Physical Characteristics of Watermass in the South China Sea, Area II: Sarawak, Sabah and Brunei Darussalam Waters

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ABSTRACT

This study provides new information on the physical characteristics of water masses in Sabah and Sarawak waters. The aim was to determine the effect of Southwest (SW) monsoon on the variability of water masses, in Sabah and Sarawak waters. Physical characteristics data were obtained using an instrument called "Integrated Conductivity Temperature Depth" (iCTD), during the third (July 1996) and fourth (May 1997) cruises of the MV SEAFDEC research vessel, conducted during the SW monsoon season. Vertical distributions and profiles of temperature, salinity and density were analyzed and their variations between the two cruises compared.

It is concluded that there were no great variations of temperature, salinity and density values in the study area, during both cruises. This is because both cruises were conducted during the SW monsoon season. However, variations of temperature, salinity and density values were observed between shallow and deep waters, as well as coastal and offshore waters. Based on their vertical distributions and profiles obtained during the two cruises, water properties in shallow waters were found to vary slightly from the deeper ones. As a result, in the southern tip of the South China Sea, where the water was shallow, its properties here differed a little from the rest of the study area. This was due to the pronounced mixing effect of surface waves in shallow waters. At the same time, lower salinity and consequently, lower density values were detected in coastal waters, resulting from of the influx of freshwater from Sabah and Sarawak rivers during this monsoon season.

Key words: SW Monsoon, SEAFDEC cruises, iCTD, Temperature, Salinity, Density, Insignificant Variability.

Introduction

South China Sea is influenced to a very large extent by the monsoon system. In fact, almost every feature of the oceanographic environment of the South China Sea is conditioned by the monsoons. This semiannual reversal of large-scale wind system is generated by the difference in atmospheric pressure between the Northern (Asian continent) and the Southern (Australia) Hemispheres [Nasir and Camerlengo (1997) and Nasir and Marghany (1996)]. The southwest (northeast) wind prevails from May to September (November to March) over the South China Sea during the northern summer (winter). Two transitional periods occur between these two monsoons, in April and in October, respectively. They last for about three to seven weeks [Morgan and Valencia (1978)].

The third and fourth cruises - on board MV SEAFDEC - of the SEAFDEC collaborative research programme in the South China Sea, between Malaysia and Thailand, were conducted from 16 to 31 July 1996 and from 1 to 24 May 1997, respectively. The cruises covered the Sarawak, Sabah and Brunei Darussalam waters. The aim of the cruises was to determine the resources and oceanographic parameters of the waters in the South China Sea.

Since the two cruises were conducted during the SW monsoon season, a study on the variability of physical parameters in Sabah and Sarawak waters due to the SW monsoon, was established. For this purpose, vertical distributions and profiles of temperature, salinity and density, from both MV SEAFDEC cruises, were analyzed and compared.

Materials and Methods

Respective in-situ water properties of Sabah and Sarawak waters were recorded, using an iCTD instruments, during the SW monsoon season. The data were collected during the MV SEAFDEC third cruise (10 to 31 July 1996) and fourth cruise (1 to 24 May 1997). For the purpose of this investigation, three transects were selected out of seventy-nine sampling stations that were established (Fig. 1).

Temperature and salinity data were obtained directly from the system, while density data were derived from temperature and salinity data, by using a sigma-t computation table [Knauss (1978)].

Data were analyzed by using a grid-based contouring and three-dimensional plotting graphics program, SURFER (Version 6), from Golden Software Inc., USA. The temperature, salinity and density vertical contours of three selected transects, for both cruises, were plotted, compared and analyzed. Profiles of the same parameters were also plotted using MS Excel.

Results

Temperature, salinity and density contours of Transect 1, 2 and 3, are shown in Figs. 2, 3 and 4, respectively. Each figure is divided into two groups, I and II. Group I represents data collected from MV SEAFDEC third cruise, while data from the fourth cruise are demonstrated in Group II. Each group is then sub-divided again into section A, B and C. Each section portrays temperature, salinity and density contour, respectively.

In general, water temperature, salinity and density did not differ greatly in both cruises. Variations of their vertical distributions, in both cruises, were also insignificant. However, variations of temperature, salinity and density in the surface waters were greater than the deeper ones, as shown in Figs. 2, 3 and 4. Water temperature decreased with increasing depth, while both salinity and density value increased with increasing depth. This increase in salinity and density, along with the decrease in temperature occurred rapidly from below the surface water until certain depth, after which the rate then declined. As a result, thermocline, halocline and pycnocline layers were distinguishable, for all three transects (Figs. 2, 3 and 4) in both cruises. The depth of these layers remained more or less similar in both cruises.

One distinctive variation is observed between coastal and offshore waters. The temperature, salinity and density values were much lower in coastal waters as compared to offshore waters (Fig. 2), in both cruises. Water properties in shallow waters were also found to vary slightly from deeper ones (Fig. 3 and 4).

Profiles of temperature, salinity and density, at all sampling stations for both the third cruise (thick lines) and the fourth cruise (thin lines), are shown in Figs. 5, 6 and 7, respectively. Profiles of parameters in shallow waters, when compared between the two cruises, showed very slight variations. However, in deep waters no variations of parameters with depth, were observed. The reason is that both cruises were conducted during the SW monsoon season.

Discussions

During northern winter season, a high atmospheric pressure system develops in Asian continent due to the cooling of the landmass and the descending of air. At the same time, the Australian continent is experiencing summer. The air rises due to the rapid warming of the continent, and thus a low atmospheric pressure system is enhanced. The combined effects of these two different atmospheric pressure systems result in the air moving from Northern Hemisphere to Southern Hemisphere. Due to the effect of Coriolis force, a northeasterly wind blows over the South China Sea. This phenomenon is generally known as the Northeast monsoon, blowing during the months of November through March.

A reverse atmospheric pressure system prevails during the northern summer season. As a result, the air motion in the South China Sea is from the southwest direction from May to September. This wind is normally known as the Southwest monsoon.

Two transitional periods occur between these two monsoons, in April and in October, respectively. Both transitional periods last from about three to seven weeks [Morgan and Valencia (1978)].

The Northeast monsoon brings heavy rainfall to the northern and remote regions of Sabah, as well as the entire region of Sarawak. The Southwest monsoon, on the other hand, also strongly influences the weather pattern of Sarawak. The winds bring relatively large amount of rainfall to the southwestern portion of the state. This is due to the intense humidification of the winds over the warm South China Sea. In conclusion, Southwest monsoon plays a significant role in the monthly rainfall distribution of Sabah and Sarawak [Camerlengo *et al*. (1997)].

Rainfall during the SW monsoon season result in the influx of freshwaters from Sabah and Sarawak rivers, thus, reducing water salinity and density values along the coast, as shown in Fig. 2. In most deep offshore stations - higher salinity and density values have been recorded.

The SW monsoon enhances mixing effects of surface waves in shallow waters [Wrytki (1961)]. As a result, temperature, salinity and density values of shallow water very slightly from the deeper ones. For the same reason, water properties in the southern part of the South China Sea show slight variations as compared to the rest of the study area (Figs. 3 and 4).

Profiles of temperature, salinity and density obtained during the Matahari Expedition ’87 [Nasir *et al*. (1988)] and ’89 [Nasir *et al*. (1990)] are similar to profiles obtained in the present study. This is because both Matahari Expeditions and the cruises conducted in the present study were done during the SW monsoon but in different years.

