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The Iceland Basin

-Topography and Oceanographic Features-

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CONTENT

Abstract

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This overview deals with the ocean region south of Iceland, named the Iceland Basin. The region is surrounded by the **Reykjanes Ridge** in the west, **Iceland** in the north, the **Iceland-Faroe Ridge** in the northeast and east, and several **banks** extending from the Faroes southwest wards to the **Hatton Bank** and **Rockall**. Only to the southwest the region is open out to the North Atlantic.

The overview was prepared in 1996 following a request from the Icelandic Post and Telephone Services because of faults in the submarine cable CANTAT-3 between North America and Europe.

The overview explains the general features of the bottom topography, especially around the western, northern and eastern boundaries of the Iceland Basin or along the lines of the submarine cable. Furthermore a description is given on the different water masses and their distribution in the area. They are the Atlantic water from the south in the uppermost 1000-1500 m, the Labrador and Irminger Sea water from the west at intermediate depths flowing across the Reykjanes Ridge into the Iceland Basin, and the "Overflow" bottom water from the north flowing through the Faroe-Shetland and the Faroe Bank Channels and across the Iceland-Faroe Ridge, and from there around the periphery of the Iceland Basin and at last over the Reykjanes Ridge into the Irminger Sea. Furthermore results of direct current measurements, mainly in the deep and bottom waters along the northern periphery of the Iceland Basin, are described. These measurements show in general velocities of 20-50 cm s^{-1} or up to one knot and with a westwards direction along the depth isobaths.

At last thoughts are given to the reason of the failures or faults in the submarine cable CANTAT-3 in the waters south of Iceland. The question arises, if these failures possibly were due to turbidity currents downhill the continental slopes and the submarine ridges or even due to trawl fisheries? But as the failures were located in deep waters and limited to regions of the different submarine ridges, it seems more likely that they were due to vibration or strumming of the cable, induced by currents along the depth contours that cause chafe faults and abrasion.

Ágrip

Svend-Aage Malmberg. 2004. Suðurdjúp - Íslandsdjúp: Botnlögun, sjógerðir og straumar. Hafrannsóknastofnunin. Fjölrit 109, 43 pp.

Yfirlit þetta fjallar um hafsvæðið sunnan Íslands, nánar tiltekið svæði það sem afmarkast af **Reykjaneshrygg** að vestan, **Íslandi** að norðan, **Íslands-Færeyjahrygg** að austan og norðaustan, og svo fjölda **grunna og banka** sem teygja sig frá Færeyjum vestur að **Hatton banka** og **Rockall**. Aðeins að sunnan eða suðvestan er hafsvæðið opið út í Atlantshaf.

Tilurð verksins var beiðni þáverandi Póst- og símamálastjórnar 1996 um úttekt á botnlögun og botnstraumum á umræddu svæði, einkum meðfram austur-, norður- og vesturmörkum þess. Um þær slóðir liggur neðansjávar-strengur milli Evrópu og Norður-Ameríku - CANTAT 3 - en hann hafði bilað eða rofnað á nokkrum stöðum. Var því leitað leiða til að skýra þessar bilanir m.a. að hve miklu leyti mætti kenna straumum og botnlögun eða lands-lagi um skemmdirnar, og þá að leita úrbóta á vandanum.

Í þessu yfirliti er gerð grein fyrir helstu einkennum botnlögunar á svæðinu og þá einkum á slóðum umrædds neðansjávarstrengs á ytri mörkum Suðurdjúps í austri, norðri og vestri. Síðan er helstu sjógerðum og útbreiðslusvæðum þeirra lýst. Þær eru hlýi Atlantssjórinn að sunnan í efstu 1000-1500 metrunum, millilög vestan úr Labrador- og Grænlandshafi (Irminger Sea) og botnsjór norðan úr hafi sem streymir suður yfir neðansjávarhryggina, „Overflow" svokallað. Í Suðurdjúpi er djúpstraumur sem streymir vestan úr Labrador- og Grænlandshafi um skörð í Reykjaneshrygg yfir í Suðurdjúp, og botnstraumur sem flæðir um Færeyjaála og yfir Íslands-Færeyjahrygg í Suðurdjúp með rótum íslensku landgrunnshlíðanna og síðan suður með Reykjaneshrygg og þaðan yfir hrygginn vestur í Grænlandshaf. Því næst er lýst niðurstöðum beinna straummælinga á slóðinni, einkum þá djúpt með nyrðri mörkum hennar. Þær niðurstöður sýna yfirleitt straumhraða á bilinu 20-50 cm sek^{-1} eða allt að **einum** hnúti með straumstefnu vestur á bóginn og tekur mið af hryggjum og skörðum.

Að lokum er hugað að orsök bilana á strengnum CANTAT-3. Því má velta fyrir sér hvort orsakirnar séu t.d. eðjustraumar niður brattar hlíðar landgrunnshalla og neðansjávarhryggja eða jafnvel togveiðar. En þar sem bilanirnar voru djúpt á slóðum neðansjávarhryggja þá berast böndin þó fremur að titringi strengs og núningi þar sem strengurinn liggur þvert á brattar hlíðarnar og er líklegur til að vera fremur slakur og/eða jafnvel svífa laus ofar botni. Tillaga til úrbóta er að forðast slíka slóð af fremsta megni og jafnframt að huga vel að því hvernig strengurinn leggst á hafsbotninn. Eftir sem áður þarf einnig að huga að togslóðum fiskiskipa.

1 Introduction

This report is an overview of physical conditions including bathymetry and bottom topography, water masses and circulation in the oceanic area south of Iceland, an area named the Iceland Basin. The overview was originally prepared in 1996 following a request by the Icelandic Post and Telephone Services, because of failures in the submarine cable CANTAT-3 between North America and Europe (Fig. 1). Later on the CANTAT-3 submarine cable was relayed at some other location farther south off the Icelandic coast with a longer outlier to the Vestmannaeyjar Islands.

There may be some a broader interest for the outlined physical features of the Iceland Basin. Therefore the manuscript mentioned above is made accessible with some amendments.

2 Bottom Topography

2.1 The Iceland Basin

The ocean areas around Iceland are the Irminger Sea to the west, the Iceland Sea to the north, the Norwegian Sea to the east, and the Iceland Basin to the south (Fig. 2; Hansen and Østerhus 2000). The Irminger Sea and the Iceland Basin are the northernmost regions of the North Atlantic Ocean, and the Iceland and Norwegian Seas are the southern regions of the “intracontinental or arctic” mediterranean seas consisting of the Arctic and Nordic Seas.

