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Observation of the Salinity Minimum Layer in the Shikoku Basin South of Japan

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Abstract

Salinity observations in the Shikoku Basin south of Japan have been made during the period of 1983–1988. Focus is placed on the salinity minimum layer, which exists at depths of 400–600 m over a continental slope and/or ridge slope and at depths of 700–1000 m over a flat deep basin. In the present report, all the salinity data along the observational lines are presented.

Some interesting features of the salinity fields are detected. Two dominant salinity minimum areas are found in the salinity minimum layer. One minimum area exists over the continental slope and the other minimum exists over the flat basin in the Shikoku Basin, which locates 200–300 km offshore to the former minimum. It is suggested that the former minimum is originated by the intermediate Oyashio water, which flows sourthward along the Boso Peninsula. The latter minimum over a flat basin is inferred to be originated from the second Oyashio intrusion. On the whole, the character with two minimum salinity areas is observed in further south in the Shikoku Basin, which was well observed in the eastern region to the Izu-Ogasawara Ridge.

Key words: salinity minimum layer, the Oyashio, intermediate water, ventilation.

1. Introduction

It has been observed that some zooplanktons which ordinary lives in the water of the Oyashio system, Copepoda calanus and Sagitta elegans, are found from salinity minimum layer to bottom layer in the Sagami Bay[1),2),3)]. This fact suggests that the Oyashio water intrudes southward to the Sagami Bay. It is also well known that a surface Oyashio water sometimes intrudes remarkablly southward upto offshore of a southern area of Ibaraki Prefecture[4),5)], whereas the mean southward limit of the surface Oyashio water is about 38°–39°N. However, because the surface southward intrusion of the Oyashio water is confined to the north of the Boso Peninsula[4)], the further southward intrusion of the Oyashio water is carried out only in an under surface layer.

The southward intrusion of the Oyashio water in an intermediate layer has been studied by some authors[6),7),8)]. Recently, YANG et al. (1990)[9)] pointed out by the historical data analysis that the intermediate Oyashio water intrudes upto the Sagami Bay, but it does not intrude to a western side of the Izu Peninsula. They also resulted that low salinity water with relatively high oxygen content is observed at the southeast off of the Boso Peninsula, which is carried by the anomalous southward Oyashio intrusion in the surface layer.

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However, because the observation lines analyzed by YANG et al. (1990)[9] are confined to a north of 33.5°N, the intrusion of the Oyashio water in south to this latitude has been not studied. In order to see the salinity distribution to further southern area, we have observed the salinity fields by use of the training & research vessel Seisui-maru of Mie University, during the period of 1983 to 1988. In the present report, all of the salinity data is presented. Some interesting features of the salinity fields are detected.

2. Observations

All the observations have been carried out by the training & research vessel Seisui-maru of Mie University, of which details are tabulated in Table 1. Temperature and salinity are observed by CTD, of which maximum depth of the observation is 3200 db. Although this maximum depth is insufficient for the study of bottom water, it is enough to see the salinity minimum layer almost above 1200 db.

Table 1. Observations made by the Seisui-maru for the present study

Cruise name	Periods of Observation	No. of observational lines
83MAY	8–12 May 1983	2
83JUL-1	16–19 Jul. 1983	1
83JUL-2	25–28 Jul. 1983	1
83OCT	30 Oct.–3 Nov. 1983	2
84JAN	28 Jan.–2 Feb. 1984	2
84APR	16–25 Apr. 1984	4
84JUL-1	15–18 Jul. 1984	1
84JUL-2	25–28 Jul. 1984	2
84SEP	14–20 Sep. 1984	3
84NOV	21–30 Nov. 1984	4
85MAY	17–24 May 1985	3
85JUL-1	14–17 Jul. 1985	1
85JUL-2	21–25 Jul. 1985	1
86MAY	10–16 May 1986	3
86JUL-1	14–17 Jul. 1986	1
86JUL-2	23–26 Jul. 1986	1
86NOV	28 Nov.–10 Dec. 1986	3
87JUL-1	16–18 Jul. 1987	1
87JUL-2	24–26 Jul. 1987	1
87NOV	27 Nov.–9 Dec. 1987	2
88MAY	8–16 May 1988	1
88OCT	27 Oct.–3 Nov. 1988	2

3. Vertical distribution of salinity south of Japan

The observed salinity fiedls along all the observational lines are presented in Fig. 1. Some common characteristics are detected. The salinity minimum layer exists at depths of 400–600 m over a continental slope. As it goes offshore region, depth of the salinity minimum layer increases.

If we see the spacial salinity variation in the salinity minimum layer, two dominant minimum areas are

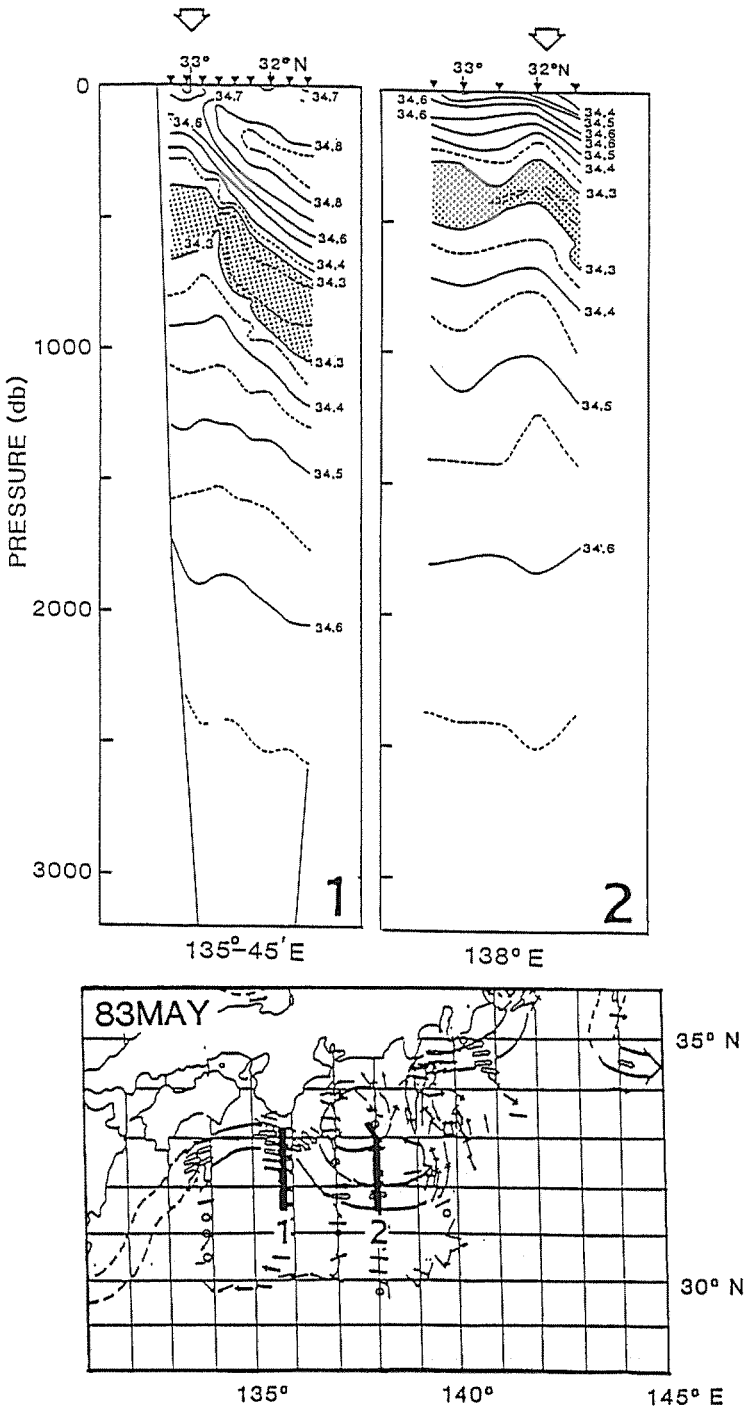
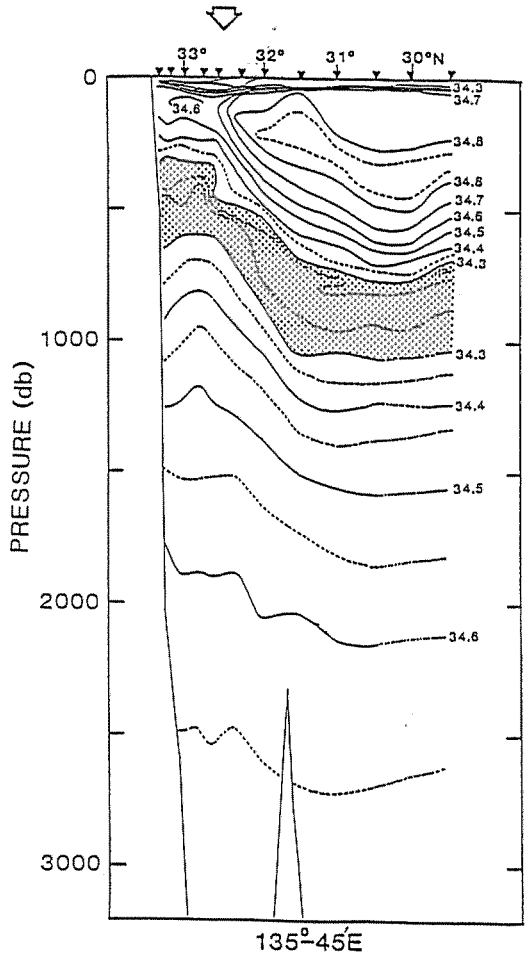


Fig. 1. Vertical section of salinity fiels (in ‰). Contour interval is 0.1‰ and regions less than 34.3‰ are stippled. The location of the vertical section is shown by solid line in the bottom map, where location of the main Kuroshio axis and velocity vectors by Japan Hydrographic Department are also shown. Vertical large arrow over the vertical section show a location of main axis of the Kuroshio.