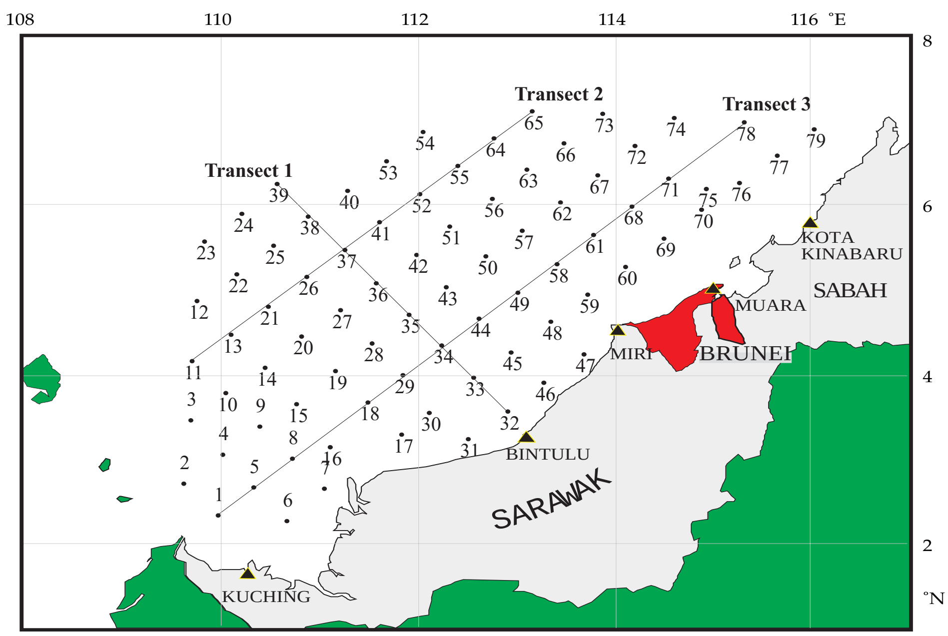

Fig. 1 All sampling stations and three selected transects

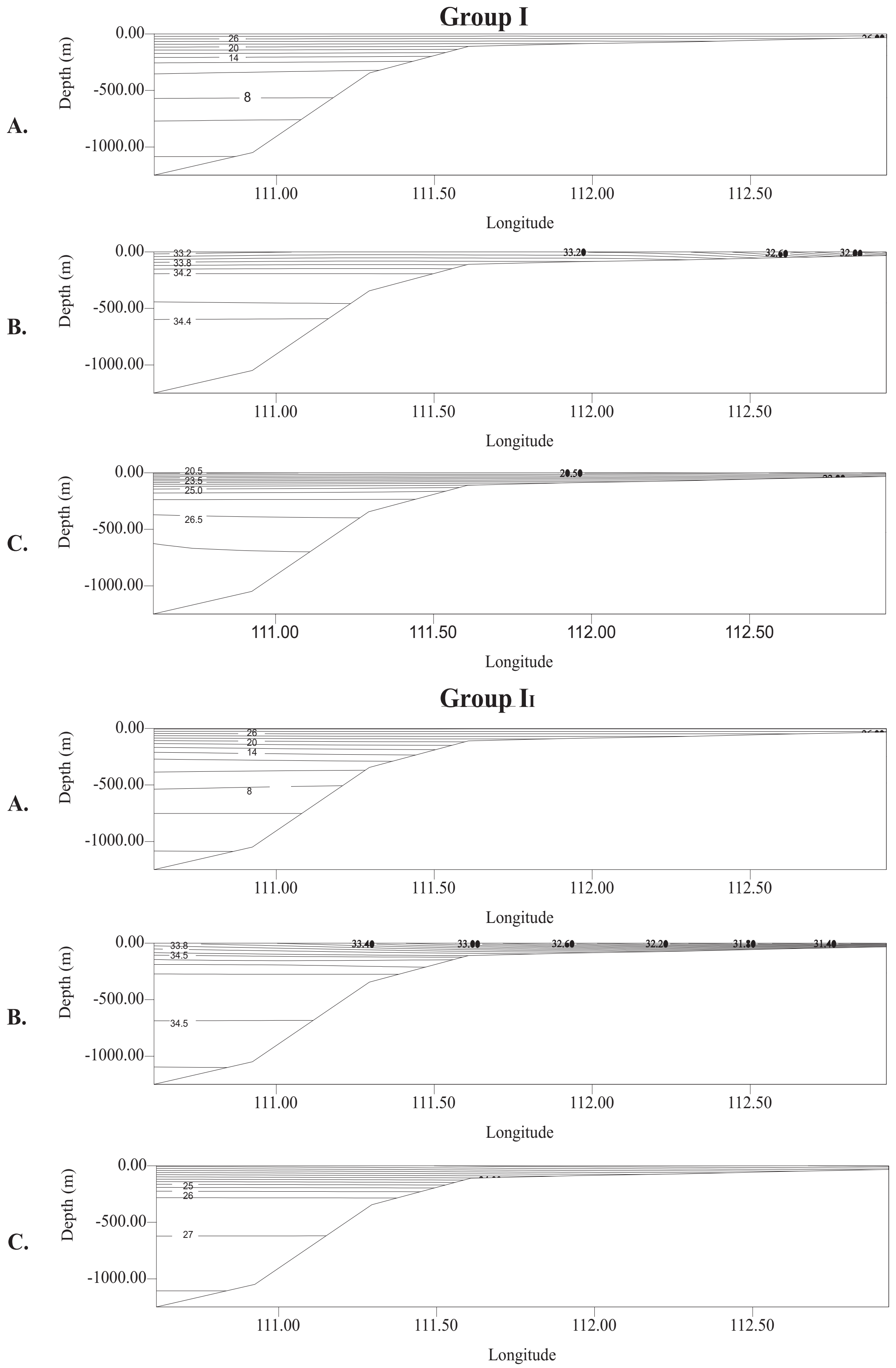

Fig. 2. Transec 1 in : I) M.V.SEAFDEC third cruise and II) M.V.SEAFDEC fourth cruise with: A) Temperature, B) Salinity and C) Density contours.

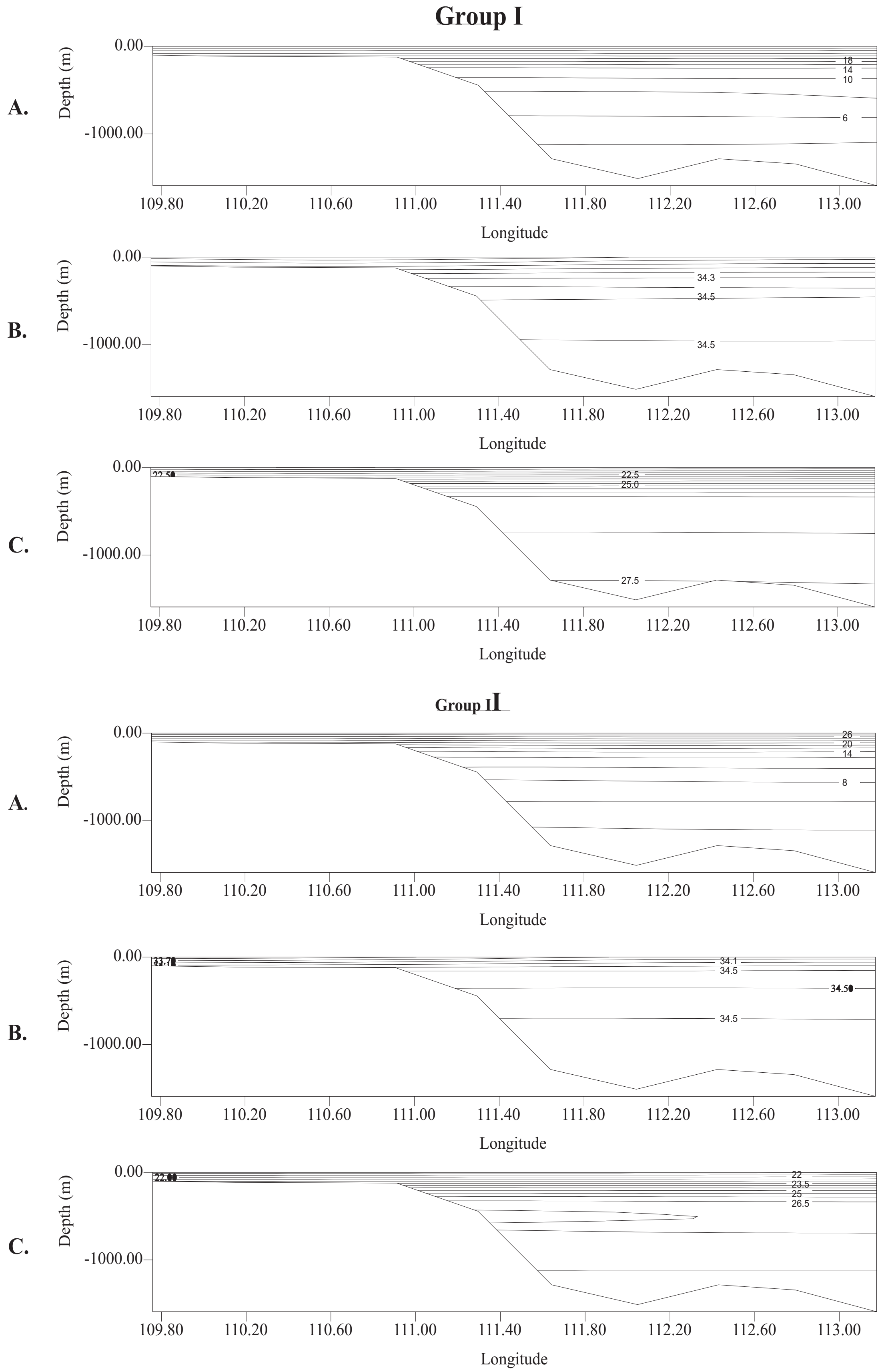

Fig. 3. Transec 2 in : I) M.V.SEAFDEC third cruise and II) M.V.SEAFDEC fourth cruise with: A) Temperature, B) Salinity and C) Density contours.

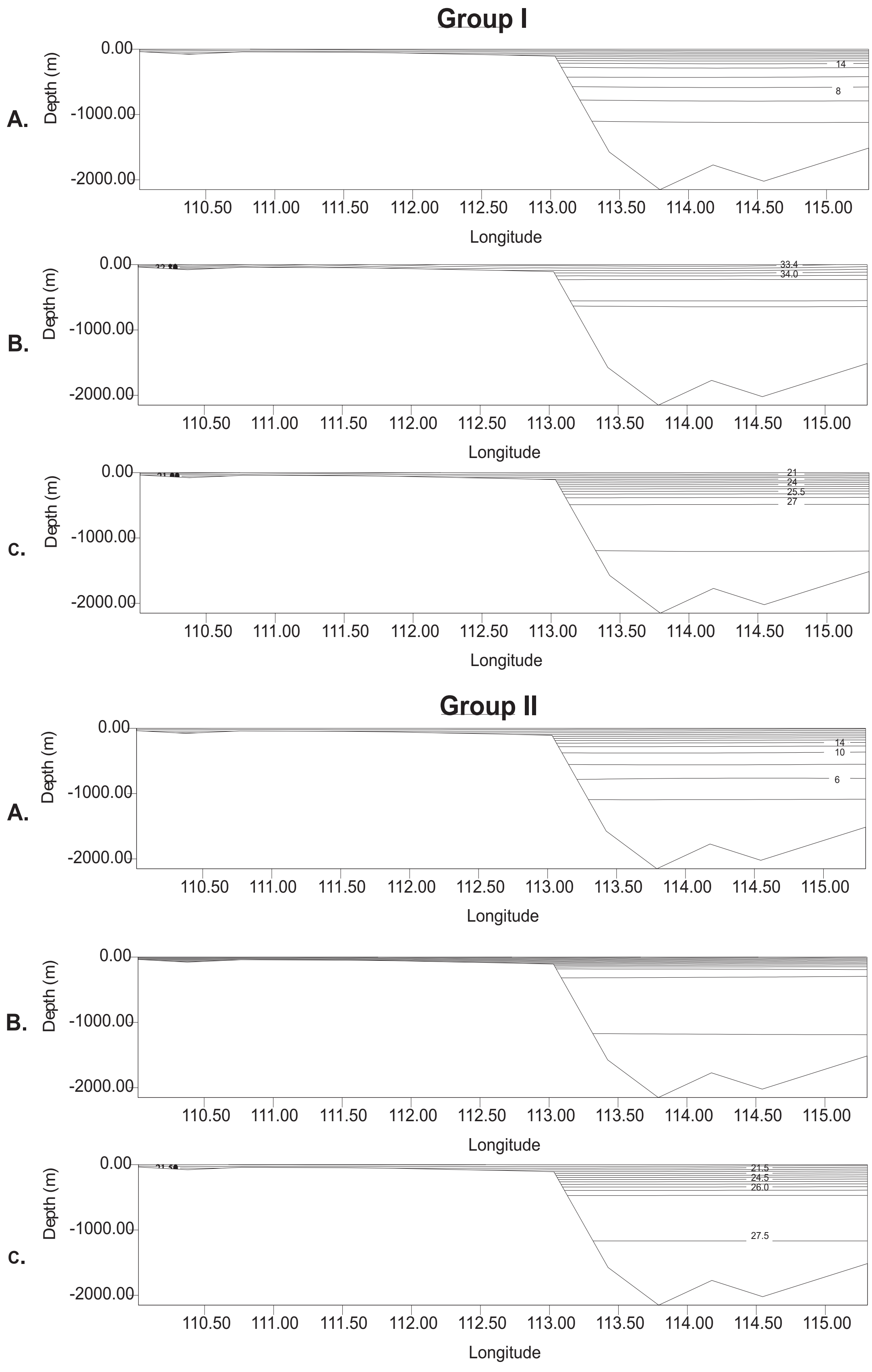

Fig. 4. Transec 3 in : I) M.V.SEAFDEC third cruise and II) M.V.SEAFDEC fourth cruise with: A) Temperature, B) Salinity and C) Density contours.