The boundaries between these oceanic regions are several submarine ridges. These ridges are the Reykjanes Ridge and Greenland-Iceland Ridges to the west of Iceland, and the Jan Mayen and Iceland-Faroe Ridge to the east of Iceland.

The Iceland Basin with depths exceeding 2000 m is bordered by the Reykjanes Ridge in the northwest with depths less than 1000 m, by the Icelandic margin in the north, and the Iceland-Faroe Ridge in the northeast with depths less than 500 m (Fig. 3). To the south-east the Basin is bordered by several banks such as the Faroe Bank (100 m), the Bill Bailey Bank (50-100 m), the Lousy Bank (200 m), the Georg Bligh Bank (500 m) and the Hatton (500-1000 m) and Rockall Banks, the latter reaching to the surface as the Rockall itself. The Iceland Basin can be considered as a separate oceanographic reg-ion of the North-east North Atlantic Ocean.

2.2 The Reykjanes Ridge

The Reykjanes Ridge is the part of the Mid-Atlantic Ridge extending from Iceland about 300-400 nm to the southwest into the North Atlantic, and even 600 nm in the extreme form as the South Reykjanes Ridge. The ridge separates depths of 2000-3000 m on each side. It is distinguished by the 1000 m and 2000 m depth contours (Figs. 2 and 3). The ridge system is extremely irregular and rough, being an active volcanic rift system and earthquake zone (Fig. 4; Ulrich 1963). At about 57°N and 52-53°N fracture zones cross the ridge (Bight and Charlie-Gibbs Fracture Zones) with sill depths of about 2000-2500 and about 3500 m respectively (see Figs. 2 and 40; Hansen and Østerhus 2000, Garner 1972). The ridge system is a natural boundary between different water masses of the North East Atlantic Drift and the Irminger Sea. It also plays an important role regarding deep and near-bottom currents (Figs. 19 and 20; Malmberg 1985, Anon. 1995).

2.3 The Iceland-Faroe Ridge

The Iceland-Faroe Ridge is a part of the Greenland-Scotland Ridge separateing the Nordic Seas and the North Atlantic (Figs. 2 and 3). It separates depths of more than 2000 m on both sides and it is a natural boundary between relatively warm Northeast Atlantic Water and cold Subarctic water masses. In the shallowest part of the Iceland-Faroe Ridge, outside the continental shelf areas off Iceland and the Faroes, depths less than 300 m are found (Rosengarten and Thorsbanki). The deepest areas are again found just off the shelves. There the treshold depths are 430 m off Iceland and 470 m off the Faroes (Fig. 26; Hansen and Meincke 1979). The morphological features on the southwest side of the ridge are more complex than on the northeastern side, presumably due to strong overflowing bottom currents, though by far not as complex as on the Reykjanes Ridge.

2.4 Iceland

Iceland is located at the crossing of the two above mentioned ridges, the Mid-Atlantic Ridge and the Greenland-Scotland Ridge. Its southern shores are very smooth and sandy were run-off and sedimentation arrive into the sea with the many rivers mostly fed by glaciers. Off the coast is a continental shelf with its many valleys or deeps between banks formed by water and sediment transport as well as of diluvial ice masses (Figs. 3, 5; for location see Fig. 6; Malmberg and Magnússon 1982, Malmberg 1961, 1962). The shelf edge is found at about 200 m depth (Figs. 7 and 8; Malmberg 1961, Malmberg and Magnússon 1982), but its seawards extension varies from between 50 nm in the eastern and western parts and about 10 nm off the mid-south coast. The mean slope of the shelf out to 200 m is calculated to be 0°08,6' and 0°52,6' respectively.

2.5 Continental slope, rise and deep sea floor

At the shelf break at about 200 m depth off the south coast of Iceland a steep canyon embedded continental slope takes over down to 1000 m depth at the foot of the continental terrace (Figs. 3, 7 and 8). From there depths of the continental rise and deep sea floor increase slowly farther off into the Iceland Basin to 2-3000 m depths. Noteworthy are the sediment ridges extending southwards from the mid of the Icelandic south coast, i.e. the Katla Ridges (Figs. 3, 9 and 10) as defined by the author (Malmberg 1974) The Katla Ridges are distinguished by the 1000-1800 m depth contours. They have an elevation above the surrounding bottom or trenches of about 500-800 m extending as far south as to 62°N. The steepness of the continental slope off South-Iceland is different from place to place and greatest off the southeast coast or up to 12° (Fig. 8; Malmberg 1961).

3 Water masses

The main water masses in the Iceland Basin are the following:

a) **North Atlantic Water** with different regional hydrographic properties found in the uppermost 1000-1500 m in the Iceland Basin proper (Figs. 11-15; Malmberg 1961, 1962, Malmberg and Magnússon 1982, Blindheim et al. 1996). Depending on origin and degree of mixing and entrainment with other water masses it has salinities above 35 and up to 35.4, and temperatures of 5-9°C. The highest values are found in the eastern part of the Basin, and the lowest in the western part, there the water mass is named Modified Atlantic Water (Fig. 16).

b) **Labrador Sea Water** is a deep intermediate water mass formed in the Labrador Sea and to some extend in the Irminger Sea, spreading from there across the Mid-Atlantic Ridge through the fracture zones into the Iceland Basin at about 1000-1500 m depth (Figs. 11, 13, 14, 15, 17, 18 and 20; Malmberg 1974, de Boer and v. Aken 1995, Anon. 1995, Blindheim et al. 1996). The characteristic values of the hydrographic parameters are variable or 3-4°C in temperature and 34.90-34.95 in salinity. This water mass occurs as an intermediate deep water in the Iceland Basin and even as bottom water below 1000 m along the continental rise south of Iceland, at least in the region of the Katla Ridges (Fig. 17).

c) **Iceland-Scotland Overflow Water** from the Nordic Seas flows across the Iceland-Scotland Ridge into the Iceland Basin. It includes water mainly of two different origins. First to mention is the Norwegian Sea Deep Water ($t<0$°C, salinity 34.9) flowing through the Faroe-Shetland and Faroe Bank Channels, the latter with a sill depth of 840 m; and secondly as variable intermediate water masses flowing above the Norwegian Sea Deep Water and across the Iceland-Faroe Ridge (temperature 0-3°C; salinity 34.7-34.9). When reaching the Iceland Basin these water masses, which flow westwards along the roots and rise of the Icelandic continental terrace below 1500 m depth, reveal temperatures of 2-3°C and salinities just below 35 (Figs. 11-15, 17).

