Ödsmål, Kville sn, Bohuslän

Hällristning
Fiskare från
bronsåldern

Rock carving
Bronze age
fishermen

MEDDELANDE från
HAVSFISKELABORATORIET · LYSEKIL
Hydrografiska avdelningen, Göteborg

nr
205

AN OCEANOGRAPHIC SECTION SCOTLAND - NORWAY MADE IN OCTOBER 1975

by

Olle Hagström (Biology Department),
Staffan Lööf, Artur Svansson and
Bengt Yhlen (Hydrography Department).

September 1976

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Institute of Marine Research, Fishery Board of Sweden.

A Hydrographic Section Scotland - Norway, October 1975.

1. Introduction. In March - June 1976 an international oceanographic excercise in the North Sea was carried out involving some 20 reseach vessels and 80 anchored stations. The project was called JONDAP 76 and is an ICES/JONSIS project. The Fishery Board of Sweden participated with a 3 weeks' cruise of hydrographic section work with the R/V Argos. As kind of precruise the R/V Argos made such section work in October 1975 at Boundary North (Stations BNP; see Fig. 1). The intention was to visit the same stations as in 1976, but a JONSDAP 76 Meeting in Aberdeen in November recommended the Swedish 1976 - section to be further south since BN would be worked extensively by Norwegian vessels.

This paper consists mainly of data sections from October 1975. A processing of the type used in Schott and Ehrhardt (1969) is tempting but will be delayed due to the large amount of information expected during JONSDAP 76. Therefore only the following short comments are made: Two cruises were made, one during 1975-10-14 -- 75-10-16 (Figures a) and one other during 1975-10-20 -- 75-10-22 (Figures b). During 75-10-23 similar work was done at section Å in the Skagerrak (Figures c). The weather was calm during the first cruise. Between the two cruises and also during 75-10-20 the winds were mostly southerly, with velocities 10-15 m/s. Most parameters of temperature, salinity, oxygen, PO_4-P, Tot.-P, SiO_4-Si, the data of which are presented here, were determined at all stations (BNP 1 - BNP 30) and at all of the following standard depths: 0, 10, 20, 30, 50, 75, 100, 125, 150, 175, 200, 225, 250 and 275 m, and if chlorophyll was sampled, also at 5 and 15 m. As indicated in the sections, measurements of nitrogen and chlorophyll compounds were carried out at a limited numbers of horizons.

Biological hauls were made by means of an Isaacs-Kidd Midwater Trawl as well as a Bongo net. Only a short preliminary result is presented below (Hagström).

2. Water Masses characterized by Chemical Parameter Data

The chemical constituents were determined according to New Baltic Manual (Carlberg, 1972). The work was made on board "Argos" except for salinity and total phosphorus. Samples for chlorophyll and phaeopigment were filtrated on board, but the final treatment was made in the land laboratory.

In this section of the North Sea six areas of different character can be found (cf Dooley 1974):

2.1. Outflowing Water along Norway (and along Sweden in the Skagerrak).

This water is found at stations BNP 1-6 (and Å 11-Å 188). It is characterized by lower salinity (Fig:s 2) at most depths. The steepness of the isopycnals (Fig:s 4) tells us that there is probably a strong variation in current velocity between surface and bottom. It should be noted that this current only to a minor extent consists of Baltic water but is nevertheless highly characterized by the presence of this water.

At this time of the year there are some special characteristic's in the upper 100 m layer: a temperature maximum (Fig: 3; cf Tomczak and Goedecke 1964) and high values of NO_2-N and NO_3-N (Fig:s 11 b, 11 c and 12 b).

2.2. Inflowing Atlantic Water in the Western part of the Norwegian Rinne.

This water is characterized by a salinity maximum at greater depths, see Fig:s 2, stns. BNP 9-18. At practically all sections made (e.g. June 1884 by "Drache") this maximum is found. There seems to be no other parameter showing special features in our sections except possibly SiO_2 (Fig:s 6).

2.3. Area between the water masses described in 2.1. and 2.2.

According to theory the two currents described as part of a cyclonic circulation give rise to upward vertical motion between them. The isolines of many chemical constituents show an upward bend at stations BNP 6-8 (Fig:s 3, 4, 6, 7, 8, 11b and 12b).

2.4. Fladen Ground Water

The Fladen Ground area is actually a little south of our section but like the JONSDAP 76 part project, Fladen Ground Experiment (FLEX), we may extend this to a larger area of the Northern North Sea, in our section represented by stations BNP 18-26. This area is supposed to be little influenced by residual currents but is mostly exposed to short-term variations of meteorological origin. The tide, however, which is of negligible significance in areas described in 2.1., 2.2. and 2.3 here begins to be of importance. Dietrich (1954) wrote an interesting paper and determined the "critical vertical gradient for suppressing the tidal current turbulence which originates from the bottom of the sea". In our section we see a horizontal transition layer at approximately 50 m depth dividing up the water mass in two parts: a surface stratum and a deep stratum.

As expected many constituents show lower values in the surface layer than in the deep layer (Fig:s 4, 6, 7, 8, 12b and 14).

2.5. Inflowing Water from the Orkney - Shetland Strait.

Dooley (1974) is of the opinion that this current is fairly narrow. Probably it is situated at stations BNP 25-27. As seen in some of the figures of data from the first cruise, there is a remarkable change between station BNP 25 and BNP 26 (Fig. 4a), on the return cruise this change has mowed a little and is now then situated between BNP 26 and BNP 27 (Fig. 4b). The current, if the indications are correct to be interpreted in this manner, is fairly near the FLEX box at least during the first of our cruises.

2.6. Scottish Coastal Water.

This water is characterized by weak stratification and salinity between 34.75 and 35 ‰. At the time of the year when our measurements were made most parameters were equal from surface to bottom, but at some times of the year there is a slight stratification (Tomczak and Goedecke 1964). It is an area of strong tidal currents, and this is assumed to be the main reason for the weak stratification.

3. Chlorophyll (Lööf).

3.1. Chlorophyll a.

Samling was made down to 30 m but probably an extended sampling at greater depth would have been intersting.

In both cruises the highest values were found in the eastern part of the section (between stations 2-16 in cruise 1, Fig. 9a, and between 2-8 in cruise 2, Fig. 9b). The outflowing water body along the Norwegian coast was approximately twice as rich in chlorophyll a as the relatively homogeneous water body to the west of the Rinne. However, in both cruises there was a local maximum at station 22. During cruise 1 this maximum extended down to the greatest sampling depth (30 m). A week later this maximum was limited to the upper 15 m.

A strong upwelling between stations 6-8 (the transition area described in 2.3) can be seen in both cruises. The only part of the section with a pronounced vertical concentration gradient was the part to the east of this upwelling area.

3.2. Pheopigment

Pheopigments are degradation products of chlorophylls. The relative amount of these is an indication of the age of the population.

The distribution of pheopigment is found in Fig. 10b. However, these data have to be interpreted with caution since the amount of absorbing pigment is rather low. A maximum of 0.3 - 0.4 mg/m^3 is present as a strip from surface to bottom at stations 18-20. The highest values are found in the region of the highest chlorophyll values, that is in the upper part of the water body just off the Norwegian coast. As was shown in Fig:s 9a and 9b the isolines of chlorophyll a rise considerably when approaching the coast indicating the presence of the less light-penetrable Baltic water. This feature is absent as for pheopigment. Remarkable is the water body of very low concentrations of

pheopigment below 15 m between station 6 and the Norwegian coast. As dead phytoplankton sooner or later sink one would expect high concentrations here. Instead old and/or dead phytoplankton seem to concentrate in a trench between stations 6-8. This peculier feature is difficult to explain but some mechanism involving the vertical movement of particles is probably involved.

4. Nitrogen Compounds (Yhlen).

All the work was made on board the ship. Methods in New Baltic Manual (Carlberg, 1972) were followed. There seems to be a negative correlation between NO_3-N and chlorophyll *a* , probably caused by primary production. High amounts of NO_2-N are not found only along Norway (and along Sweden in the Skagerrak) but also in the well mixed Scottish coastal water.

5. Biological Sampling (Hagström).

The main purpose of the sampling was to investigate fish larvae. Samples were collected for later processing. Only some rough results are presented here of naked eye studies made directly on board.

The Isaacs-Kidd Midwater Trawl (IKMT) had an aperture of 4.0 × 2.5 m, a length of 10 m and an inner cone 1800 µ. The Bongo net had a diameter of 60 cm, meshes 500 and 300 µ. The hauls made were oblique in the upper 50 m water. The ship's speed was 3 knots.

The larval density is low during this time of year as most larvae have metamorphosed and left the pelagic phase. With this background the small amount of larvae found in the IKMT hauls is quite acceptable.

The dominant species belongs to the clupeids and was probably sprat (Sprattus Sprattus). No hauls were made at the stations 1-3 from thereon. At the stations 4-22 there was about 0-8 individuals / 20 minute haul. At the stations 24-27 the amount increased considerably, at BNP 24, 500 ind/haul. Most larvae had a length of 25-40 mm. There were a few individuals which had already metamorphosed.

Of other species, larvae of flat-fish were few but evenly distributed, horse mackerel larvae were only found at stations 4-6 in the less saline water. Pleurobrachia in large quantities were also found in this water mass during the first cruise as well as near the Scottish coast (stations 26-27), at the remaining stations there was nearly nothing. During the second cruise the distribution was quite different at the Estern side of the section: large quantities at station 14-16 decreasing towards Norway.

Participants in expedition were S. Engström, J.-O. Bladh, M. Kilander, B. Yhlen, B. Stahm, A. Svansson, E.-G. Thelén, C.M. Lagergren, W. Thörnquist, O. Hagström, A.-Ch. Rodolphi and E. Mascher.

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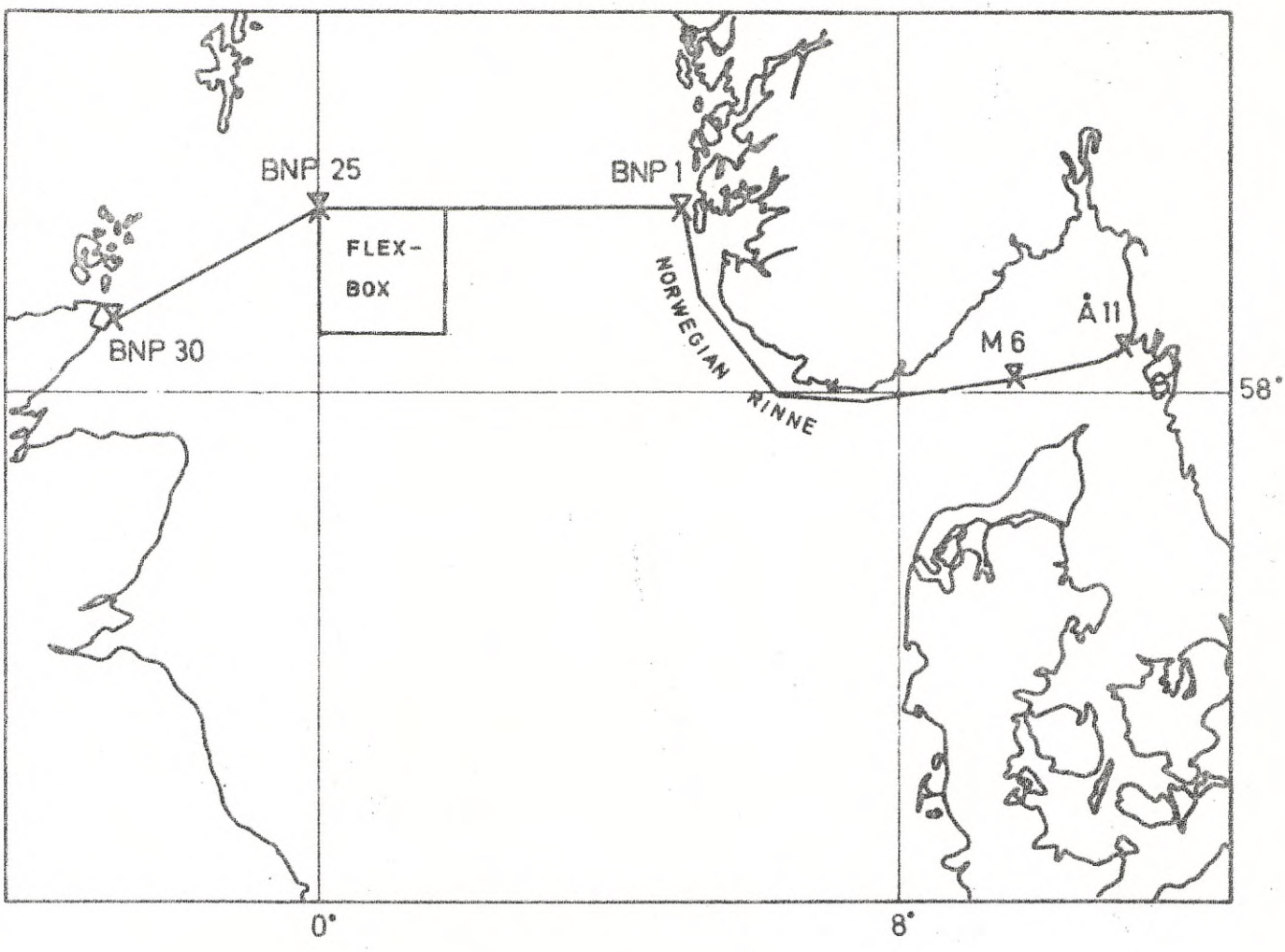
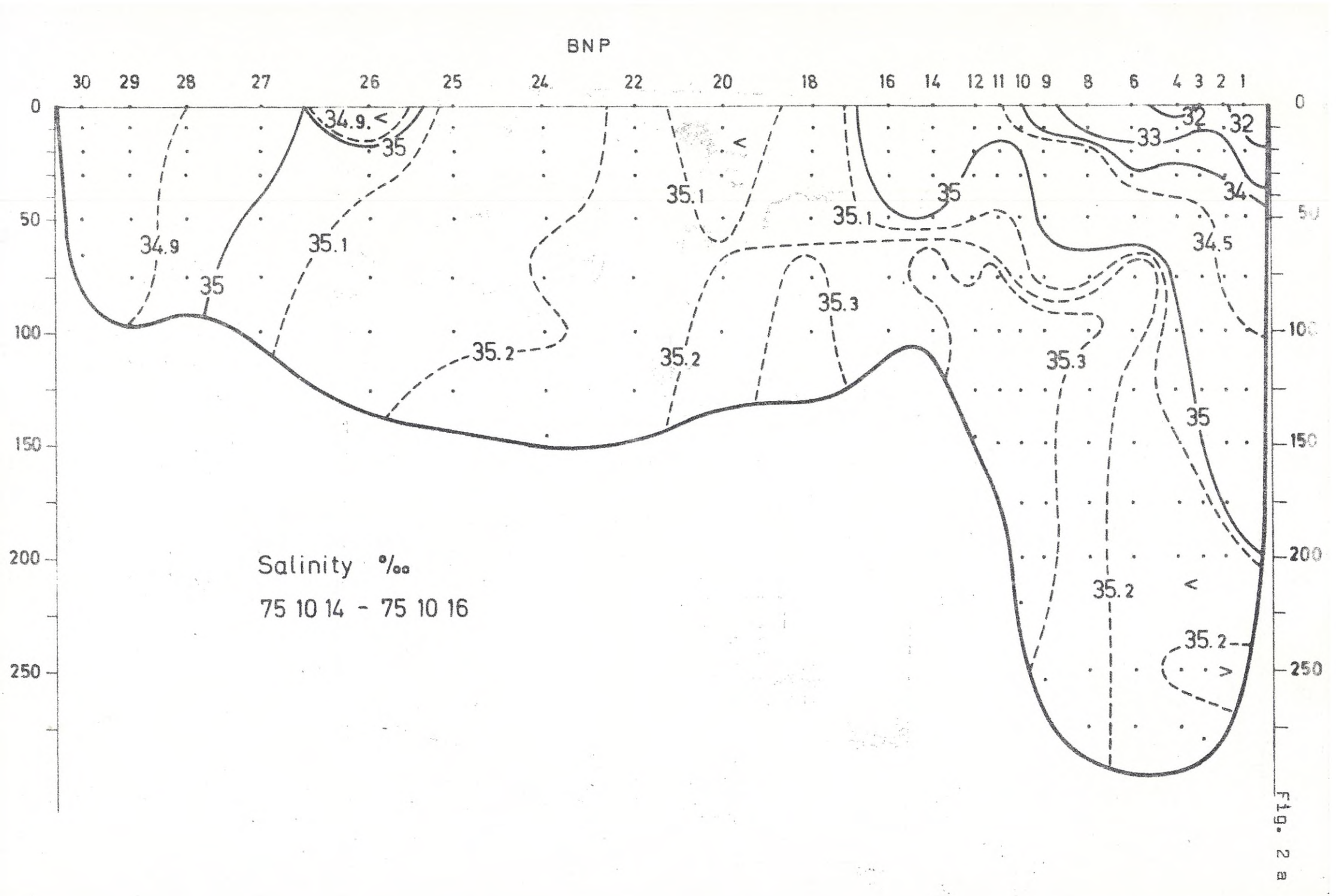
Fig. 1.