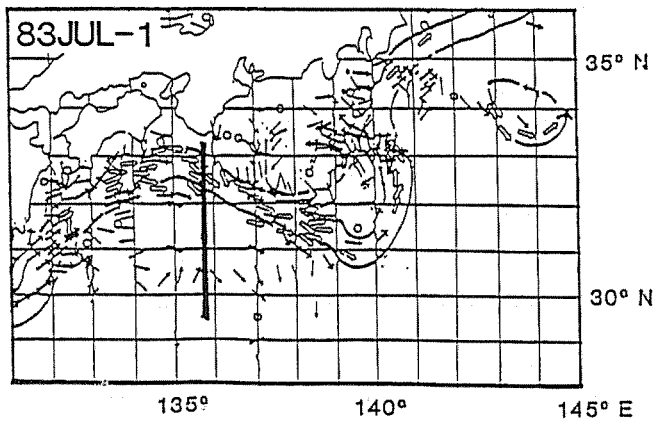
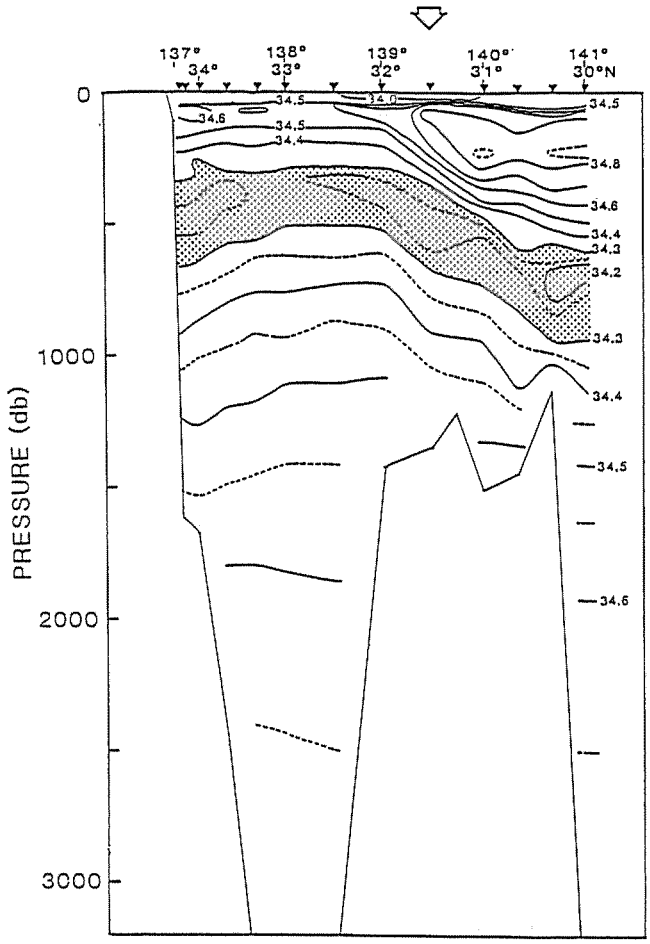
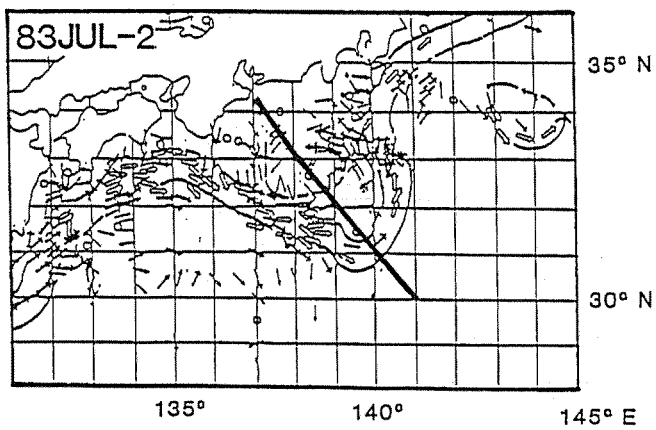


Fig. 1 continued (1)





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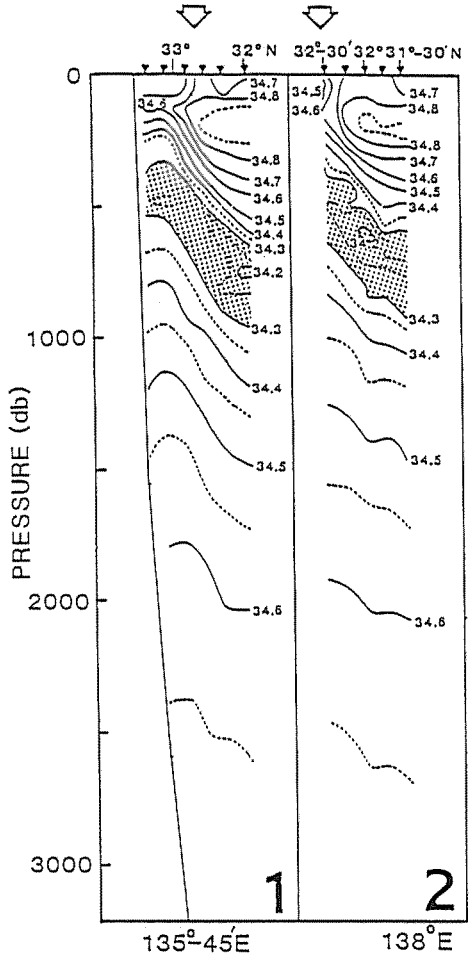

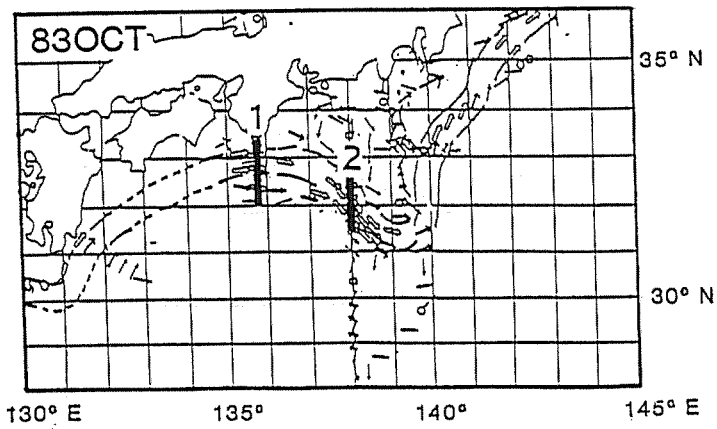

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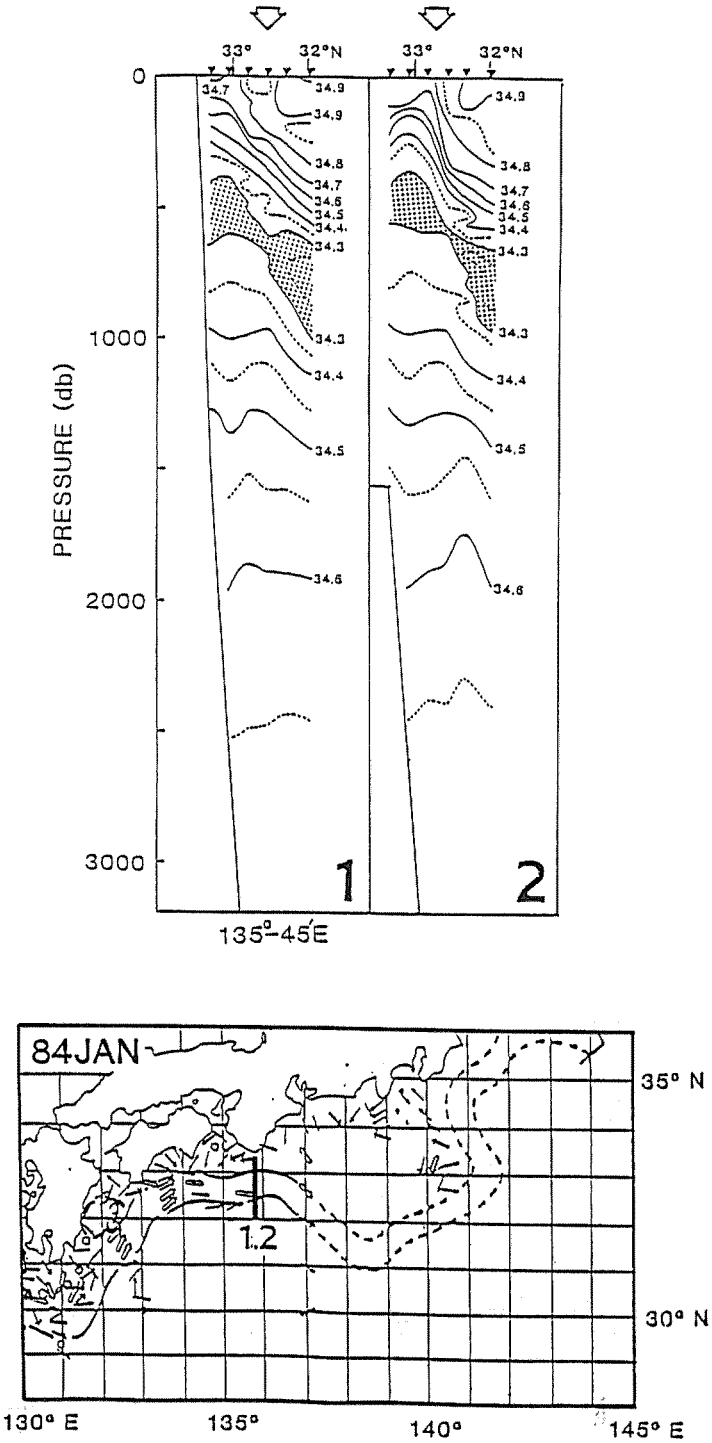

