3.8 CTD PROFILES AND BOTTOM WATER TEMPERATURES IN THE SOUTH CHINA SEA (SONNE-95 CRUISE)

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INTRODUCTION

The values and variations of temperature, salinity and density of the water in the South China Sea are affected primarily at the surface by the monsoons and at depth by bottom topography. In general, the surface temperature decreases northward. It is coldest in January and February, when the circulation induced by the winter monsoon drives the cold waters of the north southward, and warmest in August, when the current pattern is reversed and solar heating is at a maximum (LaViolette and Frontenac 1967).

The surface salinity increases from south to north. It is less than 34 ppt over much of the sea, owing to the heavy monsoonal precipitation and river outflow. Seasonally, surface salinity varies between a maximum during the NE monsoon and a minimum during the SW monsoon. During the NE monsoon, a branch of the Pacific North Equatorial Current is forced into the South China Sea and raises the values of surface salinity in the north. This saline surface water spills over the sill of Luzon Strait and, being constantly modified, spreads over the central South China Sea as far west as Vietnam (LaFond 1966). With the reversal in the circulation associated with the SW monsoon, rain-diluted local waters replace the more saline Pacific water over most of the sea. The subsurface layer of Pacific water that hurdles the peripheral sill is well defined as a tongue of higher salinity between 100 and 200 m water depth; in the deep portions of the sea, the water below the sill is generally isothermal and isohaline in space and time (LaViolette and Frontenac 1967).

MATERIALS AND METHODS

The Kiel conductivity-temperature-depth (CTD) rosette system used (KMS II) is a multiparameter probe for fast hydrographic measurements in water depths up to 6000 m. The system is equipped with C, T and D- sensors plus two sensors to measure oxygen, light attenuation and sound velocity. The raw data are transmitted from the *in-situ* unit to the board unit. The latter consists of an ME-Interface powering the probe and translating the data into a IBM PC-readable format. The physical values and derived parameters such as salinity, density and oxygen are calculated via generally used standard formulas (UNESCO formulas, DIN tables for oxygen).The accuracies of the various sensors are ±0.005 mS cm^{-1} for conductivity, ±0.005

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°C for temperature, ±0.1 %fs for pressure, ±1 % for oxygen, ±0.5 % for light attenuation and ±0.2 m s^{-1} for sound velocity.

The CTD-system is fitted with 12 water samplers. The water samples were analysed on board for Ph, conductivity and oxygen (Winkler method). Nutrient analyses (nitrate, nitrite phosphate and silicate) will be carried out in Hamburg, carbon isotope analyses in Kiel. Moreover subsurface sediment temperatures were measured in box cores by an AMA-digit AD 30 TH thermometer with a 0.1° precision (Kuhnt et al., this vol.). These temperature values correspond to the potential bottom water temperature and are generally consistent with the CTD-values.

PRELIMINARY RESULTS

During leg 1, 2 and 3 of cruise SO-95, CTD-measurements were carried out at five stations (Figs. 1, 2, 3, 4 and 5). The temperature and salinity profiles of all stations were very similar. Temperature decreases continuously from the surface waters down to about 1500 m from around 30 °C to values between 2 and 3 °C. Below 1500 m water depth, temperatures remain constant. The great uniformity of bottom water temperature is underlined by the temperature values of the box core sediments plotted in Figure 1 as transect from the Sunda Shelf up to Taiwan. Slight deviations towards higher temperatures are recognized west of Luzon Island, possibly a result of insufficient measuring precision.

Salinity increases down to 175 m water depth from about 34.0 to 34.7 ppt. reflecting the wedge of Pacific water. Between 175 and 1500 m values are lower with a pronounced minimum at about 400 m (34.5 ppt). Below 1500 m the water masses are isohaline (34.7 ppt).

Contradictory results were obtained for oxygen and light attenuation as down-column and up-column profiles were completely different (cf. Fig 1, 17953-5 and 17953-5up). Because of the slow sensor adjustment the upward profiles may come closer to reality. Problems with the oxygen sensor are also indicated by the mismatch of the oxygen data obtained from chemical (duplicate) analyses and the CTD-oxygen curves which was particularly evident in the upper water column (< 1000 m). According to the former data set the oxygen minimum lies between 400 and 1300 m with values ranging from 1.7 to 1.9 mg O_2 / l H_2O.

AREAL DISTRIBUTION OF BOTTOM WATER TEMPERATURES

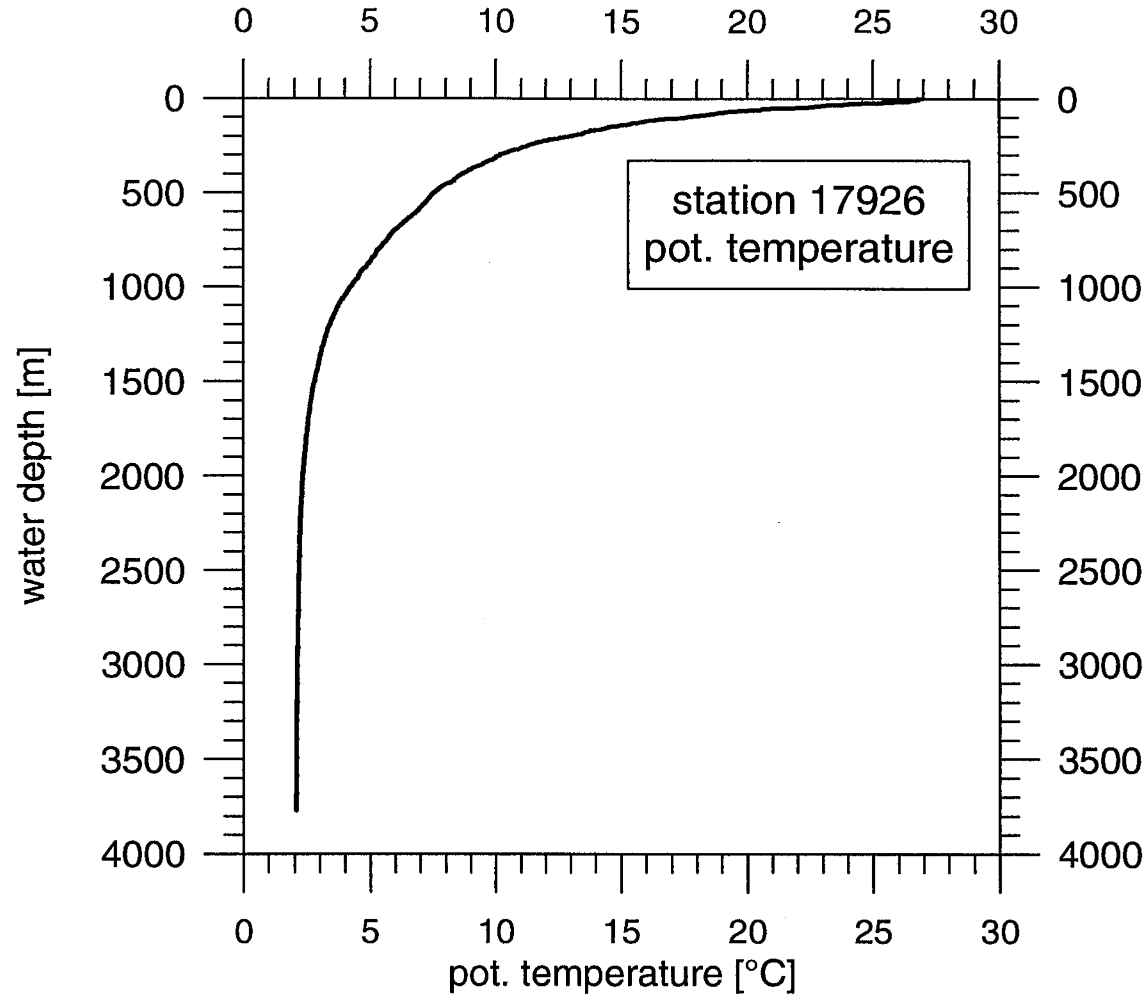
Further information on regional oceanography was obtained from measuring the temperature 5 cm below the sediment surface of box cores (see sections of Kuhnt et al., this volume). The sediment temperatures from all stations (equating to potential deepwater temperatures) are compiled in an oceanographic transect running southwest-northeast across the South

China Sea (Fig. 6) and form a reference base for interpreting benthic oxygen isotope values. Below 2000 m water depth, bottom water temperatures are 2.3-2.5°C and show a striking uniformity. Further above, the temperatures rise to about 5°C near 1000 m depth and 12°C near 350 m depth. Slight areal differences occur between data from the northern and southeastern slopes, with little higher bottom-water temperatures in the southeast, near Luzon.

