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Overflow '73 - Greenland-Scotland Ridge
Some scientific problems and methods for their solution

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It is the intention of the Hydrography Committee of the ICES to support a thorough investigation of the Greenland-Scotland Ridge. Some preparations have already been made: In 1958 a Sub-Committee for the Investigation of Sub-Arctic Deep-Water Overflow across the Iceland-Faroe Ridge — one part of the Greenland-Scotland Ridge — was established, which recommended a project to be carried out by five member states of the ICES with the aid of nine research vessels in 1960. The results have been published 1967 in the Rapports et Procès-Verbaux, Vol. 157. This "Overflow Project '60" as well as the Polar Front Survey 1958 in the North Atlantic Ocean and some recent observations give a base to formulate the problems of a new overflow investigation. In 1969 the Hydrography Committee decided to continue the investigations in 1973, this time covering the whole ridge between Greenland and Scotland.

The general situation given by the previous investigations will be described, and some points concerning the present problems will be added. The discussion on this ICES-Meeting should bring some additional remarks concerning the general situation. Furthermore, the realization of the project should be considered in detail.

The general situation is the following: The ridge between Greenland and Scotland, which is one of the most remarkable ridges in the entire world ocean, consists of four parts:

1. The Greenland-Iceland Ridge with a cross channel connecting the Greenland Sea with the Irminger Sea. The sill depth is approximately 800 m.
2. The Iceland-Faroe Ridge. A broad plateau forms the top with a sill depth of about 480 m.

3. The Faroe-Faroe Bank Ridge with a recently discovered cross channel. The sill depth is about 820 m.

4. The Wyville Thomson Ridge between Faroe Bank and the shelf off Scotland with a sill depth of about 600 m.

The Greenland-Scotland Ridge divides the Northern North Atlantic Ocean into two parts: the northern one — the Norwegian and Greenland Sea — is under the regime of cold polar water renewed in the central region near Jan Mayen by vertical convection in late winter, the water of the southern part is determined by the North Atlantic Current fed by the Gulf Stream. A branch of this current system crosses the Wyville Thomson Ridge and enters the Norwegian Sea as the Norwegian Current. As a counterpart cold subpolar and polar water leaves this region to the South in the East Greenland Current. There are two other warm surface currents — a small one west of the Faroe Islands, and the Irminger Current west of Iceland —, which transport water to the North. The East Iceland Current transports cold surface water to the South. The water transport of the five surface currents mentioned is not in balance: the water volume flowing into the Norwegian and Greenland Sea is greater than the water volume flowing out. Therefore, an additional deeper outflow must exist. This is the overflow of interest — the topic of the project "Overflow '73" — crossing the ridge as cold arctic water with temperatures below 0°C and with a typical salinity of about 34.92‰.

It is well-known that the deep overflow prefers more or less three distinct locations:

1. The cross channel of the Greenland-Iceland Ridge.

2. The Iceland-Faroe Ridge without a marked channel.

3. The Faroe Channel lying in the Faroe-Faroe Bank Ridge.

The overflow through the cross channel of the Greenland-Iceland Ridge, which renews the bottom water in the Northwest Atlantic Ocean, is strong, fixed by the topography, but variable in time. The time scale of the fluctuations and the variations of volume transport is practically unknown.

The overflow passing the broad platform of the Iceland-Faroe Ridge prefers three or four locations as shown by the results of the overflow investigation 1960. But in any case, the vertical extent of the overflow across the ridge is small. It is usually below 50 m. During the "Overflow '60" the first continuous recordings of currents in this bottom layer were carried out at two positions, but they must be considered as a first experiment. These recordings of currents and temperature near the sea bottom showed great temporal changes of the overflow and, in addition, strong tidal currents.

No systematic survey of the current was obtained in 1960. The lack of continuous recordings really was one of the weak points during that expedition. Also the vertically continuous recordings of temperature and salinity were only in the stage of an experiment at that time. Meanwhile, considerable progress has been achieved with regard to instrumental techniques. This includes continuously recording current meters as well as STD recorders.

The overflow through the Faroe Channel found in "Overflow '60" was confirmed as a considerable volume transport. Outside the channel it seems to follow the contour lines along the southern slope of the Iceland-Faroe Ridge. Therefore, it is difficult to distinguish between water masses from the outflow through the Faroe Channel and from the overflow across the Iceland-Faroe Ridge if not the particular flows through the channel and across the ridge were tracked.

Summarizing the general situation on the Greenland-Scotland Ridge, two main problems exist concerning the overflow, namely the variations in time and space. In both cross channels, mentioned above, the bottom topography canalizes the outflow. There are no changes in space, but in time. On the Iceland-Faroe Ridge there are not very distinct places favouring the overflow,so here the problem concerns both space and time.Whereas the spatial scale of the overflow in the Greenland-Scotland Ridge area is approximately known from previous investigations, this is not true for the time scale of the process. The scanty information available indicates large fluctuations occurring within hours to days. These fluctuations however, are most important because they will shed light on the dynamics of the overflow, e.g. whether pressure fluctuations by moving atmospheric depressions are related to particular overflow events. Therefore, special emphasis should be given to continuous measurements of temperature and currents by means of moored instrument arrays. In addition, the hydrographic conditions should be recorded thoroughly taking advantage of the continuously recording STD-instruments.

It is self-evident that such a program requires a huge amount of instrumentation as well as a certain number of research vessels. The results will not only serve physical oceanographers for solving various problems of the overflow process, but may also be of interest to marine chemists, planktologists and fishery biologists. It offers a great chance of co-operation for all marine scientists, a co-operation which proved to be successfull already during the first overflow investigations in 1960.