The vertical distribution of the different water masses in the Iceland Basin is shown in a N-S section along 20°W extending from Iceland to 60°N on Figure 18 (de Boer and v. Aken 1995).

4 Circulation

Three different current systems are most pronounced in the Iceland Basin and adjacent ocean areas (Figs. 19 and 20; Malmberg 1985, Anon. 1995). These are the northwards flowing warm water of the North-East Atlantic Drift in the uppermost 1000-2000 m of the Iceland Basin; an intermediate or deep flow from the Labrador and Irminger Seas in the west across the Mid-Atlantic or Reykjanes Ridge into the Iceland Basin at 1200-1500 m depth; and a near-bottom flow mainly consisting of cold water from the north crossing the submarine ridges between Greenland and Scotland, i.e. the socalled overflow. These overflows and their pathways are very much depending on the submarine ridges, i.e. passes and fracture zones, as well as on other topographic features in the different areas. Thus the main flow of Norwegian Sea Deep Water into the Iceland Basin occurs between the Faroes and the Faroe Bank where the deepest part of the Iceland-Scotland Ridge is found (840 m). From there the overflow water flows as bottom current northwards along the Iceland-Faroe Ridge and further westwards, with an additional flow directly across the ridge at upper levels (Fig. 22; Joseph 1967), into the waters south of Iceland at 1000-2000 m depth. There the flow is mainly concentrated along the Icelandic continental rise and foot of the slope. This westward flow south of Iceland is influenced by the deepest part of the Katla Ridges. Farther uphill to about 1200 m depth, Labrador or Irminger Sea Water may be found at near-bottom, at least occasionally (Fig. 17; Malmberg 1974). Farther west the bottom current bends to the south again along the Reykjanes Ridge until it reaches the Charlie-Gibbs Fracture Zone at 52-53°N and the Bight Fracture Zone at 56°N, where it crosses the Mid-Atlantic Ridge into the Irminger Sea. From there again the bottom flow bends northwards along the Mid-Atlantic Ridge until it, in the northern Irminger Sea, again bends westwards and southwards along the East-Greenland continental slope and rise. There it joins the bottom overflow from the north through the Denmark Strait (sill depth 620 m). Together, these overflows, the Denmark Strait Overflow and the Faroe Bank Channel as well as the Iceland-Faroe Ridge overflow contribute to the deep water of the Northwestern Atlantic.

5 Direct current measurements

Following are outlined some results of direct current measurements in the Iceland Basin. The main areas of relevance in this review are a) along the Iceland-Faroe Ridge, not least just southeast of Iceland; b) in the area south of Iceland especially around the Katla Ridges; and c) along the Reykjanes Ridge as far south as to Charlie-Gibbs Fracture Zone and further through the fracture zone itself.

During the times in the latter half of the 20th century some effort was made to measure ocean currents in the Iceland Basin directly. Special attention was paid to observations of the deep overflows across the submarine ridges, but some data are also available from the slope south of Iceland, mainly around the Katla Ridges.

In summer 1960 some direct current measurements were carried out on and along the Iceland-Faroe Ridge during the so-called "Overflow '60 Project" of the International Council for the Exploration of the Sea (ICES). The results are shown in Figs. 21 and 22 (Joseph 1967). The near-surface layer at 20 m depth southeast of Iceland revealed a NE-wards flow of North Atlantic Water of about 40 cm s^{-1}. The deep overflow at the same location showed up with strong currents of 20-30 cm s^{-1} now with south-westerly direction. Relatively strong currents, both near-surface and near-bottom were also observed farther south on the ridge.

In summer 1973 direct current measurements were again carried out in the Iceland-Faroe Ridge region in the so-called "Overflow '73 Project" of ICES. The results are shown in Figs. 23-26 (Koltermann et al. 1976, Ross and Meincke 1976, Hansen and Meincke 1979). Again the deep overflow across the Iceland-Faroe Ridge and along the ridge showed up with strong currents periodically up to 50 cm s^{-1}, but 10-25 cm s^{-1} in general. The component to the NE or inflowing North Atlantic Water at 250 m depth southeast of Iceland was also revealed (Fig. 24).

During the years 1989-1992 some investigations on behalf of the NATO Saclant Research Centre in Italy were carried out in the area east of Iceland. Some results from direct current measurements are shown in Figs. 27 and 28 (Perkins et al. 1996). The deep overflow again revealed strong and relatively stable currents of about 50 cm s^{-1} with a southwesterly direction, but less strong northerly flow of the North Atlantic Water in the upper layers (Fig. 28).

Summarized, direct current measurements in the Iceland-Faroe Ridge region reveal more or less constant strong bottom currents across and along the ridge into the Iceland Basin of 20-50 cm s^{-1}.

During the years 1990-1991 seven current meter moorings were deployed in the Iceland Basin east of the Katla Ridges. The locations and results are shown in Figs. 29 and 30 (Saunders 1996). It is evident that the flow is intensified and confined to the bottom depth range of 1300-2100 m, with current vectors westwards along the depth contours of up to 20-30 cm s^{-1}.

Some direct current measurements were carried out from six mooring stations in the Katla Ridges area in 1997 on the slope a little to the west of the easternmost Katla Ridge. The results are shown in Fig. 31 (Shore 1978). The flow was confined to the bottom features with maximum velocities of about 20 cm s^{-1} towards the west found near-bottom at 1400-1800 m depths.

Observations carried out in 1991 in the western valley or the Reynis Canyon west of the Katla Ridges at around 2000 m depth are shown in Figs. 32 and 33 (van Aken 1995). The near-bottom flow was also here found along the depth contours with a velocity up to 20 cm s^{-1} in a southwesterly direction.

Summarized, direct current measurements in the area south of Iceland show more or less constant near-bottom currents of up to 20-30 cm s^{-1} in westerly/southwesterly direction. The flow is confined to the upper rise and the foot of the continental terrace at depths of 1300-2000 m. At deeper levels further offshore the velocities decrease and directions become more variable.

Along the eastern slopes of the Reykjanes Ridge or Mid-Atlantic Ridge no near-bottom current meter data seem to be available, only hydrographic data showing the different water masses including overflow water in the near-bottom layers (Fig. 15; Blindheim et al. 1996).