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0
50
100
150
200
250
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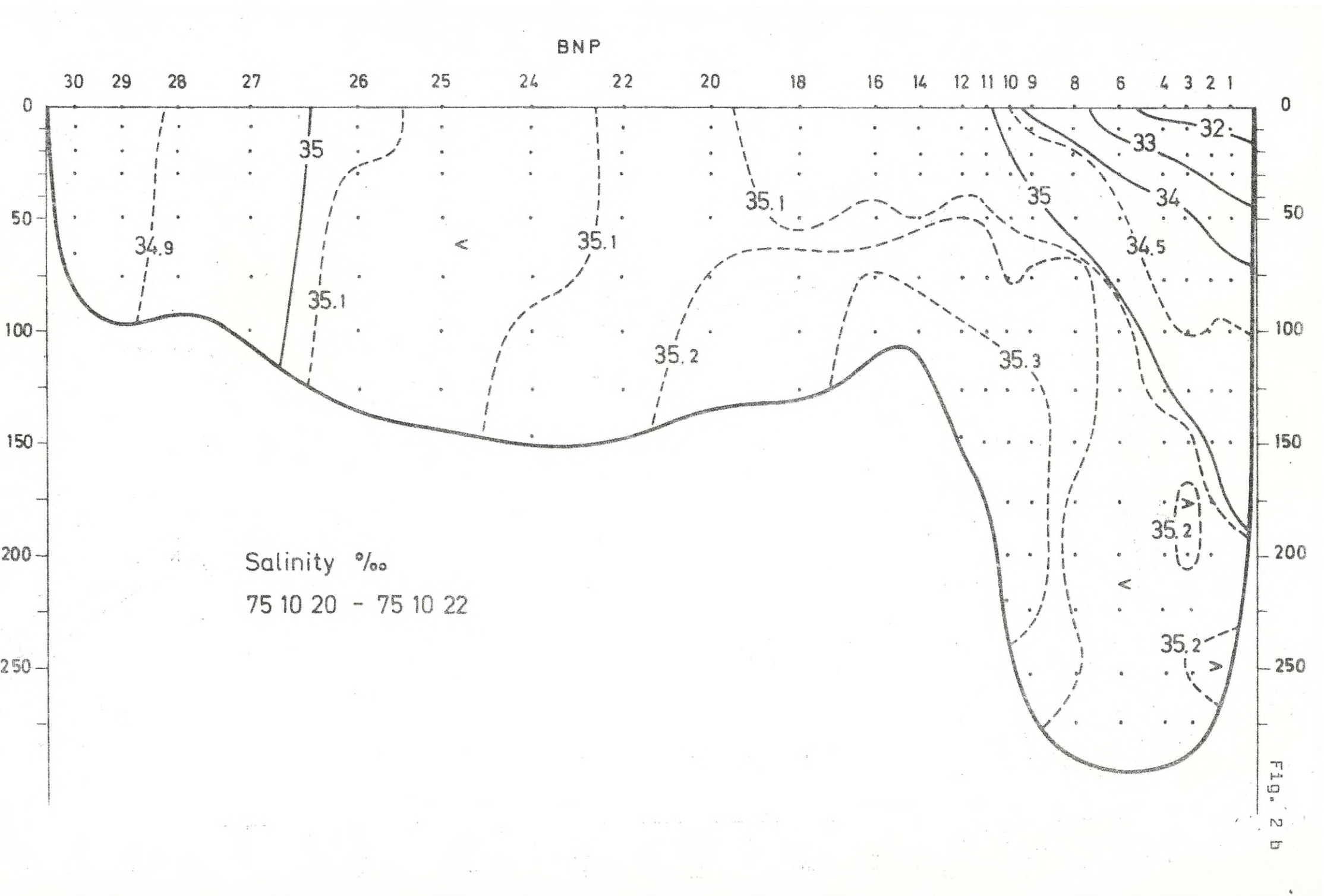
35
34.9
35
35.1
35.2
35.1
35
35.1
35
35.3
35.2
35.3
35
35.2 <
35.2 >
33
32
32
34
34.5
Salinity ‰
75 10 14 - 75 10 16
Fig. 2 a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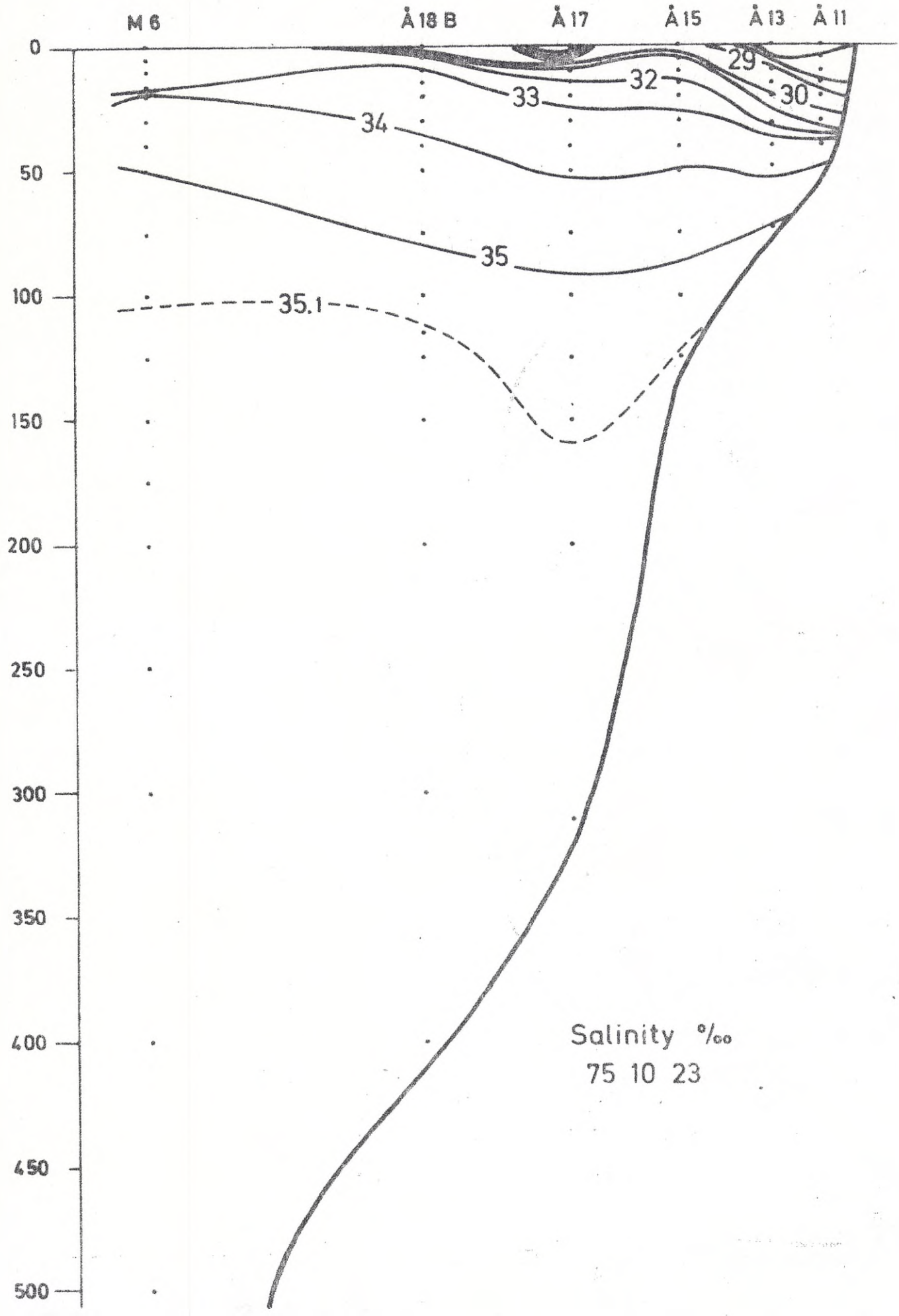
0
50
100
150
200
250
35
34.9
35.1
35.1
35.1
35.2
35.3
35
34.5
34
33
32
35.2
35.2
Salinity ‰
75 10 20 - 75 10 22

Fig. 2 b

Fig. 2 c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Å 17
Å 15
Å 13
Å 11
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200
250
300
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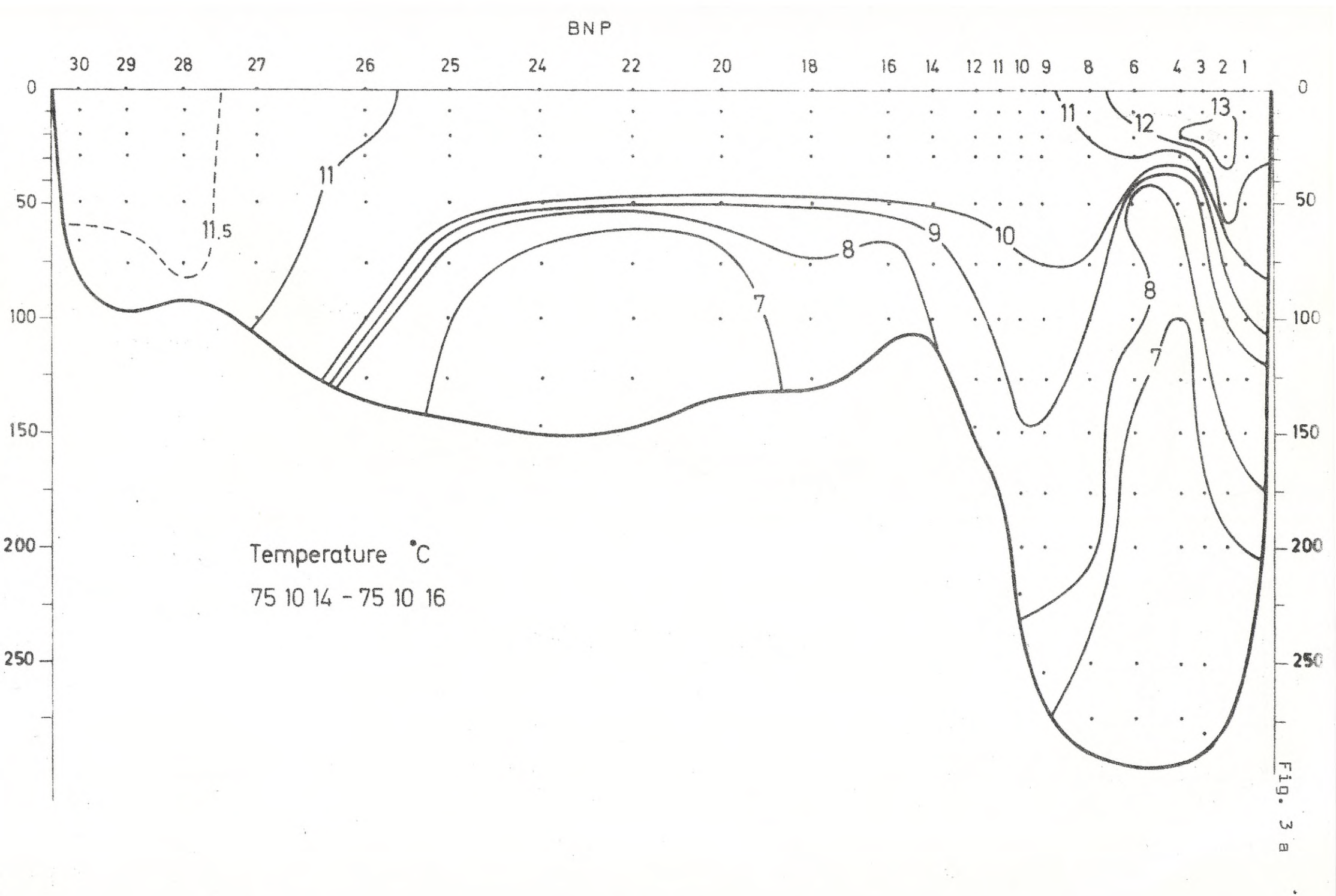
32
33
34
35
35.1
Salinity ‰
75 10 23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0
50
100
150
200
250
11
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7
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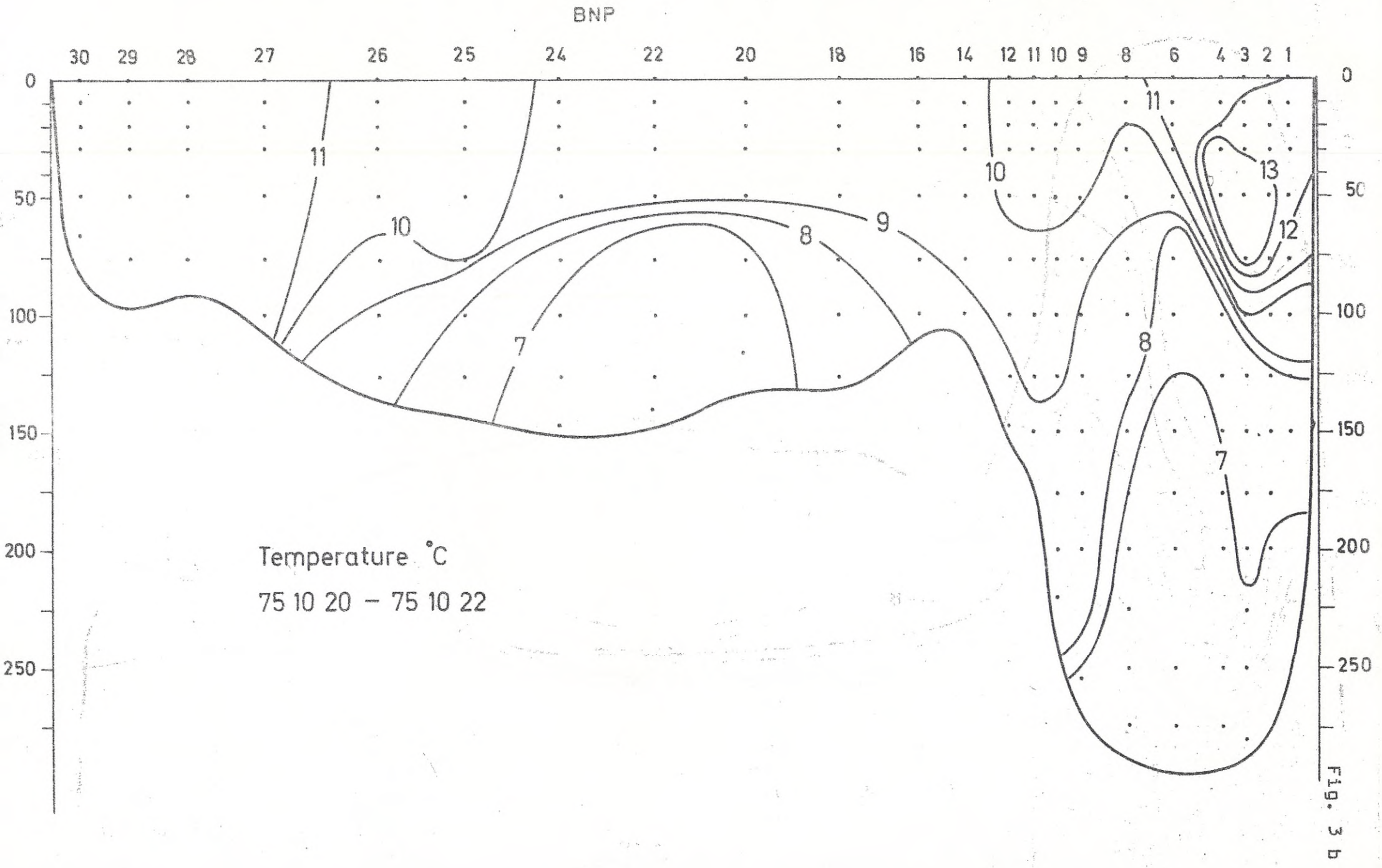
11
12
13
Temperature °C
75 10 14 - 75 10 16