Conclusions

The vertical distributions and profiles of water properties in Sabah and Sarawak waters resulting from the two cruises, during the SW monsoon, are analyzed and compared. The results show that different periods (i.e. May and July) of the SW monsoon did not cause great variability of physical parameters in Sabah and Sarawak waters. Temperature, salinity and density contours of three selected transects and their profiles at all sampling stations, showed slight variations in the coastal and offshore waters, as well as in the shallow and deep waters. It is concluded that influx of freshwater from Sabah and Sarawak rivers has a pronounced effect of decreasing both salinity and density values of the coastal waters.

Water properties of shallow waters vary slightly from the deeper ones, as vertical mixing is enhanced by surface waves. As the waters are shallower in southern part of the South China Sea, the variability of physical parameters of the water mass is slightly different from the rest of the study area.

Thermocline, halocline and pycnocline layers are apparent in all three transects and profiles (especially deeper stations), for both cruises. Due to the fact that there are only slight differences of water properties in both cruises, the depth of these layers also do not vary greatly.

It is felt that knowledge on oceanographic characteristics of the South China Sea (including Sabah and Sarawak waters) is scarce and limited. As such, more physical oceanographic cruises are needed; so as to have a better understanding on the physical characteristics of Sabah and Sarawak waters.

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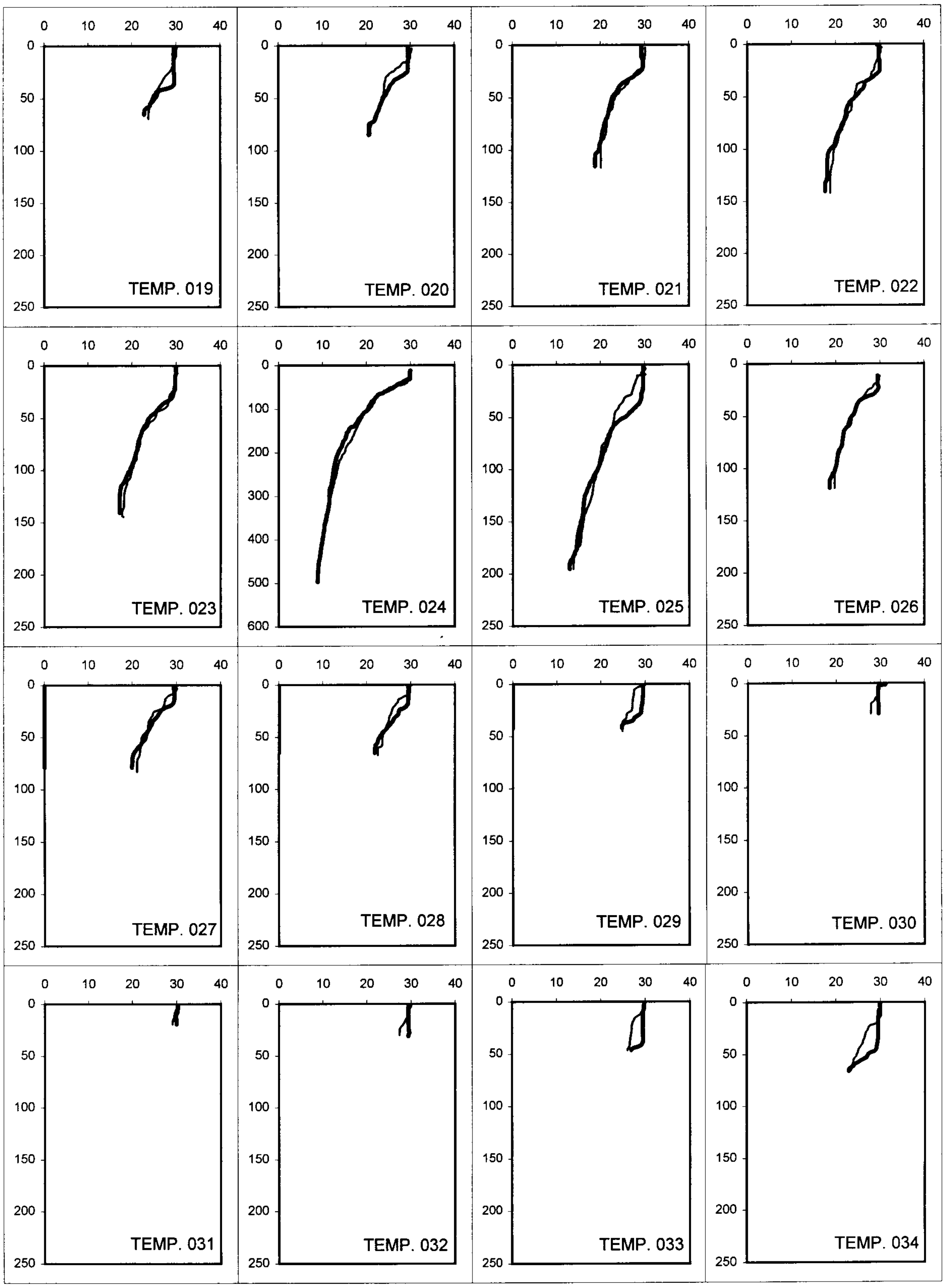
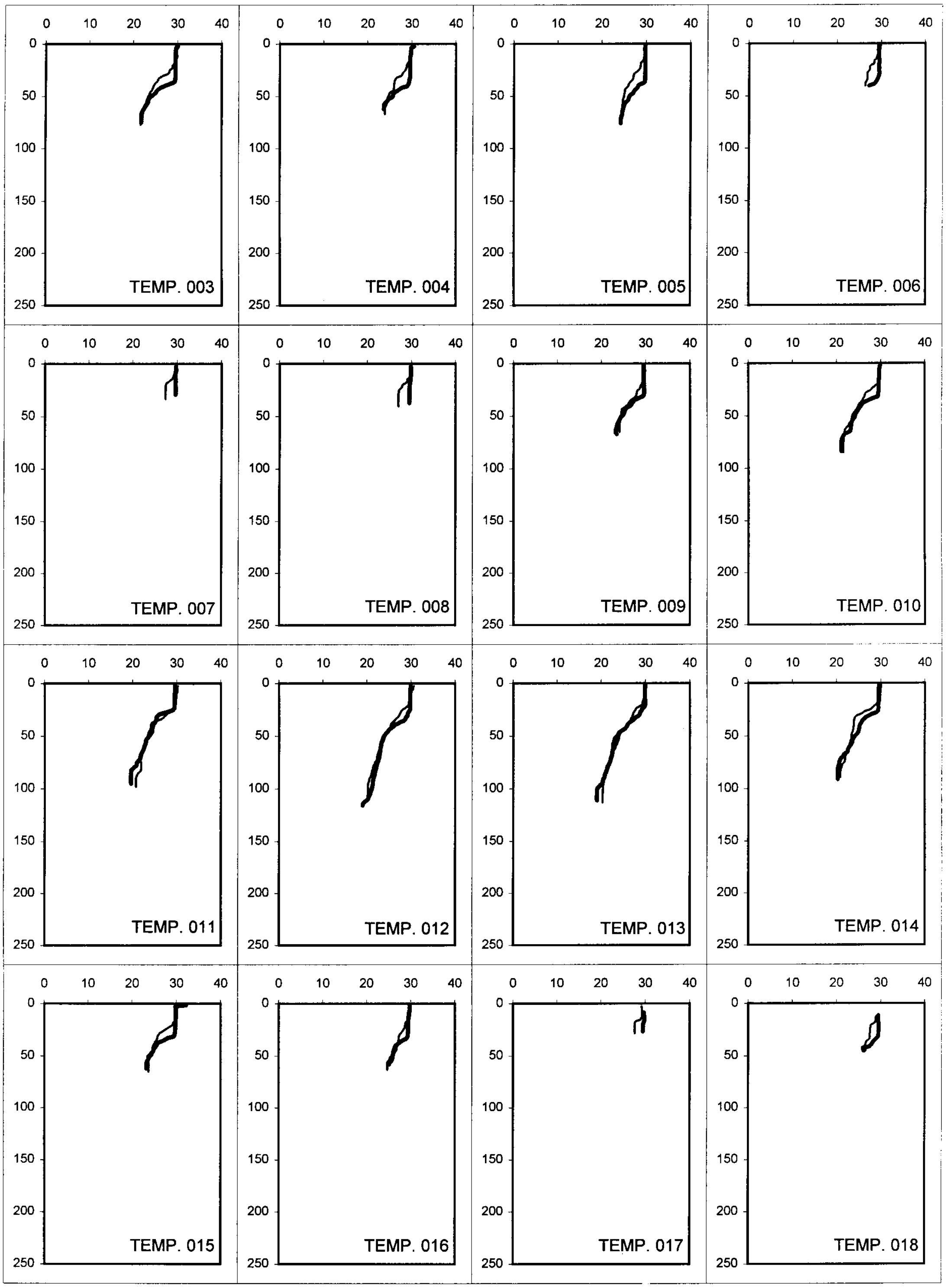


