International Council for the Exploration of the Sea

C. M. 1980/C. 18
Hydrography Committee

The beginning of the renewal of the deep water in the central basins of the Baltic in 1980

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Renewal of the deep water in the central basins of the Baltic is associated with episodic intrusions of large quantities of higher saline water from the Kattegat. Börngen (1978) stated that such inflows of salt-rich water occur at a mean interval of three years. The last radical renewal of the Baltic deep water took place in 1977 but could not be attributed by any specific extreme inflow situation (Nehring, Francke, 1980).

The period of stagnation following the last renewal led to considerable oxygen depletion in the deep water of the central basins of the Baltic and to the formation of hydrogen sulphide. The salinity in the near-bottom water layers also decreased as a result of horizontal and vertical mixing, so that conditions favouring renewal of the water arose. On account of this situation it was predicted towards the end of last year that the renewal of the deep water would again take place in the central basins of the Baltic during 1980 (Nehring, 1979; Nehring, Francke, in preparation).

Several large intrusions of Kattegat water across the Darss Sill were observed as early as the late autumn of 1979, and their effects were noticeable in the salt and oxygen concentrations of the bottom water in the Arkona and Bornholm Basins. However, these were obviously of insufficient magnitude or density to initiate any radical

renewal of the deep water in the Baltic. In March/April 1980 the water masses which entered the Baltic towards the end of the previous year appeared to have reached the southern part of the eastern Gotland Basin where they formed a layer at a depth of 80-90 m corresponding to their density (Fig. 2 and 3).

In November 1979, the salinity of the deep water in the Bornholm Basin was 15.4 ‰, ie only 0.5 ‰ higher than the minimum for the period 1969-1978 (Nehring, Francke, 1980). During January/February 1980 the brief intrusion transported considerable amounts of oxygen-rich water into the Baltic, and this led to improved oxygen conditions in the bottom water of this basin as early as March. However, the small (0.5 ‰) increase in salinity showed that this water was unable to initiate the exchange of the bottom water in the Gotland Sea (Fig. 2).

Past experience has shown that salt water intrusions usually occur between October and February (Wolf, 1972). One exception to this rule was the salt water inflow in 1972 which took place between 21st March and 10th April (Nehring, Francke, 1974). 1980 appears to be another exception. During the seasonal cruise of the r/v "Professor Albrecht Penck" in May this year further decisive hydrographic and chemical changes were observed in the deep water of the Bornholm Basin (Francke, 1980). For example the salinity of the deep water in some places had increased by around 2 ‰ up to about 18 ‰ (Fig. 2c). The oxygen content near the bottom was 5-6 ml/l in the western and central parts of the basin, whereas old, oxygen-depleted water containing less than 2 ml/l was still present in the eastern slope (Fig. 3c). The studies were therefore apparently performed during the actual renewal of the water in this basin.

The graphs show that the water swept forward in a front and pushed the previously stagnation water back towards the east. We can therefore assume that the intrusion was a type 3 intrusion after Grasshof (1974) which also leads to a radical renewal of the deep water in the Gotland Sea.

The following data were measured at station 5A on May 25th 1980, about three weeks after the first investigations.

Table 1

Depth (m)	Temperature (°C)	Salinity (‰)	Oxygen (ml/l)
1.0	5.84	7.95	9.39
4.8	5.86	7.95	9.33
9.5	5.76	7.95	9.33
14.6	5.57	7.98	9.40
19.3	5.31	8.01	9.30
29.2	3.50	8.10	9.33
39.2	3.47	8.17	9.33
49.3	2.40	8.27	8.92
59.2	2.44	11.80	7.51
69.2	4.34	14.78	3.21
79.4	4.01	15.91	4.92
88.5	3.70	17.29	4.49

Since the highly saline deep water with a salinity exceeding 20 ‰ (Fig. 2c) had already flowed out of the Arkona Basin at this time, the figures shown in Table 1 simultaneously characterize the onset of a new period of stagnation. In this connection the residual old water (69.2 m) is not expected to have any major impact on further developments.