Fig. 3a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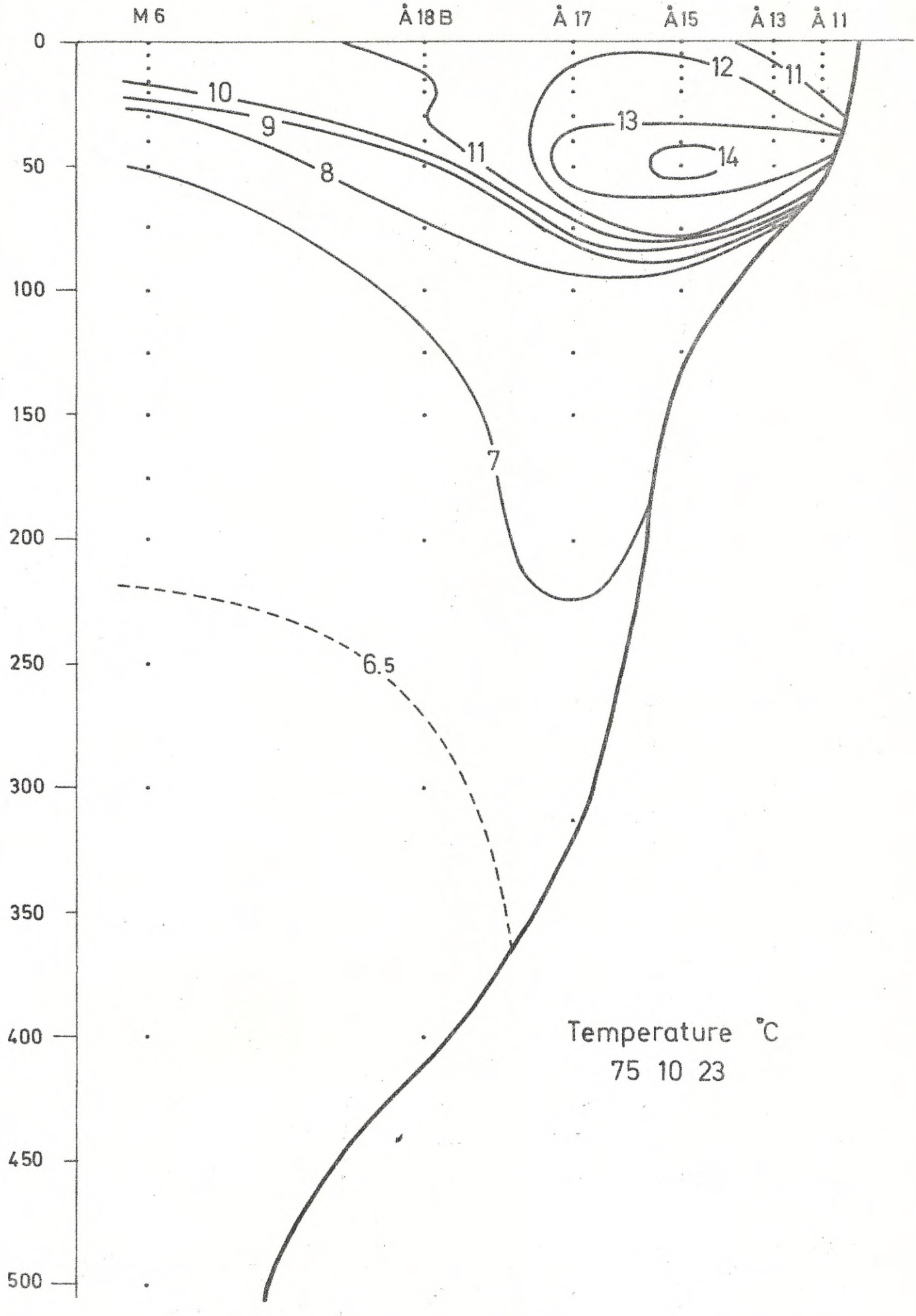
50
100
150
200
250
11
10
9
8
7
13
12
Temperature °C
75 10 20 – 75 10 22

Fig. 3 b

Fig. 3 c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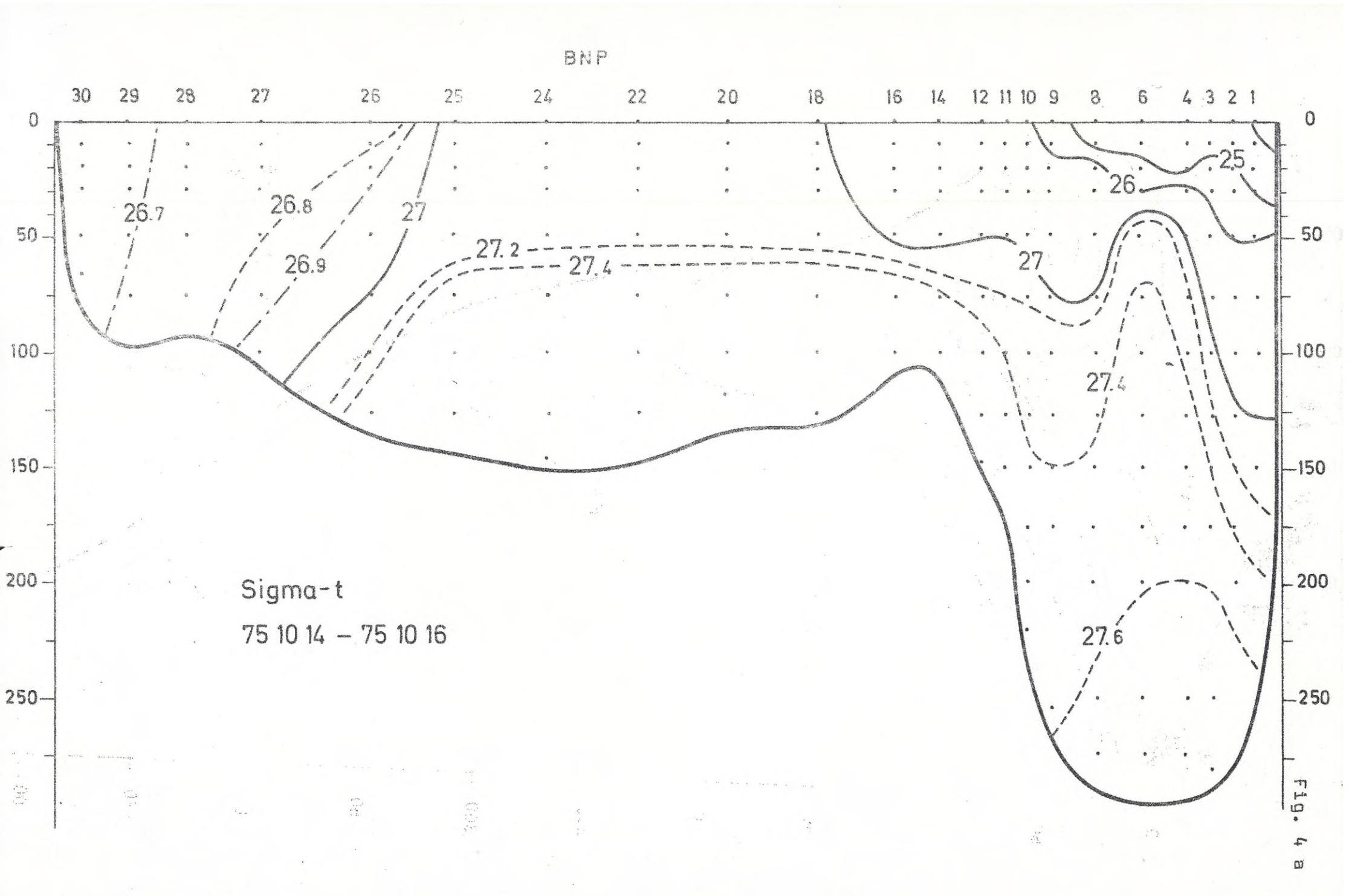
11
13
14
7
6.5
Temperature °C
75 10 23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50
100
150
200
250
26.7
26.8
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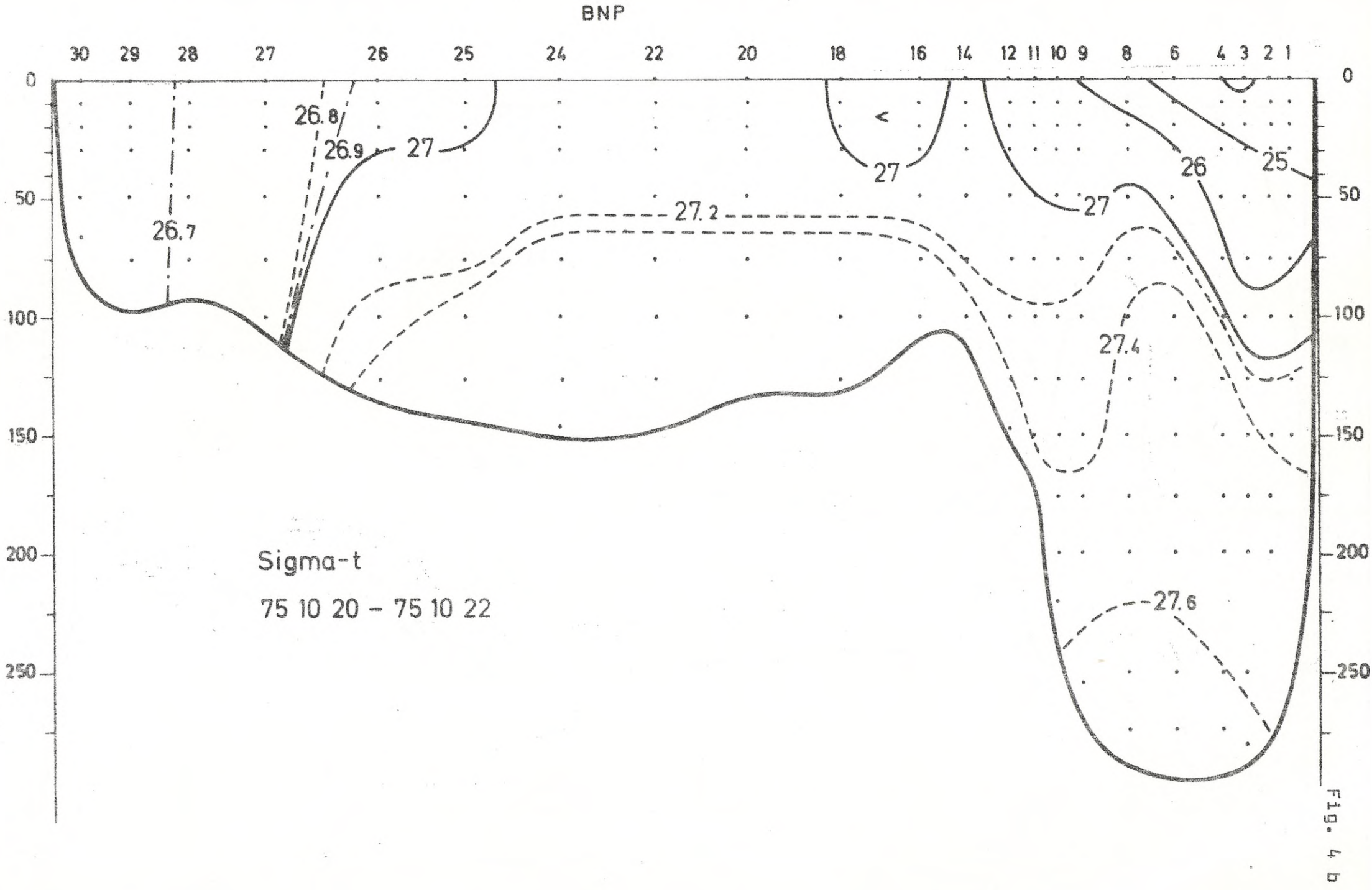
27
27.2
27.4
25
26
27
27.4
27.6
Sigma-t
75 10 14 – 75 10 16