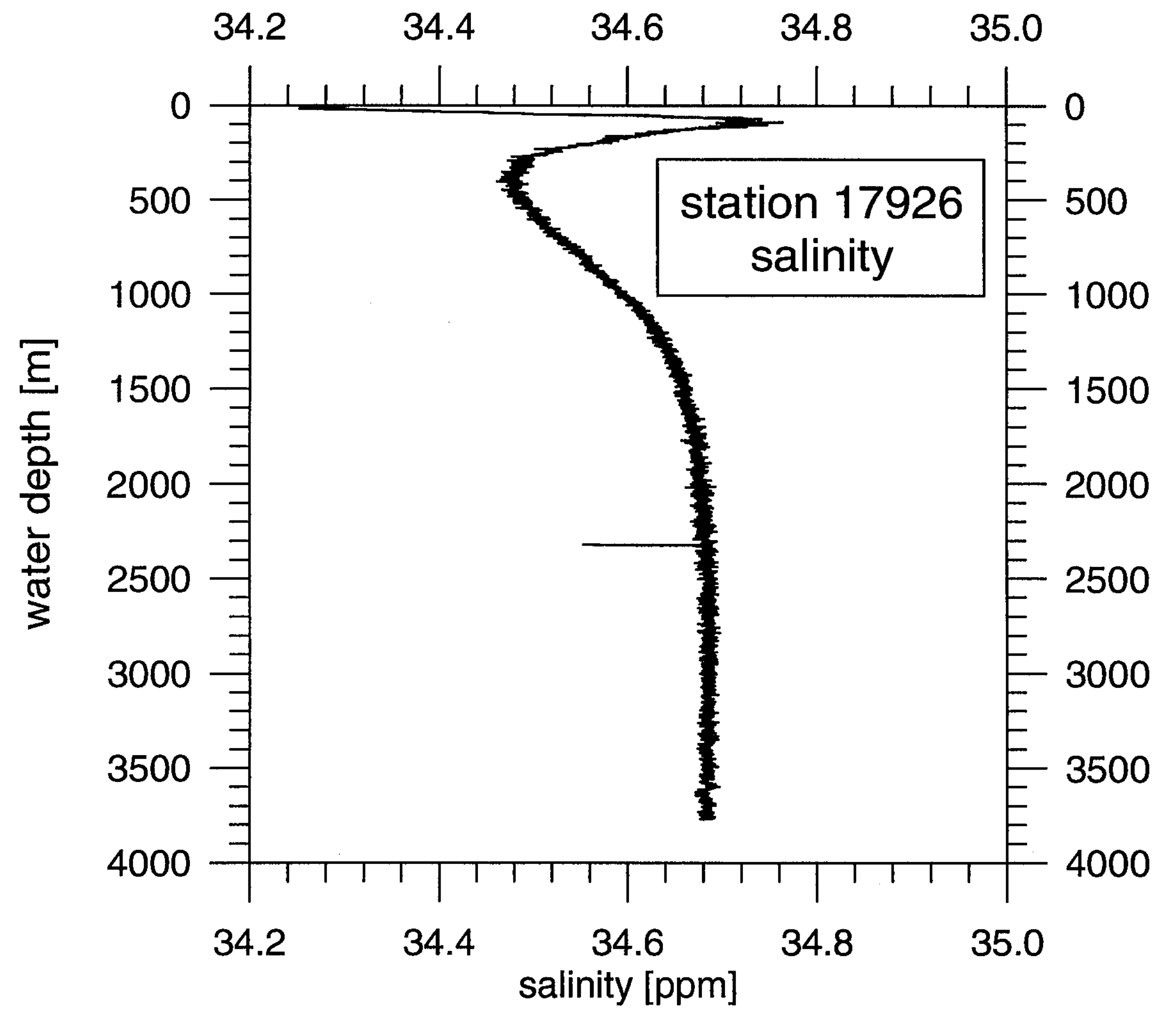
REFERENCES

LaFond, E.C. (1966): South China Sea. In: The Encyclopedia of Oceanography. (Reinhold Publ., New York), 829-836. .

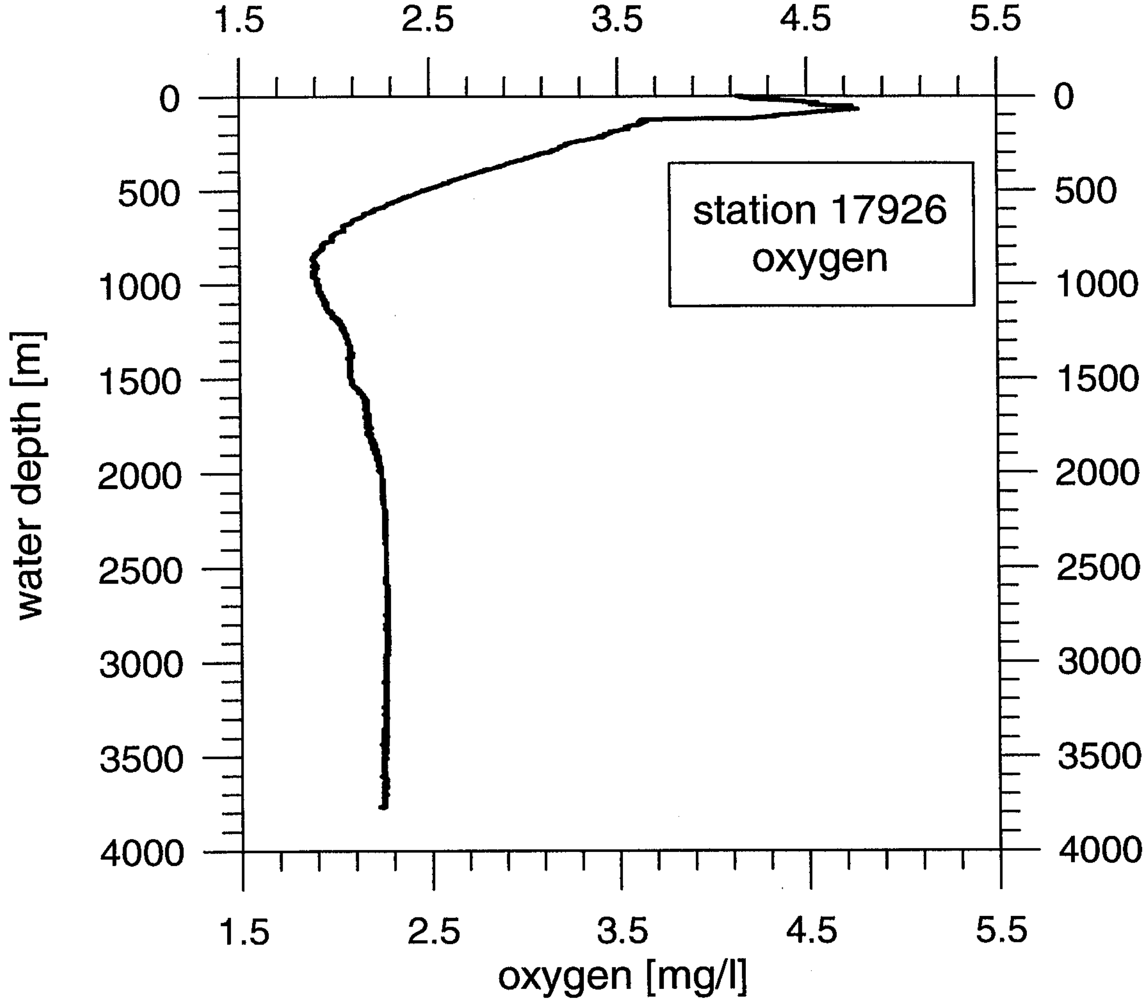
LaViolette P.E. and Frontenac T.R. (1967): Temperature, Salinity and Density of the World's Seas: South China Sea and adjacent Gulfs. - Informal Manuscript No. 67-5 (U.S. Naval Oceanographic Office, Washington D.C.), 134 pp.