Fig. 5. Profiles of temperature from the third (thick lines) and the fourth (thin lines) cruise



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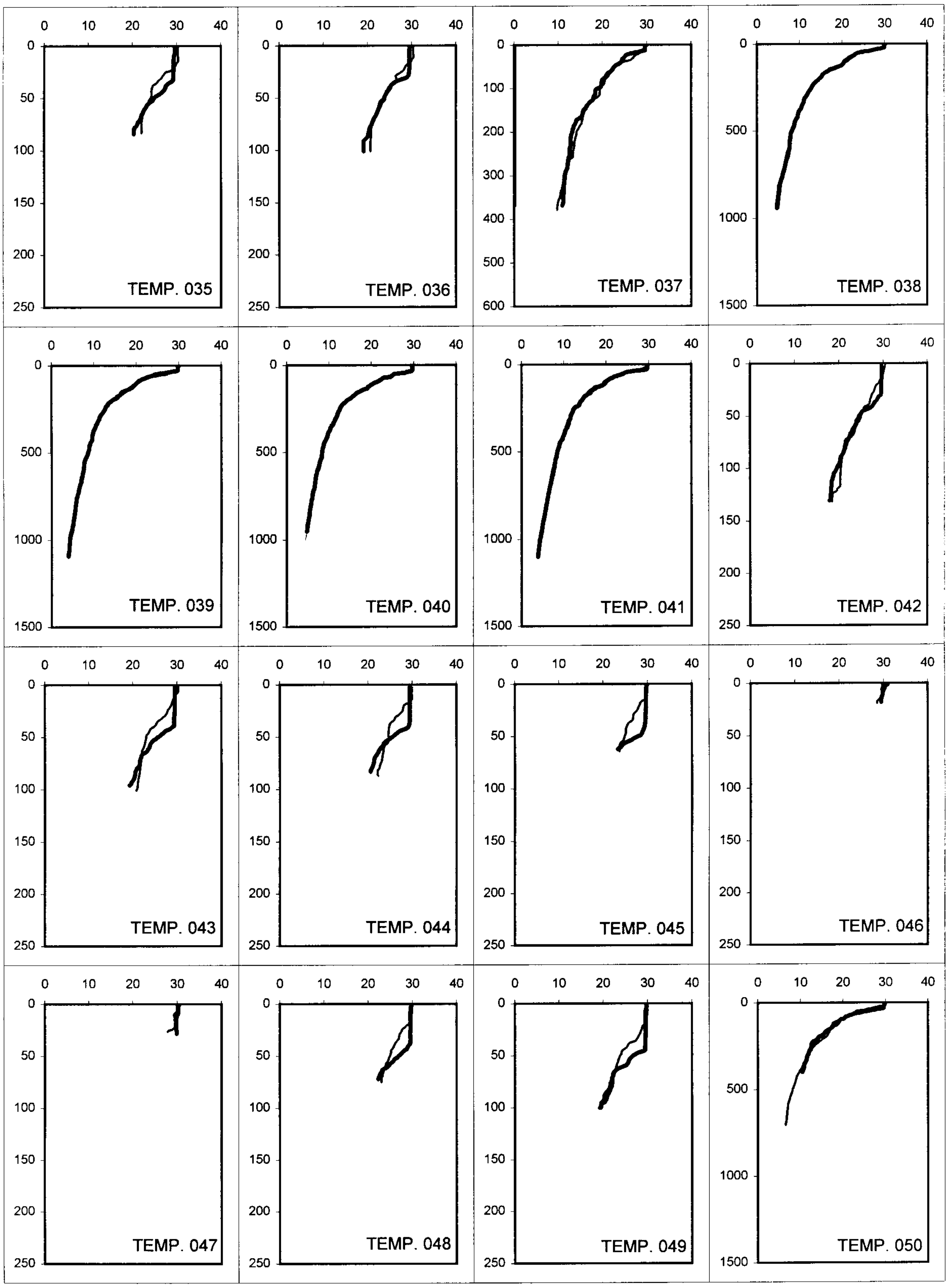

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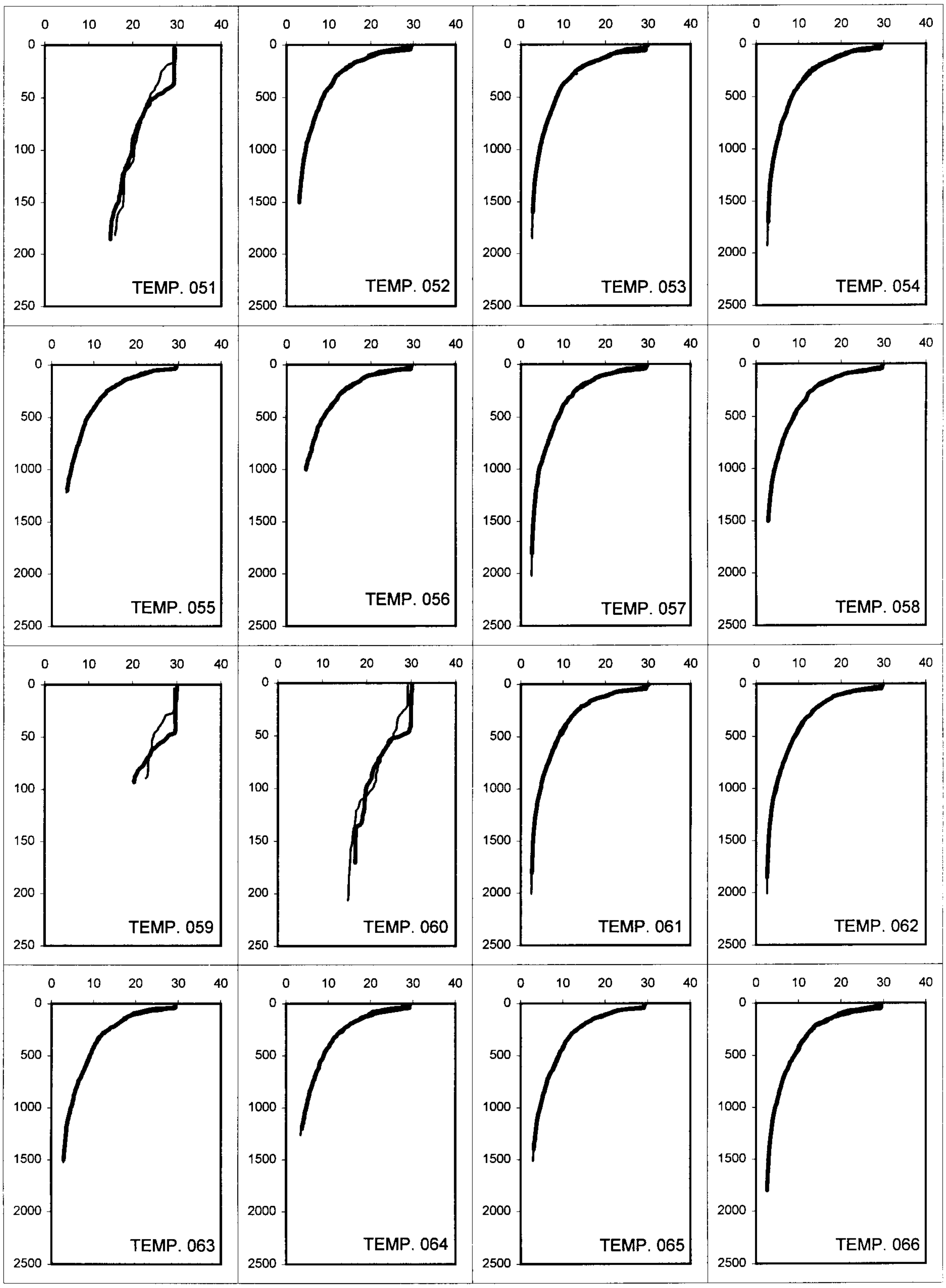

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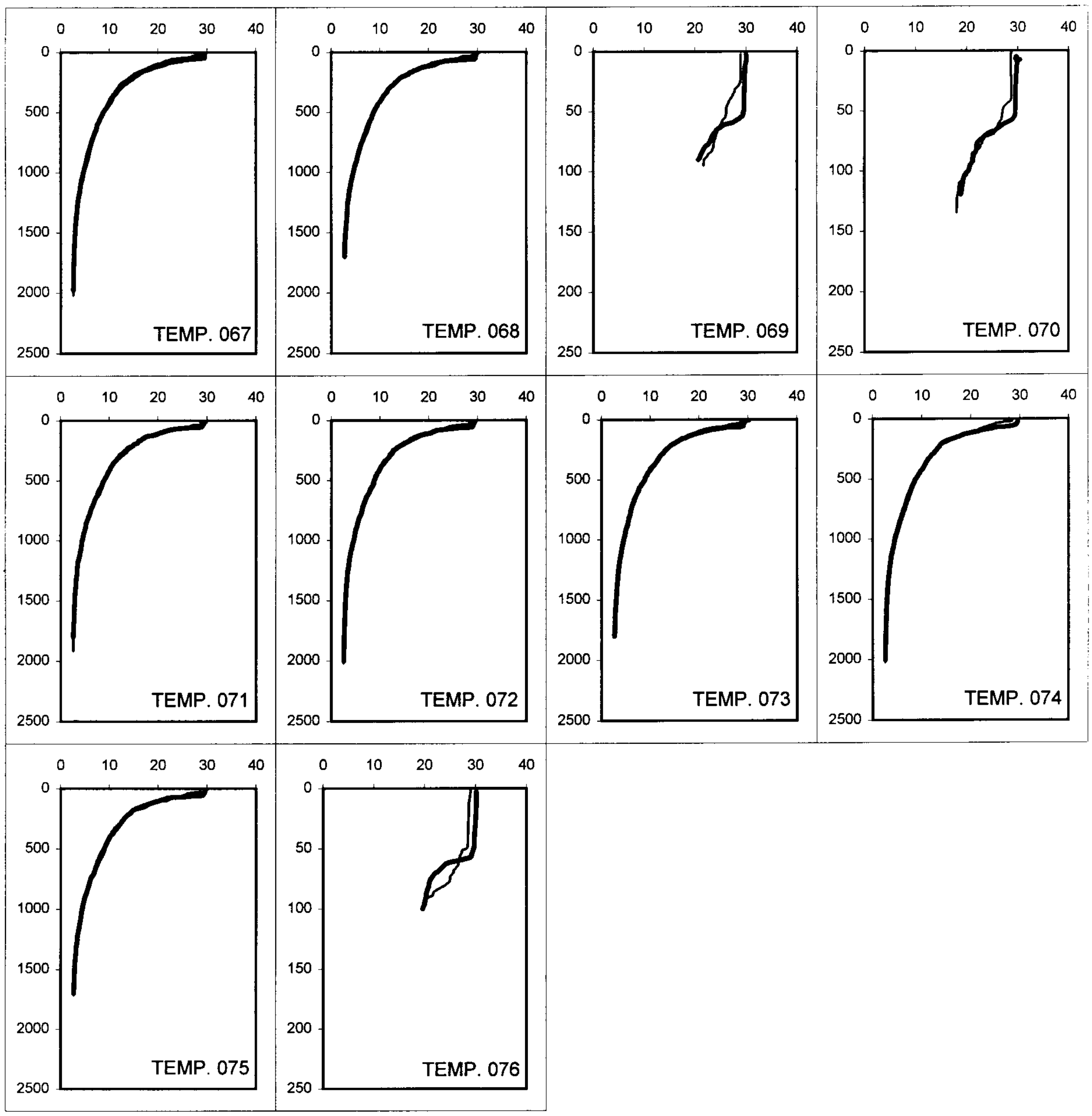