6. Charlie-Gibbs Fracture Zone

Finally several attempts have been made to measure the deep and near-bottom flow below 2000 m across the Reykjanes Ridge through the Charlie-Gibbs Fracture Zone (Figs. 34-41; Saunders 1994, Shore et al. 1976, Dickson et al. 1980, Garner 1972). No data seems to be available from the over-laying eastwards flow of the Labrador or Irminger Sea water (Fig. 20; Anon. 1995). In this very complicated area with two separated throughs, a northern and southern one of more than 3000 to 4000 m depths, the observed deep and near-bottom currents were more variable than those in the Iceland Basin and in the Iceland-Faroe Ridge area. The obtained velocity mean values of the currents are frequently only a few cm s^{-1} (Figs. 38, 41 and Table 1), but the variations are from 0 cm s^{-1} to 20 cm s^{-1} or more. In general, the deep flow of the Iceland-Scotland Overflow Water at 2500-3000 m depth is westwards from the Iceland Basin into the Irminger Sea. This is especially so in the northern through (Figs. 38, 39, 41) but also an eastwards flow is obtained on the southern slopes of the through and in the deep of the southern through (Figs. 39 and 41). There even the westwards and eastwards transports are in balance (Table 1. Last column; Dickson et al. 1980).

7 Conclusions

When the failure sites or faults in the subsurface CANTAT-3 communication cable (Fig. 1; Jónsson Icelandic Post and Telephone Services, personal communication) are compared with the bottom topography in the Iceland Basin it is evident that the failures were concentrated around areas of relatively rough bottom topography in the Iceland-Faroe Ridge area, the Katla Ridge area and the Charlie-Gibbs Fracture Zone area (Fig. 1).

Thus turbidity currents downhill the continental slope and submarine ridges and even trawl fisheries, seem not to be involved in the faults and neither current velocity alone. But as the failures were located in deep waters and limited to the regions of the different submarine ridges, it is considered that they may presumably be due to **vibration** of the cable induced by strong bottom currents along the depth contours, and then chafe faults and abrasion (Eales 1996).

8 Acknowledgement

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Table 1. Selected hourly current means and maximum scalar speed, and daily means-vectors and directions, common 247 day duration - from moorings in the southern trough of the Charlie-Gibbs Fracture Zone; 1977-1978. For location see Figs. 36 and 37. From Dickson et al. 1980.

Valin klukkustunda meðaltöl straums og hámark straums, og dagleg meðalgildi -vektorar og stefnur- frá syðra Charlie-Gibbs skarði; 1977-1978. Mælistaðir eru sýndir á 37. og 38. mynd. (Dickson o.fl. 1980).

	Depth	Number of obs.	Mean speed scalar cm s^{-1}	Max speed cm s^{-1}	Mean speed vector cm s^{-1}	Mean Direction (°)
A_U	2500	6001	4.94	25.0	0.57	36
A_B	3000	6001	3.40	13.5	0.82	291
B_U	2977	6074	7.56	30.9	1.63	93
B_B	3977	6075	6.06	27.5	3.36	263
C_P	3527	6002	4.62	20.5	2.71	101

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Figures

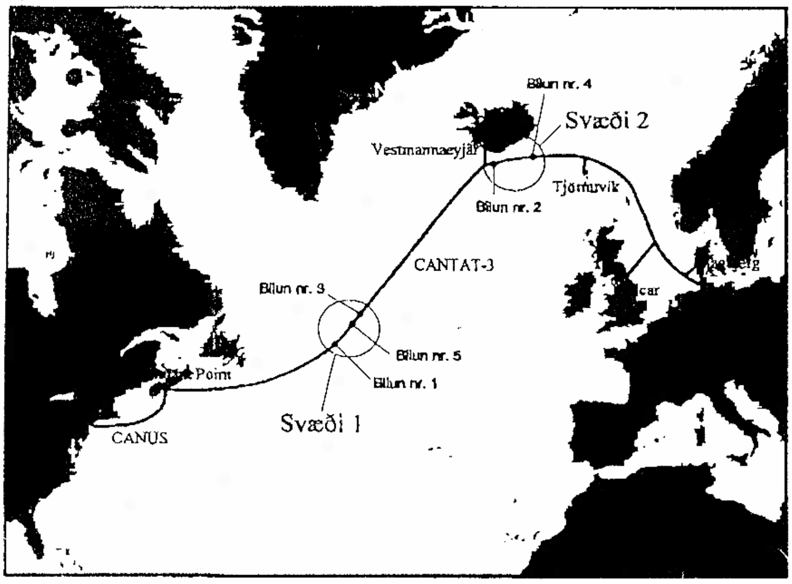


Figure 1. The location of the submarine cable CANTAT-3 and where it failed (Páll Jónsson, Póstur og Sími. Icel. Post and Telephone Service. Personal communication).

1. mynd. Lega neðansjávar strengsins CANTAT-3 og bilunarstaðir hans (Páll Jónsson, Póstur og Sími, munnlegar upplýsingar).

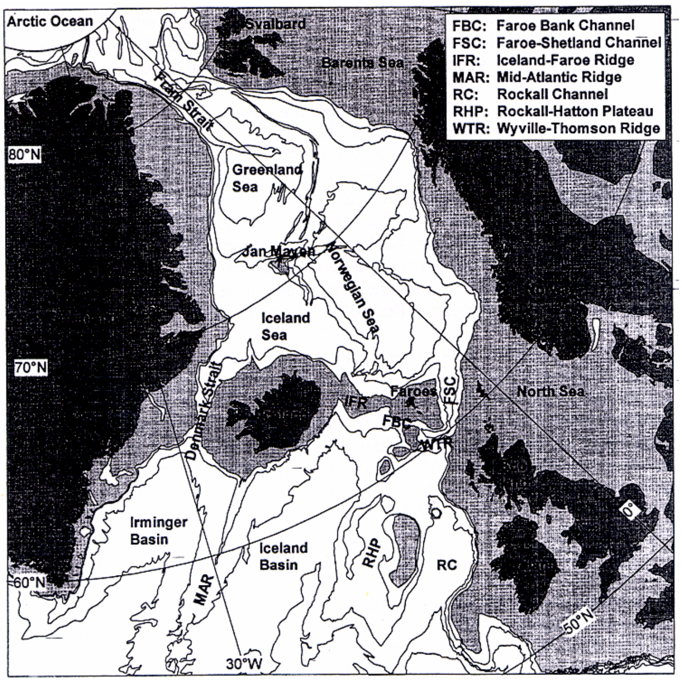


Figure 2. Bathymetry and nomenclature of the northern North Atlantic and Nordic Seas. Areas shallower than 500 m are lightly shaded (Hansen and Østerhus 2000).