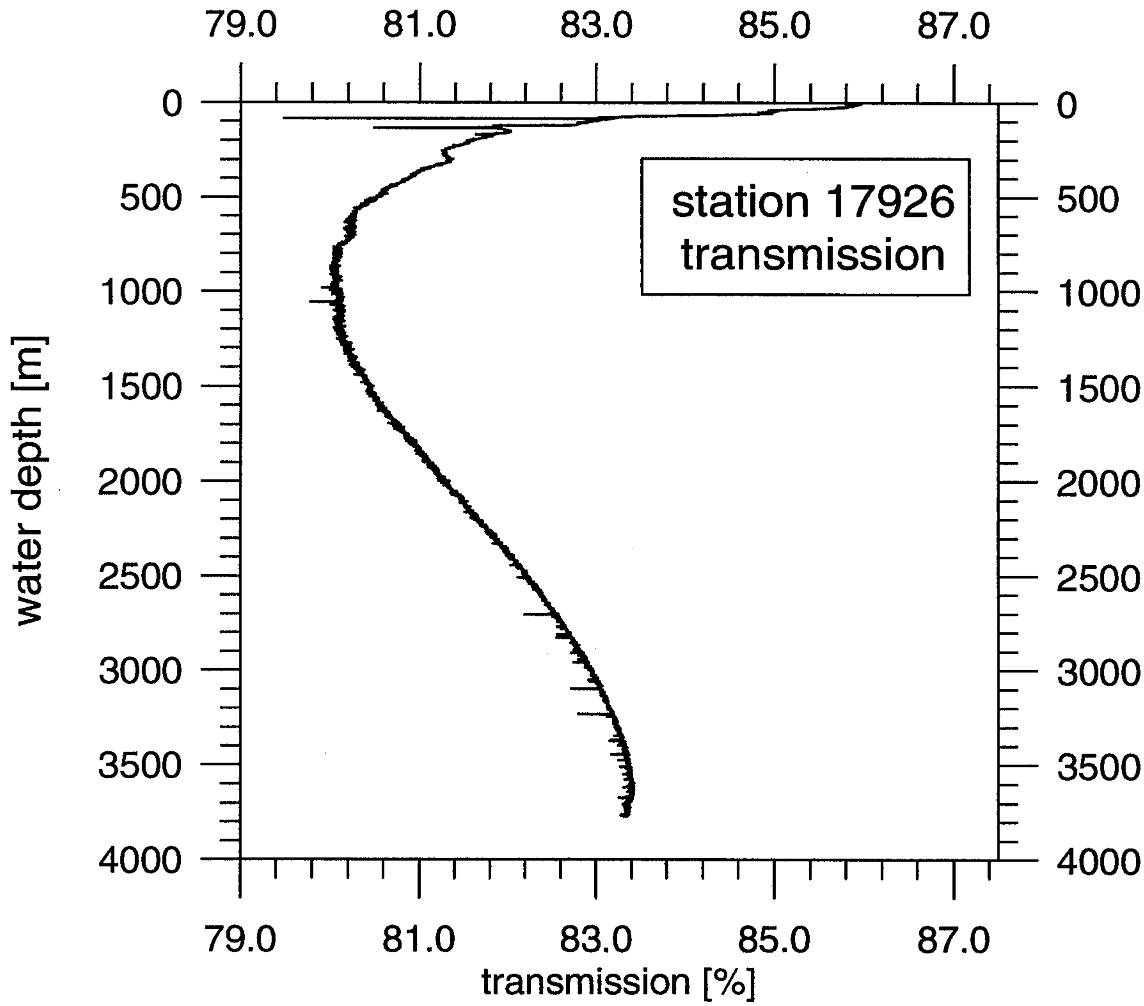


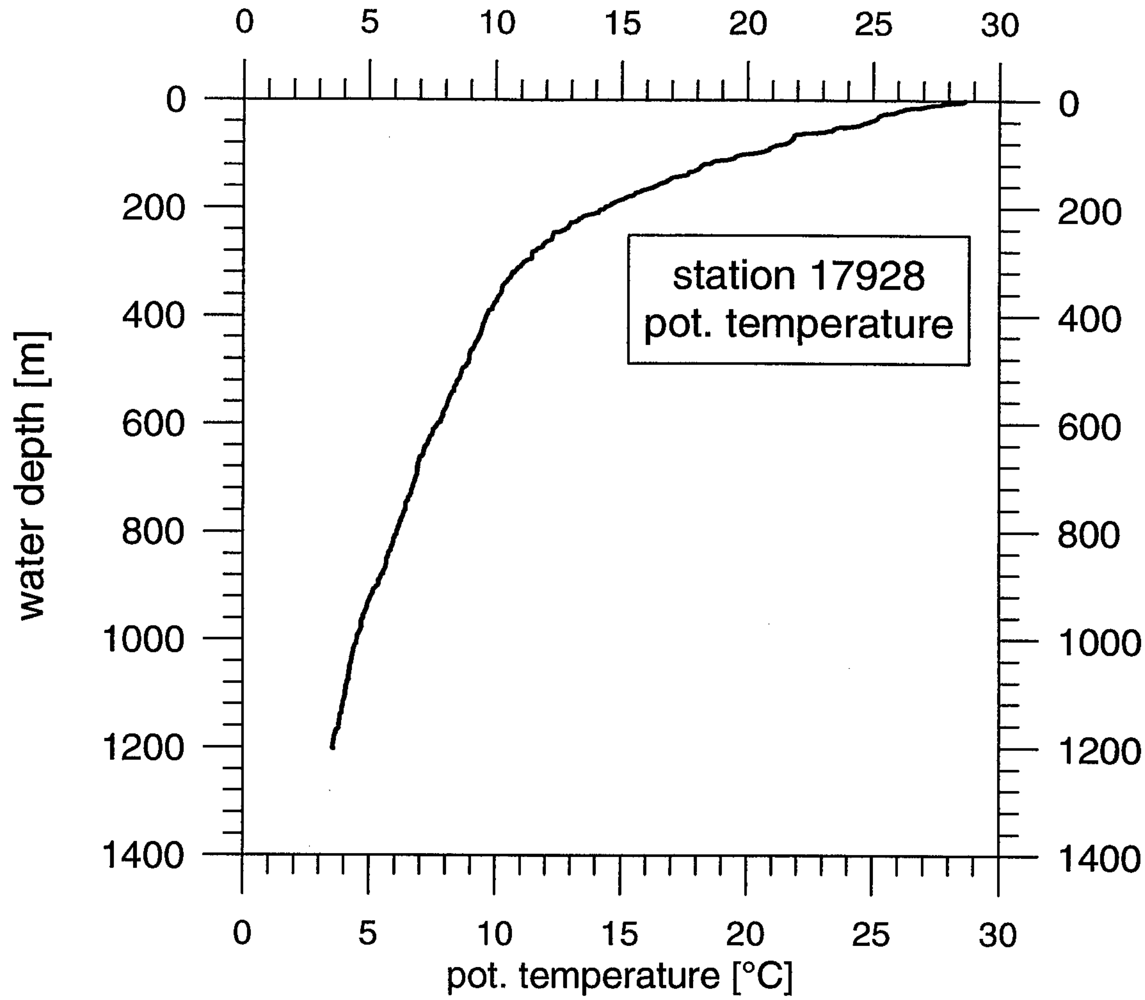
station 17926
pot. temperature
water depth [m]
pot. temperature [°C]



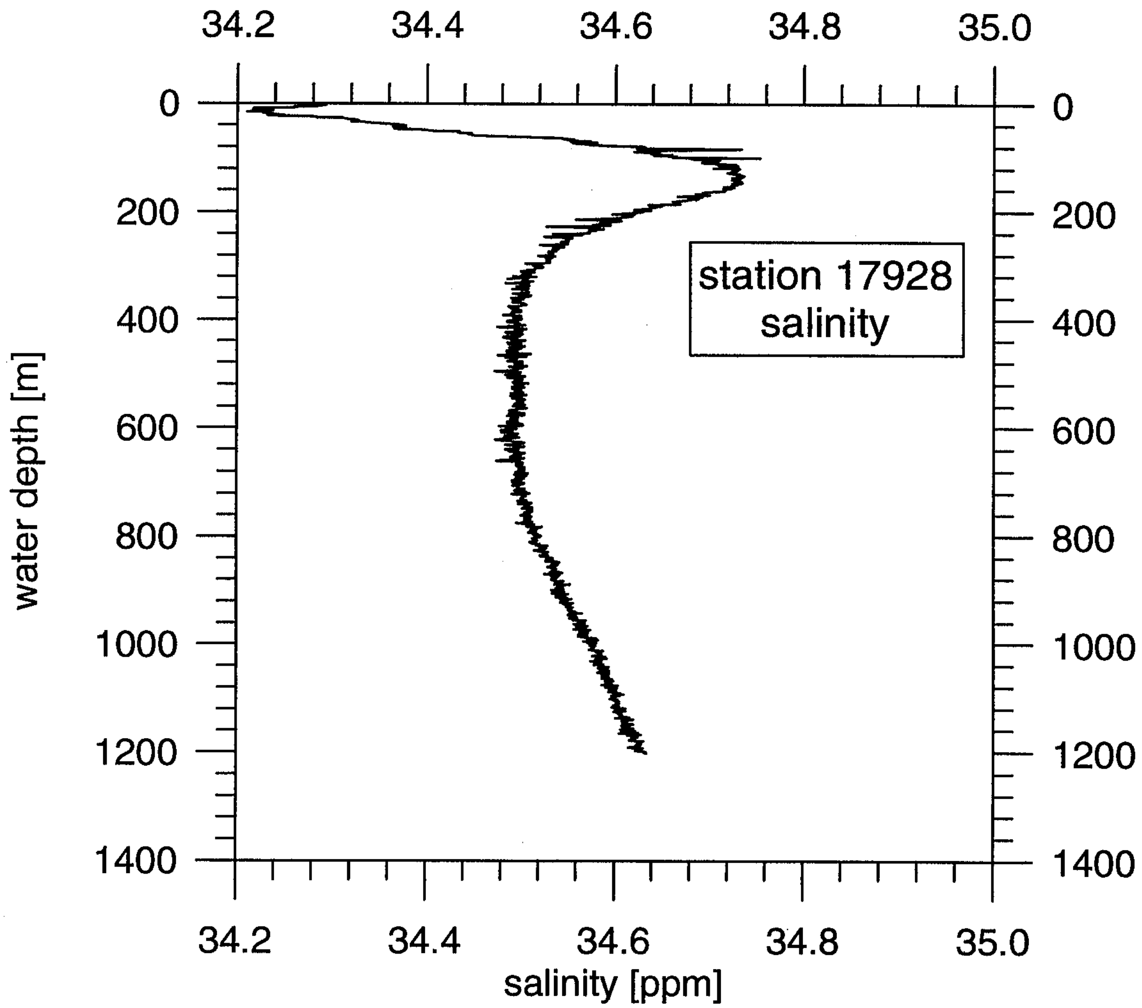
station 17926
salinity
water depth [m]
salinity [ppm]


station 17926
oxygen
water depth [m]
oxygen [mg/l]
0
500
1000
1500
2000
2500
3000
3500
4000
1.5
2.5
3.5
4.5
5.5

