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Results from recent investigations in the Greenland-Scotland overflow area

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In 1973 a new investigation of the overflow problem in the Greenland-Scotland-Ridge area is planned. It is well known that this region is hydrographically highly complex and that it is usually adverse to the use of costly modern instrumentation like moored current meter arrays. On the other hand, however, this area has already been investigated by national and international efforts to a state (e.g. "The Iceland-Faroe Ridge International "Overflow" Expedtion, May-June 1960." Rapp. P.-v. Réun. Cons.perm.int.Explor.Mer, Vol 157) where field experiments can be designed on a very realistic basis. The purpose of this note is to add some further information to our knowledge of stratification and currents in the Iceland-Faroe ridge area and to raise a few questions which might be worth to be followed up during the planned Overflow 73 investigation.

From 1959 to 1971 the German fishery research vessel "Anton Dohrn" has carried out 14 standard hydrographic surveys of a section running along the southwestern flank of the Iceland-Faroe ridge (see Figure 1). The section consists of 13 stations at depths between 500 and 680 meters. A typical cast consisted of 8 Hansen bottles and a sampler to obtain temperature and salinity of the bottom water. The time of investigation was February to April in eleven cases and June to October in three cases. Temperature and salinity observations of each cast were interpolated to obtain values at depths of 25, 75, 125 m etc. The observation within 30m next to the bottom were averaged and considered to represent bottom temperature and salinity. Having standardized each cast by this procedure, mean values of temperature and salinity as well as their standard deviati for the surveys 1959-1971 were computed for each station and plotted in Figures 2 and 3. Figure 4 represents all temperature and salinity observations in the form of a TS-diagram. Without discussing details of Fig. 2-4 the following facts can be read from the graphs:

(a)

Large variations of temperature and salinity with space and time do occur in the layer 100 to 150 meter next to the bottom. Areas of maximum variability within this layer are found between stations 3 and 7, 10 and 11 and at station 13, where high values of standard deviation even extend into the surface layers. The bottom near layer of large variability is related to what is named by "overflow", i.e. the intermittend occurrence of cold, low, saline water spilling over the summit and the southwestern flanks of the Iceland Faroe ridge and contributing to the Northeast Atlantic deep water. At station 13 the hydrographic section intersects with the subarctic frontal zone. Its advective changes do account for the large values of standard deviation found at this position.

(b)

From the temperature-salinity plot of all observations along the standard section it is obvious that in no case pure Norwegian Sea deep water (NS: $T = -0.6^{\circ}C$, $S = 34.92‰$) and that only in a very few cases North Ice-

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landic winter water (NI:T = 2.5°C, S = 34.87‰) was observed. The water masses along the southwestern flank of the ridge consist of a mixture of NS- and / or NI-water with Northeast Atlantic water (NA: T = 9.0°C, S = 35.34‰). This mixture is formed in the bottom near layer above the ridge, so that with respect to the deep arctic water and its overspill in the Faroe-Bank channel and in the Denmark Strait the overflow across the Iceland Faroe ridge has to be considered as a secondary one.

(c) Figure 5 represents an example of a temperature and current profile which has been obtained in June 1971 by using a Bergen current meter in connection with the hydrographic cast. The current meter is shackled between the hydrographic wire and the bottom water sampler. Following bottom contact of the bottom sampler and tripping of the Nansen bottles, the cast is slowly pulled (approx. 6 meters per minute) until 200 meters distance from the bottom. With a sampling rate of 1 scan of all channels per 32 seconds for the current meter an average vertical resolution of 3 meters is obtained. The critical point is the drift of the ship which however can easily be controlled by using a simple reference mooring with a small surface radar buoy. Profiled were obtained at the positions 8, 10 and 12 of the standard section. They all showed that in the layer of 20 to 50 meter to the bottom the current was flowing parallel to the isobaths with a speed definitely larger than in the layers above. Fig. 5 illustrates this result for station 8. At station 10 the bottom current was directed toward NNE, station 12 showed SW bottom currents with the same magnitude as station 8. The current above the bottom layer was toward S to W in all cases.