2. mynd. Dýpi og örnefni á norðanverðu Norður-Atlantshafi og í Norðurhafi. Dýpi minna en 500 m er skyggt (Hansen og Østerhus 2000).

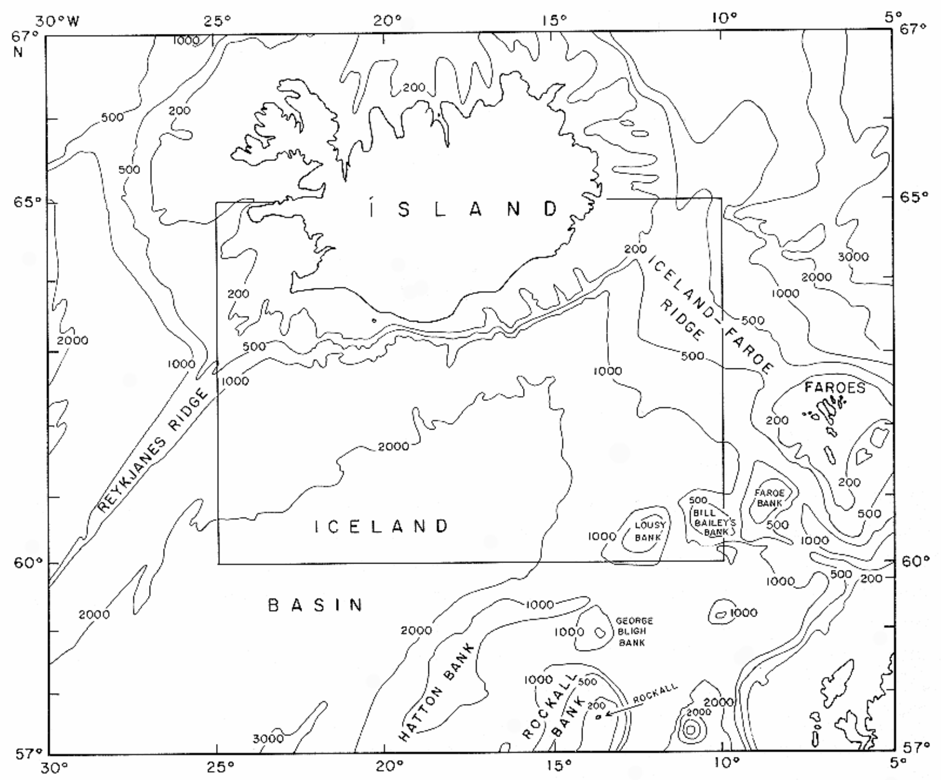


Figure 3. Iceland and adjacent waters to the South - bathymetry and nomenclature (Malmberg and Magnússon 1982). The frame is showing the study area in the referred paper.

3. mynd. Ísland og aðliggjandi hafsvæði í suðri - dýpi og örnefni (Malmberg og Magnússon 1982). Ramminn sýnir athugunarsvæði í tilvitnaðri grein.

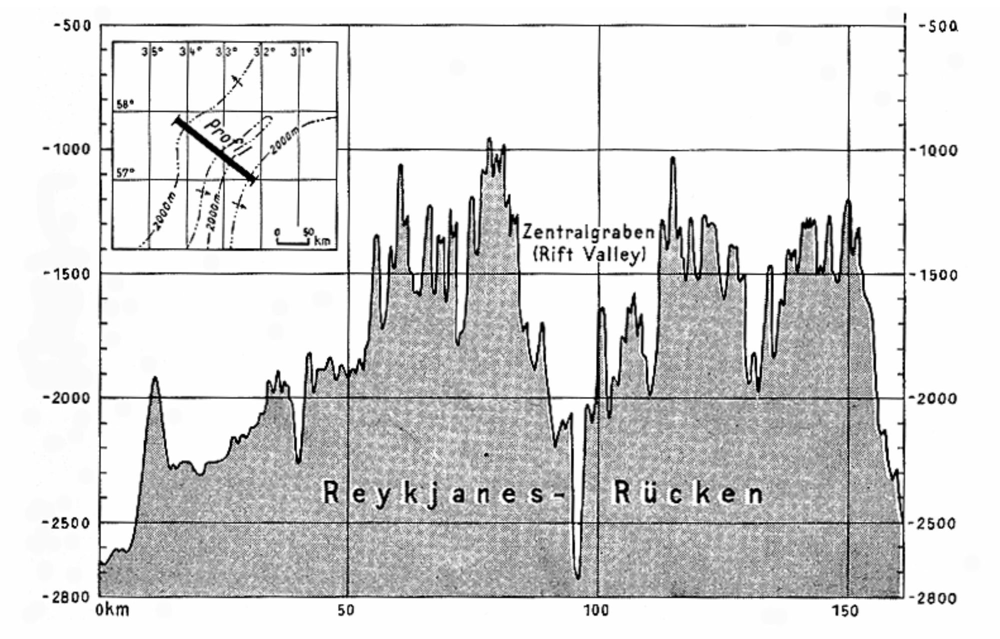


Figure 4. A section across the Reykjanes Ridge at 57.5°N (Ulrich 1963).

4. mynd. Dýptarsnið yfir Reykjaneshrygg á 57°5'N (Ulrich 1963).

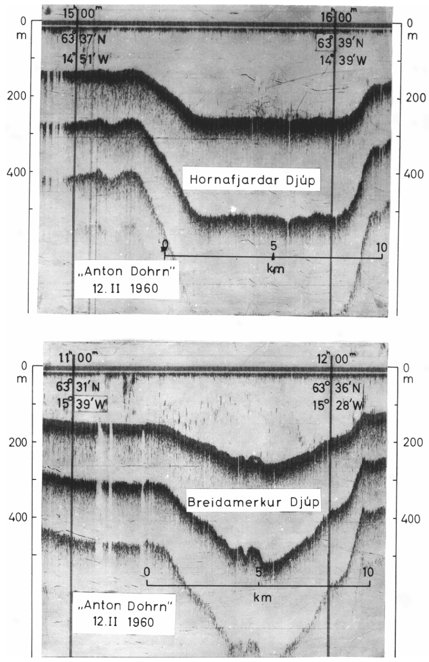


Figure 5. Depth profiles across two sub-marine valleys on the South Icelandic shelf, Hornafjardar (E-III) and Breidamerkur (E-II) Deeps. For location see Fig. 6 (Malmberg 1961).