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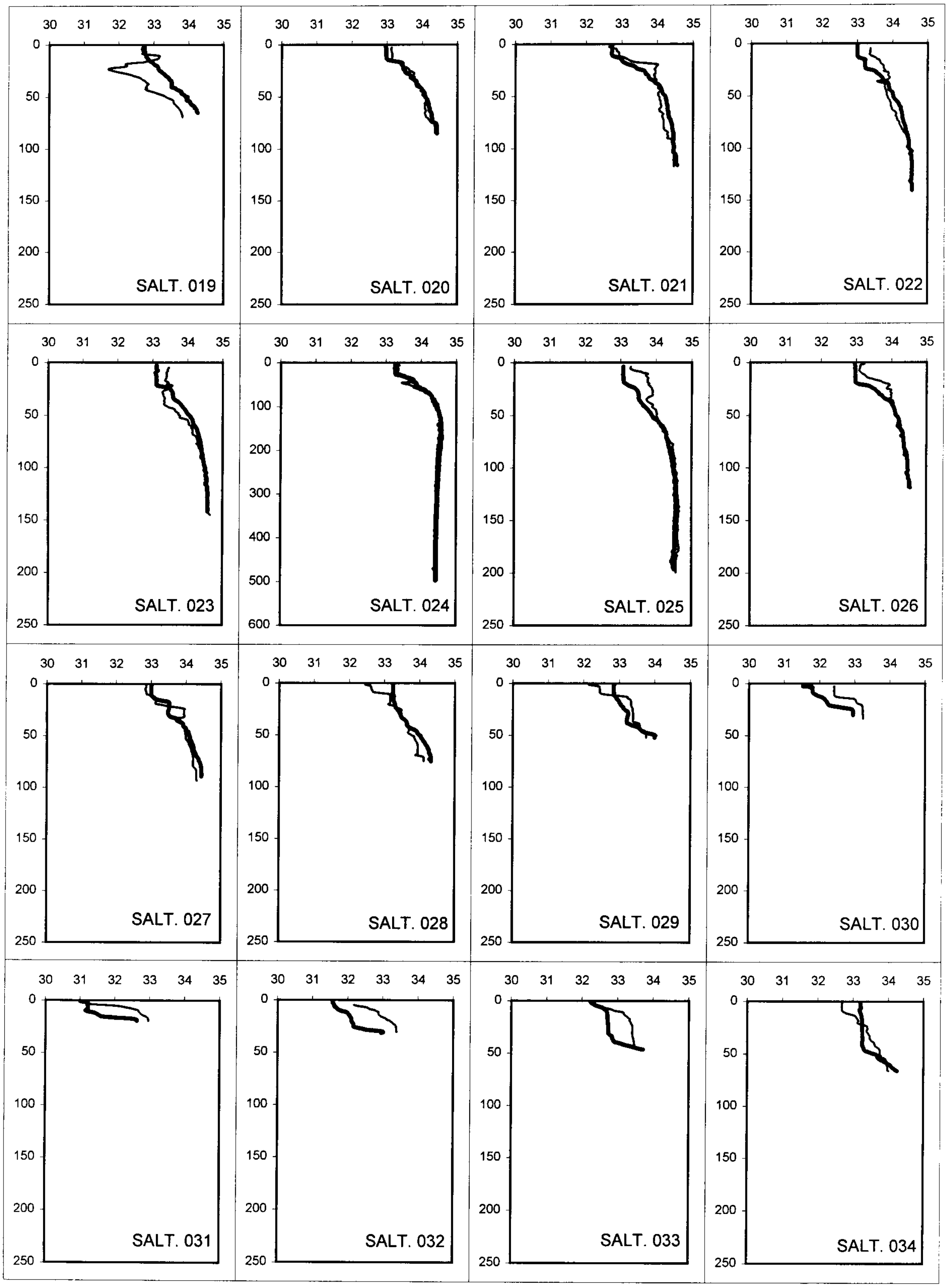
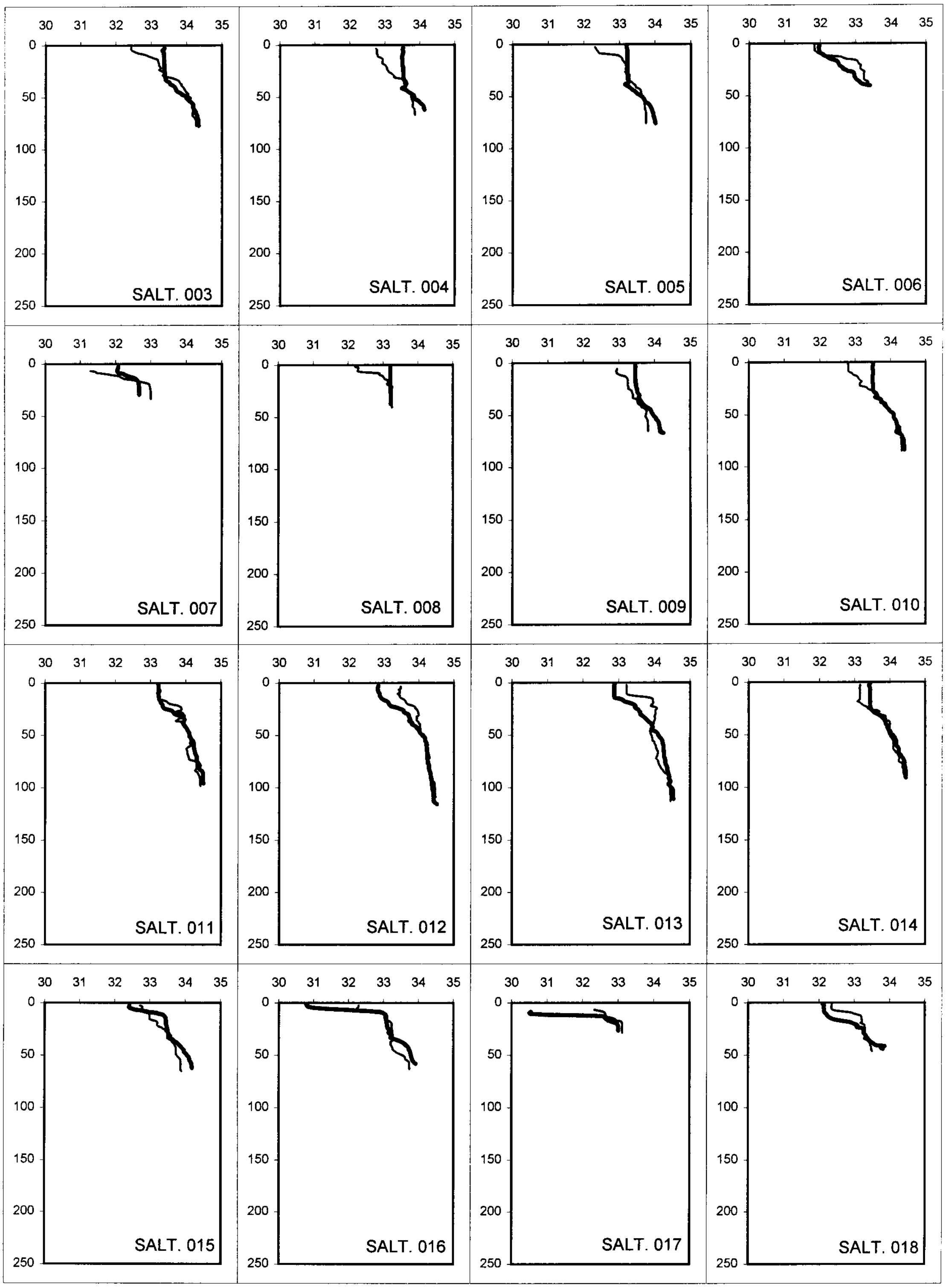


Fig 6. Profiles of salinity from the third (thick lines) and the fourth (thin lines) cruises.