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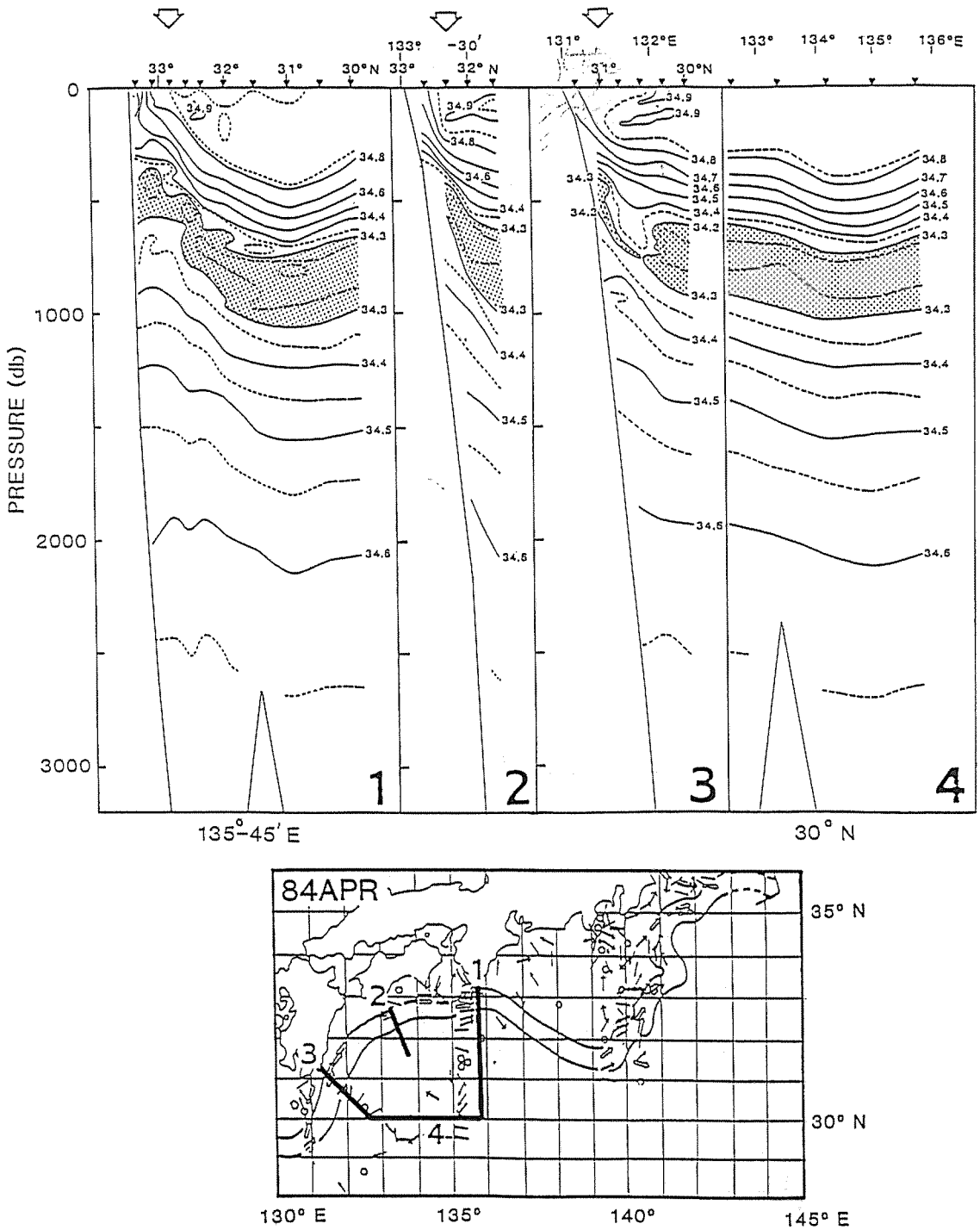

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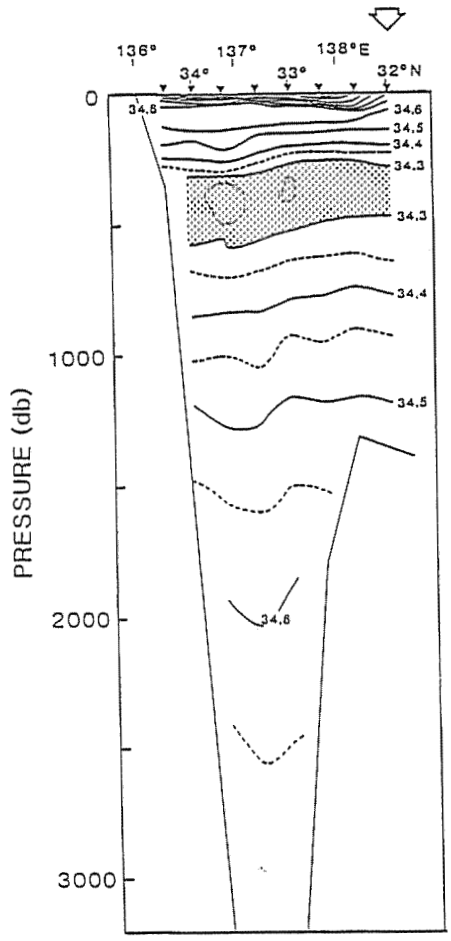

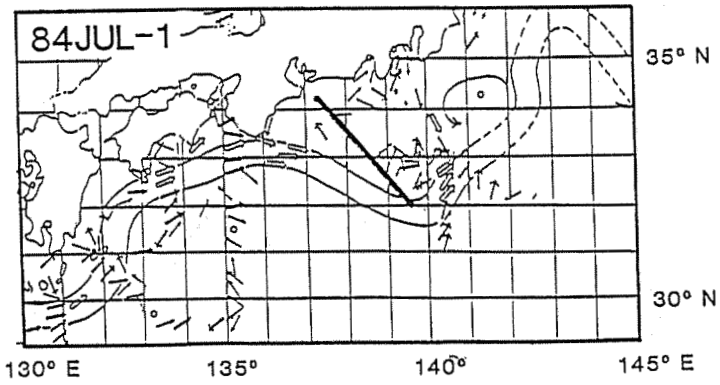

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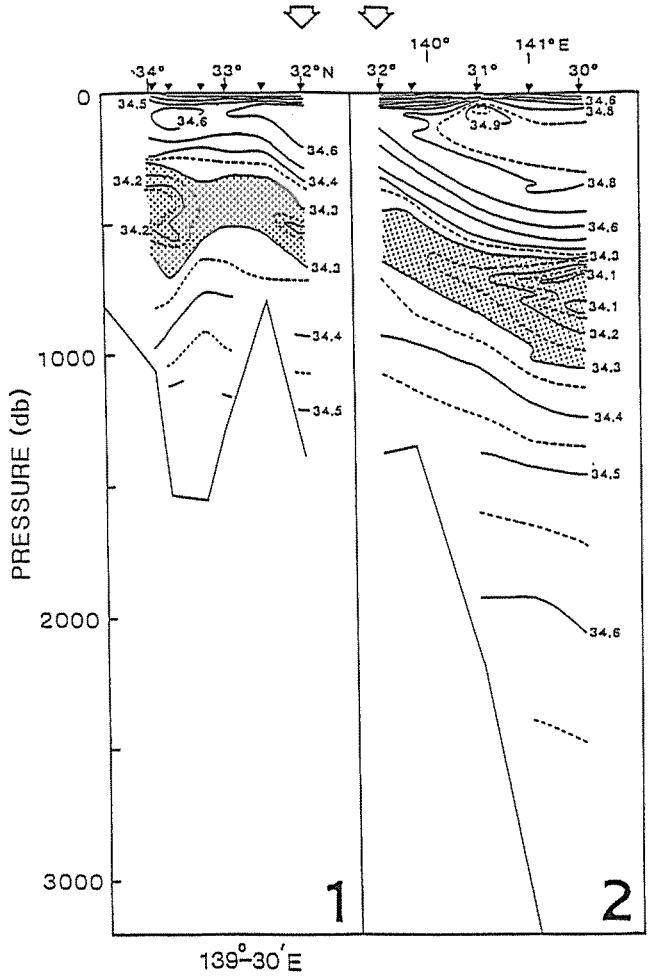

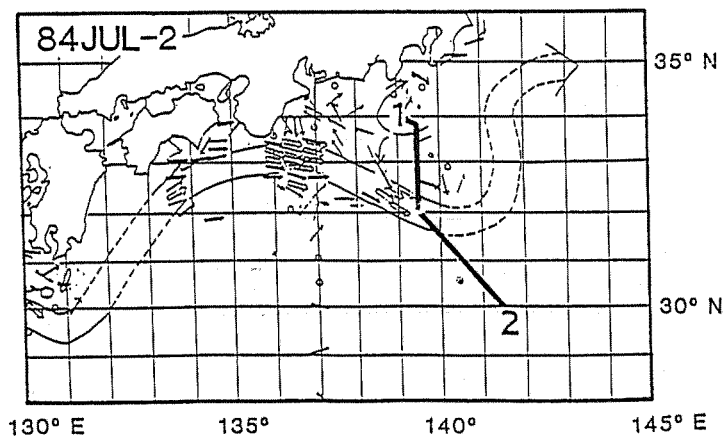

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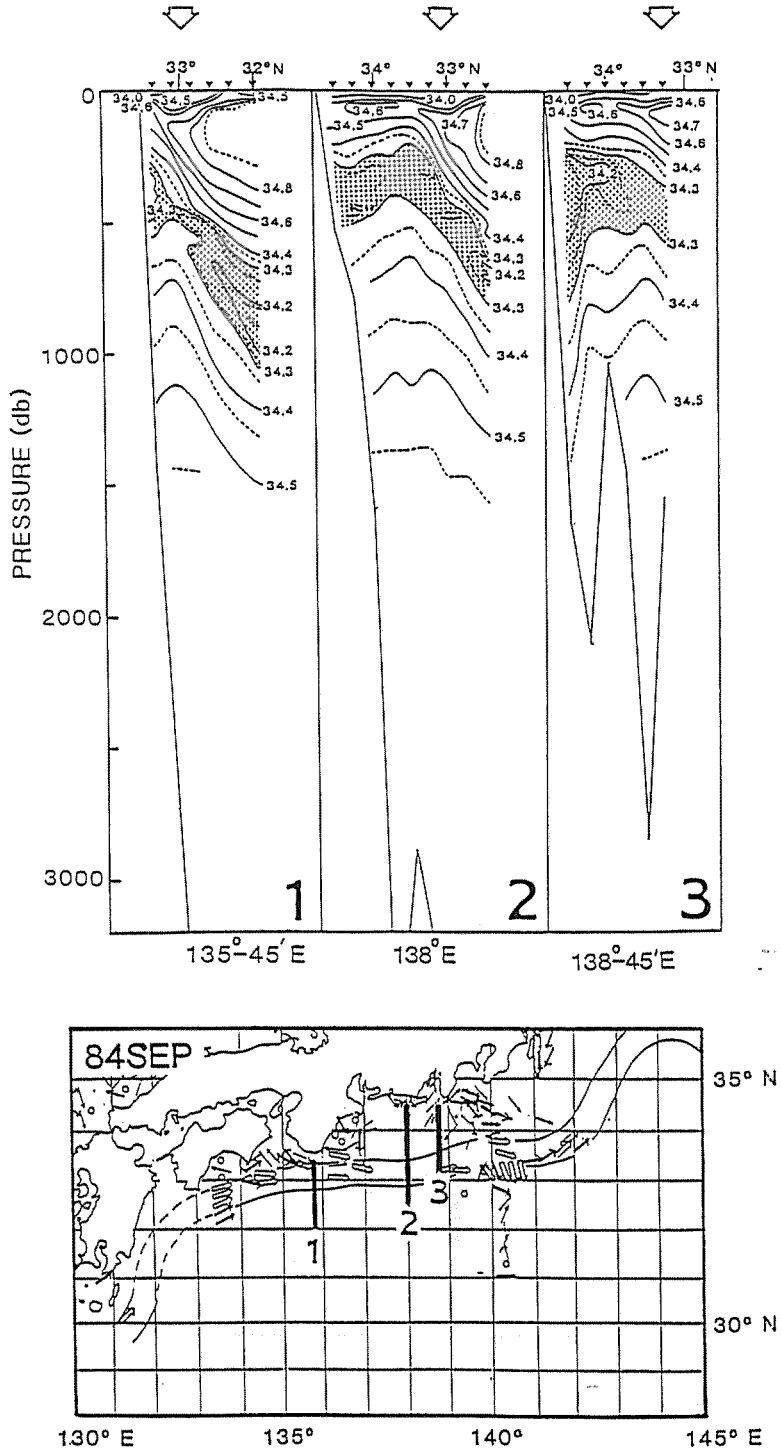