The points made under (a) and (b) have certainly been known before (e.g. GRASSHOFF, 1965 and HERMANN, 1967) but it is now that they are well confirmed by 13 years of observation on the Iceland Faroe standard section. The results mentioned under (c) were not unexpected (e.g. DIETRICH, 1967) but more observational work is necessary before coming to an appropriate use of the profiles. But combining (a), (b) and (c) one can formulate a problem group which is of general importance and can be studied at the example of the Iceland-Faroe ridge:

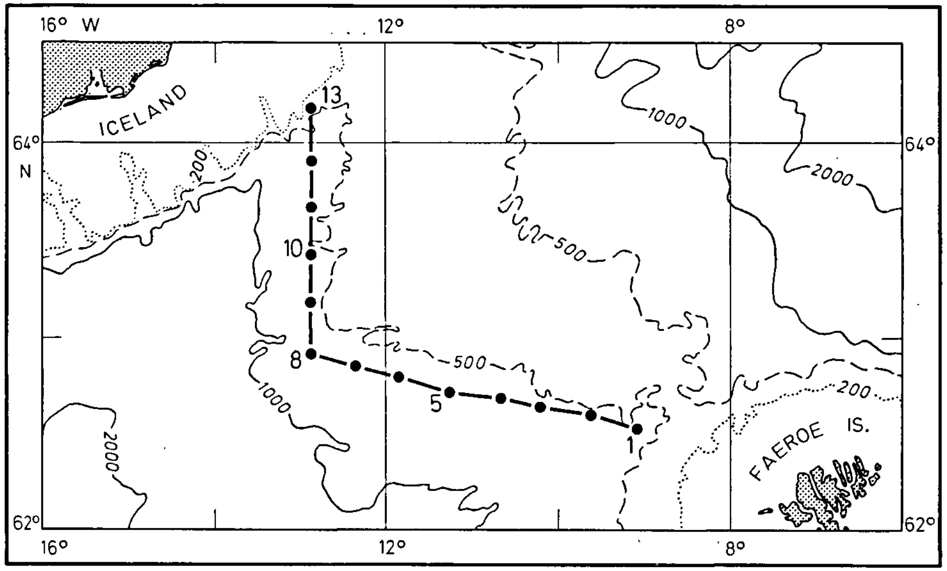
1. What are the dynamics of the water masses involved in the formation of the "overflow" water, e.g. how does the Norwegian Sea deep water north of the ridge react on moving atmospheric pressure disturbances?
2. Which role play advective processes for mixing in the ridge area, e.g. how important are eddies and meanders of the subarctic front or what does the outflow from the Faroe-Bank channel which consists of Norwegian Sea deep water and which follows the southern flank of the ridge, contribute to mixing?
3. What are the roles of barotropic and baroclinic tidal waves with respect to mixing? This question seems to be important because interaction of surface and internal tides above the ridge and subsequent dissipation of tidal energy is to be expected.

<u>References:</u>

DIETRICH, G. (1967) The International Overflow Expedetion of the Iceland-Faroe Ridge, a Review. Rapp.P.-v.Réun. Cons.perm.int. Explor. Mer, 157, 268-274

GRASSHOFF, K. (1965) Hydrographische Beobachtungen im Seegebiet des Island-Faroer Rückens von 1959-1963 mit FFS "Anton Dohrn". Ber. dt. Komm. Meeresforsch., 18 (1), 1-12

