

Formation of dense bottom water in the Barents Sea

Extended abstract

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The question of dense water formation and the processes of deep water production in the northern seas has recently been raised again by some authors, for example Aagaard (1981) and Swift, Takahashi and Livingston (1983). Already in 1906 Nansen, taking notice of early observations of Russian scientists (Knipowitsch 1905) together with the results from Amundsen's expedition with "Gjøa" and his own observations on the "Fram" expedition, presented his

theories on the formation of bottom waters of the northern seas (Nansen 1906). Nansen particularly emphasized the formation of dense water in the eastern Barents Sea, notably on the Novaya Zemlya Shelf, where the salinity is increased by rejection of brine during the freezing process. A similar process is also the basis for bottom water formation in the Antarctic (Mosby 1934 and 1967).

Nansen further believed that dense water

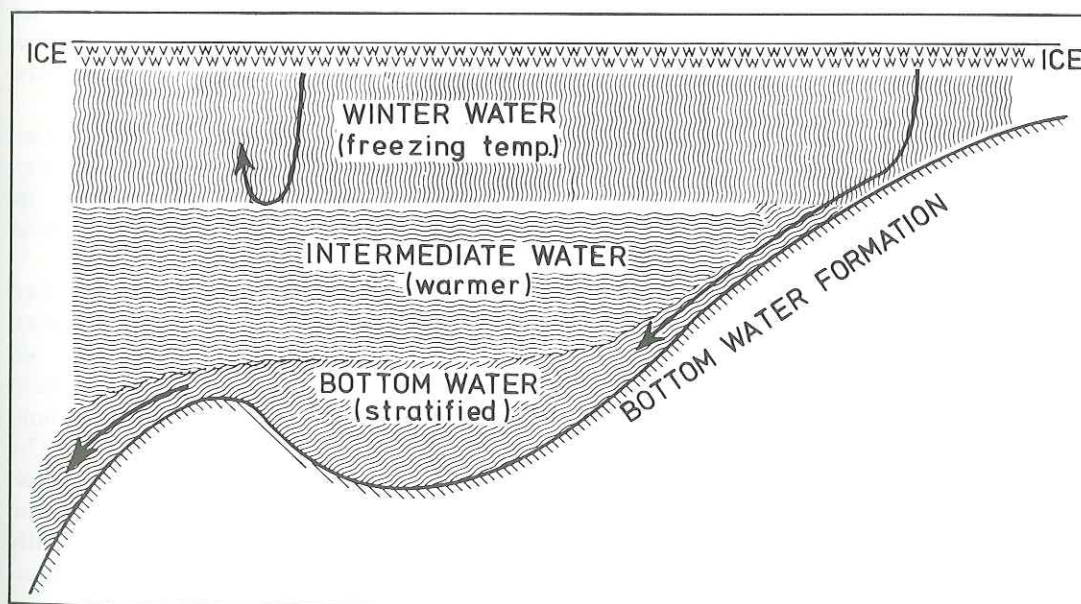


Fig. 1. Illustration of dense water formation.