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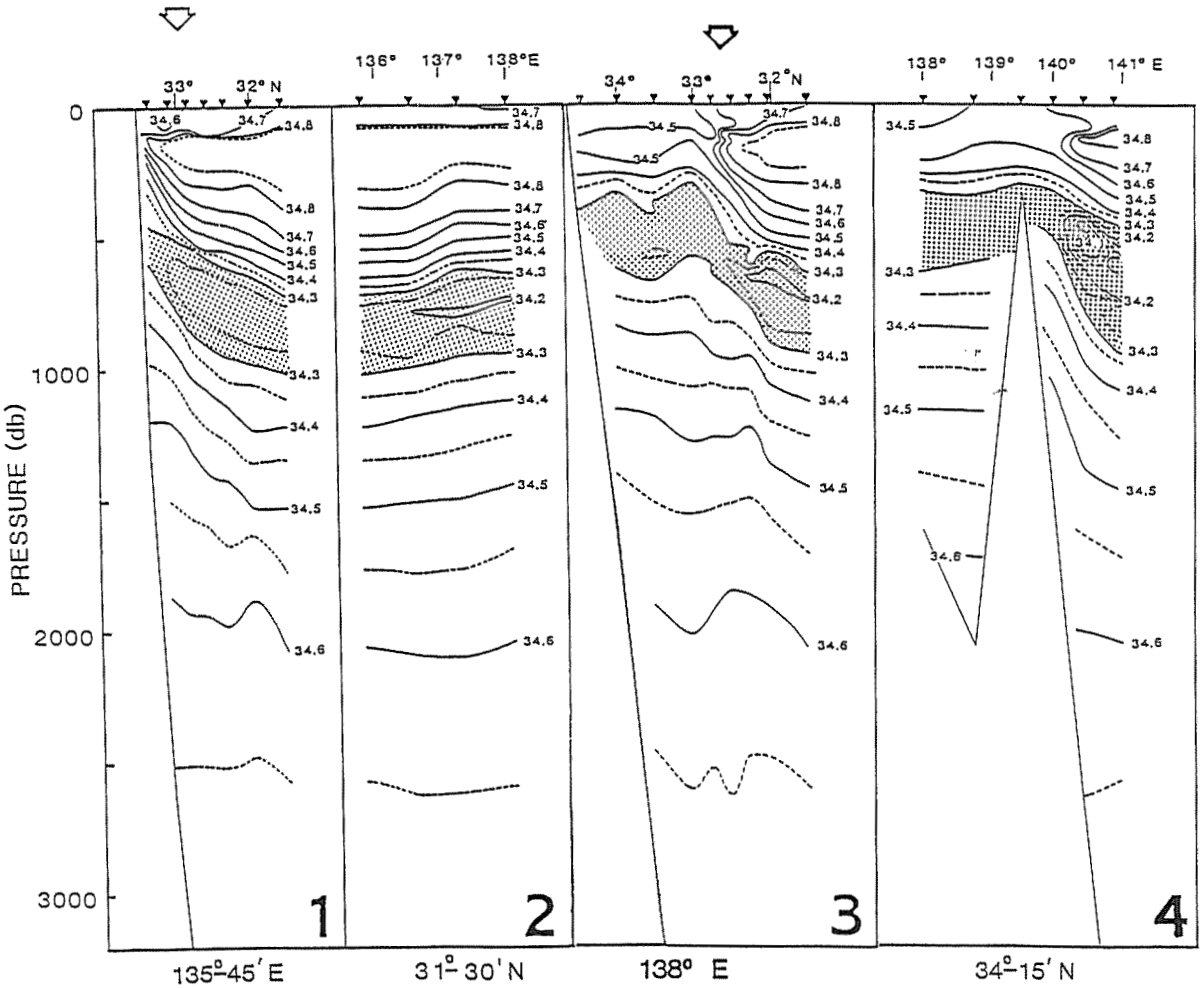

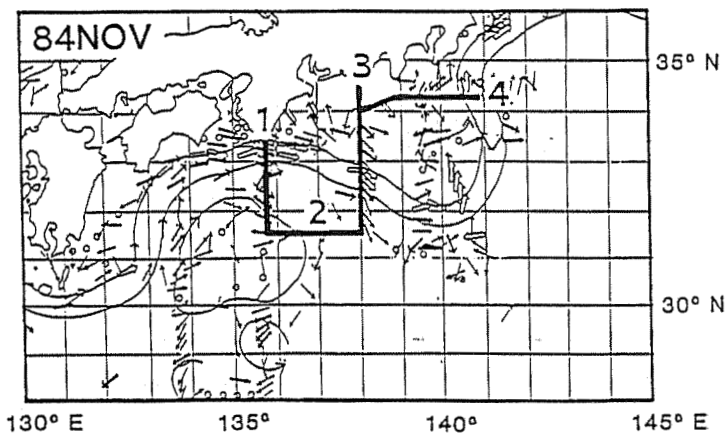

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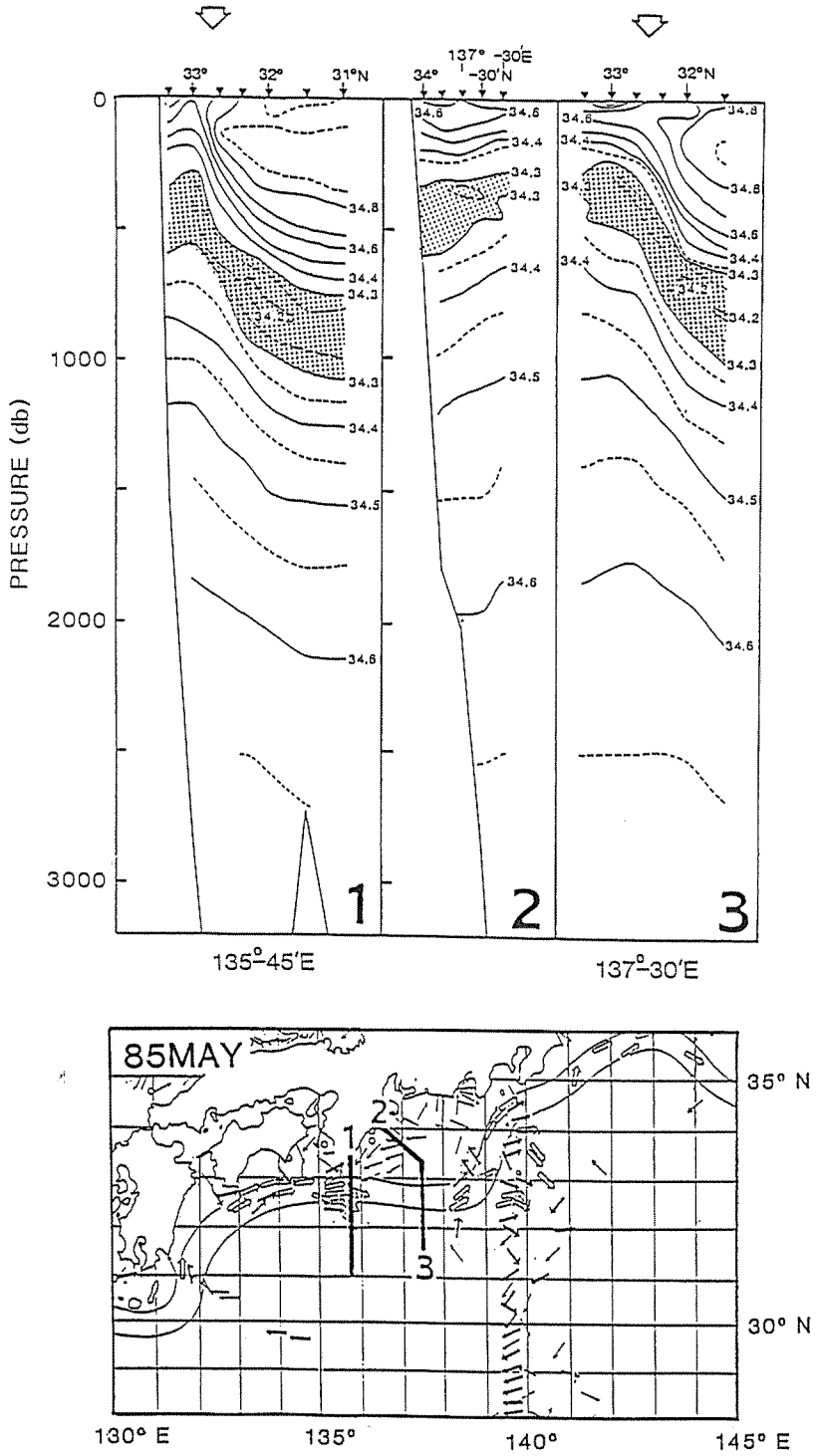