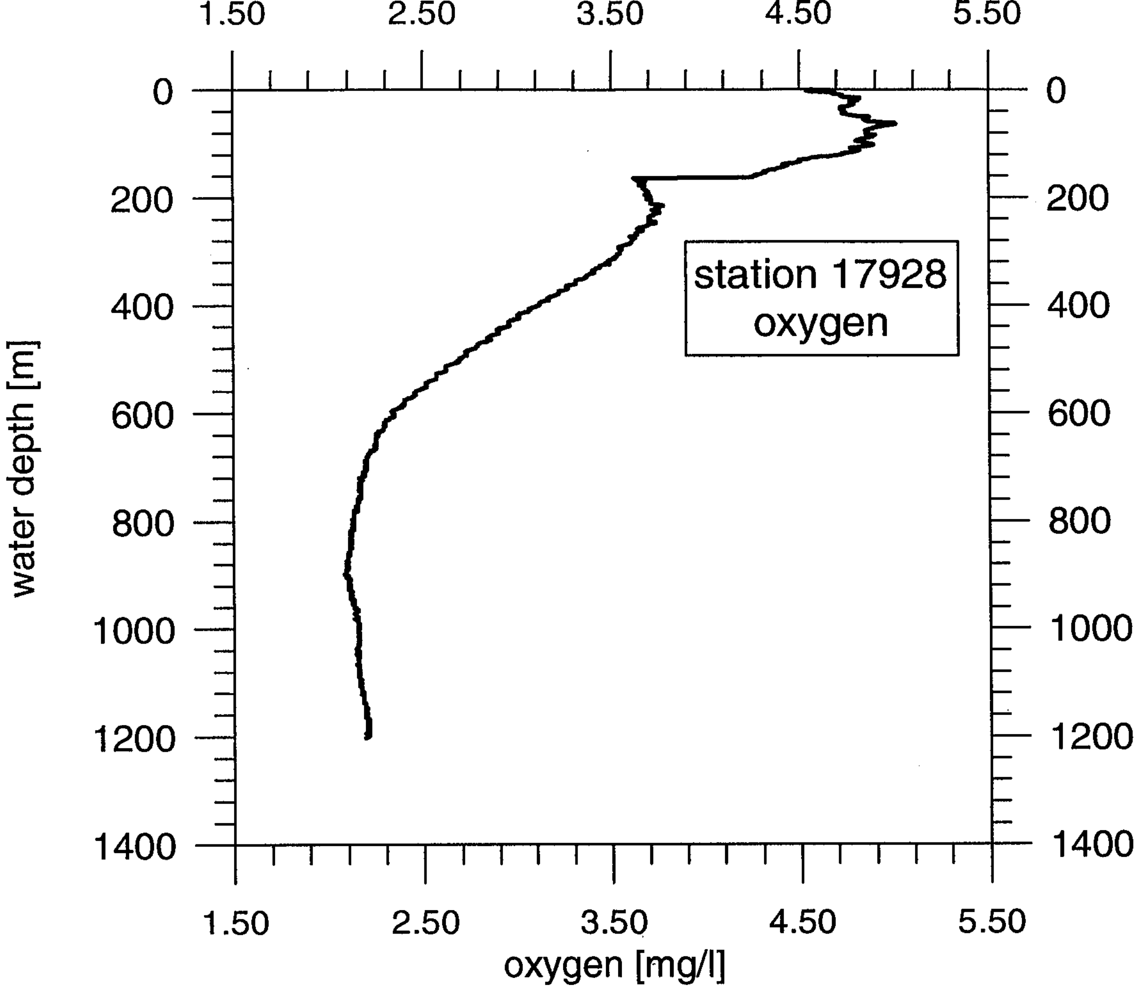

station 17926
transmission
water depth [m]
transmission [%]
0
500
1000
1500
2000
2500
3000
3500
4000
79.0
81.0
83.0
85.0
87.0



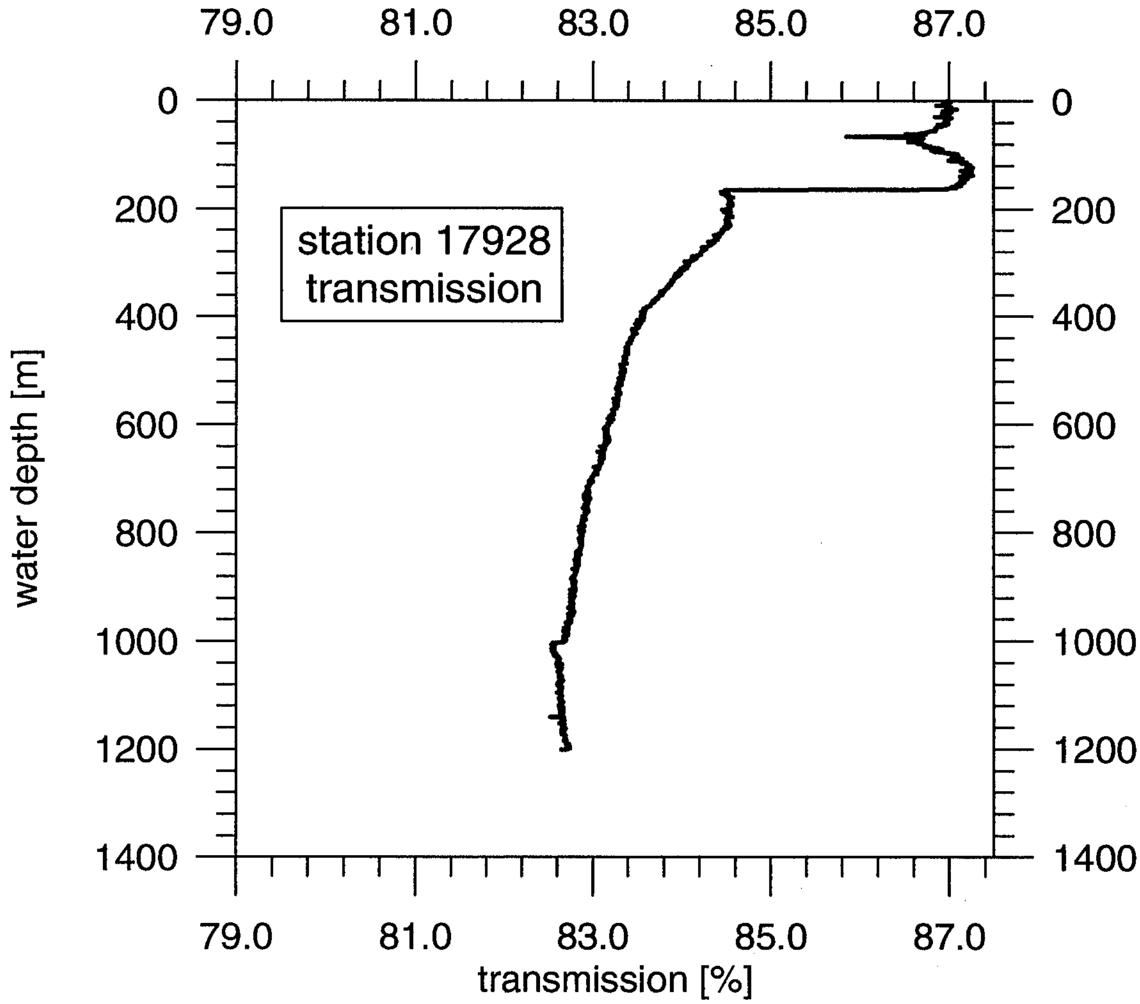
station 17928
pot. temperature
water depth [m]
pot. temperature [°C]



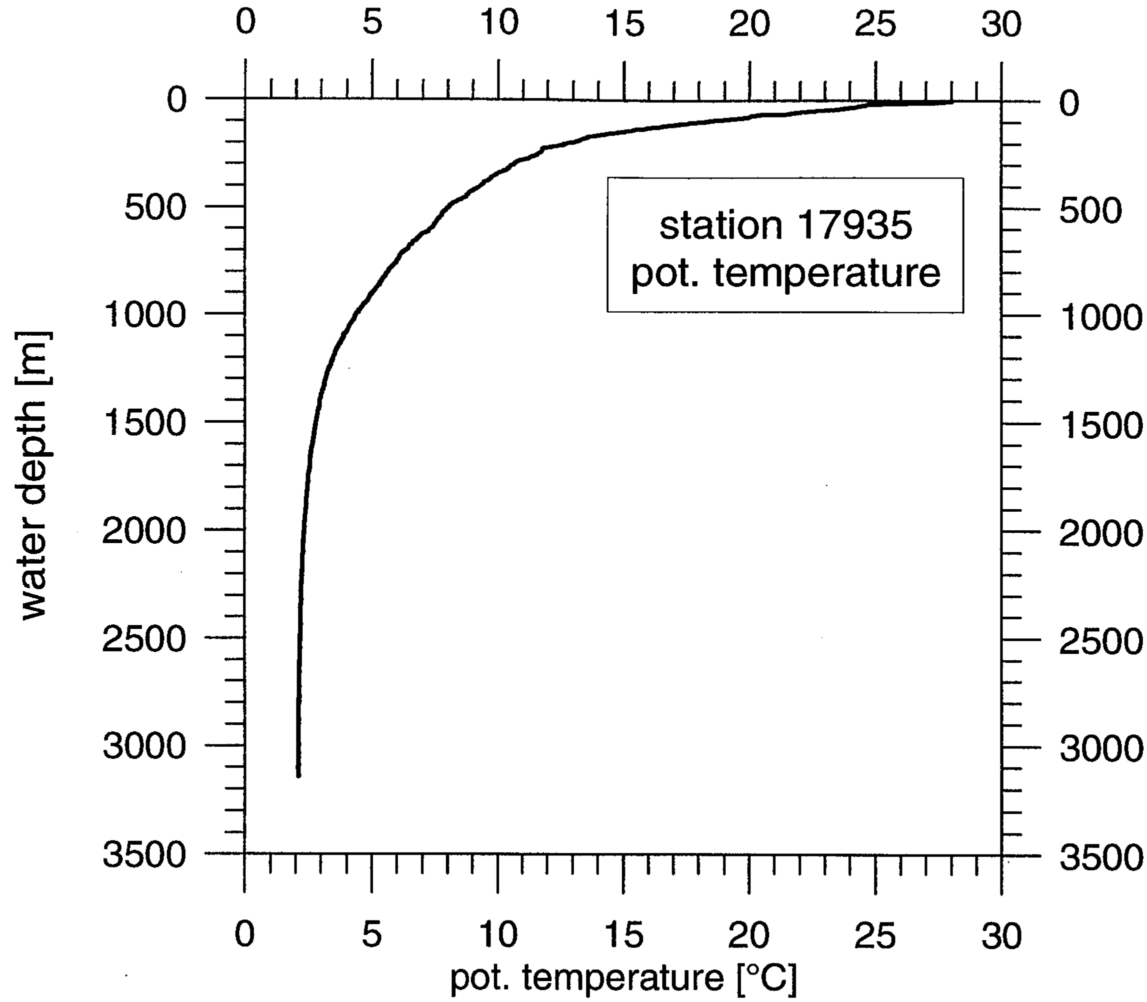
station 17928
salinity
water depth [m]
salinity [ppm]