Fig. 4 a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100
150
200
250
26.8
26.9
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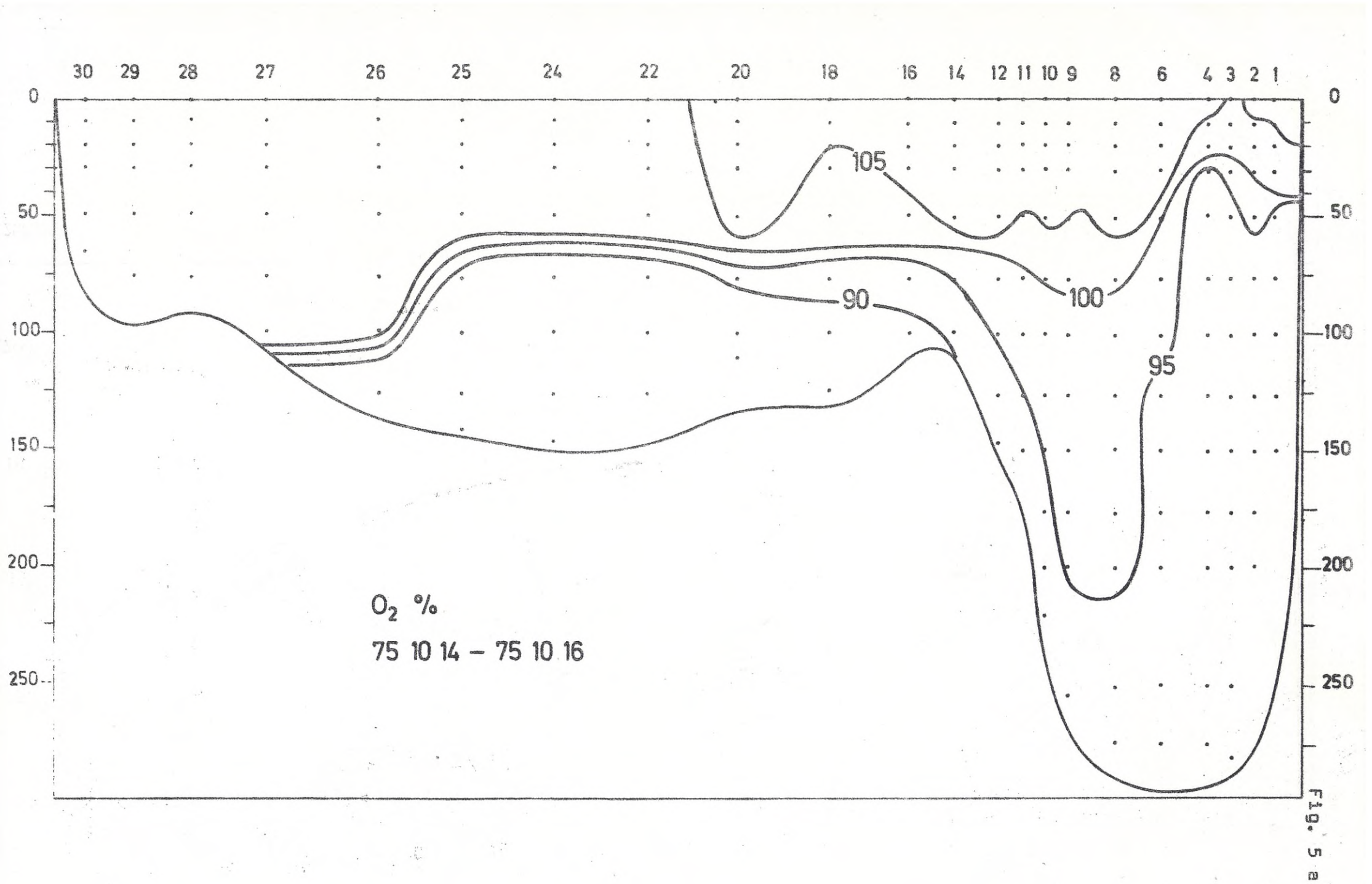
27
27
26
25
27
27.4
27.6
Sigma-t
75 10 20 - 75 10 22

Fig. 4 b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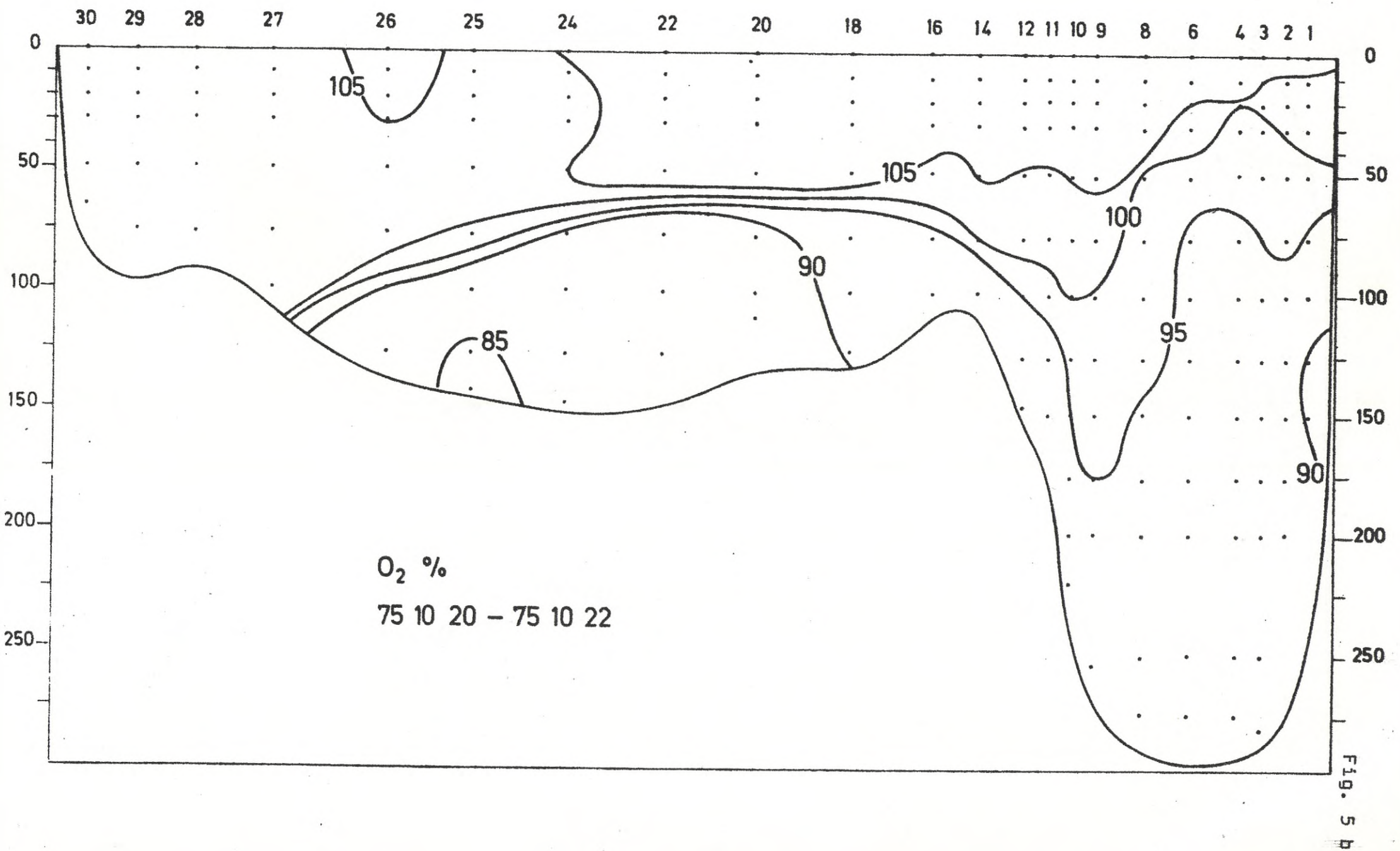
150
200
250
105
100
95
90
O_2 %
75 10 14 – 75 10 16

Fig. 5 a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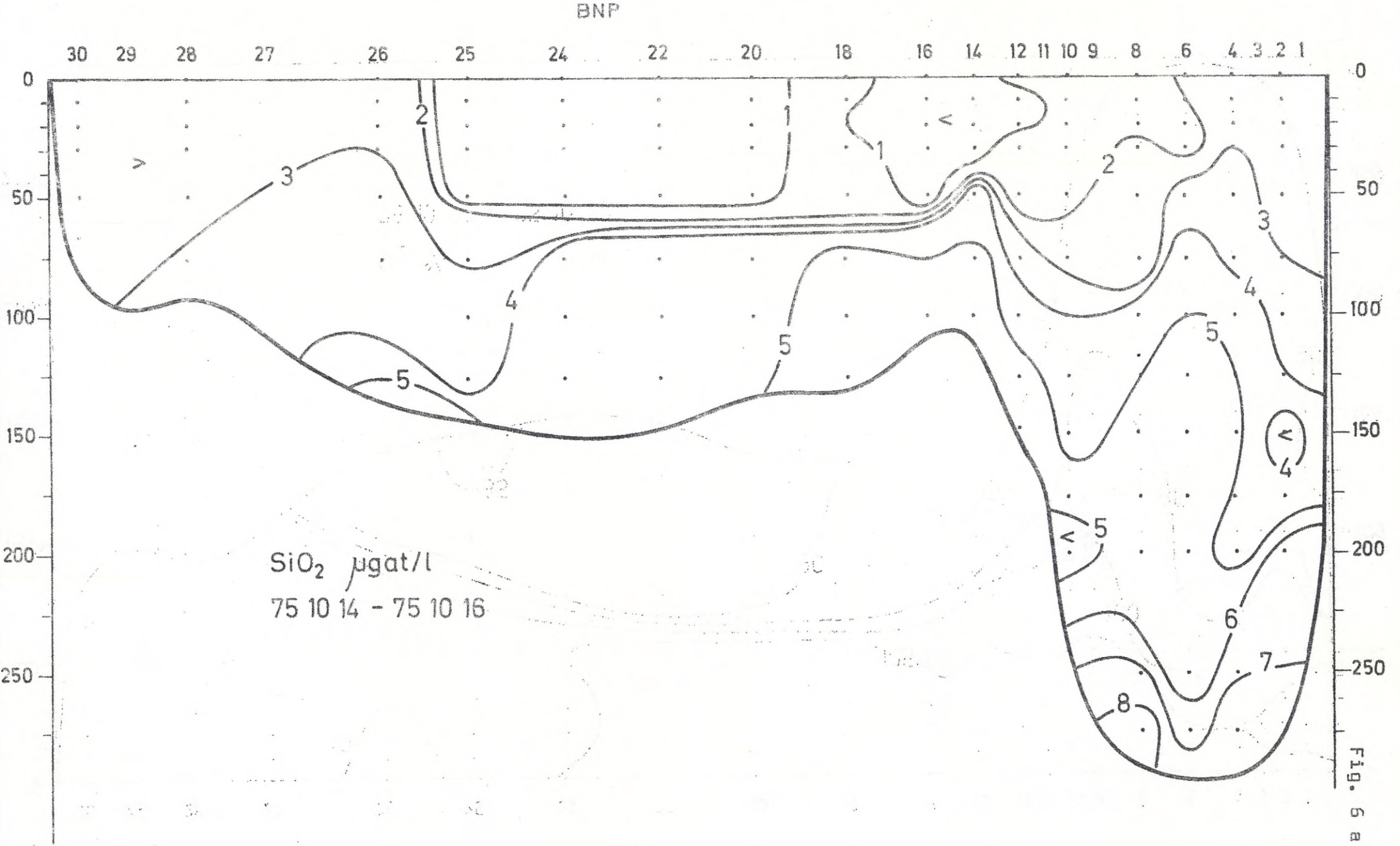
85
90
O_2 %
75 10 20 – 75 10 22

Fig. 5 b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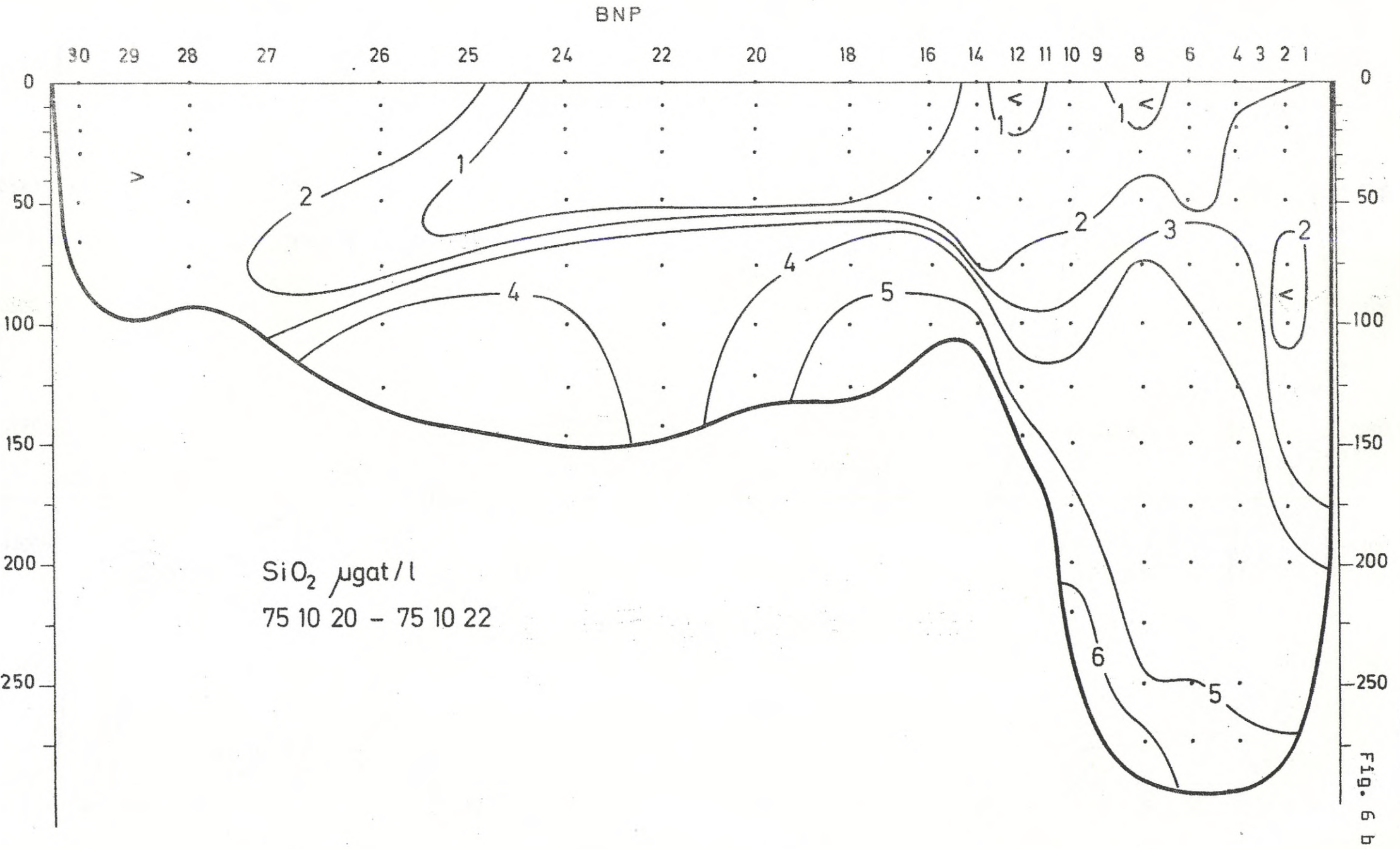
100
150
200
250
SiO2 µgat/l
75 10 14 - 75 10 16