5. mynd. Dýptarsnið yfir tvo neðansjávardali á íslenska landgrunninu Sunnanlands, Hornafjarðar (E-III) og Breiðamerkur (E-II) djúp. Sjá staði á 6. mynd (Malmberg 1961).

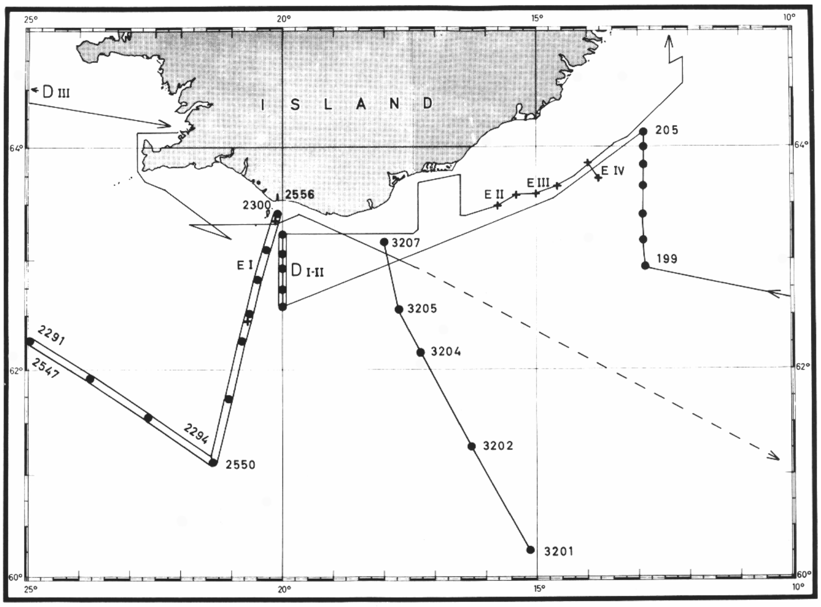


Figure 6. Location of sections used (Malmberg 1961, 1962).

6. mynd. Lega lóðréttra sniða til umræðu (Malmberg 1961, 1962).

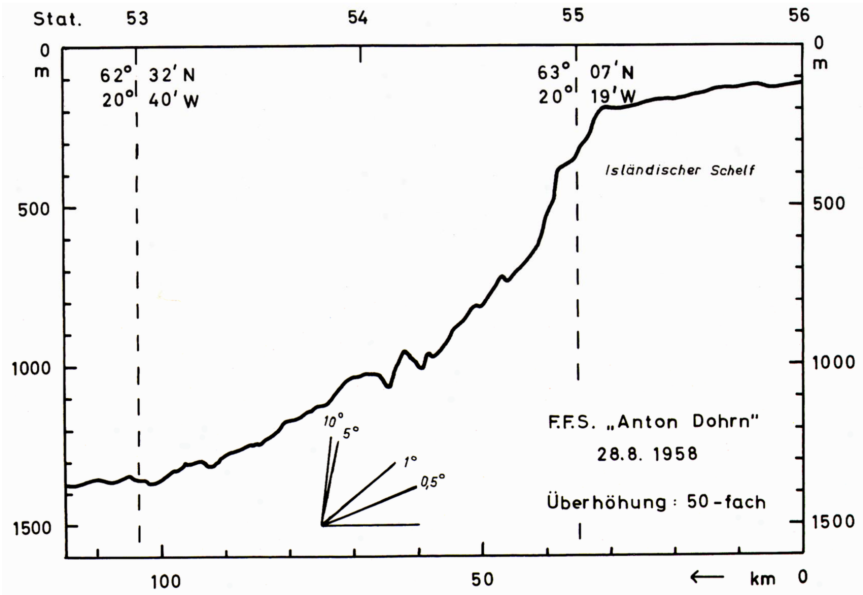


Figure 7. A section perpendicular to the South Icelandic shelf. For location see Fig. 6, E-I (Malmberg 1961).

7. mynd. Dýptarsnið þvert á suðurströnd Íslands. Lega er sýnd á 6. mynd, E-I (Malmberg 1961).

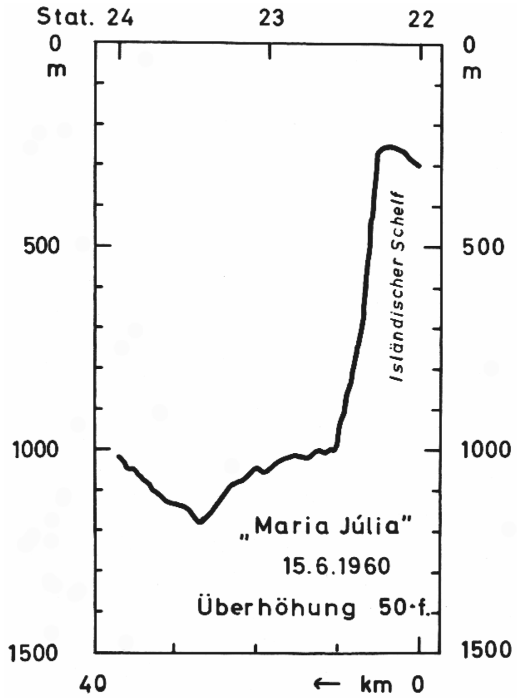


Figure 8. A section perpendicular to the South Icelandic shelf. For location see Fig. 6, E-IV (Malmberg 1961).

8. mynd. Dýptarsnið þvert á suðurströnd Íslands. Lega er sýnd á 6. mynd, E-IV (Malmberg 1961).