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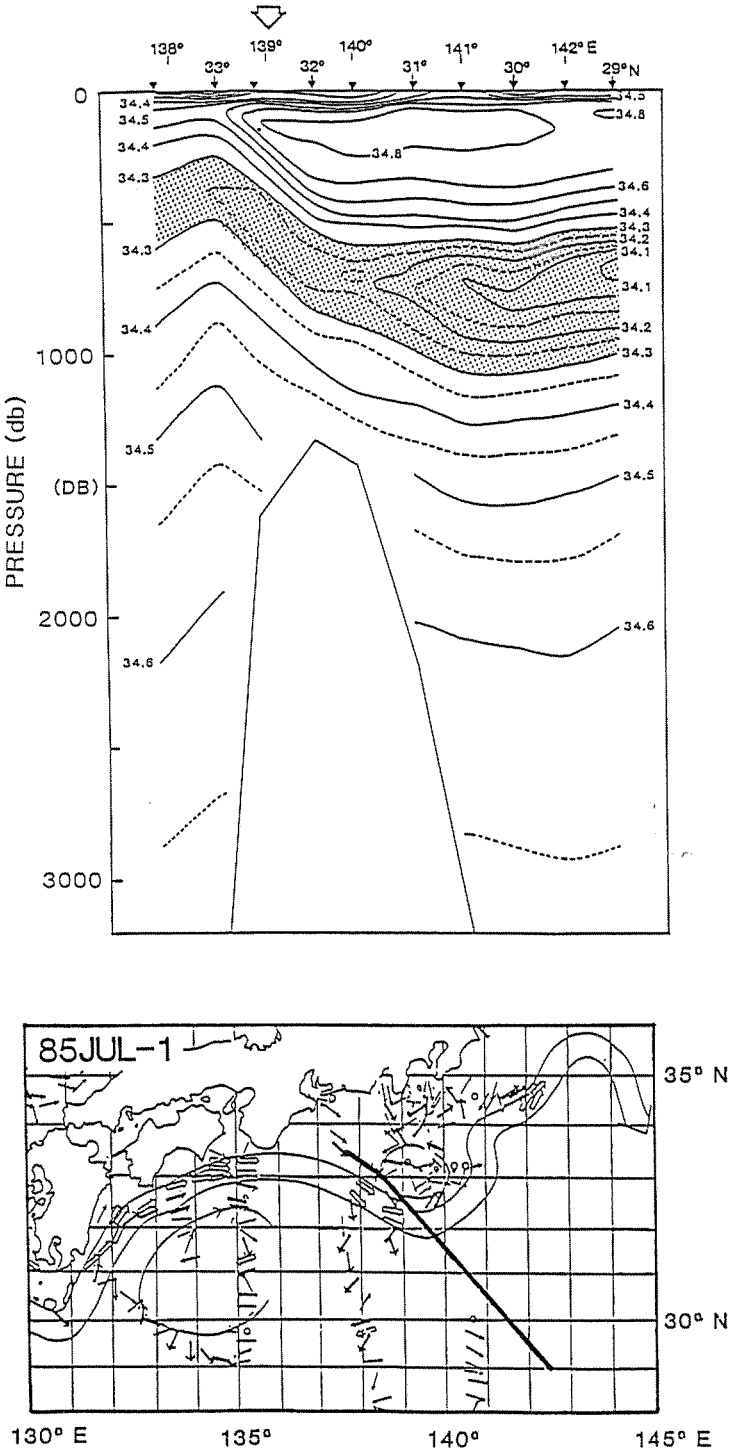

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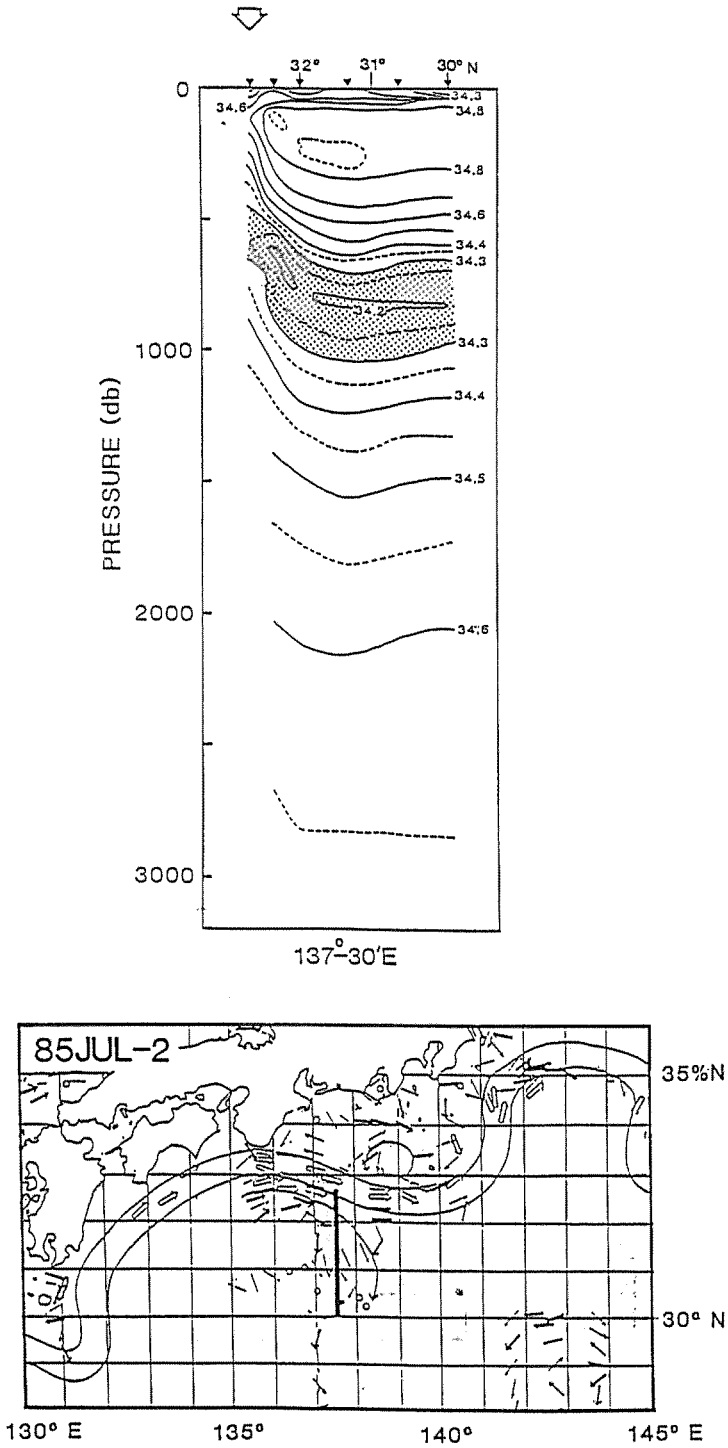

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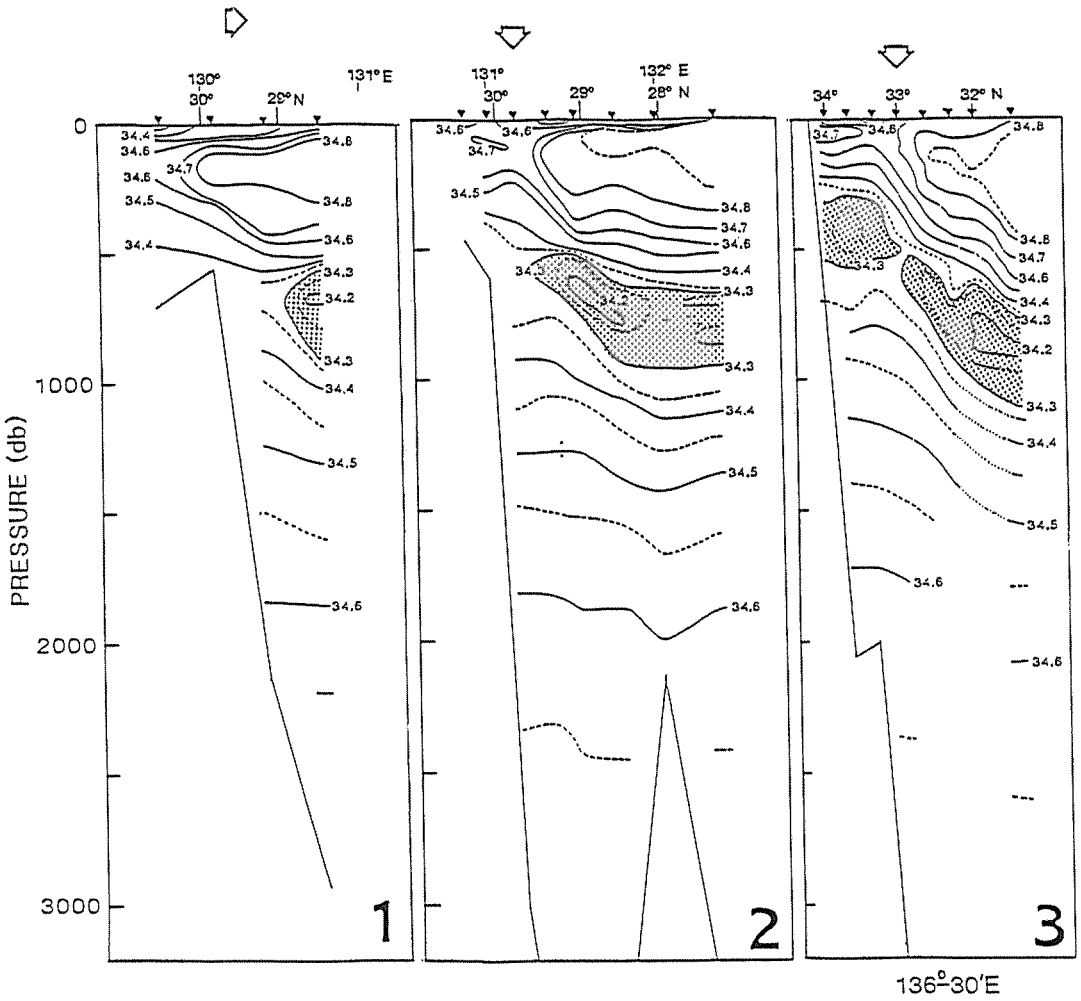