Fig. 6 a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100
150
200
250
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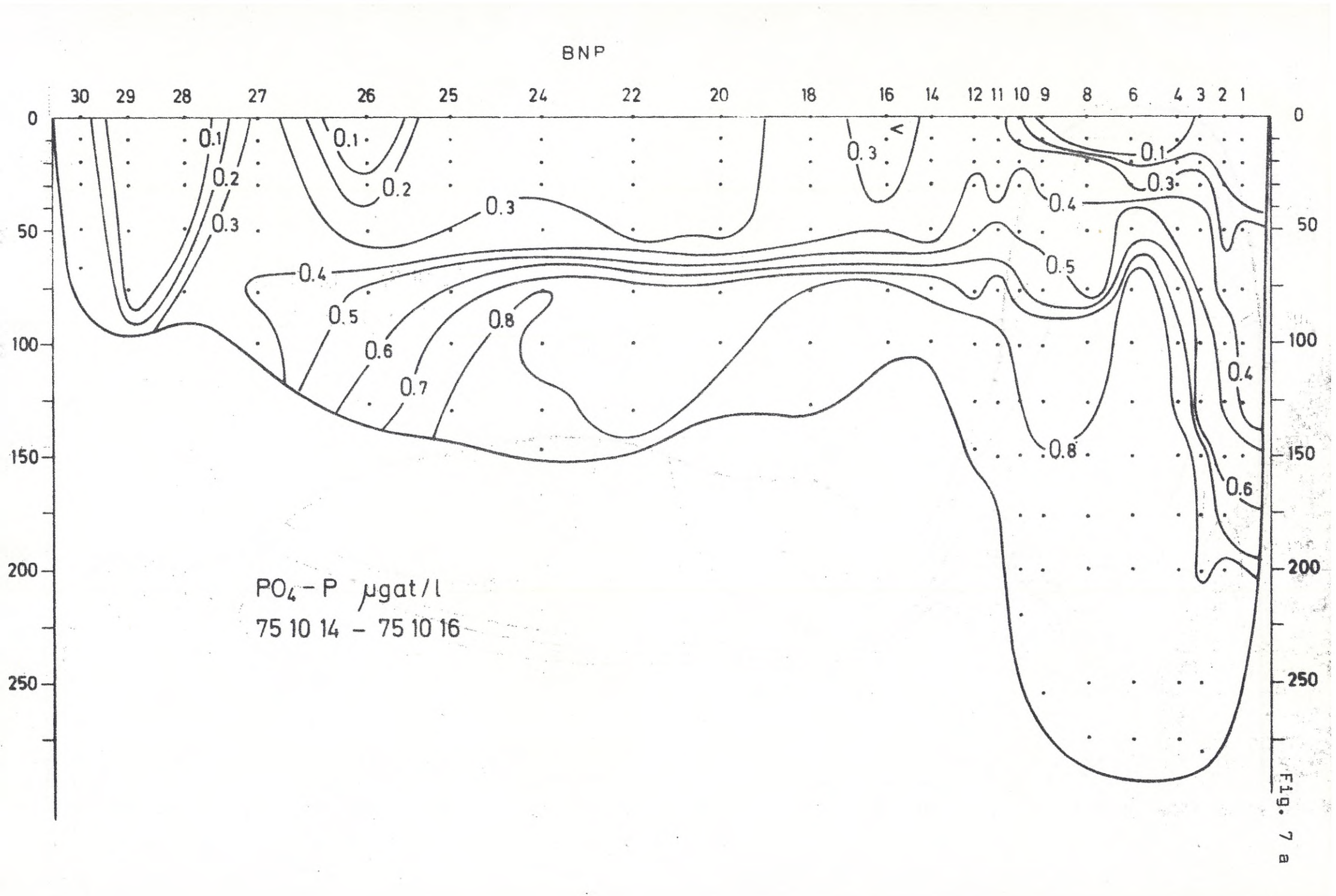
75 10 20 - 75 10 22
Fig. 6 b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0
50
100
150
200
250
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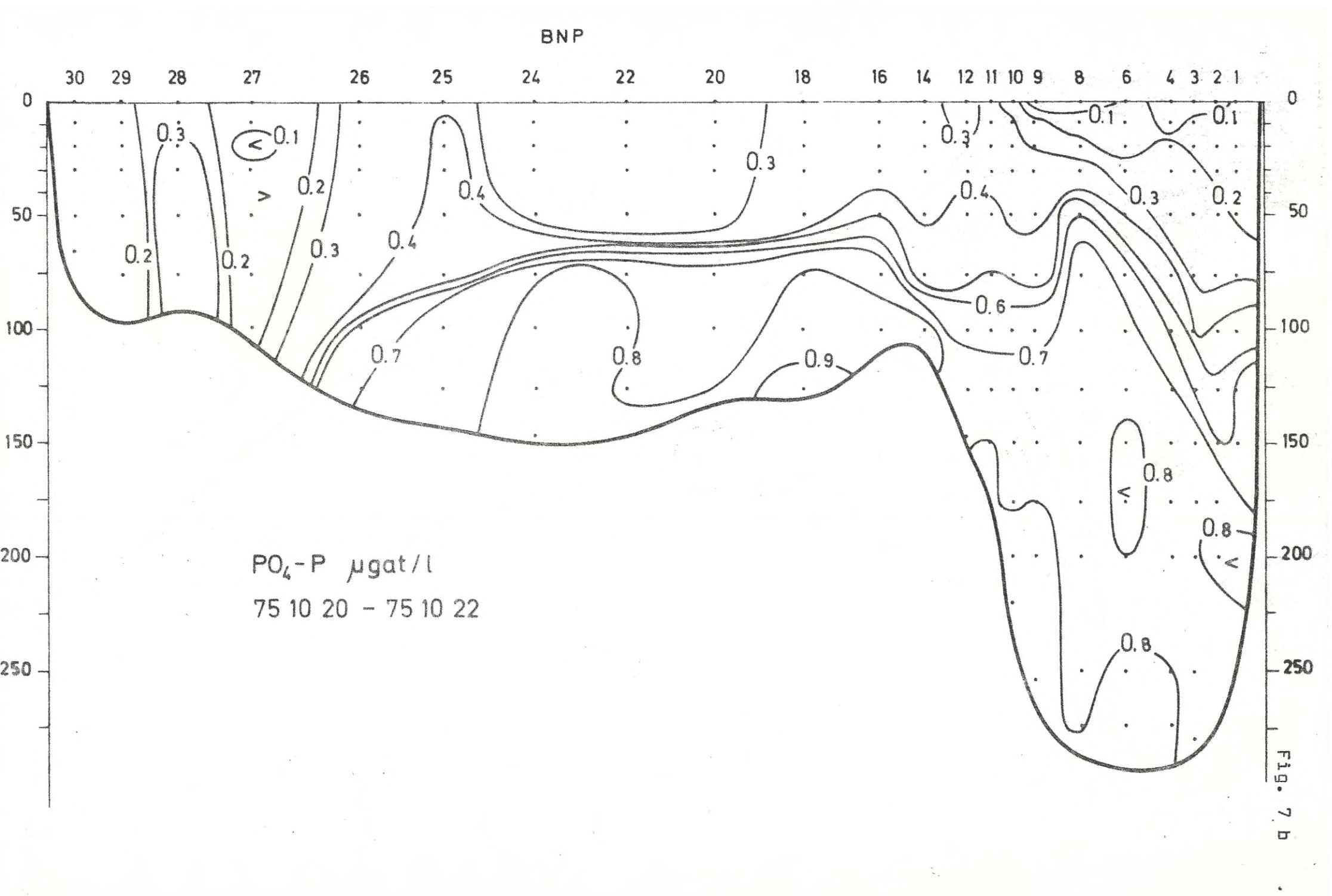
0.2
0.3
0.4
0.5
0.6
0.7
0.8
PO4 – P µgat/l
75 10 14 – 75 10 16

Fig. 7 a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0.2
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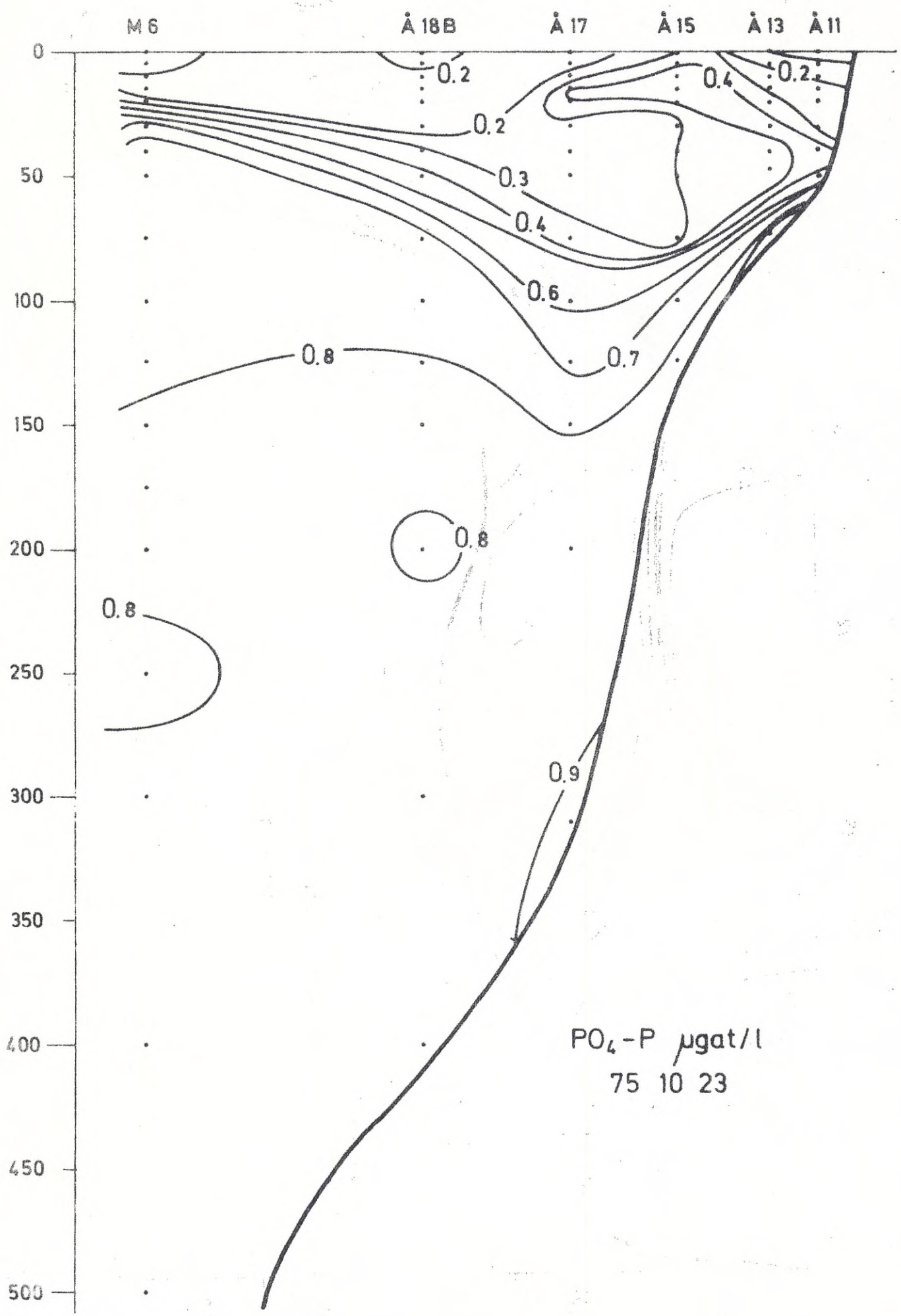
0.8
0.9
PO4-P µgat/l
75 10 20 - 75 10 22