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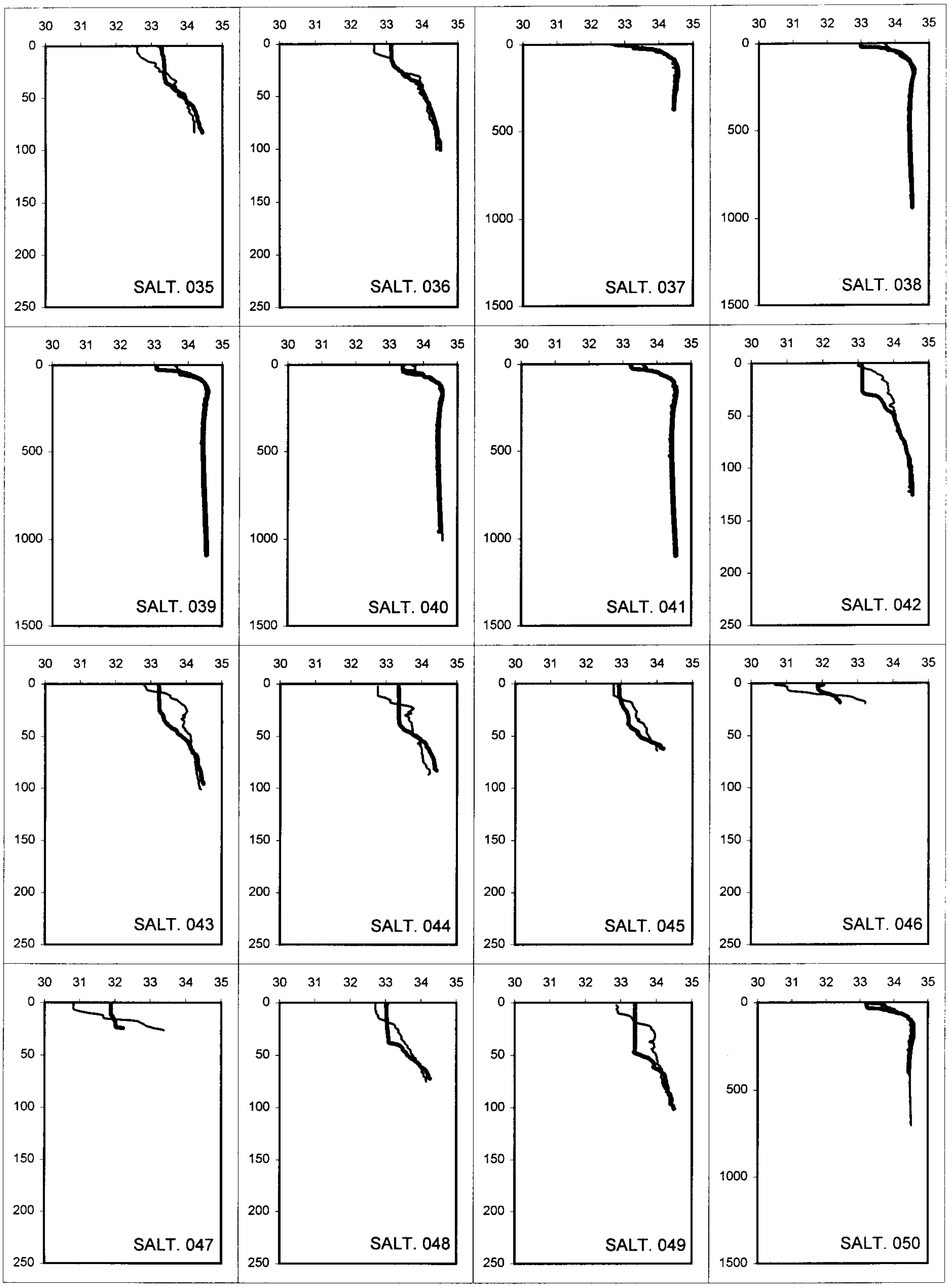

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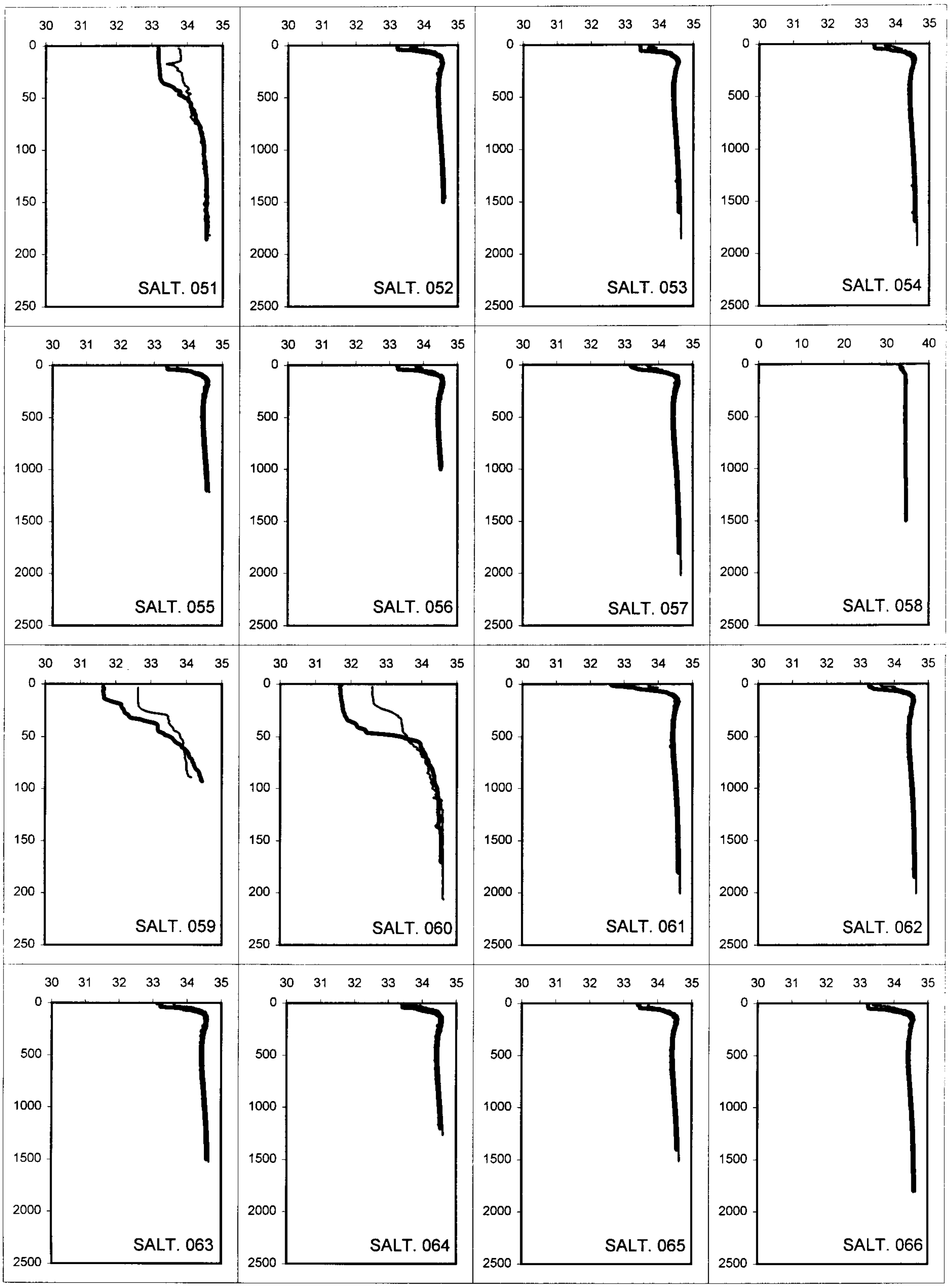

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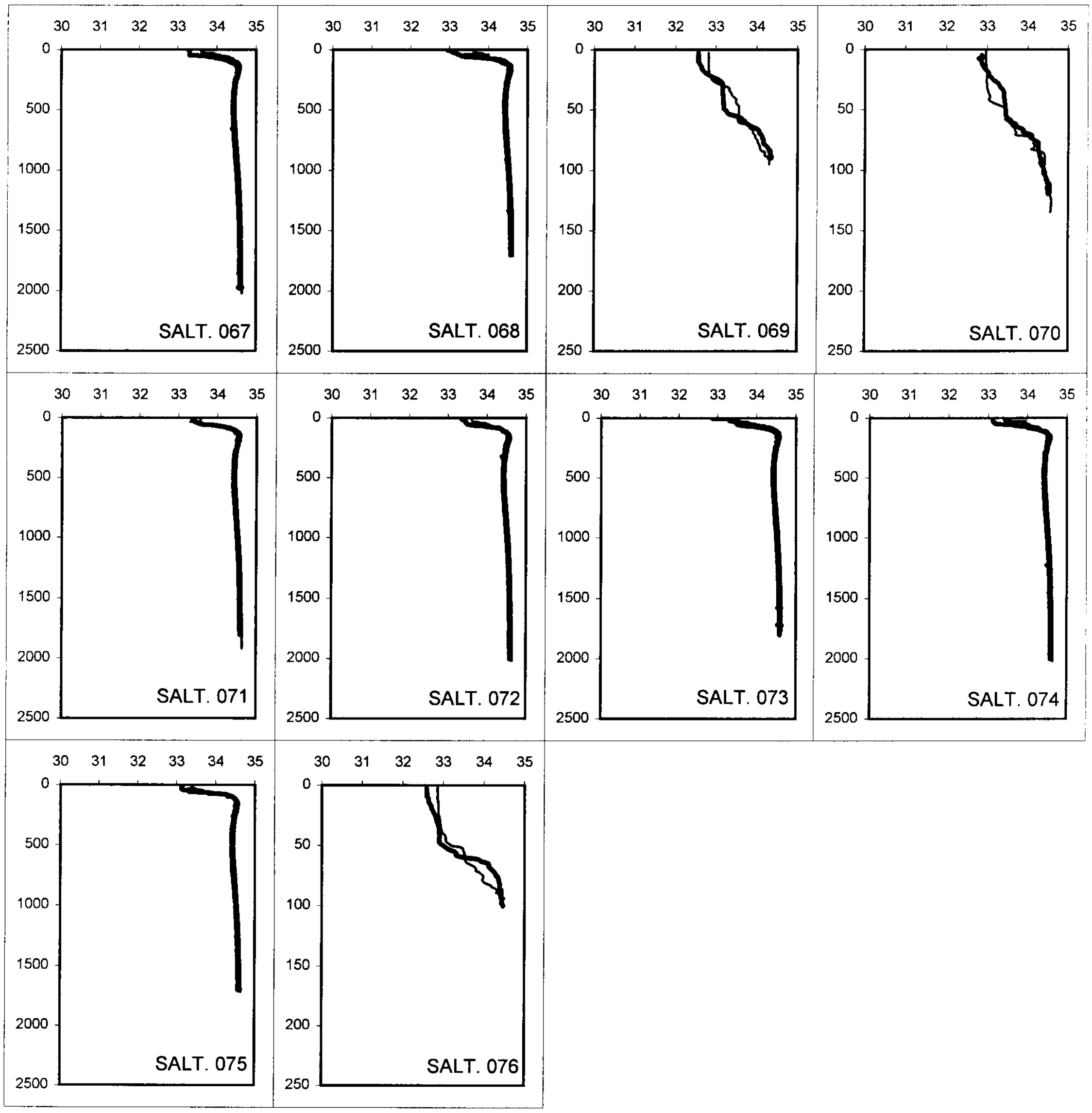