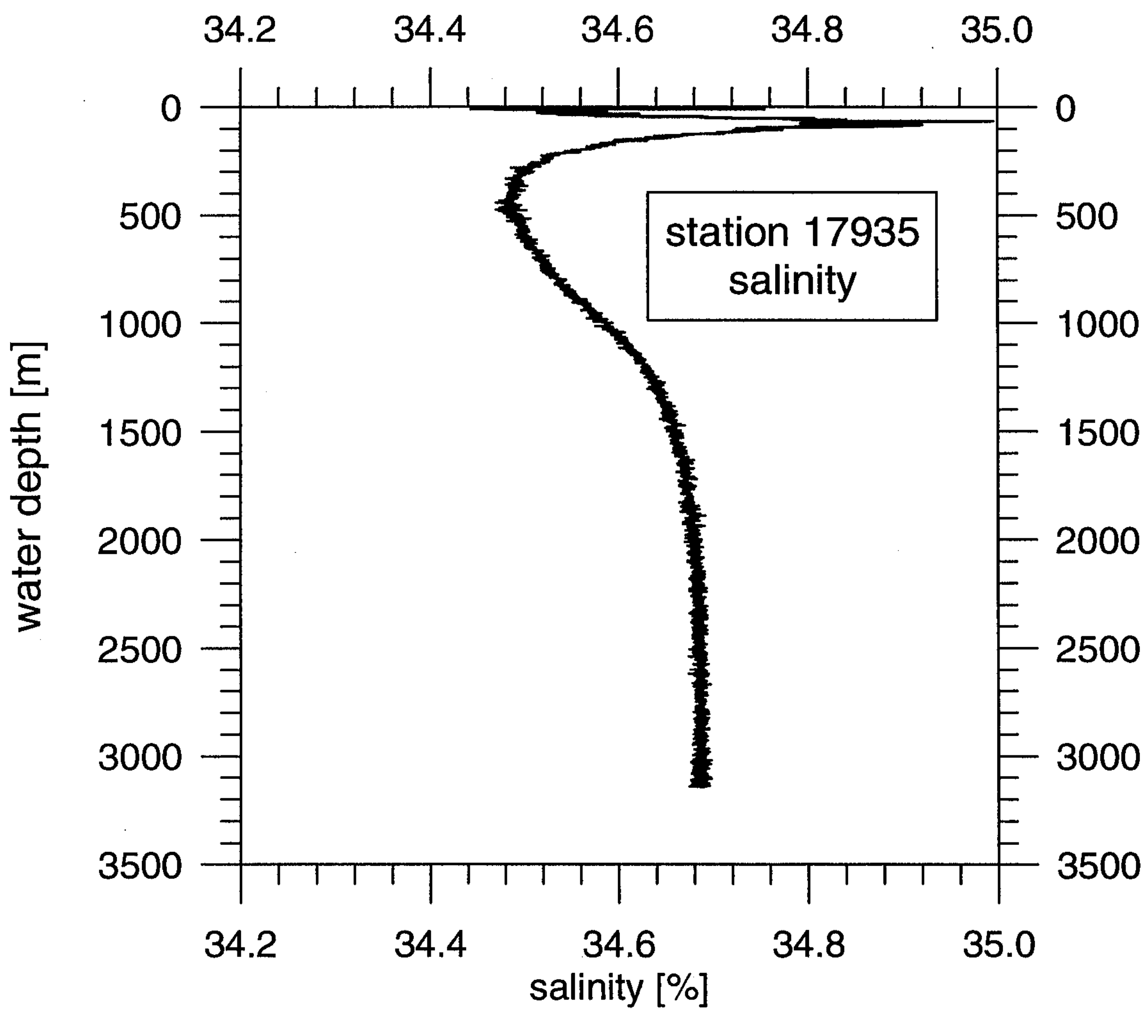
1.50
2.50
3.50
4.50
5.50
0
200
400
600
800
1000
1200
1400
water depth [m]
station 17928
oxygen
oxygen [mg/l]



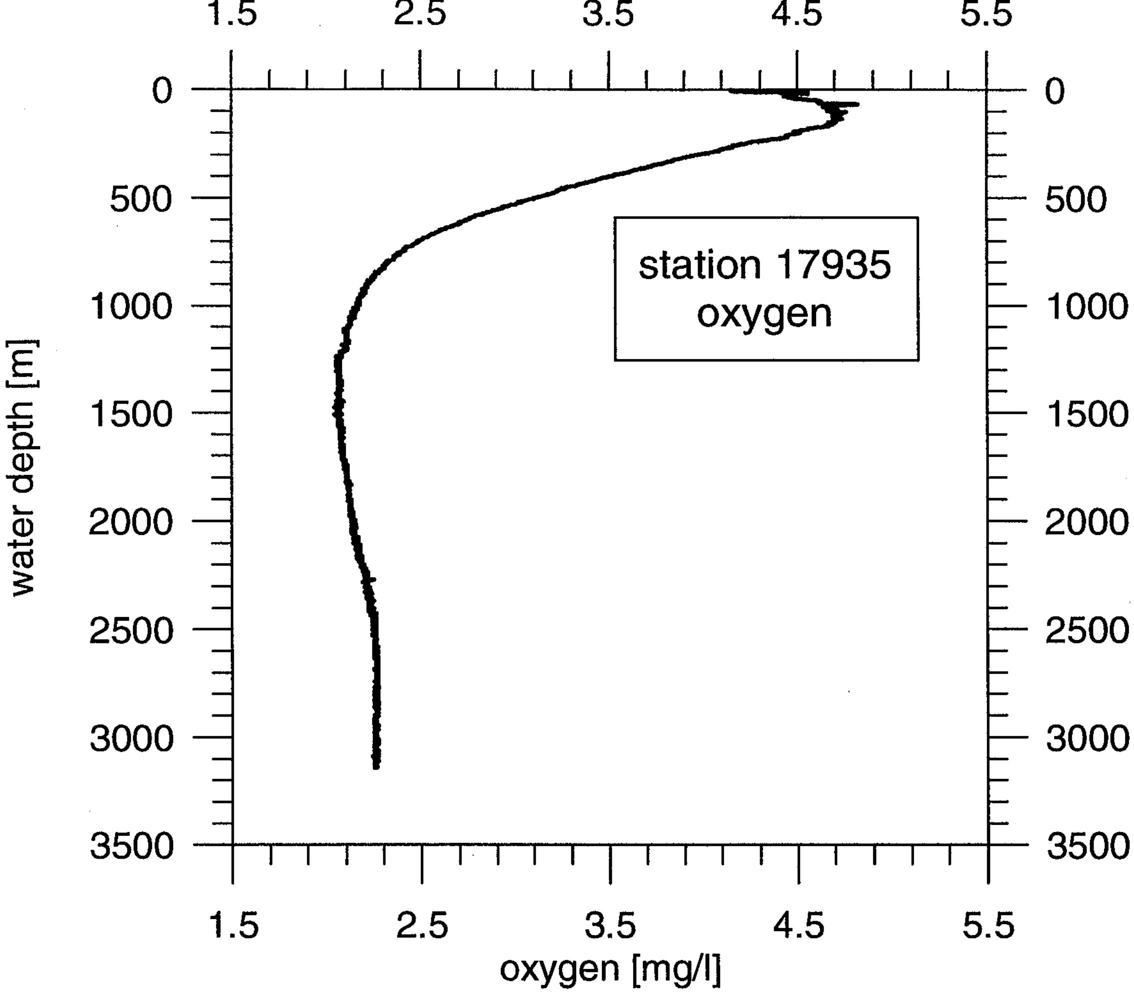
79.0
81.0
83.0
85.0
87.0
0
200
400
600
800
1000
1200
1400
water depth [m]
station 17928
transmission
transmission [%]