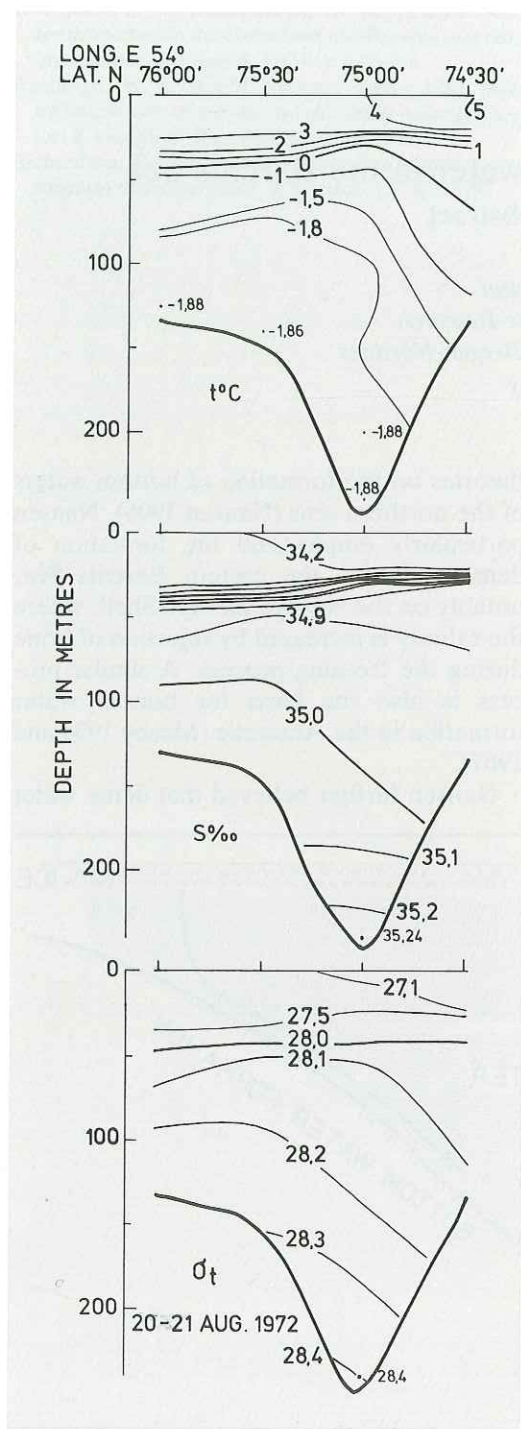


Fig. 2. "Johan Hjort" section August 1972.

formed in the eastern Barents Sea can supply the bottom water of the Arctic Ocean through the deep channel between Novaya Zemlya and Franz Josef Land, but due to lack of reliable salinity observations a definite conclusion could not be reached.

In the present study (described in details in Midttun, 1985) observations from the Barents Sea are examined. This analysis confirms the observations and conclusions drawn by Nansen (1906).

Figure 1 illustrates how the formation of dense water is expected to take place.

Observations from a short section running north-south along 54°E between 74°30'N and 76°00'N are shown in Figure 2. On the bank area in the northern part of the section, bottom water with a freezing temperature and a salinity of 35.09 is found. The upper 50 meter layer has been diluted by ice melting and somewhat warmed up during the summer season. Melting of 158 cm sea ice of salinity 5‰ would be enough to change a homogeneous water column with salinity 35.09 to the present structure. In the deep depression at 75°N the salinity was 35.24 and near freezing temperature. This water has obviously been formed on a shallow bank area and drained down into the hollow where it was observed.

Dense water may spread farther westward into the deeper depressions of the eastern Barents Sea. This was quite apparent in the cold year of 1979, but the sinking effect varies from year to year.

In 1971 and 1973 "G. O. Sars" worked the section along 60°E meridian between Novaya Zemlya and Franz Josef Land. Cold and saline water was found on the southern side of the channel with temperature around -1°C and salinity around 35.00 (Fig. 3). The relatively high salinity is a result of admixture from dense water formed during the freezing process. The water is apparently moving eastward through the channel communicating with the Arctic Ocean.