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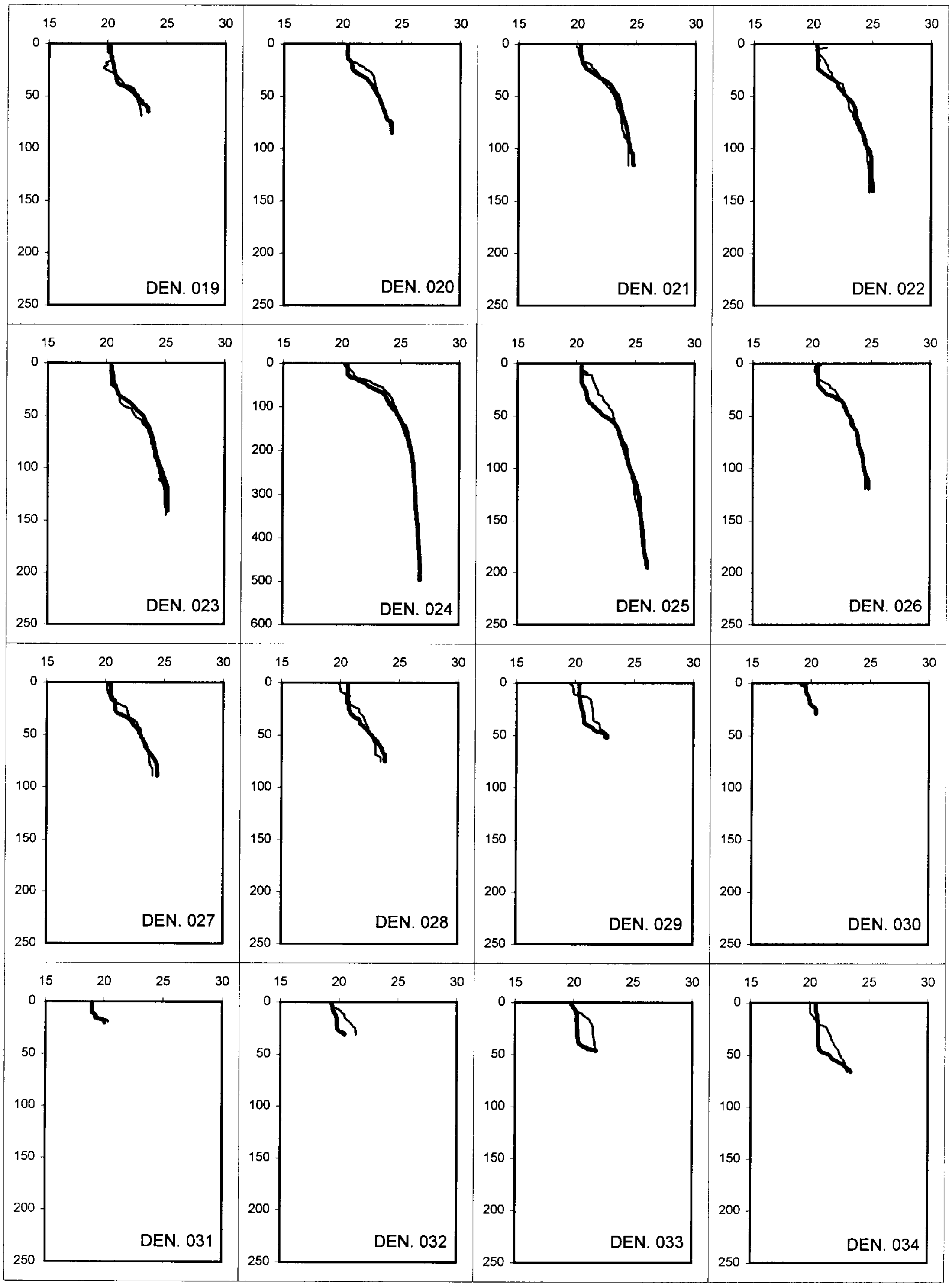
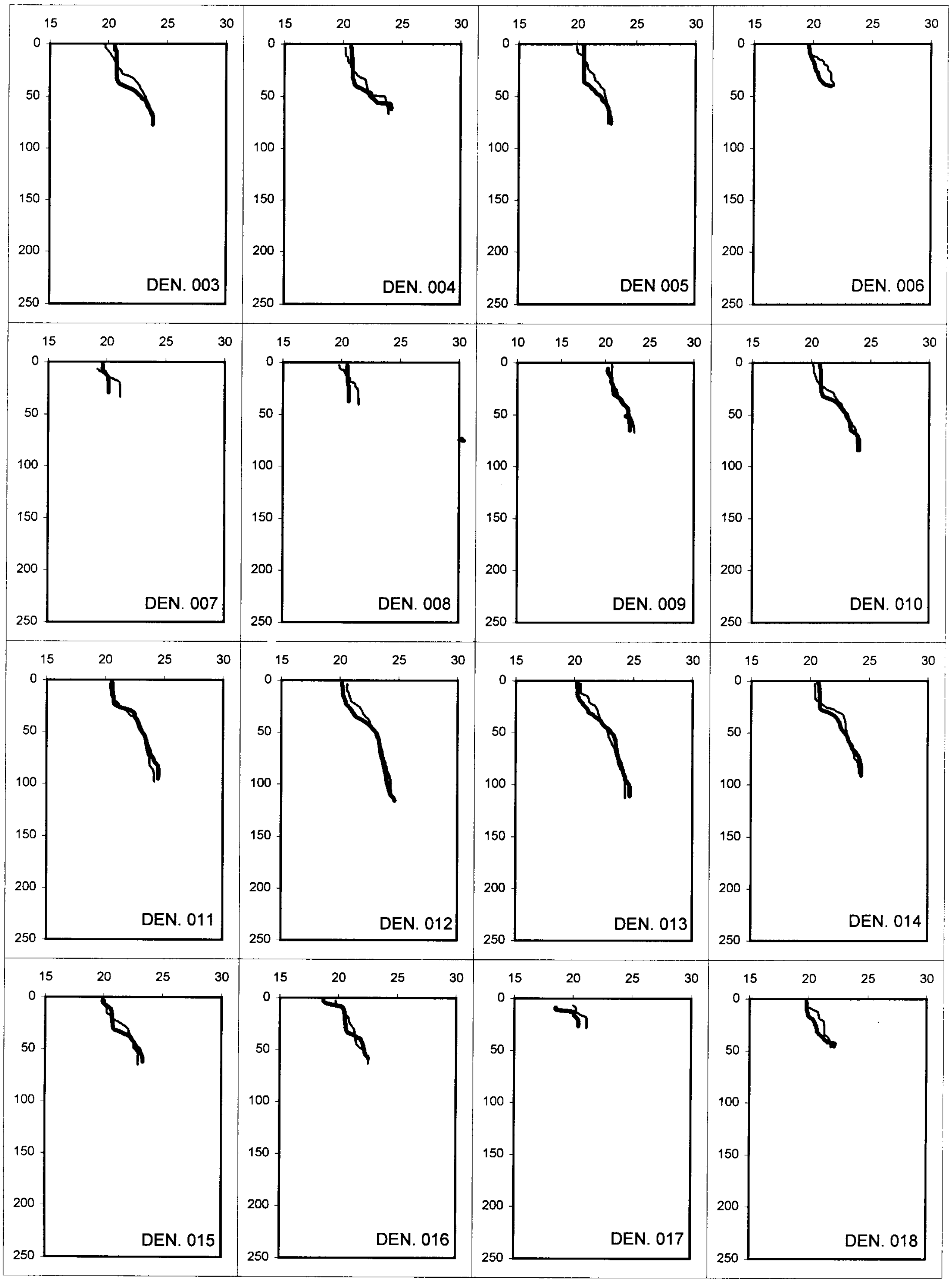


Fig 7 Profiles of density from the third (thick lines) and the fourth (thin lines) crouses.