HERMANN, F. (1967) The T-S Diagram Analysis of the Water Masses over the Iceland-Faroe Ridge and in the Faroe-Bank Channel. Rapp.-P.-v. Réun.Cons.perm.int.Explor.Mer, 157, 139-149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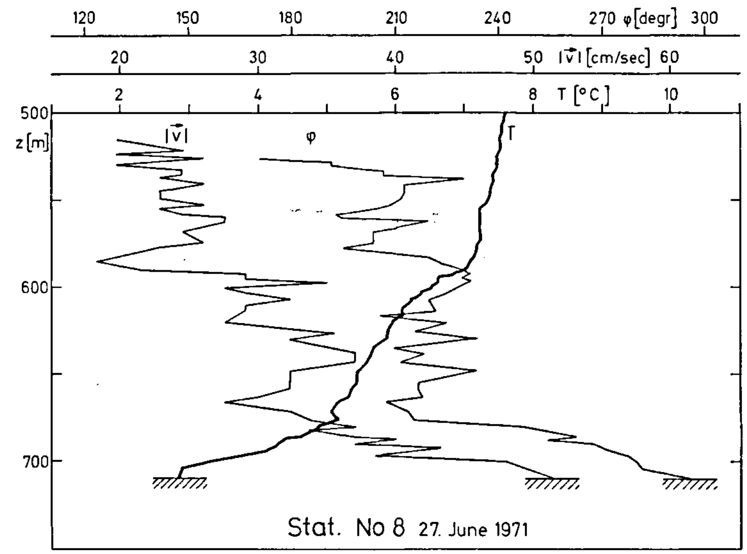
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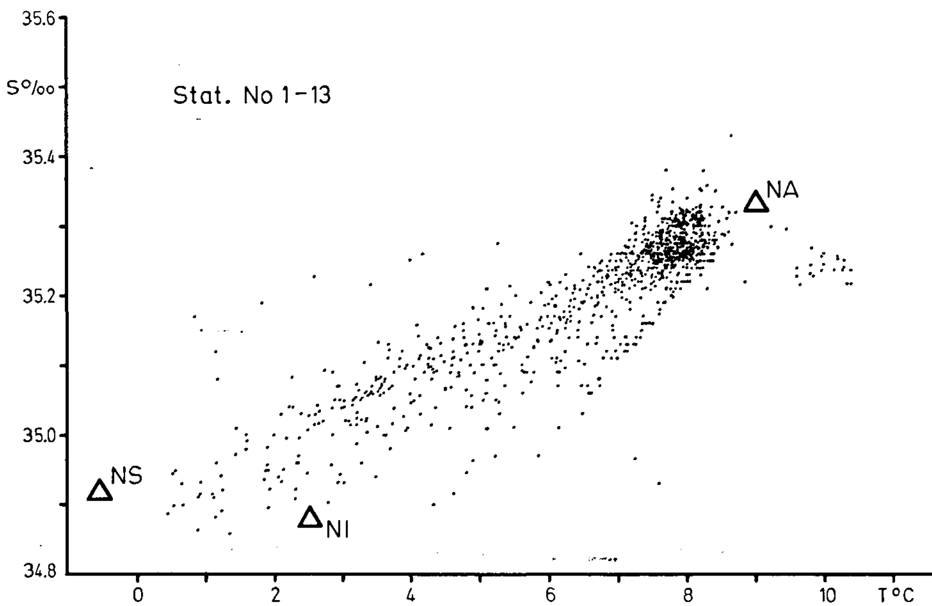