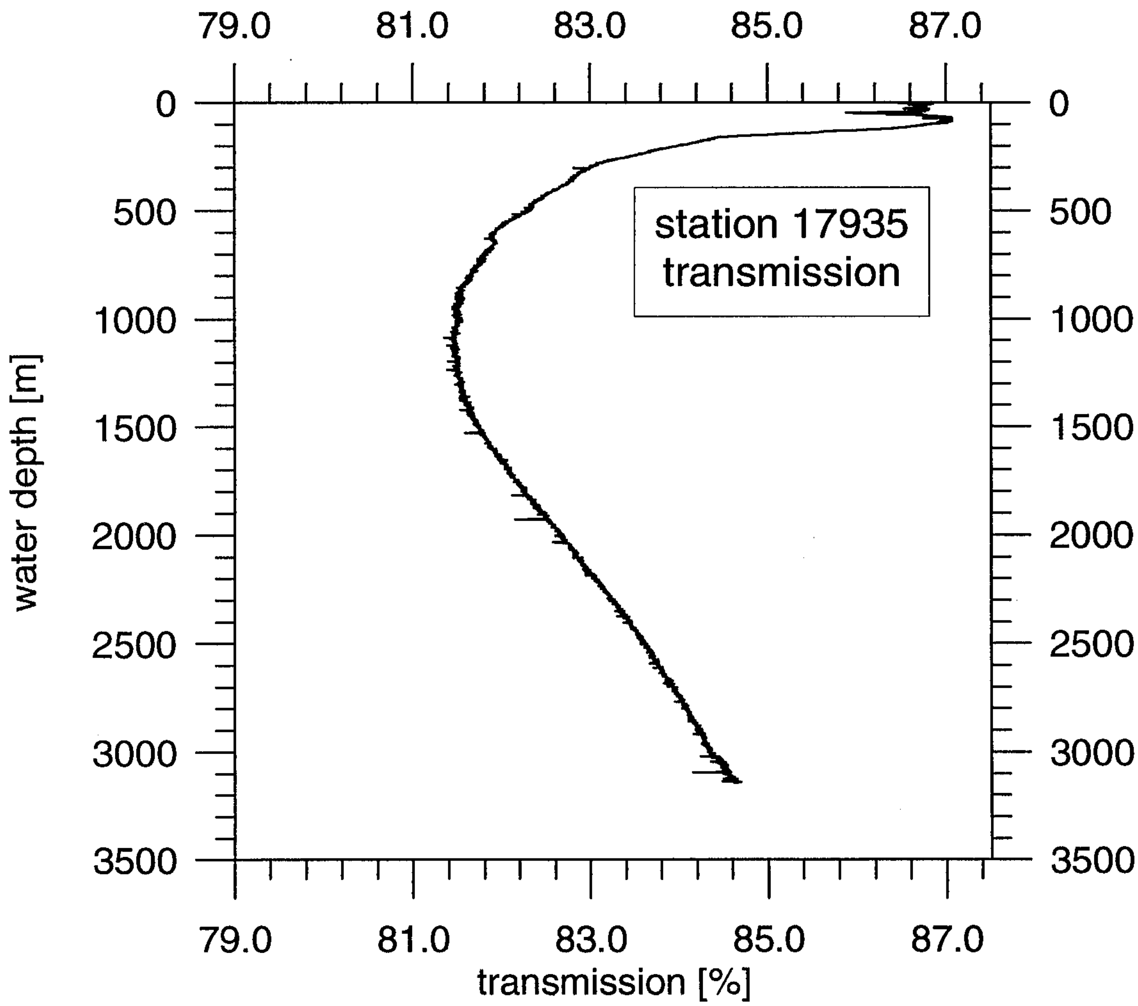


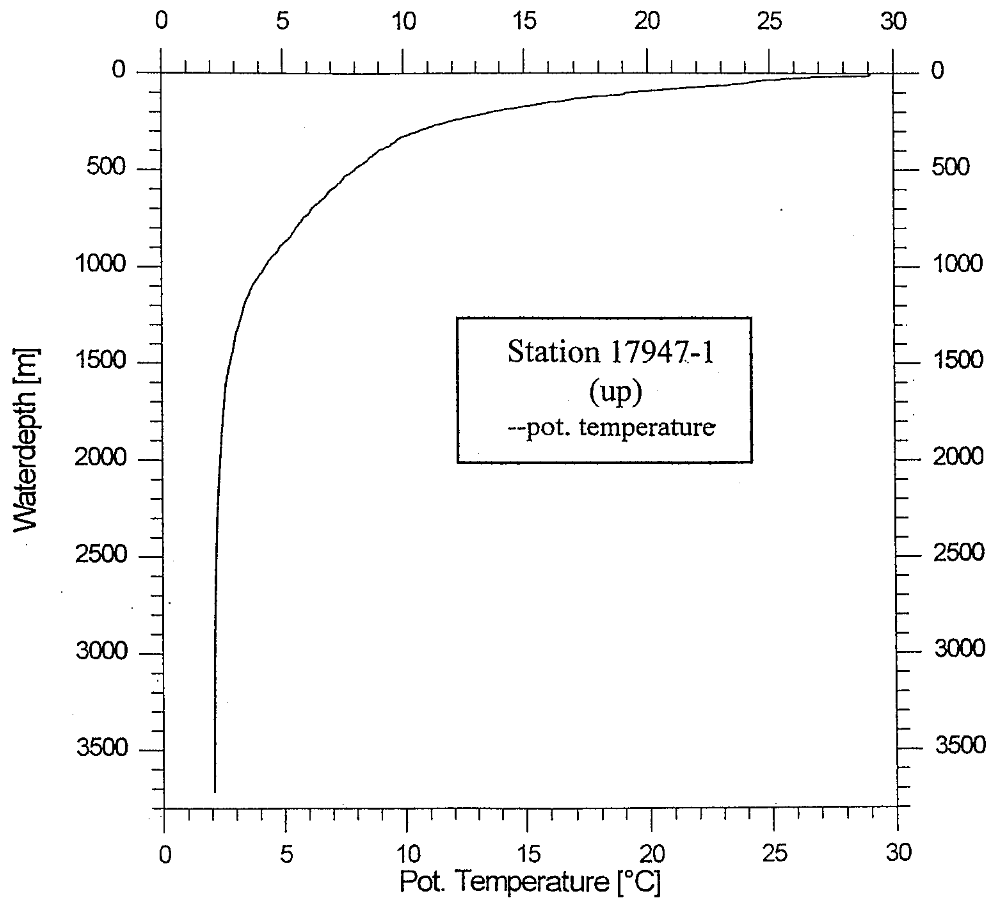
0
5
10
15
20
25
30
0
500
1000
1500
2000
2500
3000
3500
water depth [m]
station 17935
pot. temperature
pot. temperature [°C]



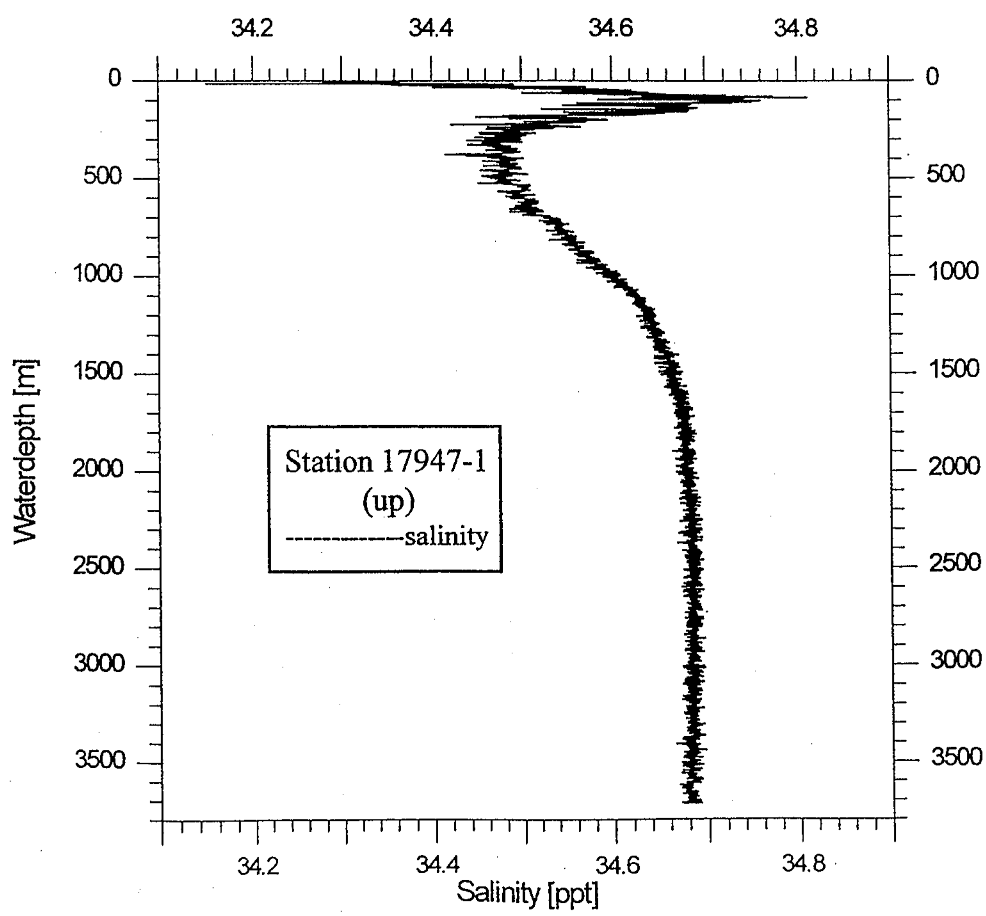
34.2
34.4
34.6
34.8
35.0
0
500
1000
1500
2000
2500
3000
3500
water depth [m]
station 17935
salinity
salinity [%]


station 17935
oxygen
water depth [m]
oxygen [mg/l]
1.5
2.5
3.5
4.5
5.5
0
500
1000
1500
2000
2500
3000
3500

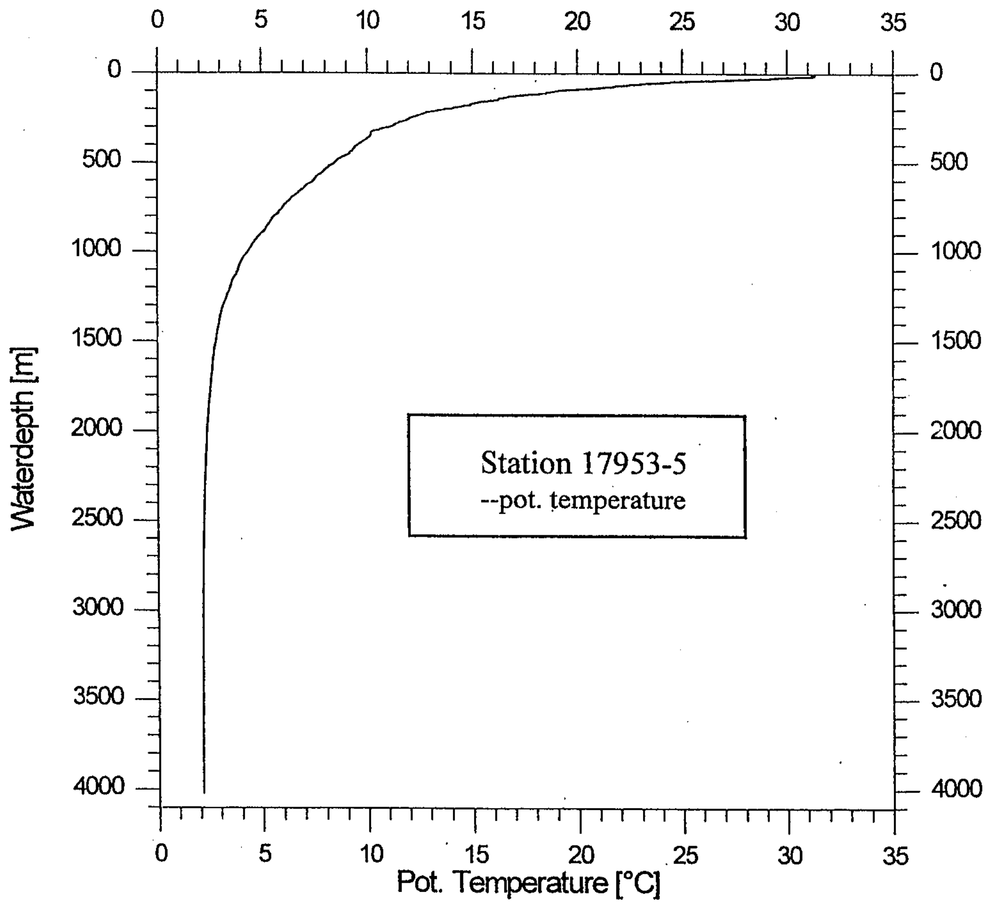

station 17935
transmission
water depth [m]
transmission [%]
79.0
81.0
83.0
85.0
87.0
0
500
1000
1500
2000
2500
3000
3500

