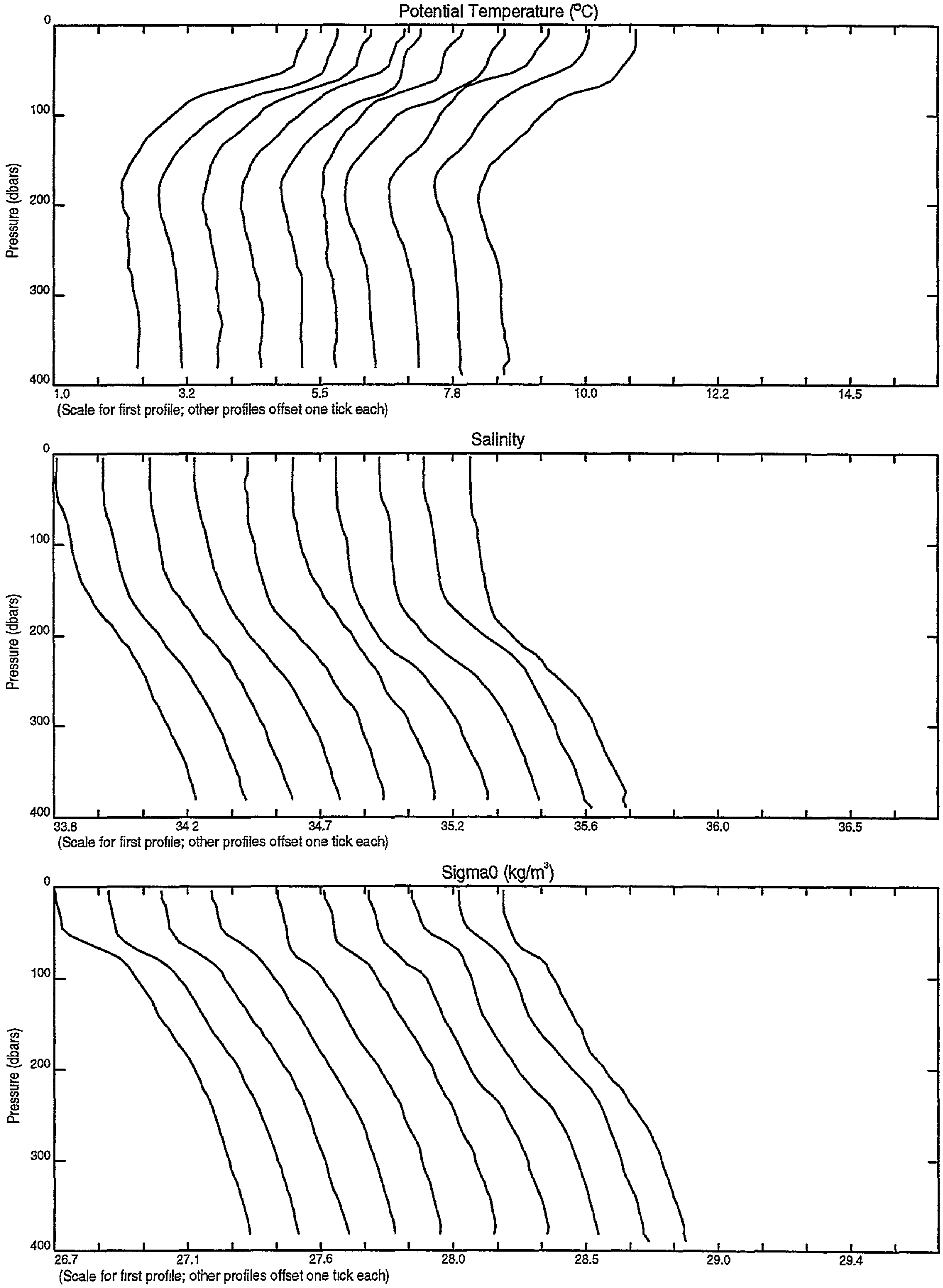
SeaSoar Fine Scale Survey - Run 8.10



SeaSoar Fine Scale Survey - Run 8.11



SeaSoar Fine Scale Survey - Run 8.11



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