Fig. 7 b

Fig. 7 c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0.4
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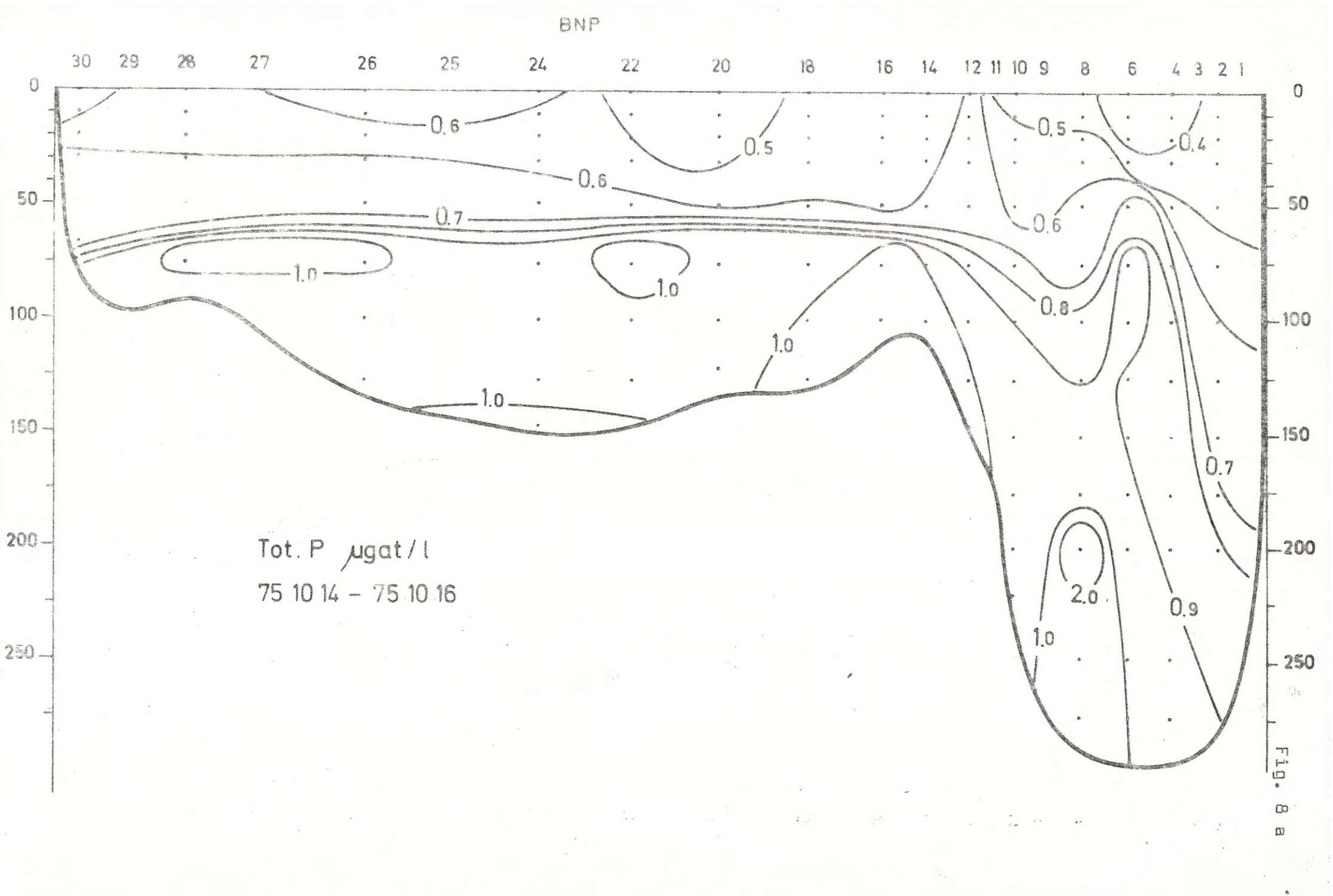
0.9
PO4-P µgat/l
75 10 23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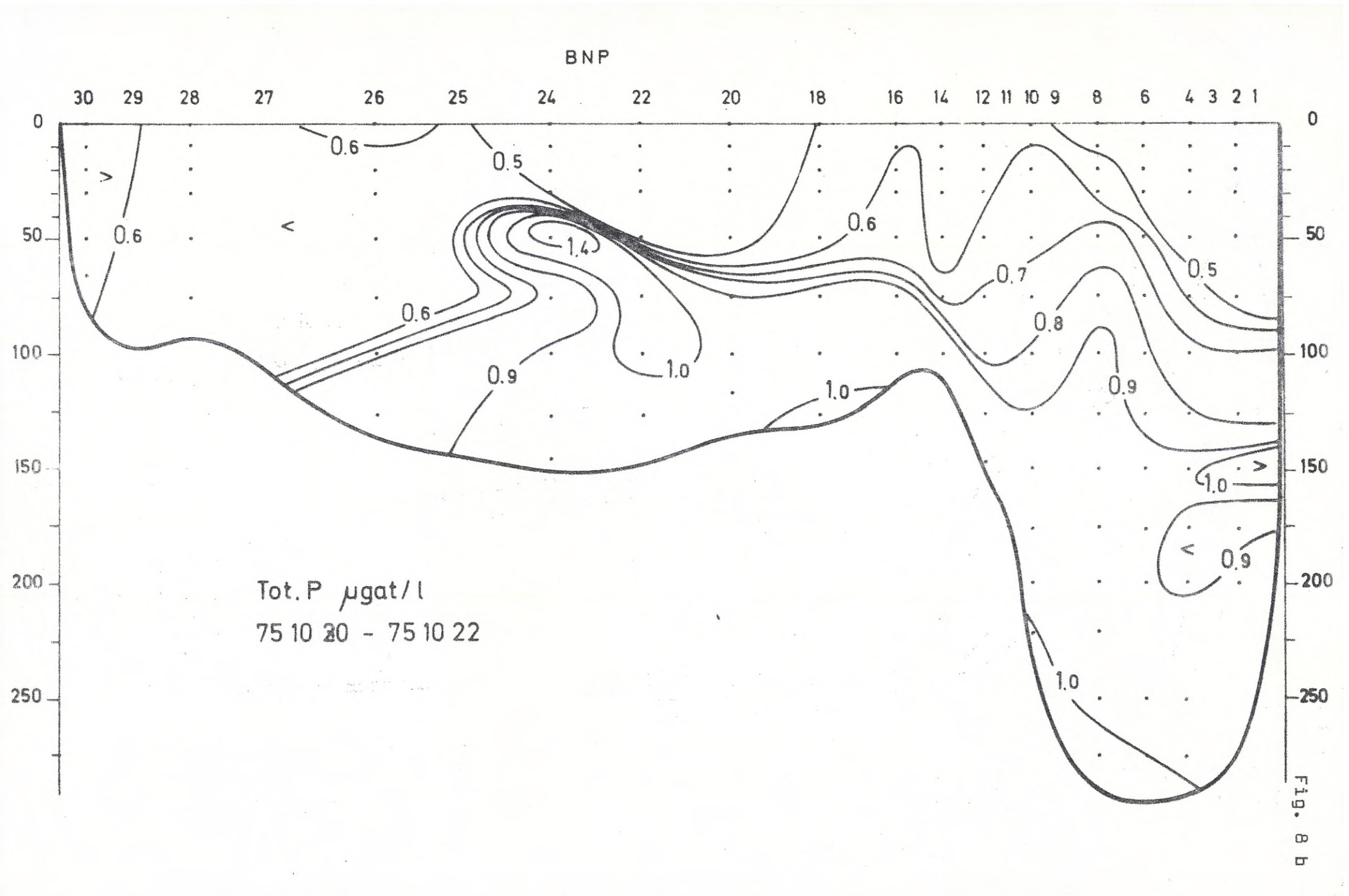
0.7
1.0
1.0
1.0
1.0
0.5
0.4
0.6
0.8
0.7
2.0
0.9
1.0
Tot. P µgat / l
75 10 14 – 75 10 16

Fig. 8 a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0.8
0.6
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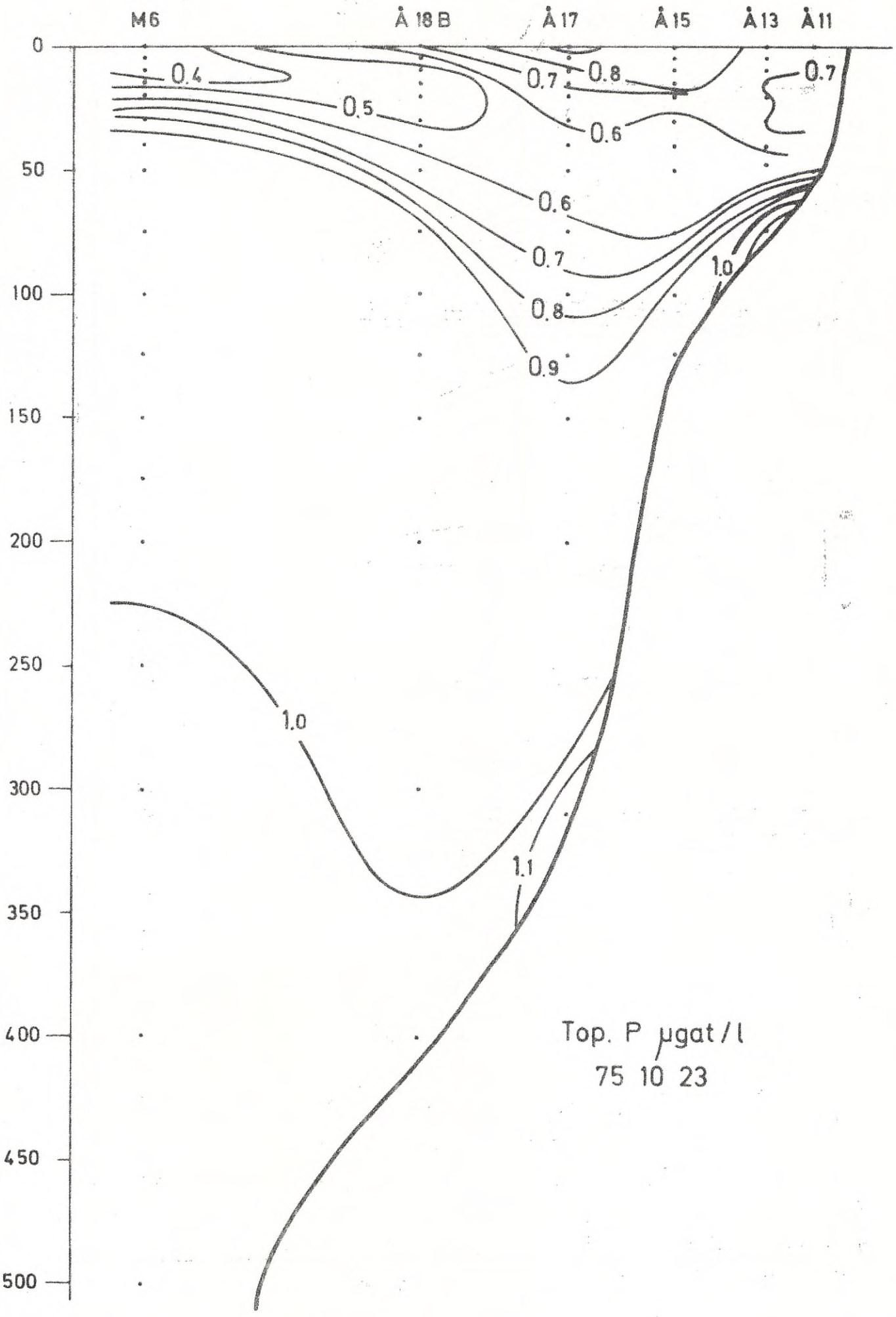
Tot. P µgat/l
75 10 20 - 75 10 22

Fig. 8 b

Fig. 8 c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350
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1.0
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Top. P µgat / l
75 10 23

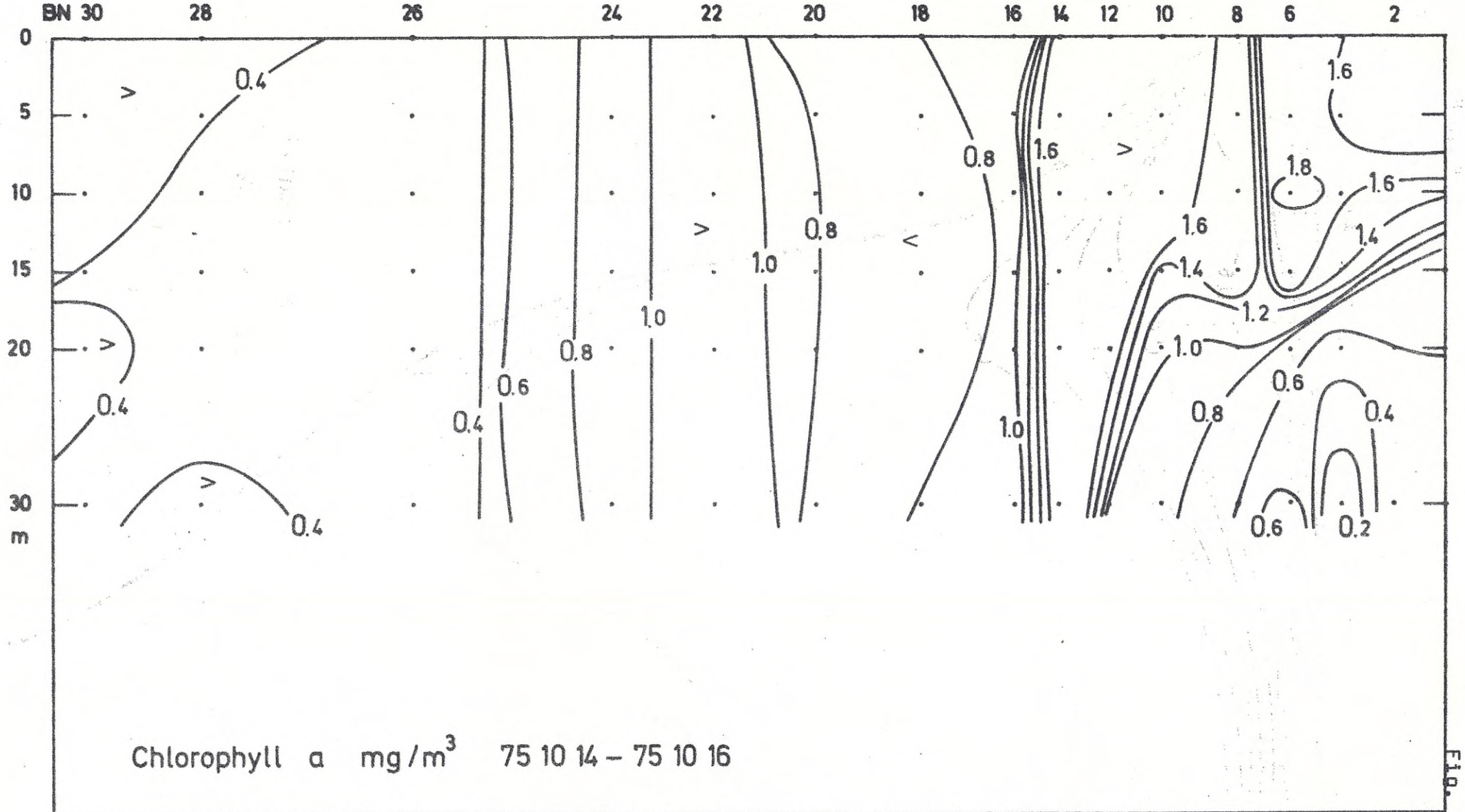
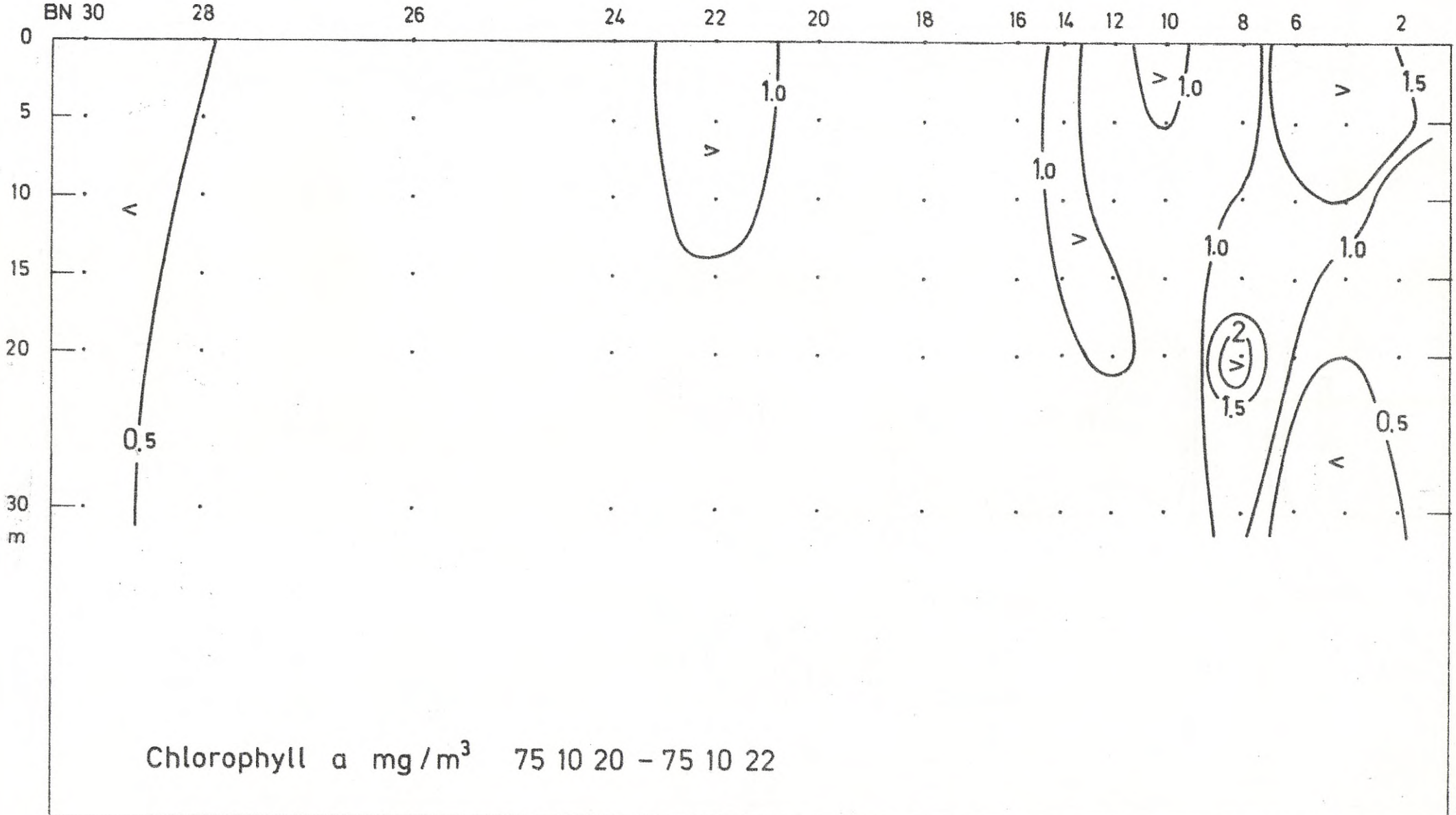
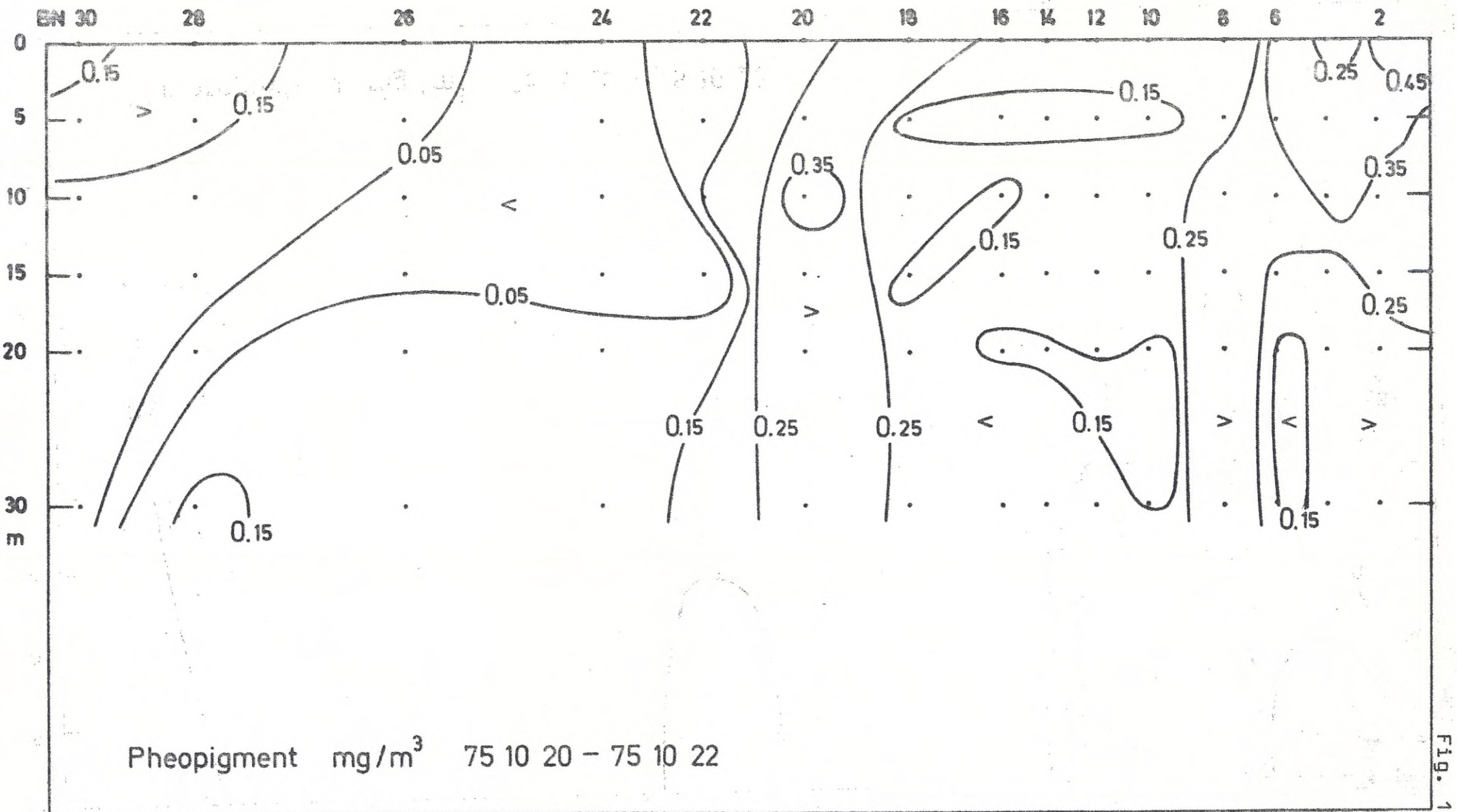