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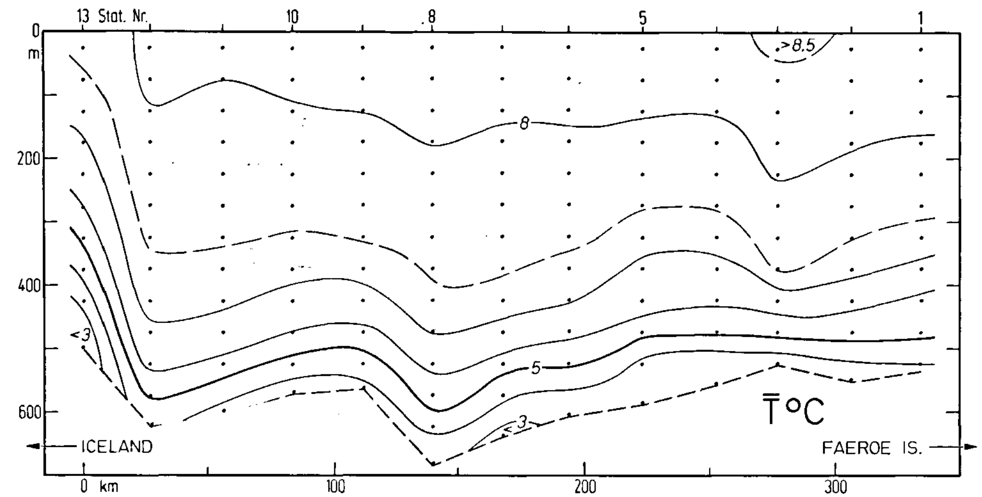
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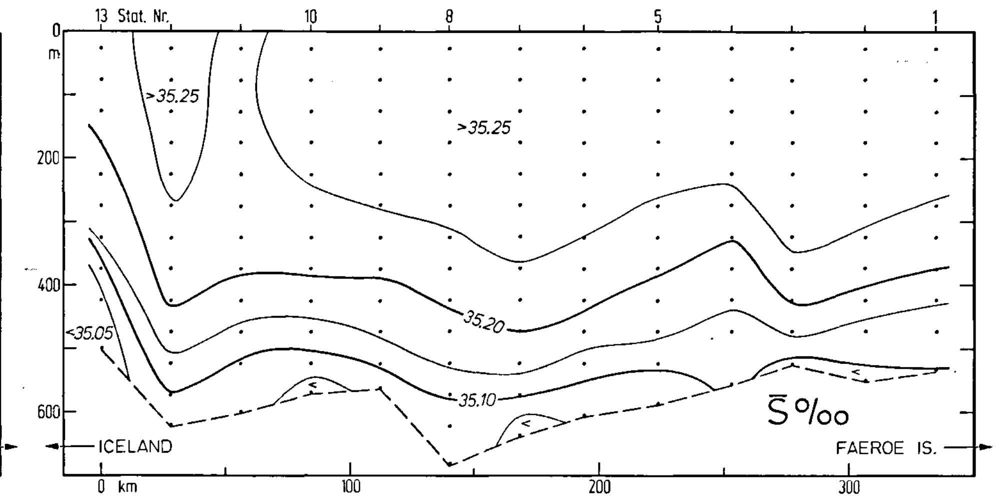
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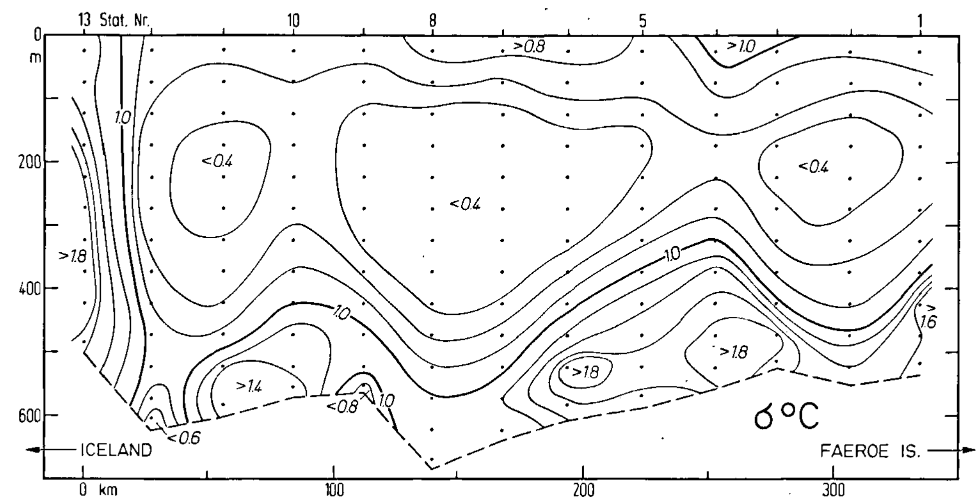
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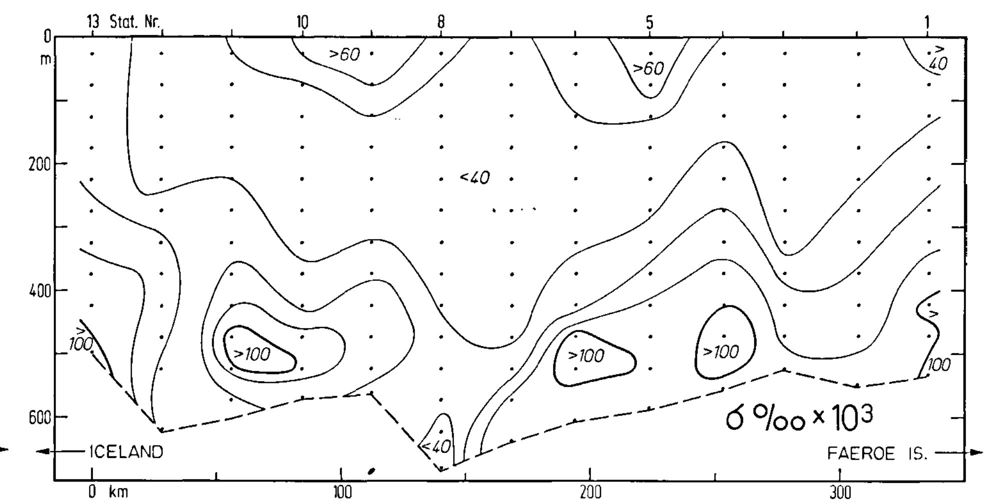
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