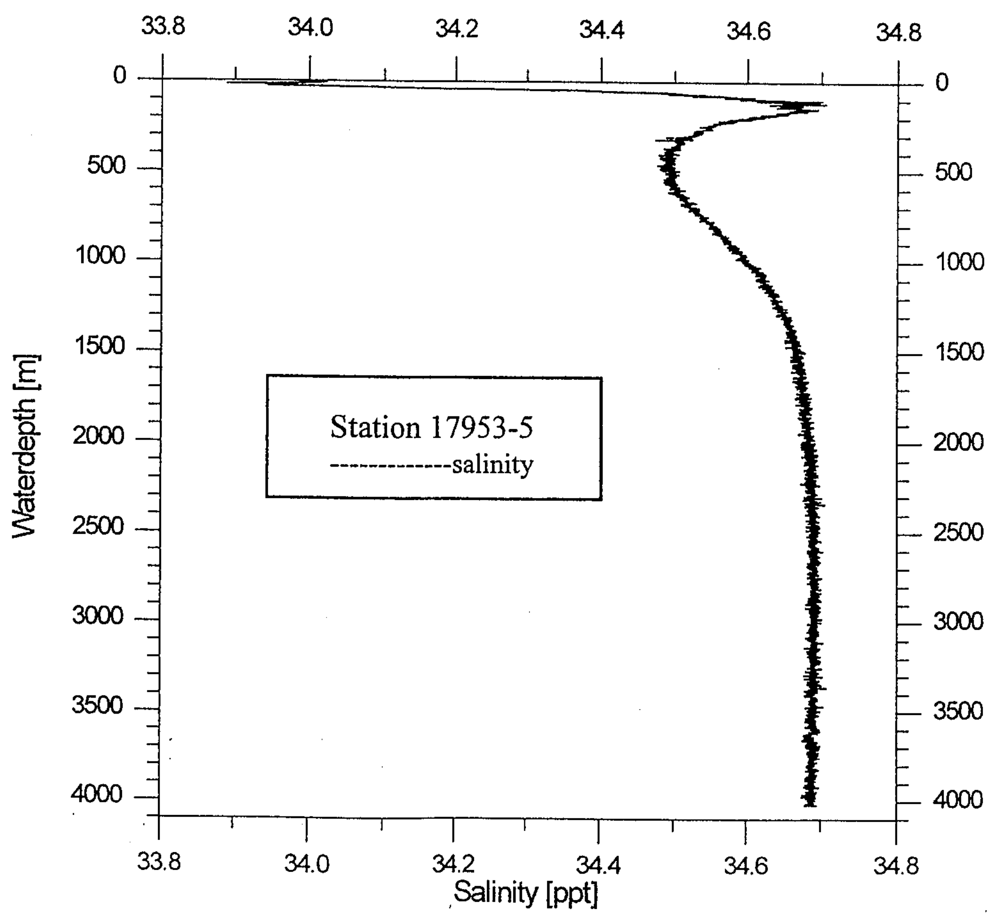


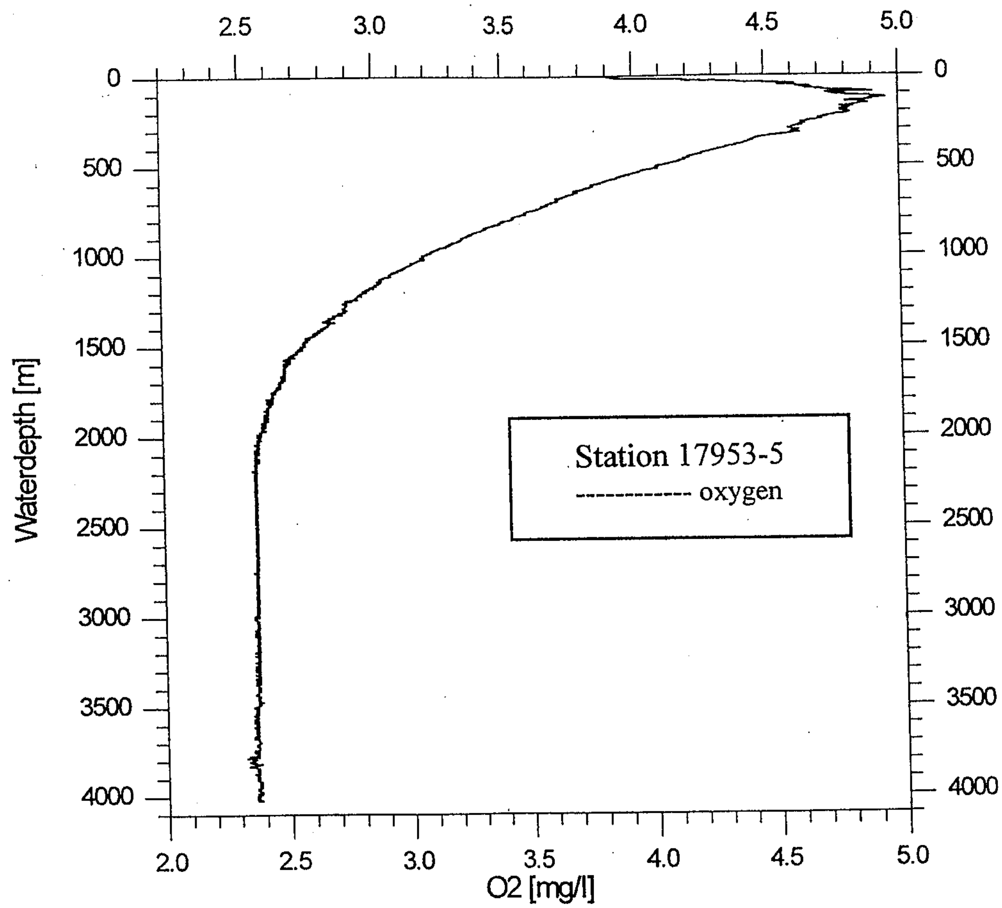
Station 17947-1
(up)
--pot. temperature
Waterdepth [m]
Pot. Temperature [°C]



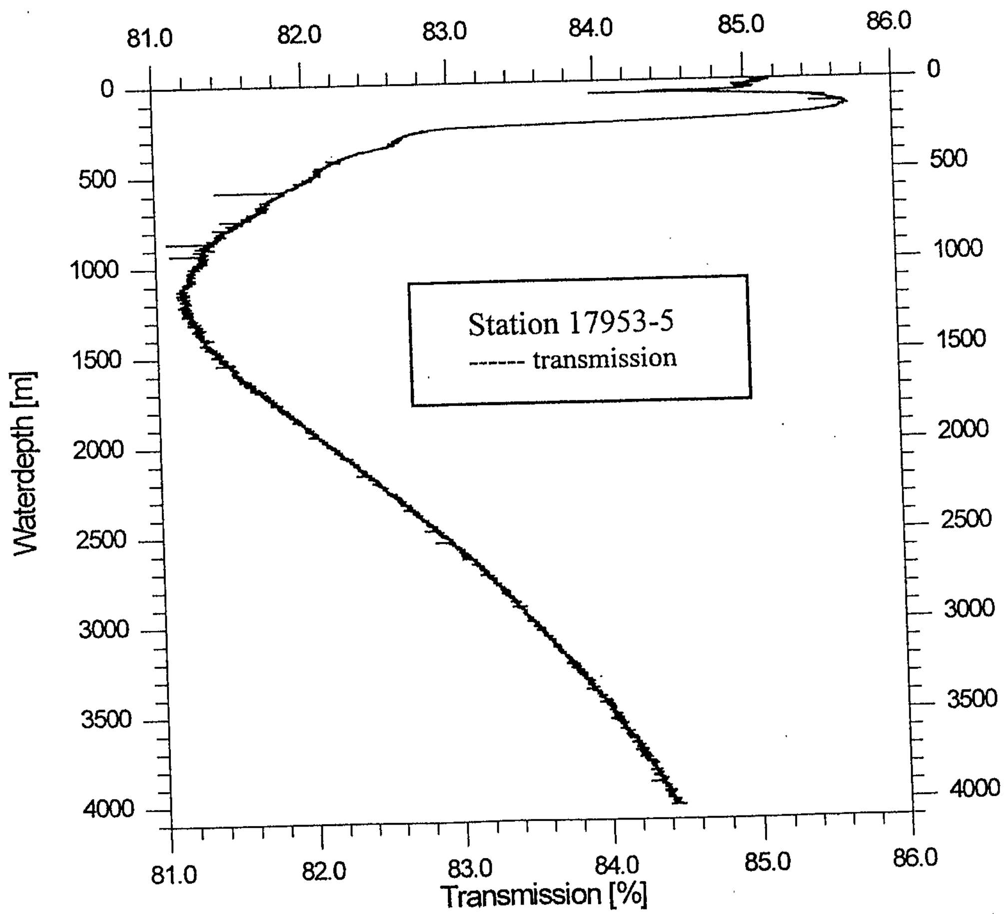
Station 17947-1
(up)
------------salinity
Waterdepth [m]
Salinity [ppt]


Station 17953-5
--pot. temperature
Waterdepth [m]
Pot. Temperature [°C]
0
5
10
15
20
25
30
35
500
1000
1500
2000
2500
3000
3500
4000