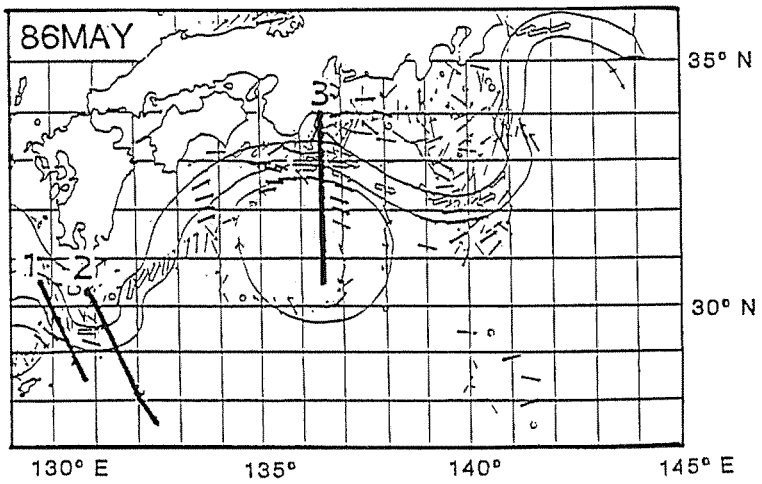

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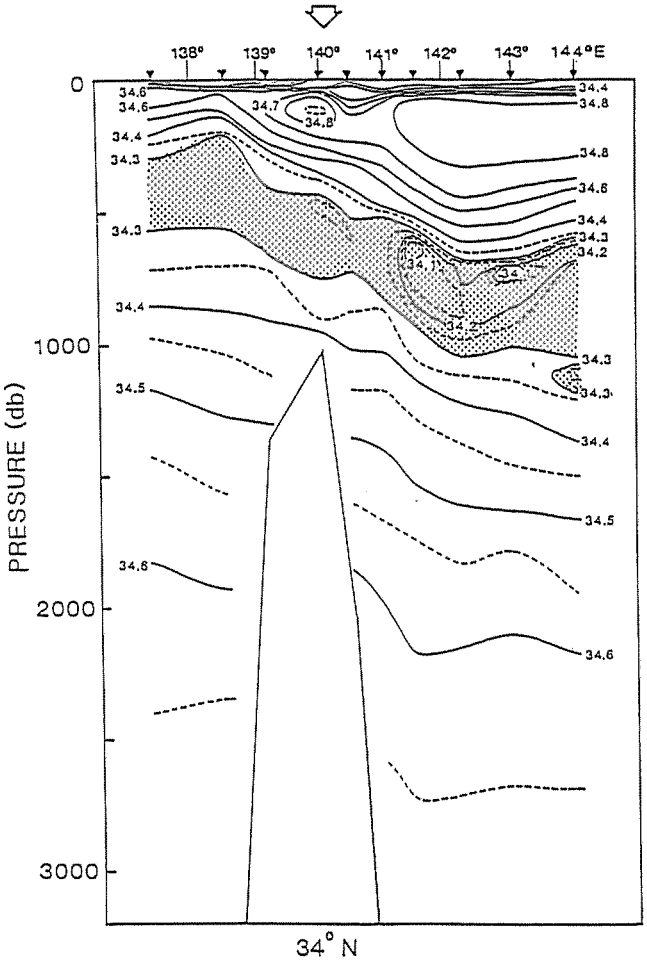

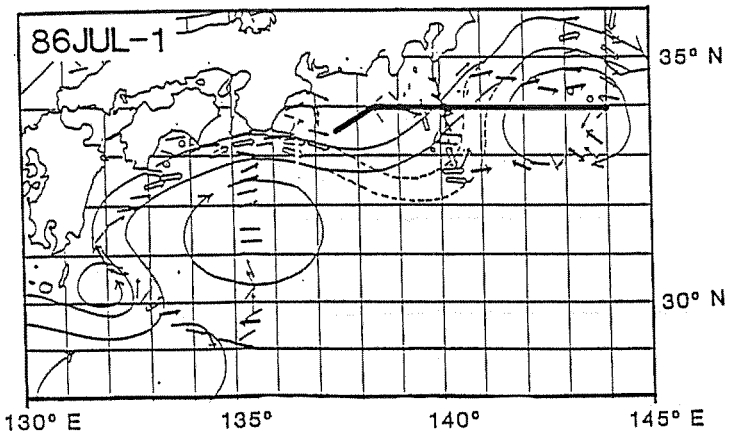

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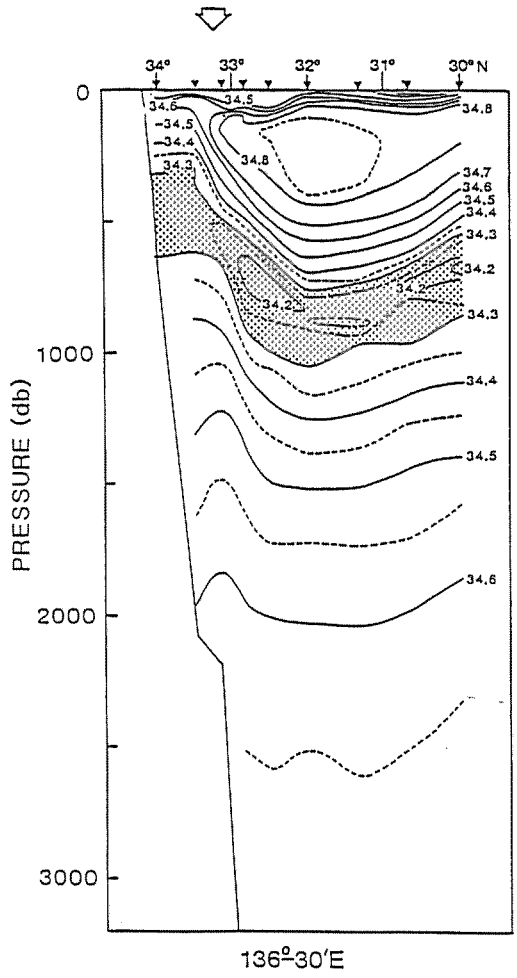

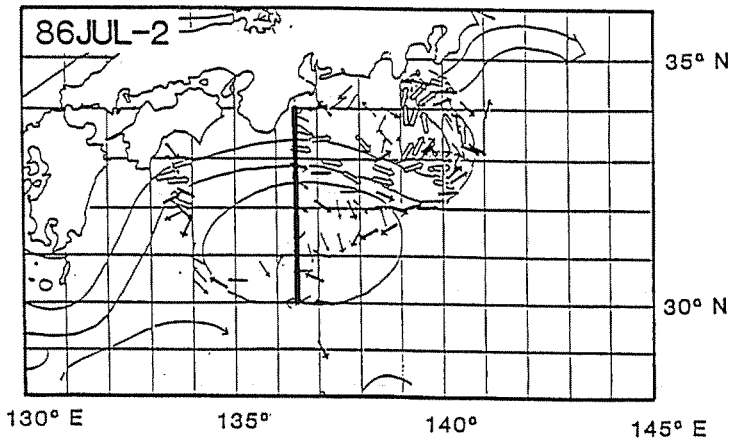

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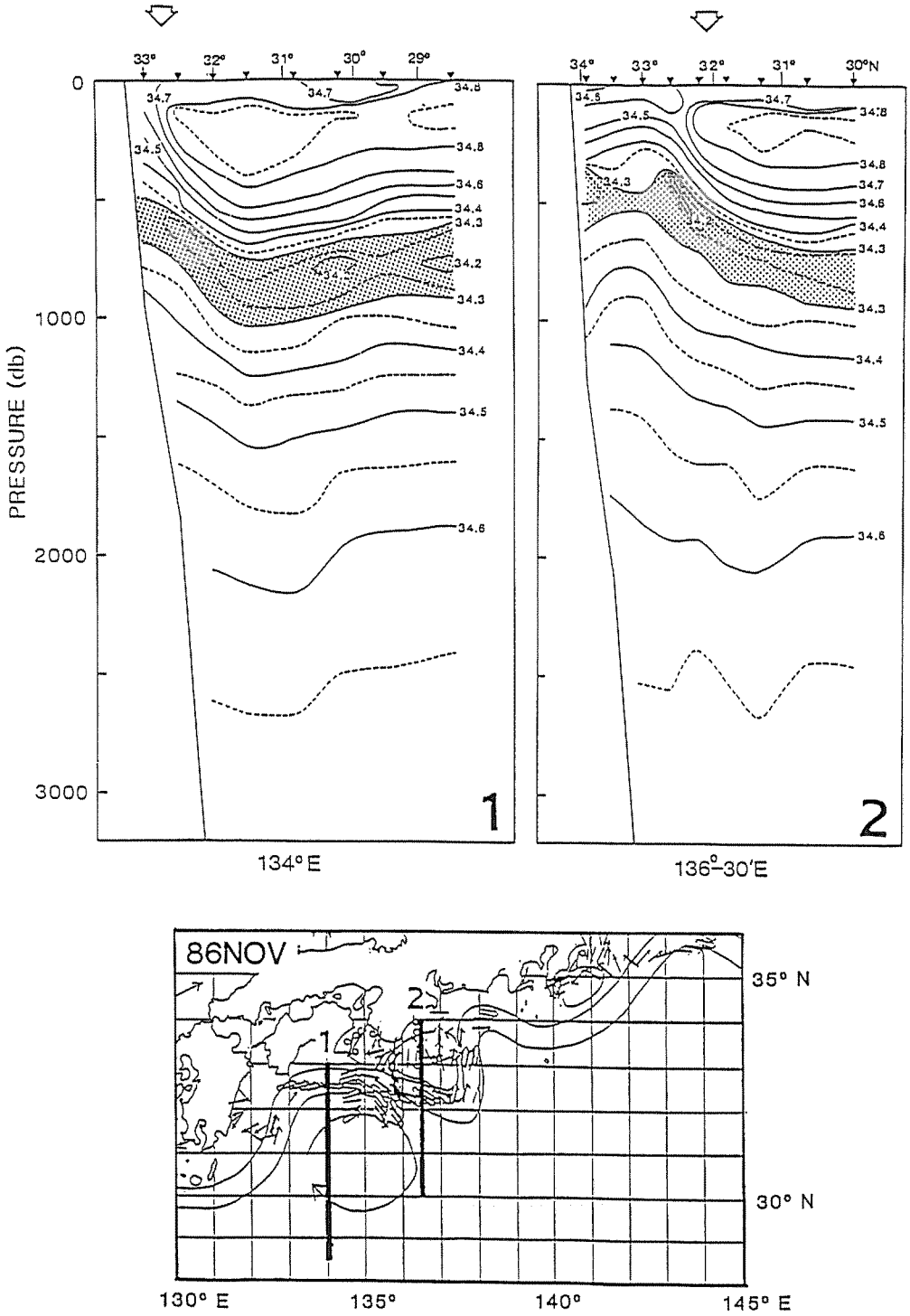