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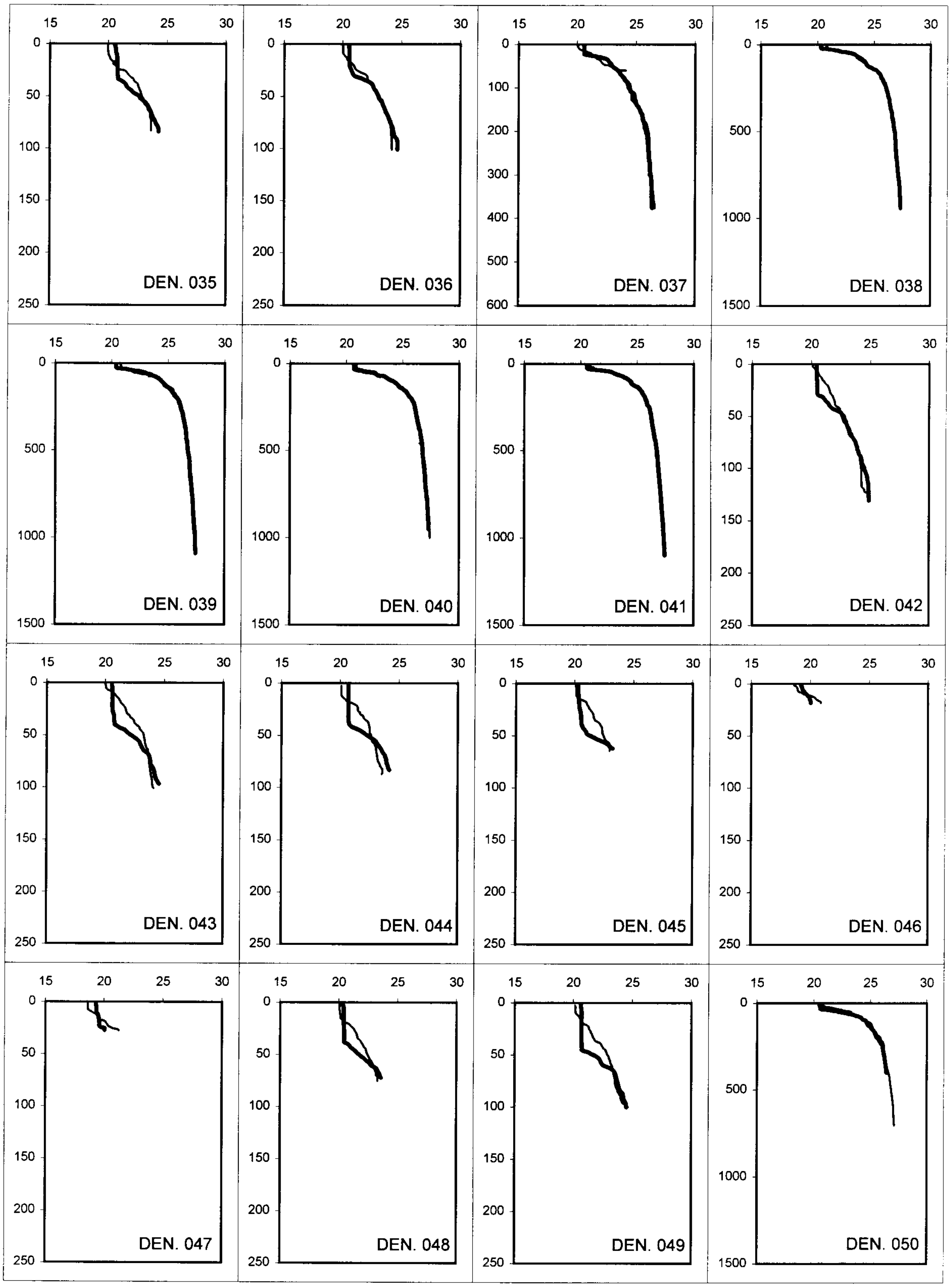

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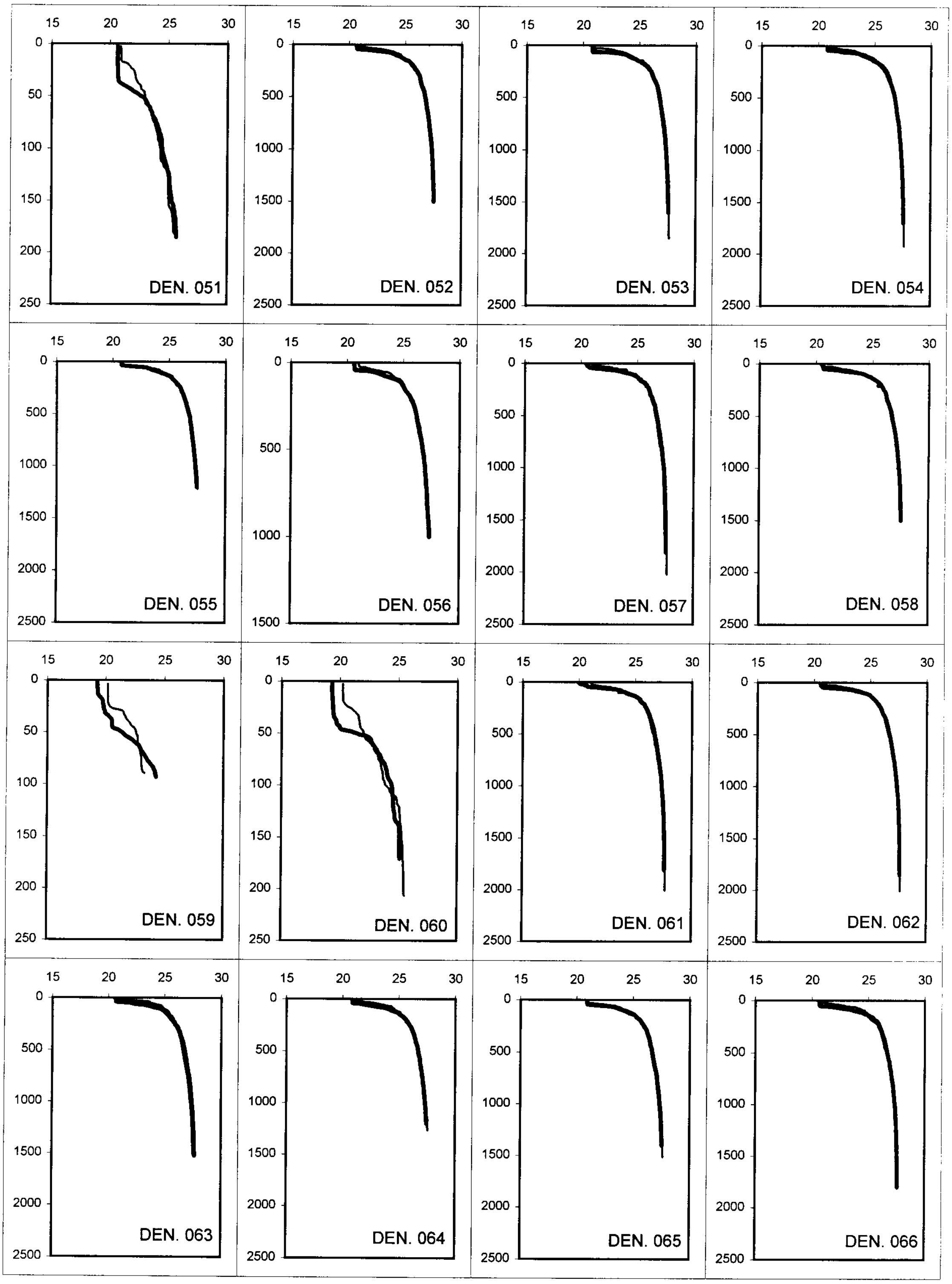

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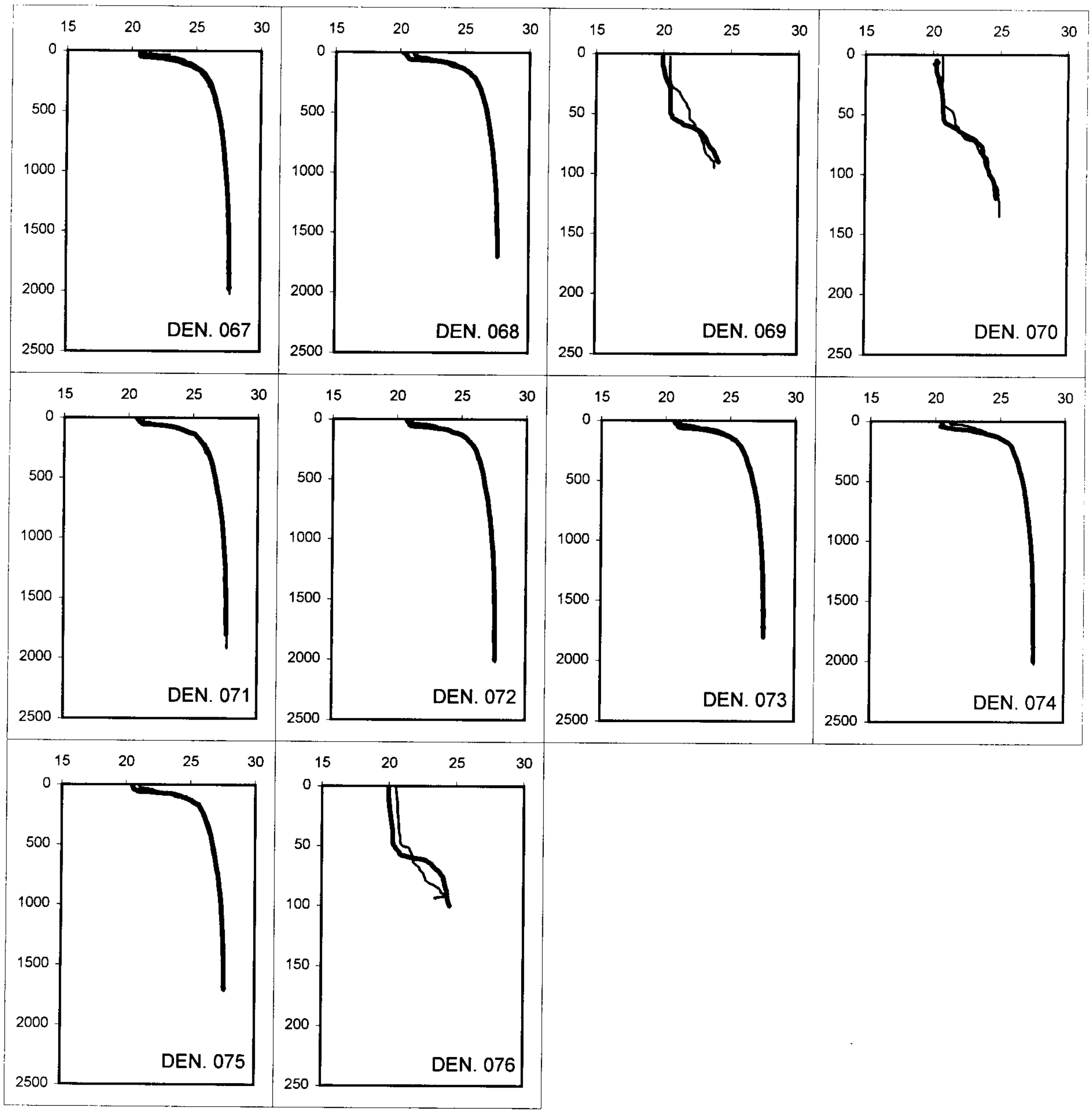

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