The changes in the hydrographical-chemical conditions in the Bornholm Basin are roughly similar to those abserved following the salt water intrusion of 1975/76 in terms of both the amount of salt-rich water and the increase in salinity and oxygen content (Francke et al., 1976, 1977, 1980; Nehring, Francke, 1978). We can therefore expect that restratification in the central basins of the Baltic will follow a similar course to that in 1976.

Since the influx of salt-rich water occured in March/April, the water masses were relatively cold and led to a drop of 1-1.5 °C in the deep water of the Bornholm Basin. Another feature of these

water masses was that they entered the Baltic Sea after the spring phytoplankton development and were therefore rather poor in nutrients. For example, the phosphate content in the bottom layer of the western Bornholm Basin (St. 4B) decreased to 0.5-0.6 µg-at/l, and the nitrate content also reached only 2.4 µg-at/l. Similarly low nitrate concentrations were observed after the salt water intrusion in 1972 which also occured relatively late (Nehring, Francke, 1974).

Current measurements taken as the buoy station "Darss Sill" (Francke, Hupfer, 1980) show that the inflow in 1980 took place in two phases, the first from 28th March to 13th April and the second from 18th to 26th April. During this time current velocities of 35-60 cm/s were measured at moderate depth within the whole water column (depth: 21.5 m) moving eastwards. Initial comparison of these results with wind measurements made at Arkona show only a poor correlation, especially for the first place. In contrast, agreement with the water levels from Warnemuende was very good. Detailed investigations taking into account the data from various light vessels and coastal stations will permit more certain analysis of the course of events and of the causal factors.