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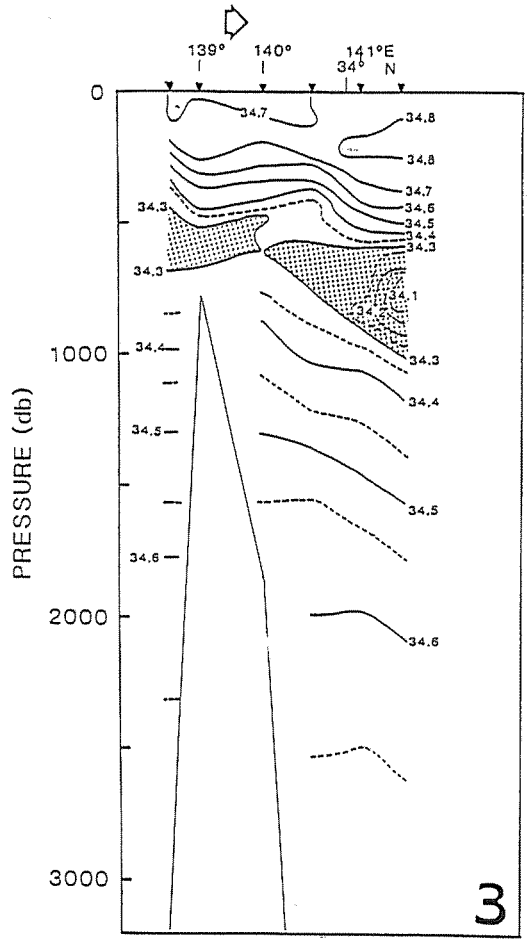

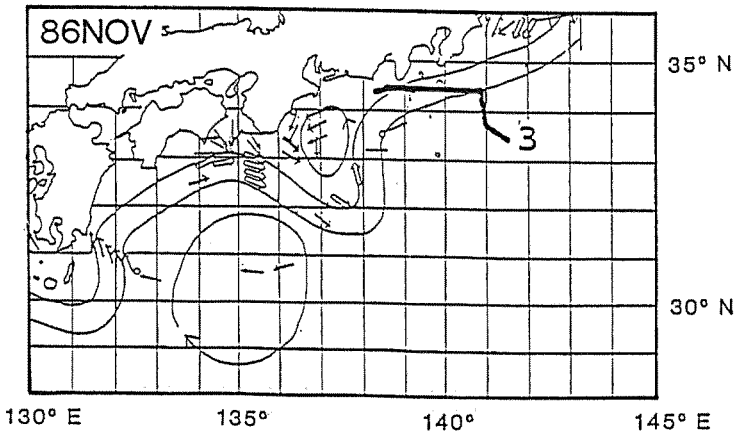

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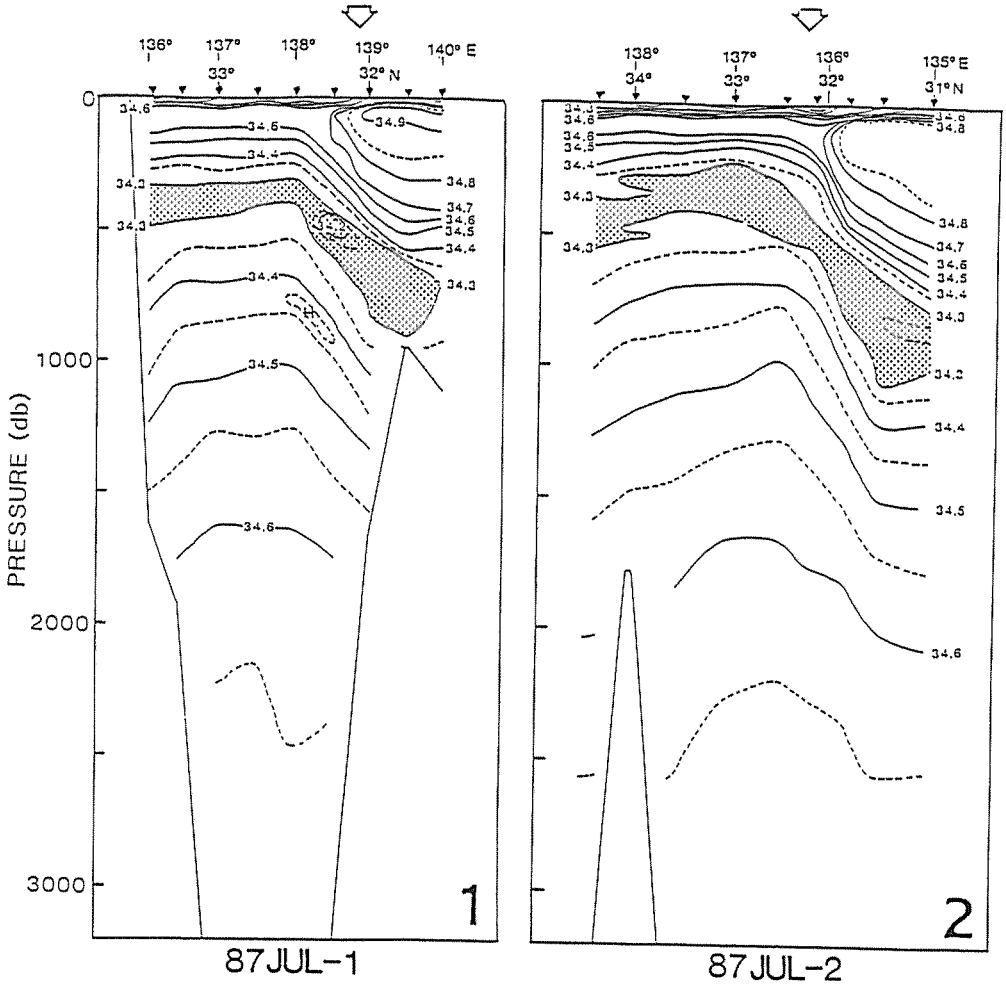

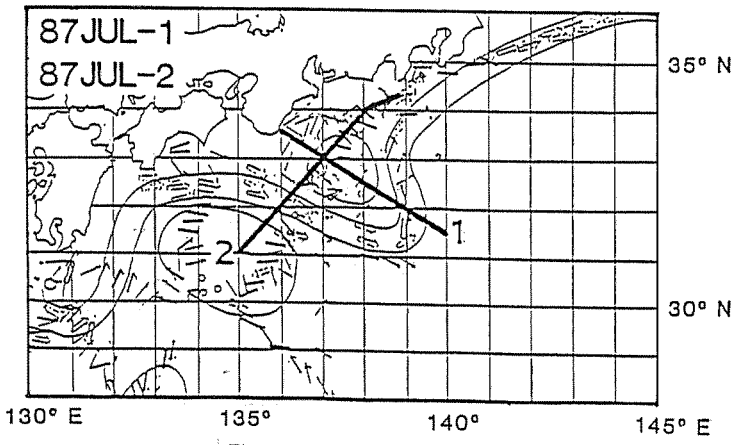

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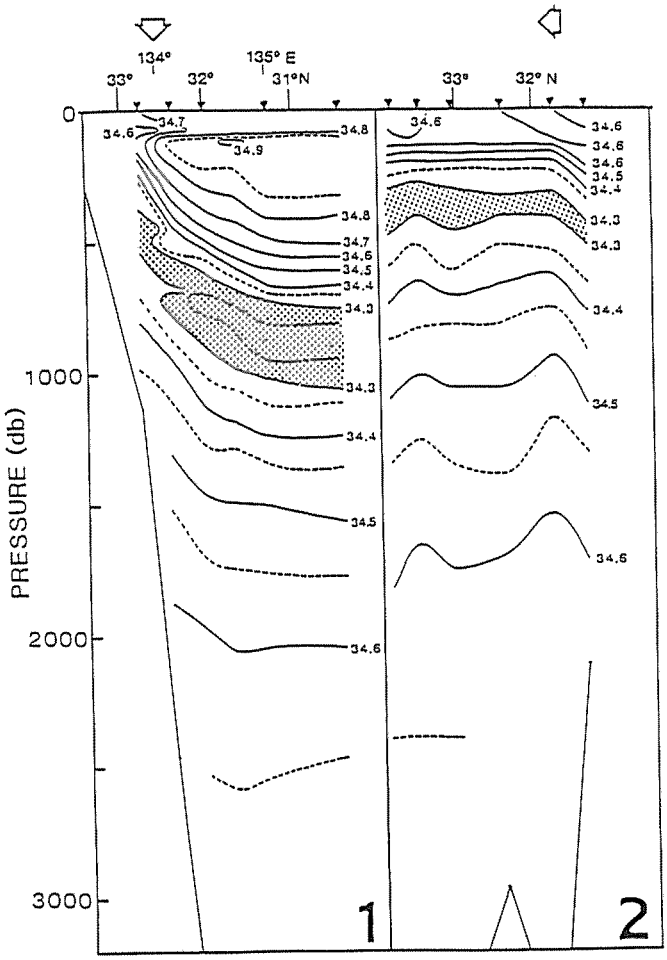