BN 30
28
26
24
22
20
18
16
14
12
10
8
6
2
0
5
10
15
20
30
m
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.2
Chlorophyll a mg/m³ 75 10 14 – 75 10 16

Fig. 9a



Chlorophyll a mg / m³ 75 10 20 – 75 10 22

Fig. 9 b


EN 30
28
26
24
22
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18
16
14
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2
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5
10
15
20
30
m
0.15
0.15
0.05
0.05
0.15
0.35
0.25
0.15
0.15
0.25
0.15
0.25
0.45
0.35
0.25
0.15
Pheopigment mg/m³ 75 10 20 – 75 10 22

Fig. 10 b

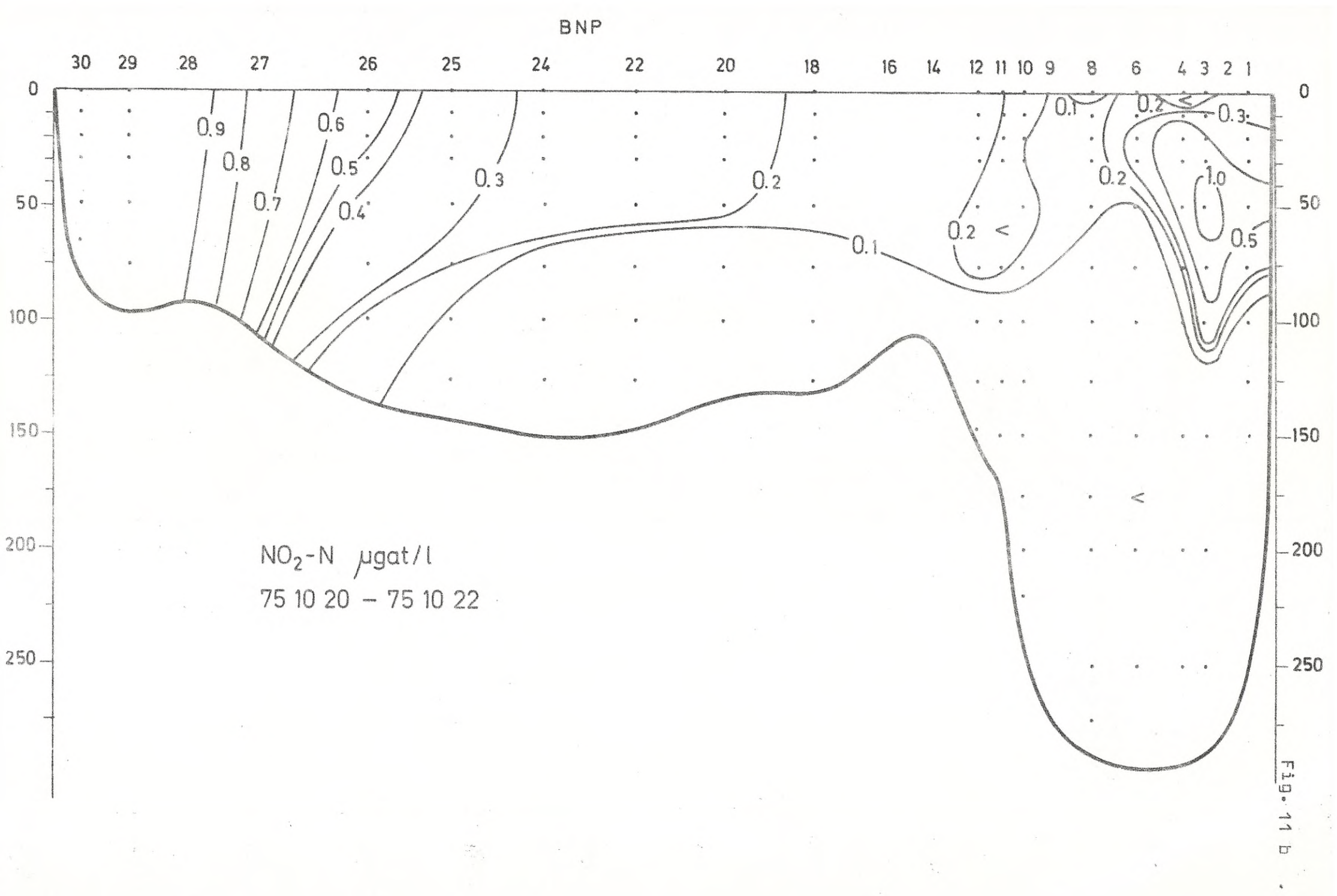
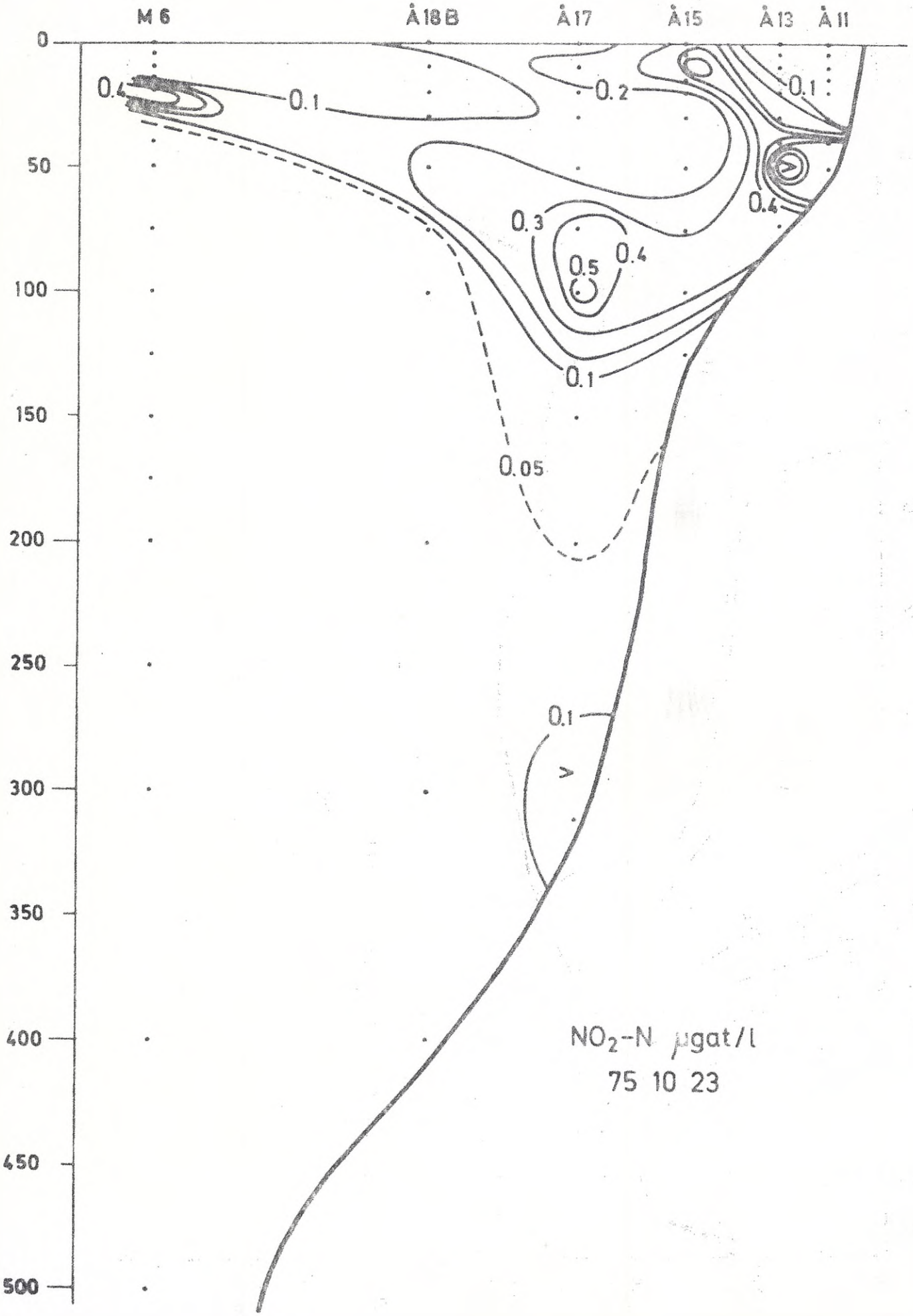

BNP
30 29 28 27 26 25 24 22 20 18 16 14 12 11 10 9 8 6 4 3 2 1
0
50
100
150
200
250
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.2 <
0.1
0.2 <
0.3
0.2
1.0
0.5
<
NO2-N µgat/l
75 10 20 – 75 10 22

Fig. 11 b

Fig. 11 c


M 6
Å 18 B
Å 17
Å 15
Å 13
Å 11
0
50
100
150
200
250
300
350
400
450
500
0.4
0.1
0.2
0.1
0.3
0.4
0.5
0.4
0.1
0.05
0.1
>
NO_2-N µgat/l
75 10 23