Dense water formed in the same way has

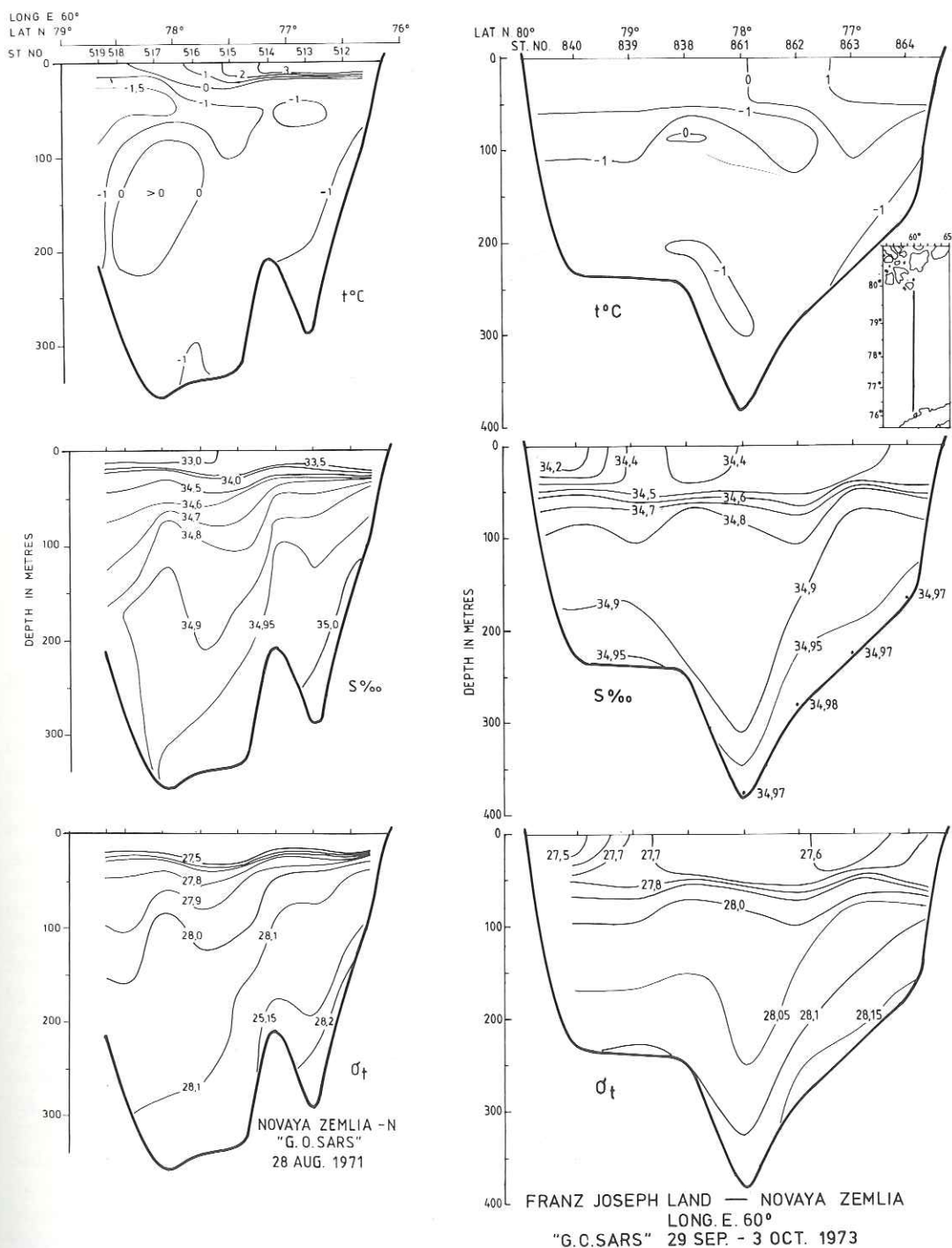


Fig. 3. Sections along 60°E between Novaya Zemlya and Franz Josef Land. Left: "G. O. Sars" 28 August 1971. Right: "G. O. Sars" 29 September — 3 October 1973.

also been observed on the Svalbard Bank area. Thus in 1981 "G. O. Sars" measured at position 77°15'N 19°34'E near bottom $t = -1.90^{\circ}\text{C}$, $S = 35.25$ and $\sigma_t = 28.40$. Such dense water will sink along the bottom and gradually mix with warmer and less saline water.

REFERENCES

- Aagaard, K. 1981. On the deep circulation in the Arctic Ocean. *Deep-Sea Res.* 28A: 251–268.
- Knikpowitsch, N. 1905. Hydrologische Untersuchungen im Europäischen Eismeer. *Annalen der Hydrographie und Maritimen Meteorologie*, 1905.
- Midttun, L. 1985. Formation of dense bottom water in the Barents Sea. *Deep-Sea Res.* 33(10): 1233–1241.
- Mosby, H. 1934. The waters of the Atlantic Antarctic Ocean. *Det Norske Videnskaps-akademi i Oslo, Scientific Results of the Norwegian Antarctic Expeditions, 1927–1928*, 1(11).
- 1967. Bunnvandannelse i havet. The Nansen memorial lecture October 11th 1965. The Norwegian Academy of Science and Letters. Universitetsforlaget, Oslo, 1967.
- Nansen, F. 1906. Northern Waters: Captain Roald Amundsen's oceanographic observations in the Arctic seas in 1901. *Videnskabs-Selskabets Skrifter*, I, Matematisk-Naturv. Klasse, 1906, No. 3, 145 pp.
- Swift, J. H., T. Takahashi and H. D. Livingston 1983. The contribution of the Greenland and Barents Seas to the deep water of the Arctic Ocean. *J. Geophys. Res.* 88: 5981–5986.