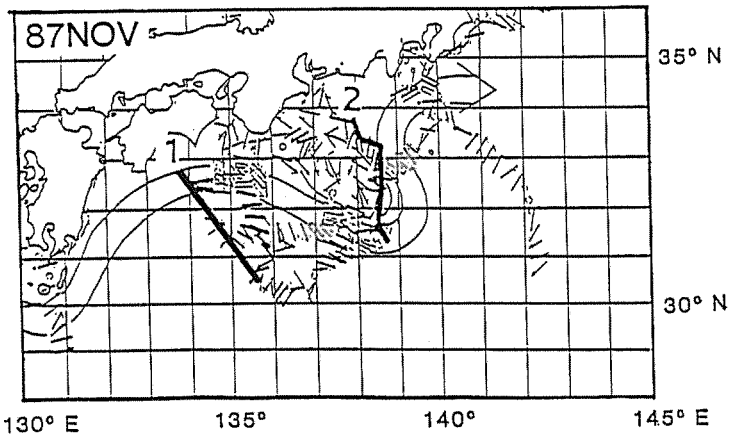

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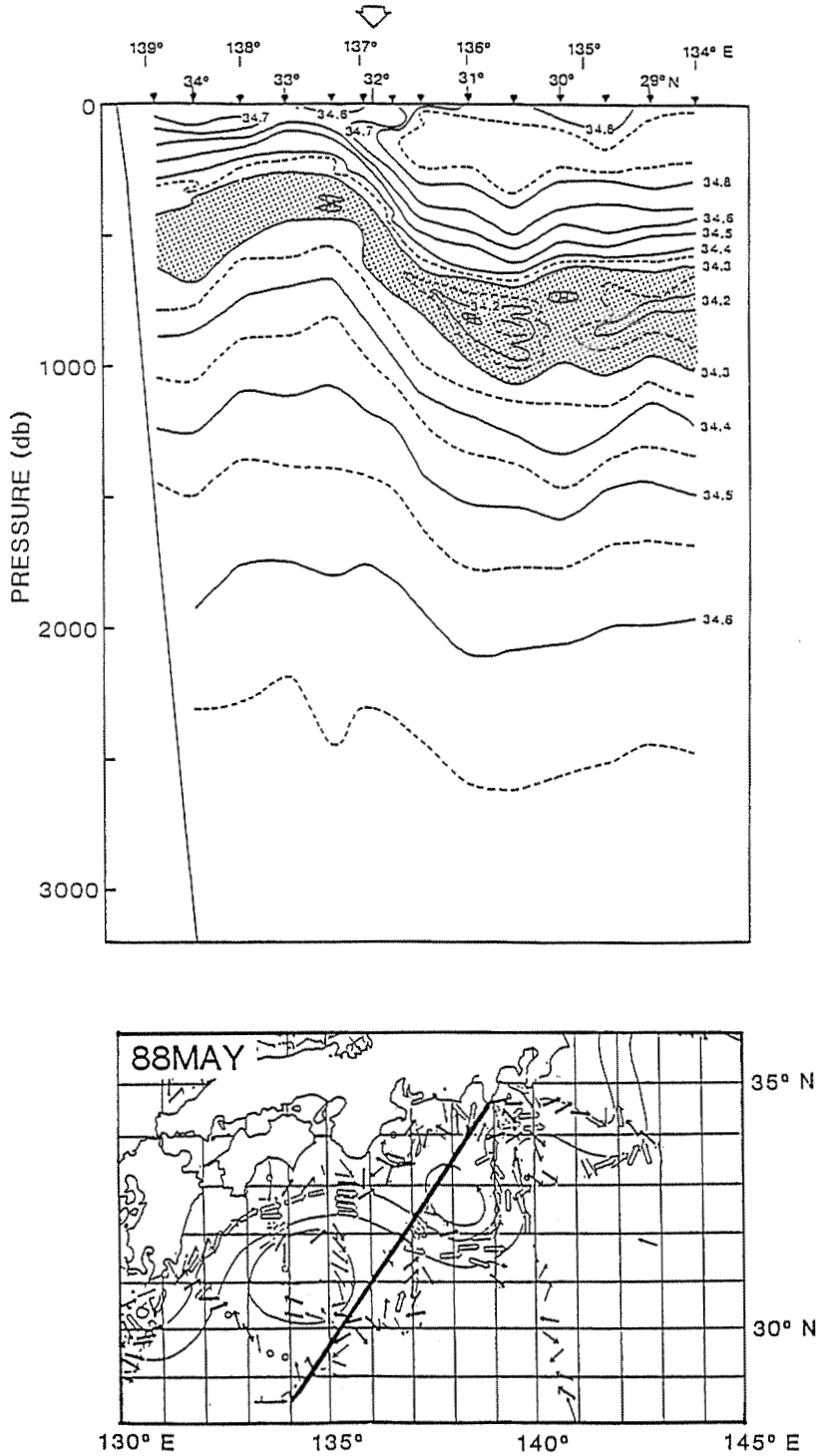

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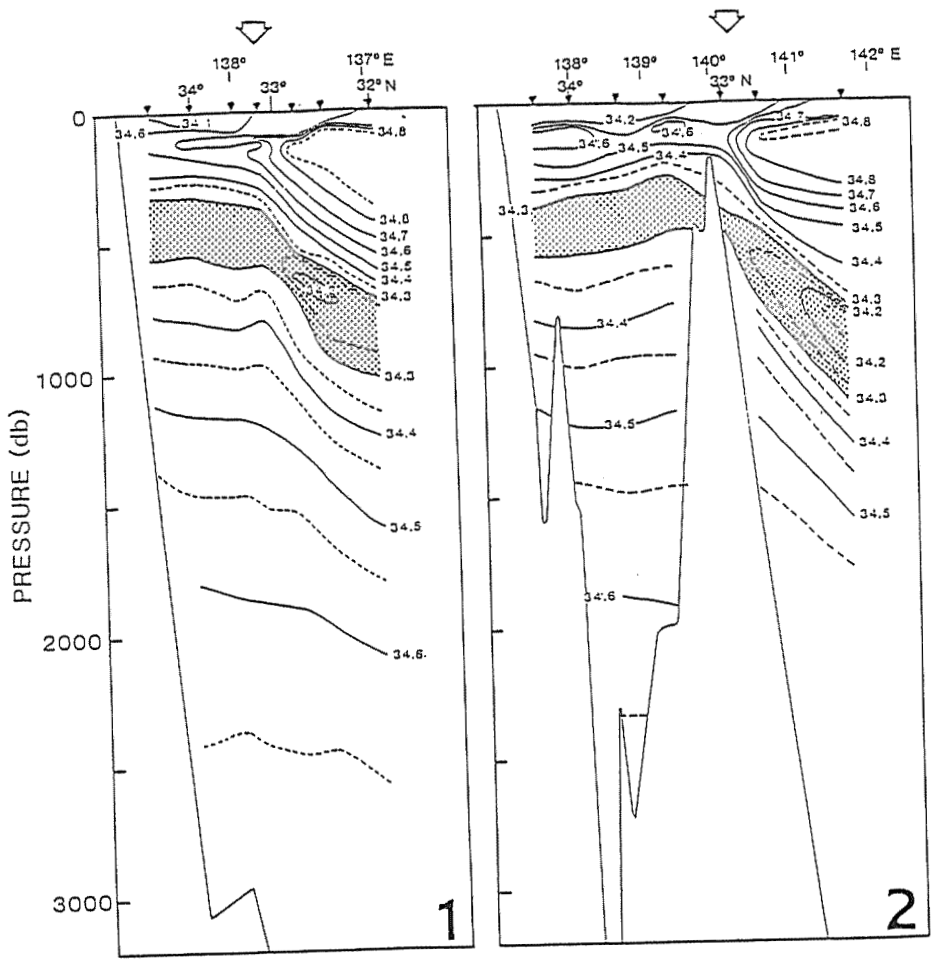

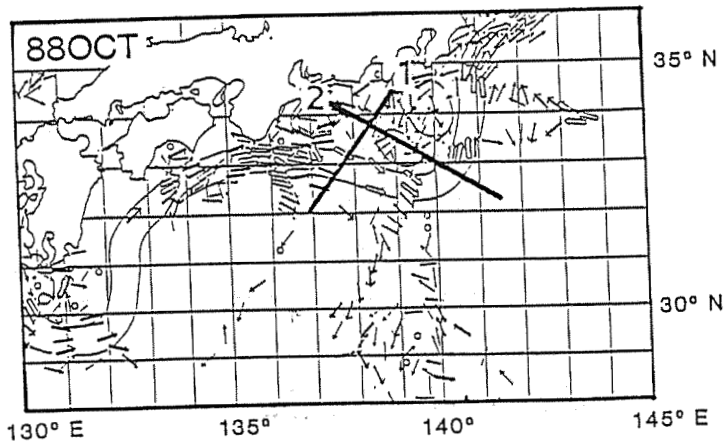

Fig. 1 continued (21)

commonly detected. One salinity minimum exists over the continental slope, of which depth is relatively shallow, 400–600 m. Another salinity minimum exists over a flat area in the Shikoku Basin. This minimum area laocates about 200–300 km offshore to the former minimum over the continental slope. As the lower layer flow shows few density stratification, it has a strong tendency to flow along the geostrophic contour (f/h, f is the coriolis parameter, and h is a depth of ocean), which is well approximated by the isopleth of depth. From this, it is suggested that the salinity minimum over the continental slope is originated by the intermediate Oyashio water, which flows southward along the Boso Peninsula. The origin of this water is associated with the first Oyashio intrusion flowing southward along the Japanese coast. On the other hand, from the geographical positions, the salinity minimum over the flat basin is inferred to be originated from the Oyashio second intrusion located offshore region to the first intrusion and/or offshore Oyashio water to the second intrusion. This water has a possibility to intrude in the Shikoku Basin after going southward clockwisely around the Izu-Ogasawara Ridge.

It is also shown that this character with two salinity minimum areas is observed in further south in the Shikoku Basin in comparison with the observational results so far proposed[8),9)]. As this feature is well observed in the eastern region to the Izu-Ogasawara Ridge, it should be noted that the almost similar feature of the salinity fields exists in the western side of the Izu-Ogasawara Ridge. Although the discussion based on the dissolved oxygen distibution should be made, the reliable data of the dissolved oxygen were not obtained by the CTD system due to its longer response time than those of temperature and salinity. More detailed analyses on these problems will be reported in a succeeding paper.

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四国海盆内部の塩分極小層の観測

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1983年から1988年の間に日本南岸の四国海盆北部の塩分分布の観測を特に塩分極小層に注目して行った。塩分極小層は大陸棚斜面上や海嶺の斜面上では 400–600 m 深程度にあり，平坦な大洋底上では 700–1000 m 深程度にある。この報告では観測したすべての観測線上の塩分分布の基礎データを提示する。

塩分観測データの解析により，幾つかの特徴的な塩分分布があることが確認された。塩分極小層は明確に大陸斜面上にあるものとそれより 200–300 km 程度沖側の平坦な四国海盆上にあるものの二つの領域に別れて存在する。前者は房総半島沿岸沿いに南下する親潮の中層水に関連し，後者は親潮の第二貫入以東の南下に関連することが示唆された。伊豆海嶺以東では常時観測されるこの二つの塩分極小の存在が伊豆海嶺以西の四国海盆でもみられることが示された。