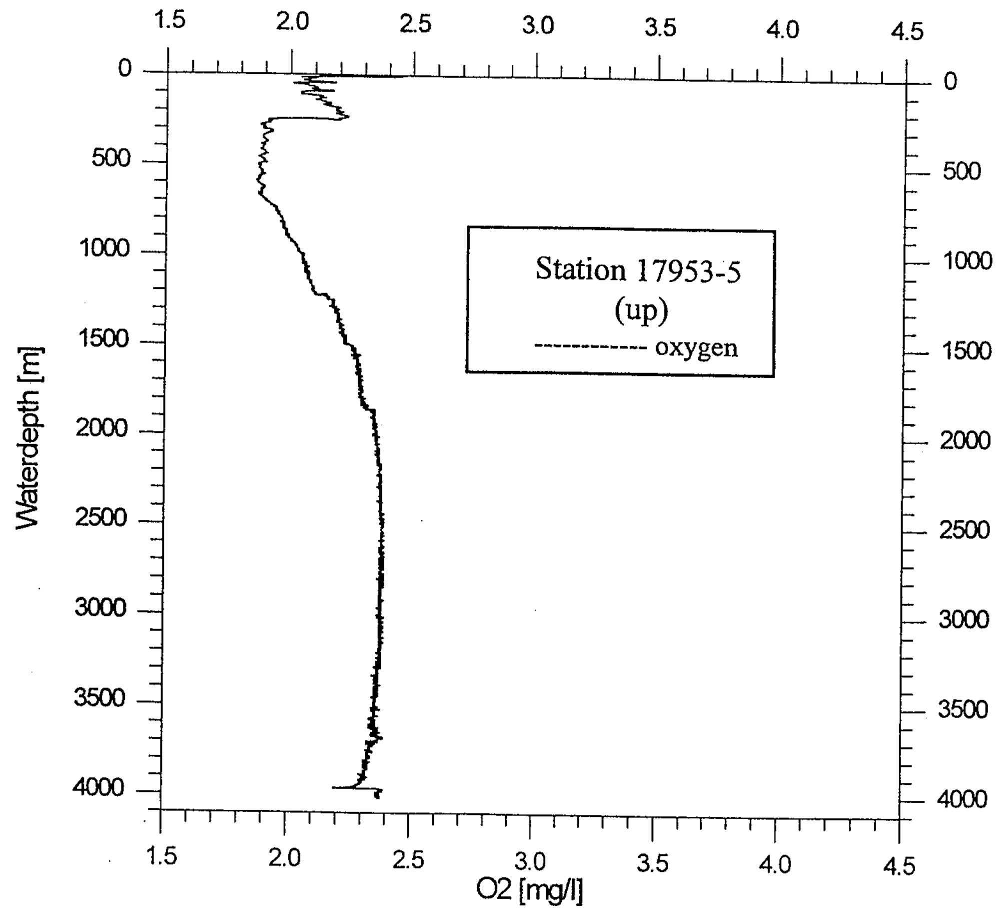

Station 17953-5
-------------salinity
Waterdepth [m]
Salinity [ppt]
33.8
34.0
34.2
34.4
34.6
34.8
0
500
1000
1500
2000
2500
3000
3500
4000



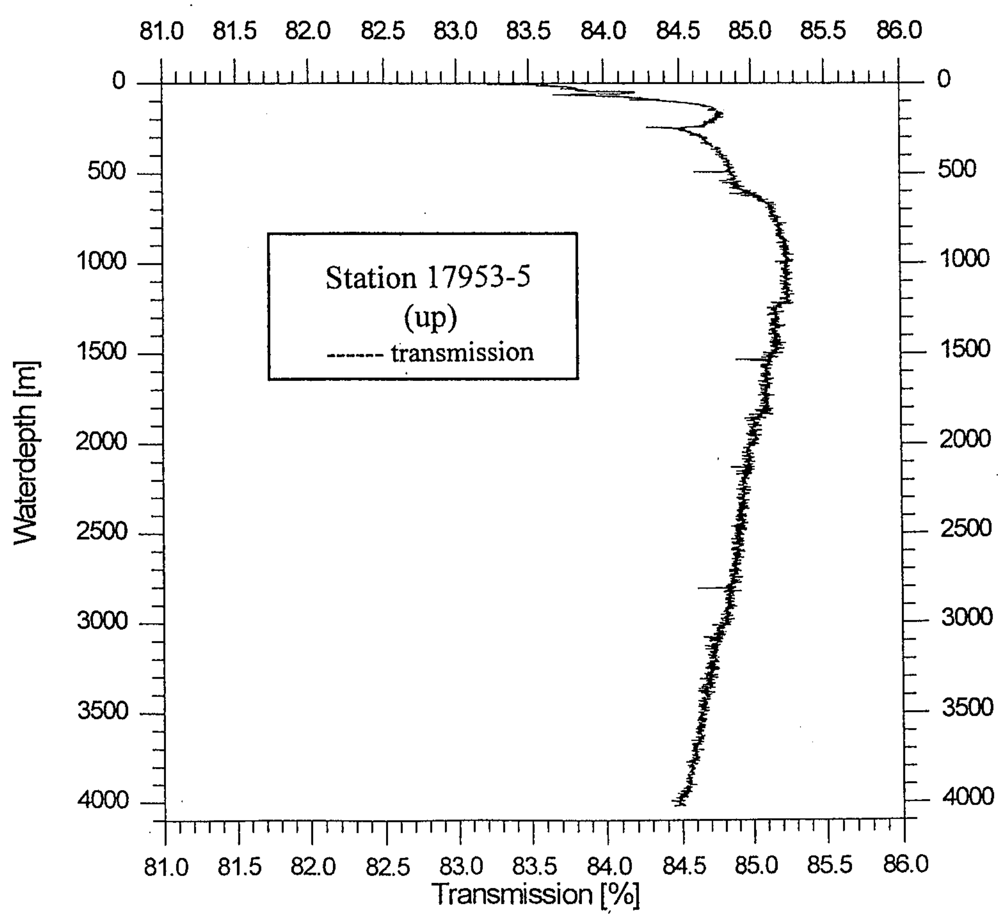
Station 17953-5
------------ oxygen
Waterdepth [m]
O2 [mg/l]



Station 17953-5
------ transmission
Waterdepth [m]
Transmission [%]



Station 17953-5
(up)
------------ oxygen
Waterdepth [m]
O2 [mg/l]



Station 17953-5
(up)
------ transmission
Waterdepth [m]
Transmission [%]

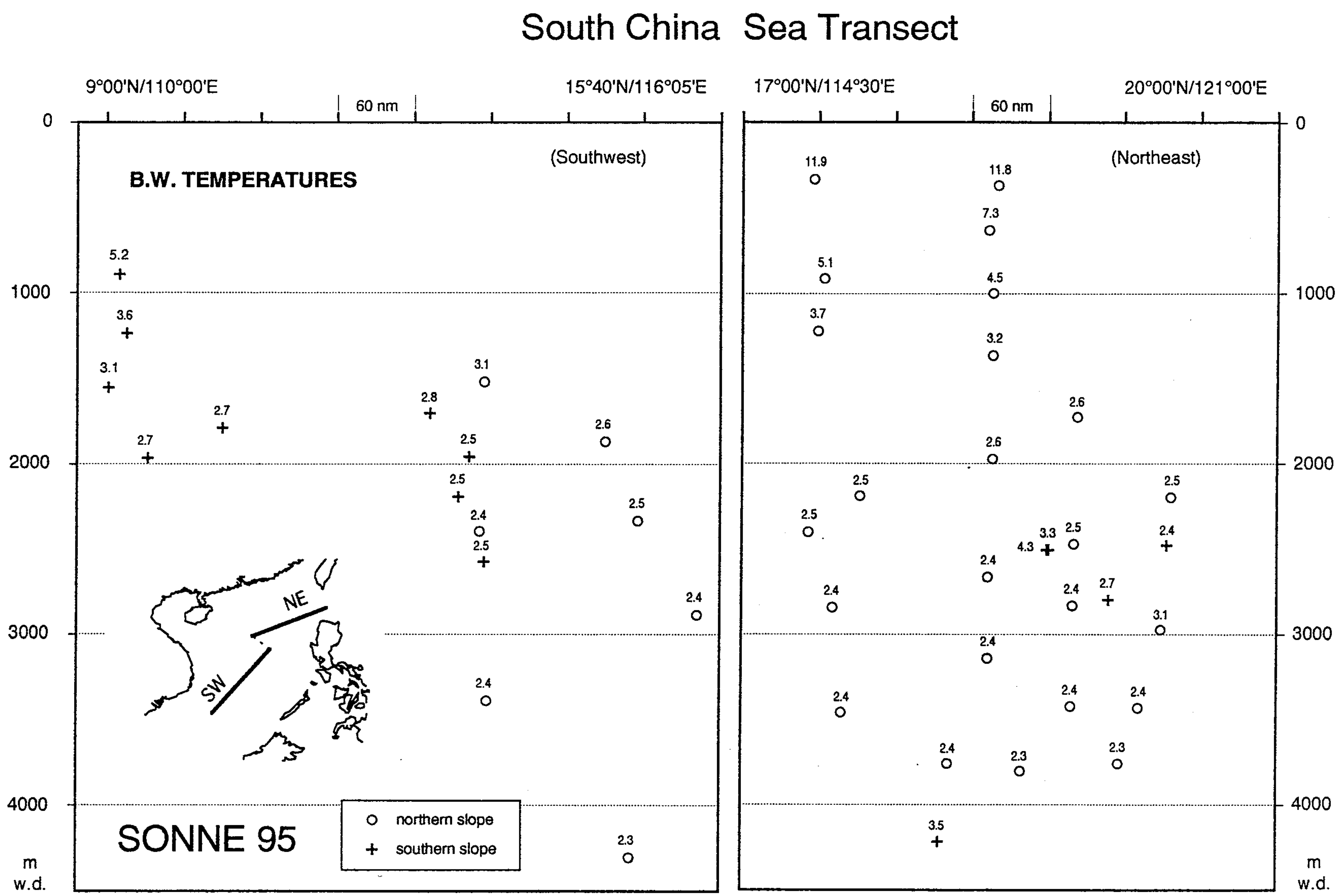


Figure 6. Transect of bottom-water temperatures in the South China Sea, as measured 5 cm below the sediment surface of box cores.