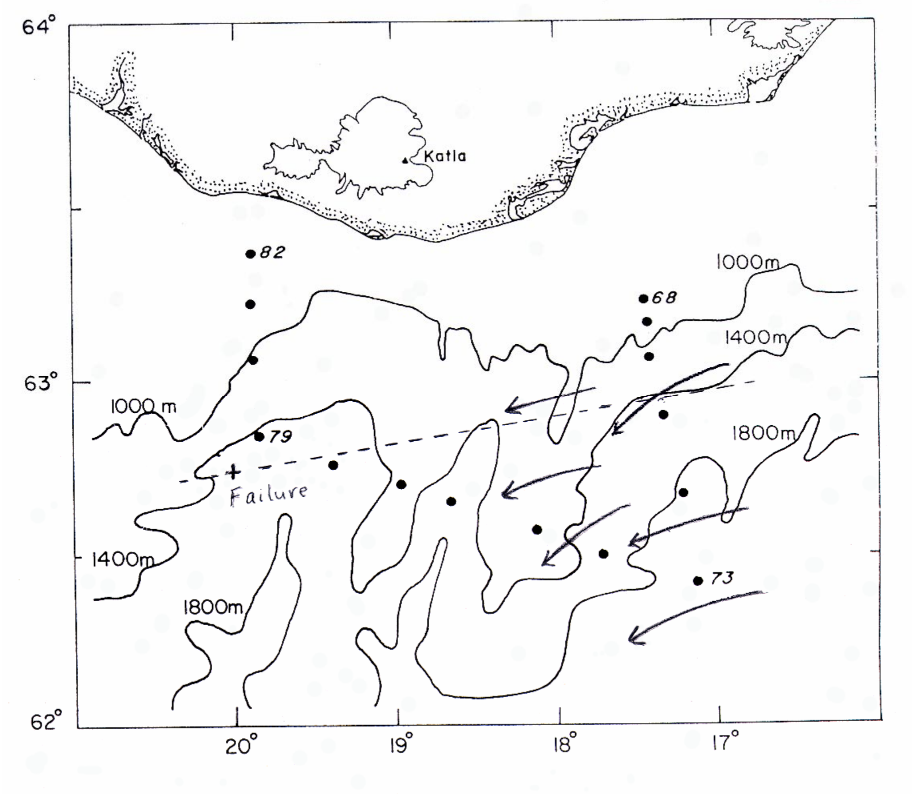


Figure 9. Depth contours and location of hydrographic stations in the Katla Ridges area south of Iceland (Malmberg 1974). Information on currents (Shore 1978, Saunders 1996; Figs. 29 and 31) and location of the sub-marine cable CANTAT-3 together with failure 2 (Fig.1) are also shown.

9. mynd. Dýpi og mælistaðir hita og seltu við Kötluhryggi út af suðurströnd Íslands (Malmberg 1974) ásamt upplýsingum um botnstrauma (Shore 1978, Saunders 1996; 29. og 31. mynd) og legu neðansjávarstrengsins CANTAT-3 sem og bilunarstaður 2. Sjá 1. mynd.

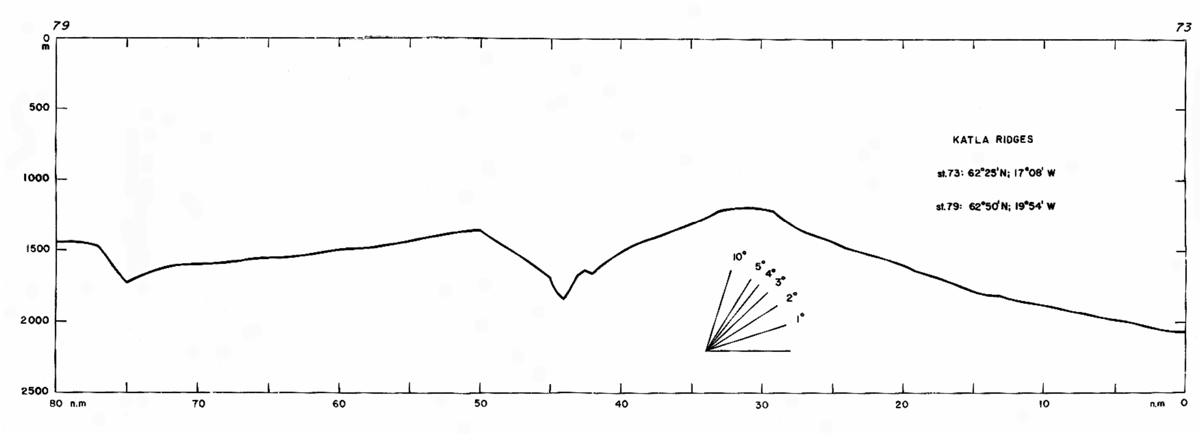


Figure 10. A depth profile across the Katla Ridges. For location see Fig. 9 (Malmberg 1974).

10. mynd. Dýptarsnið yfir Kötluhryggi. Lega er sýnd á 9. mynd (Malmberg 1974).