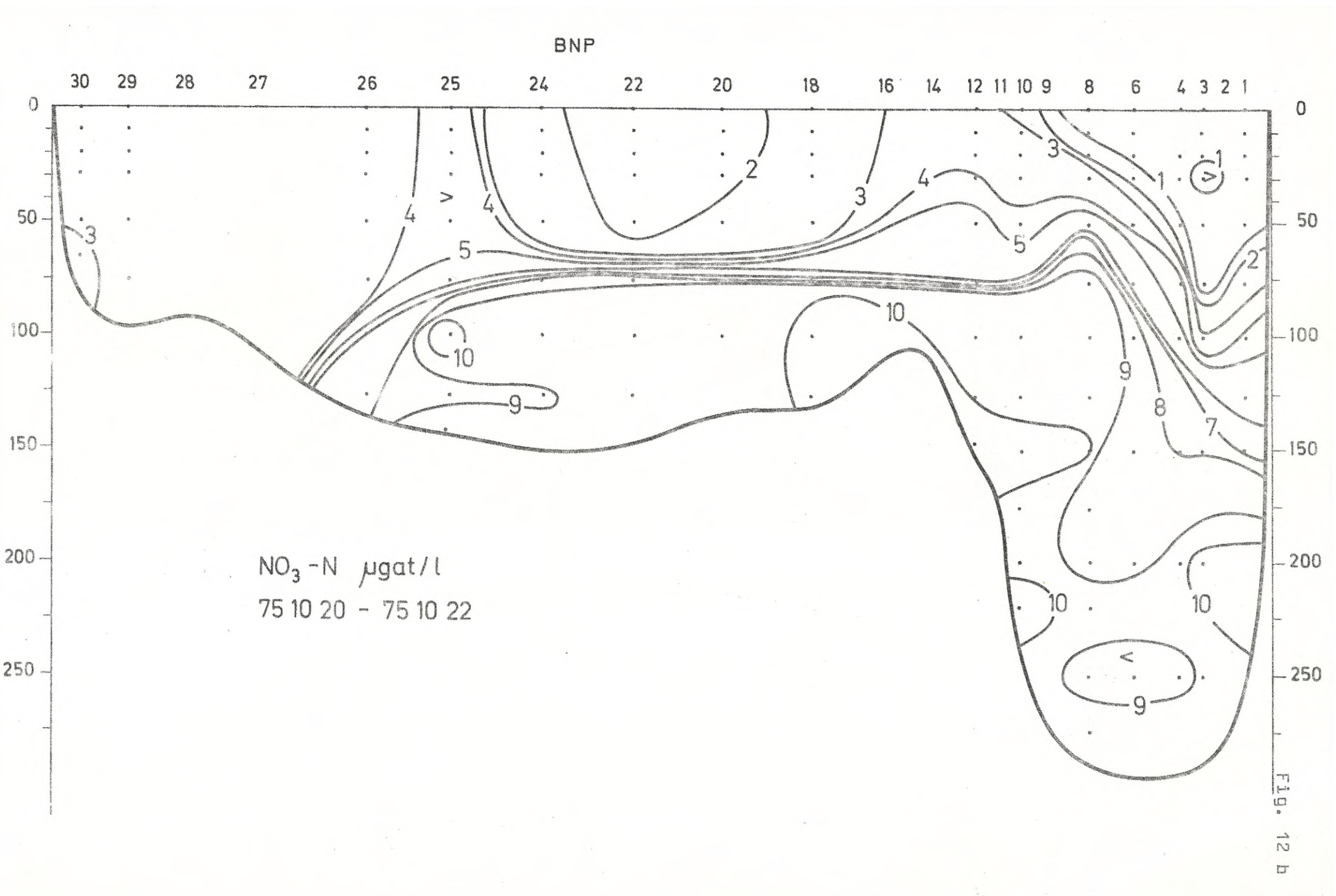
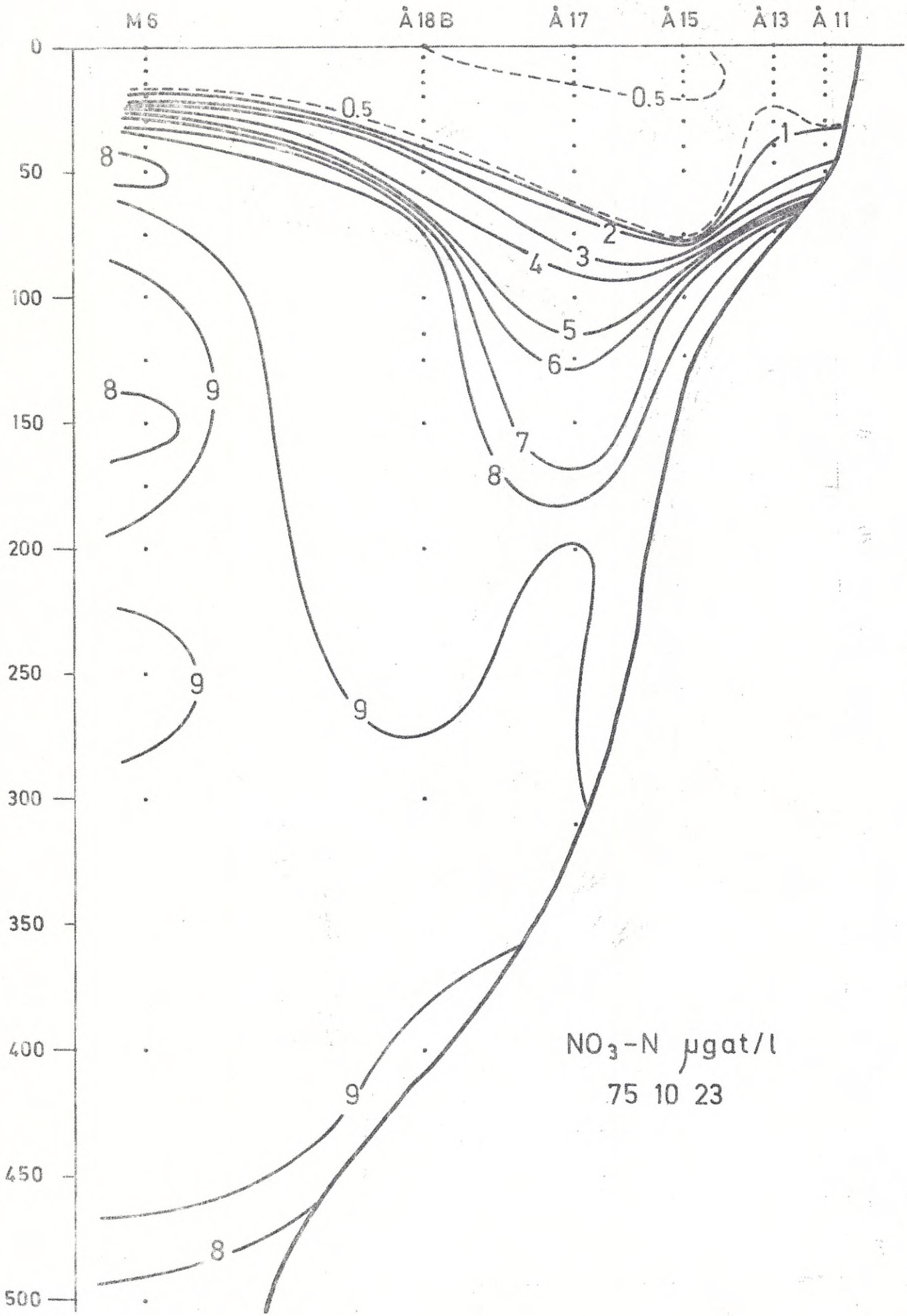

BNP
30 29 28 27 26 25 24 22 20 18 16 14 12 11 10 9 8 6 4 3 2 1
0
50
100
150
200
250
NO_3 -N µgat/l
75 10 20 - 75 10 22

Fig. 12 b

Fig. 12 c


M 6
Å 18 B
Å 17
Å 15
Å 13
Å 11
0
50
100
150
200
250
300
350
400
450
500
0.5
1
2
3
4
5
6
7
8
9
NO3-N µgat/l
75 10 23

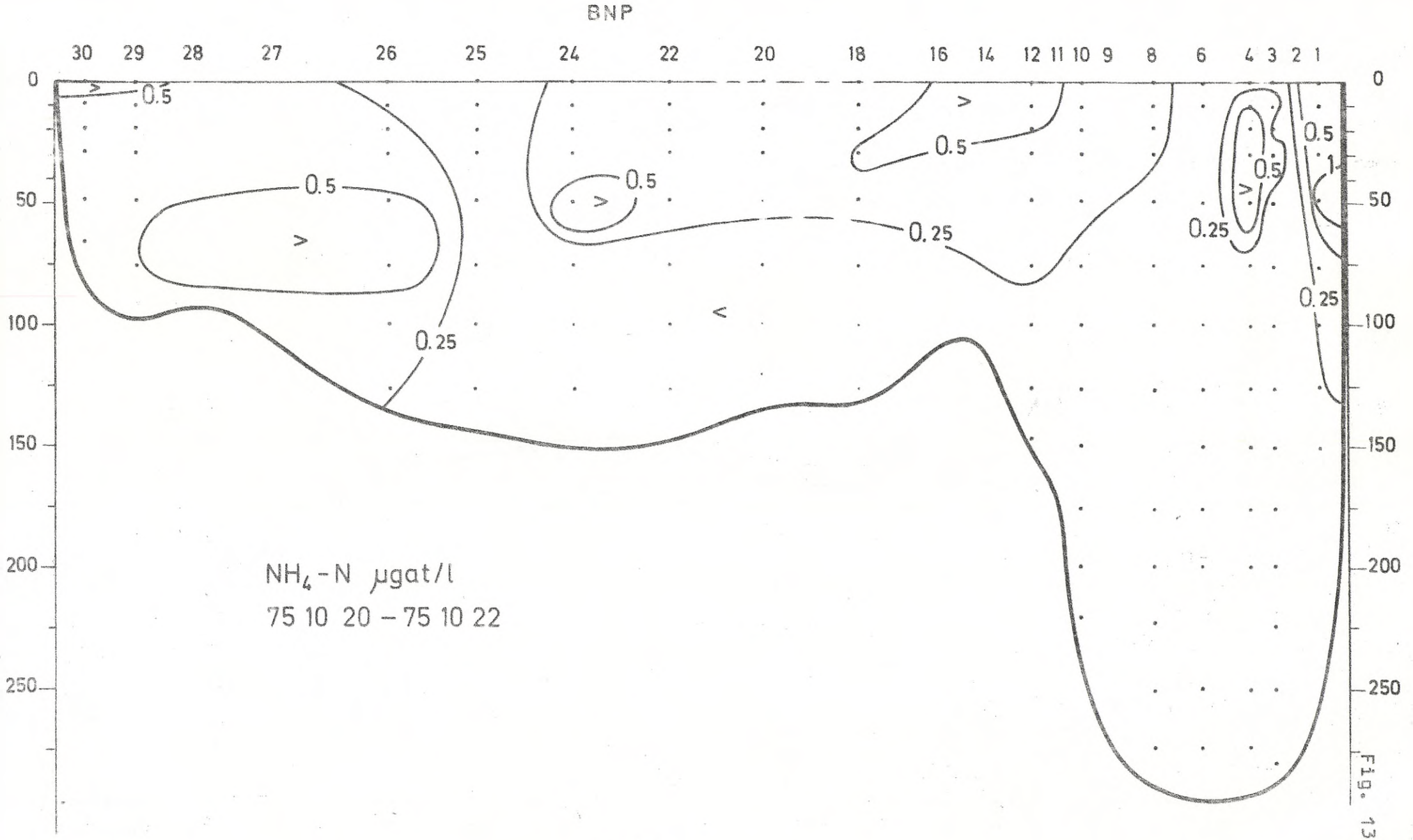

BNP
30 29 28 27 26 25 24 22 20 18 16 14 12 11 10 9 8 6 4 3 2 1
0
50
100
150
200
250
0.5
0.25
1
NH4-N µgat/l
75 10 20 – 75 10 22

Fig. 13 b

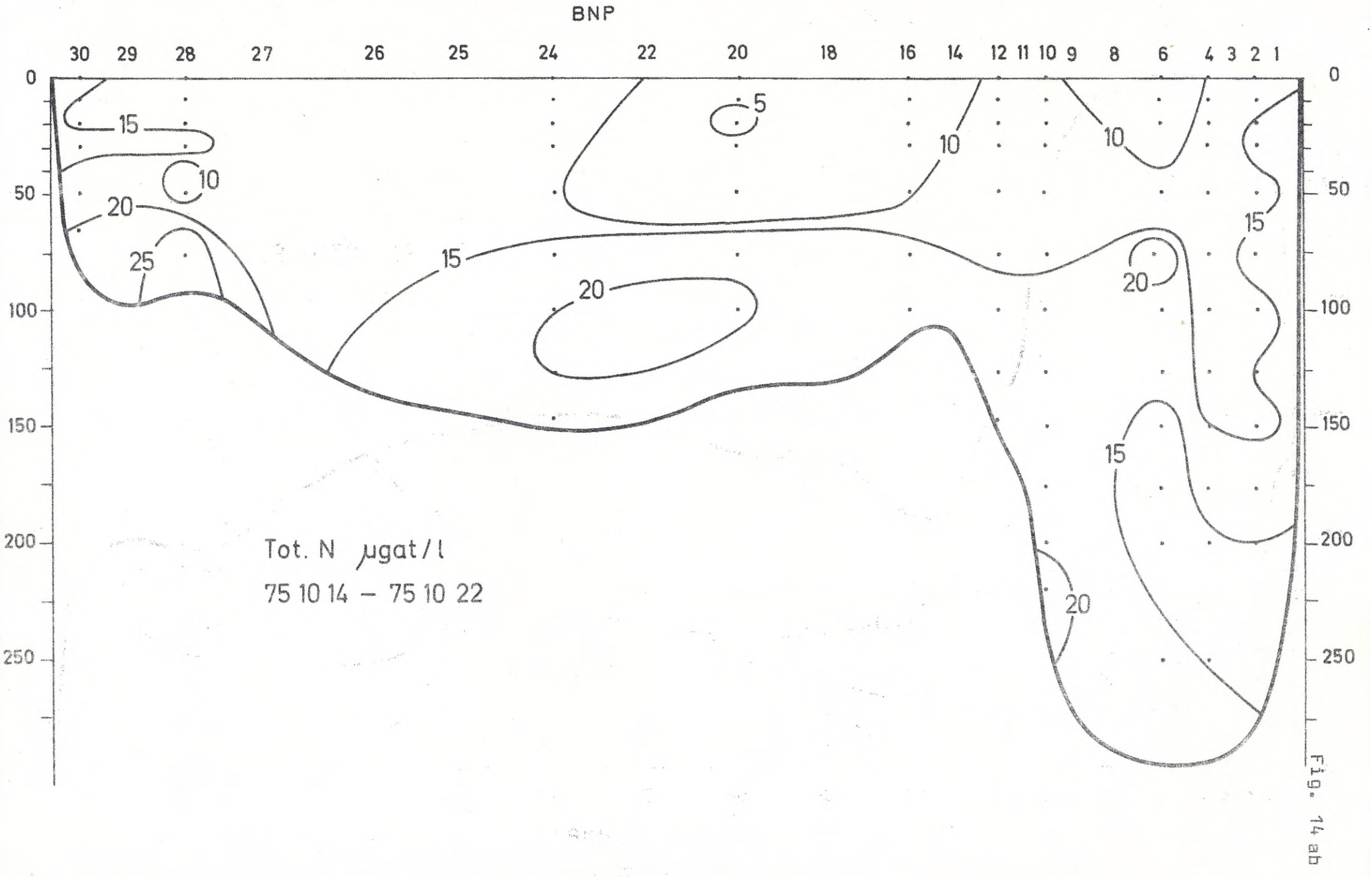

BNP
30 29 28 27 26 25 24 22 20 18 16 14 12 11 10 9 8 6 4 3 2 1
0
50
100
150
200
250
15
10
20
25
5
10
15
20
10
15
20
20
15
Tot. N µgat/l
75 10 14 – 75 10 22

Fig. 14 ab