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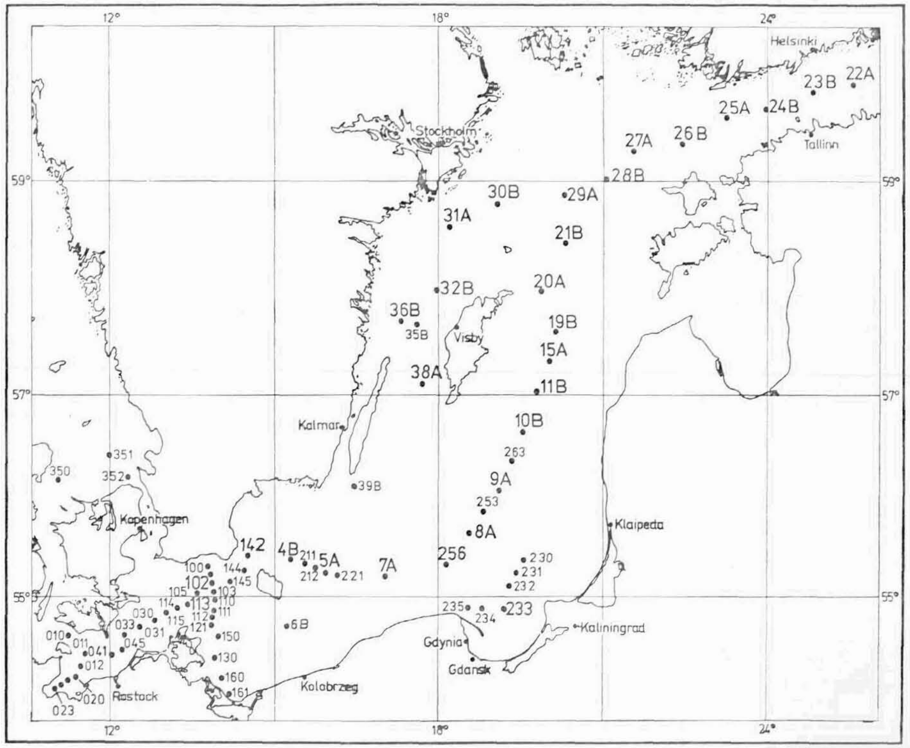
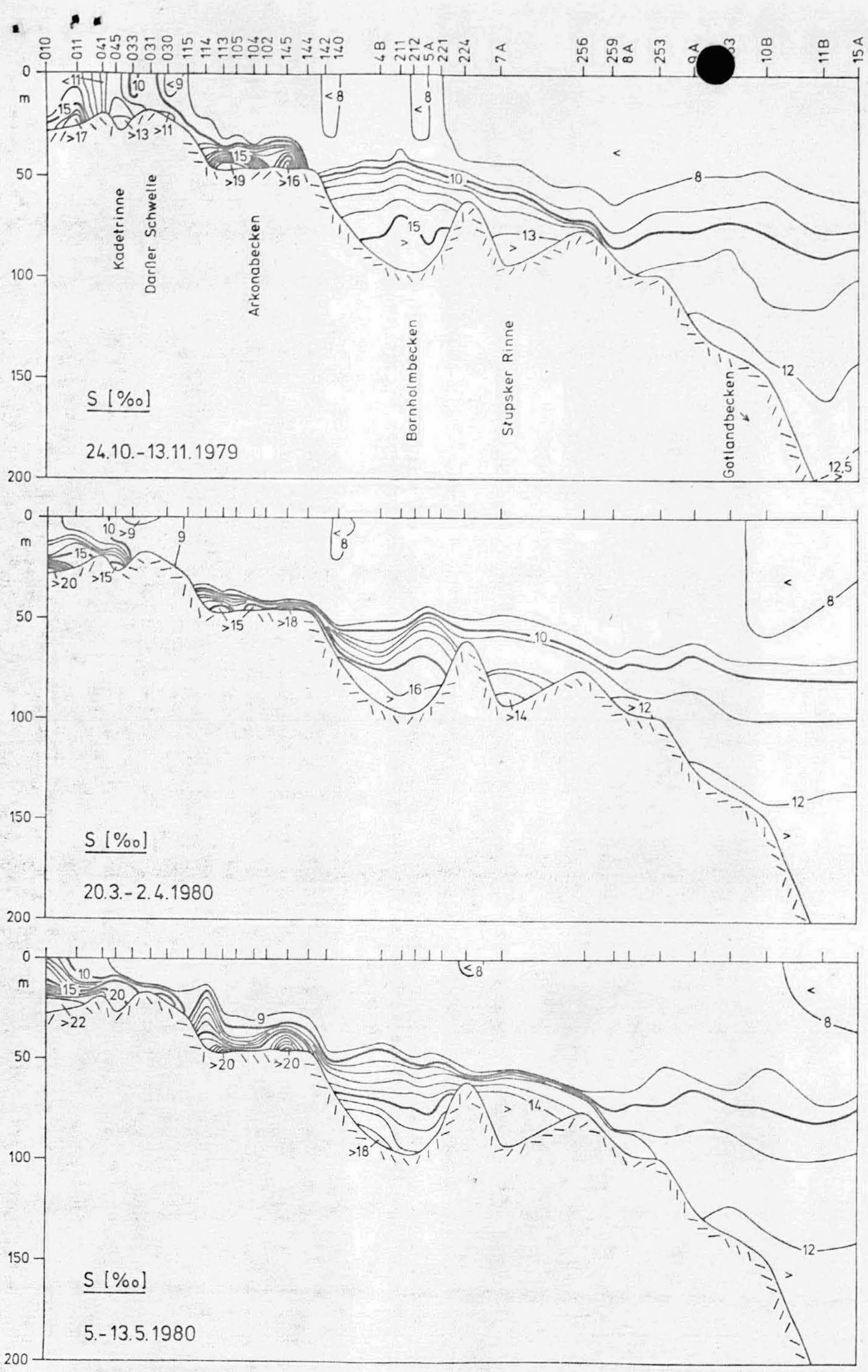


Fig. 1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Kadetrinne
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Arkonabecken
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Stupsker Rinne
Gotlandbecken
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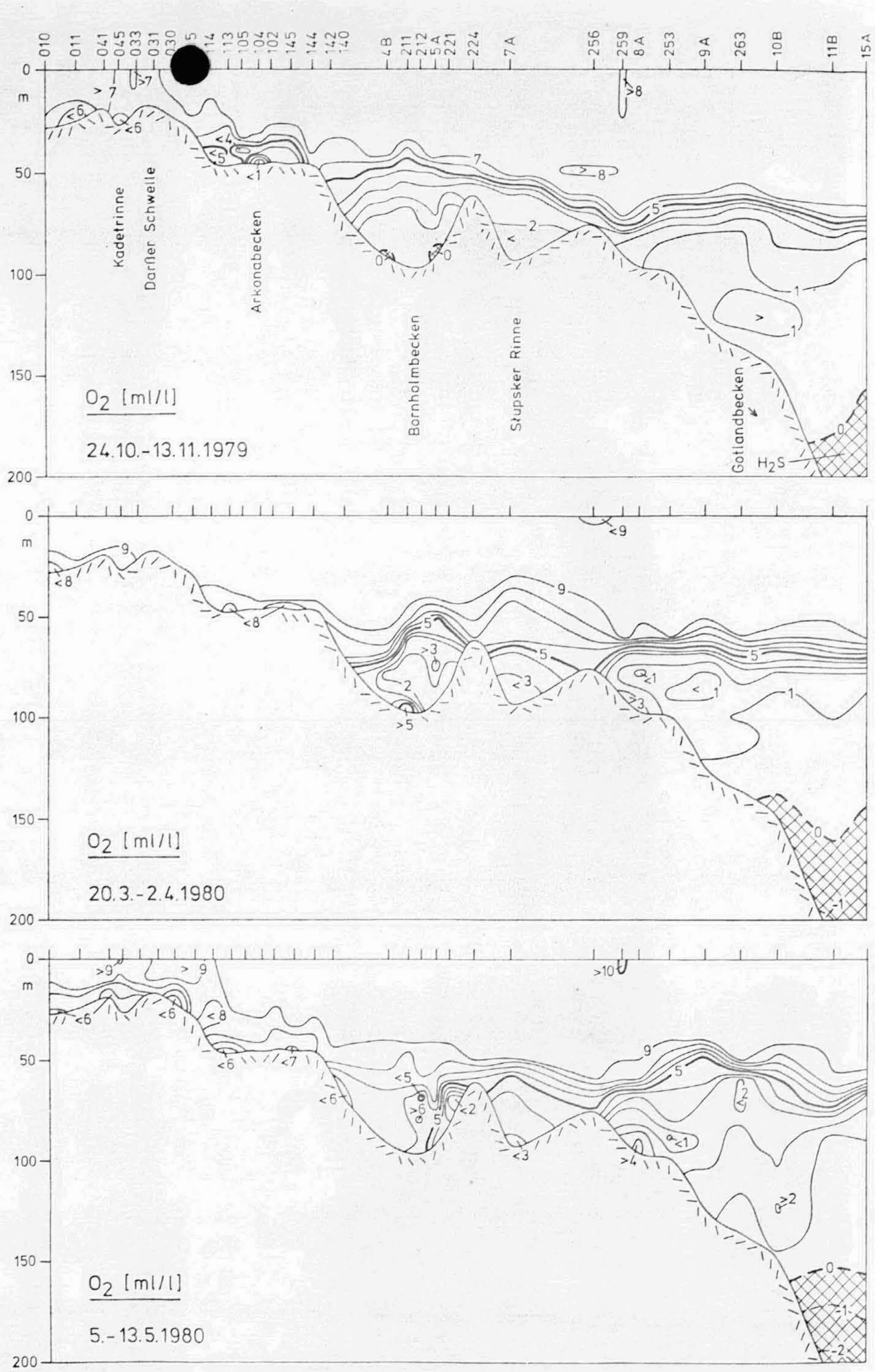
Fig. 2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Kadetrinne
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Arkonabecken
Bornholmbecken
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H2S
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O2 [ml/l]
20.3.-2.4.1980
O2 [ml/l]
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Fig. 3