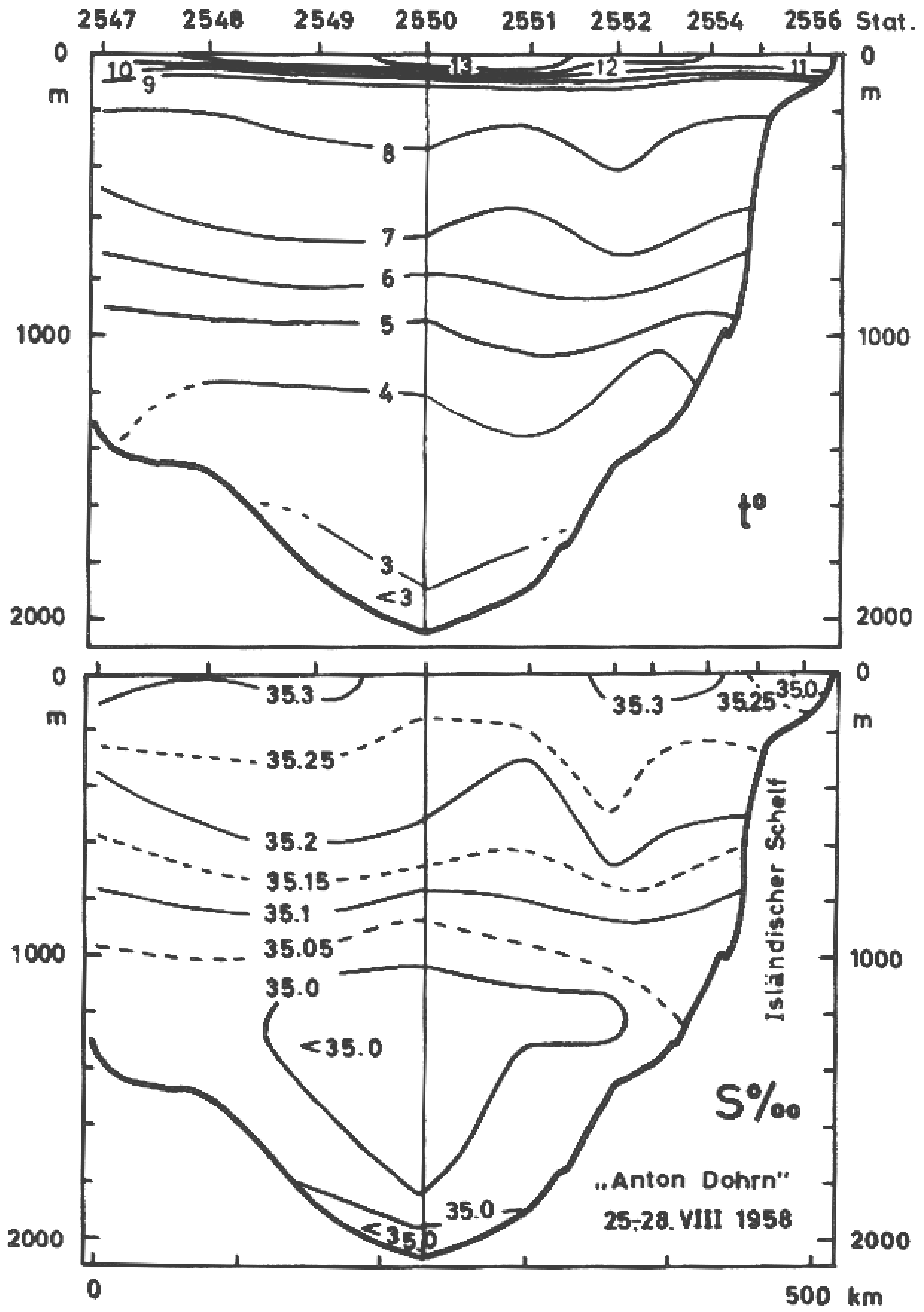


Figure 11. Temperature and salinity sections in South Icelandic waters; August 1958. For location see Fig. 6 (Malmberg 1961, 1962).

11. mynd. Lóðrétt hita- og seltusnið í Suðurdjúpi í ágúst 1958. Lega er sýnd á 6. mynd (Malmberg 1961, 1962).

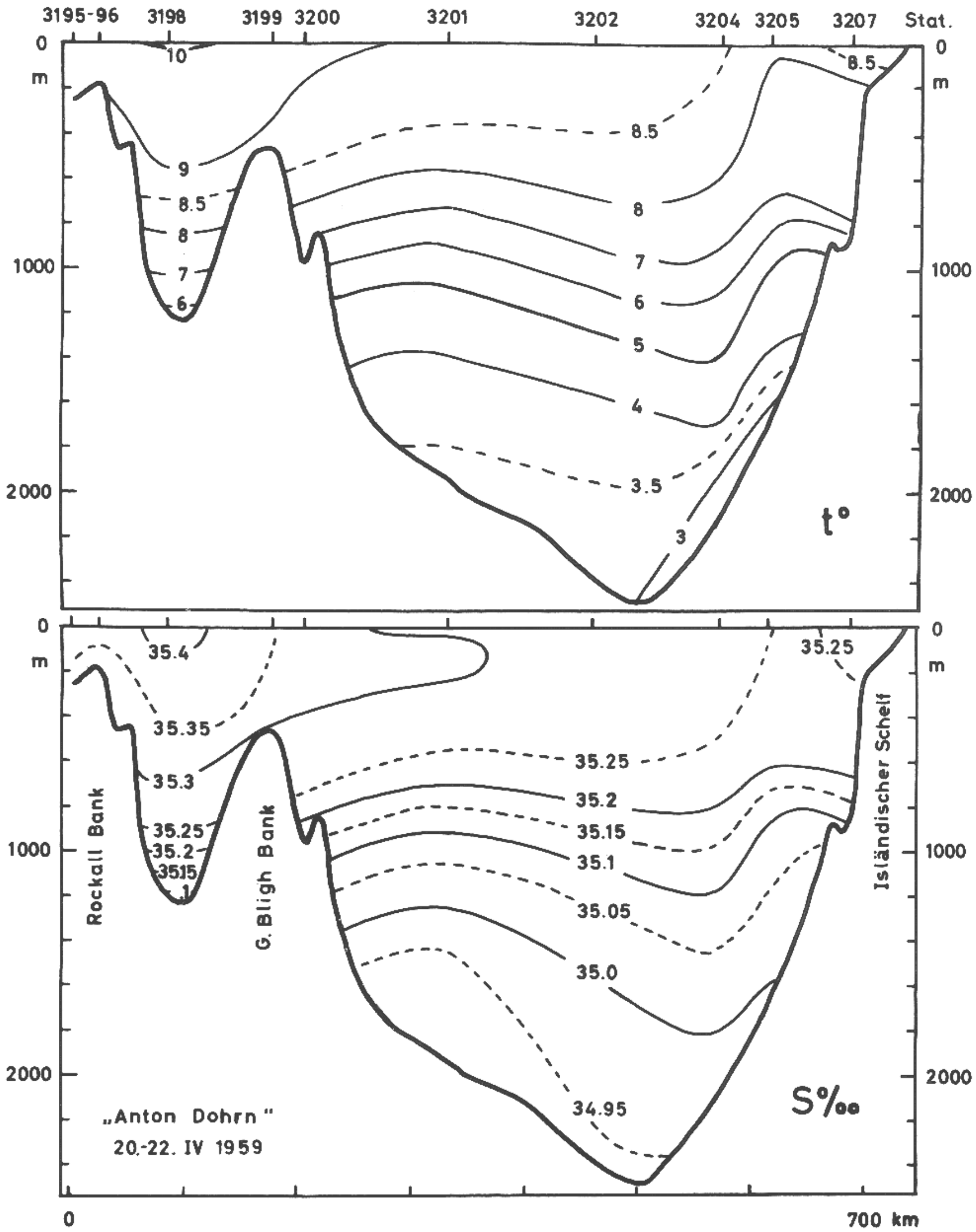


Figure 12. Temperature and salinity on a section from Iceland to Rockall; August 1959. For location see Fig. 6 (Malmberg 1961, 1962).

12. mynd. Lóðrétt hita- og seltusnið frá Íslandi til Rockall í ágúst 1959. Lega er sýnd á 6. mynd (Malmberg 1961, 1962).

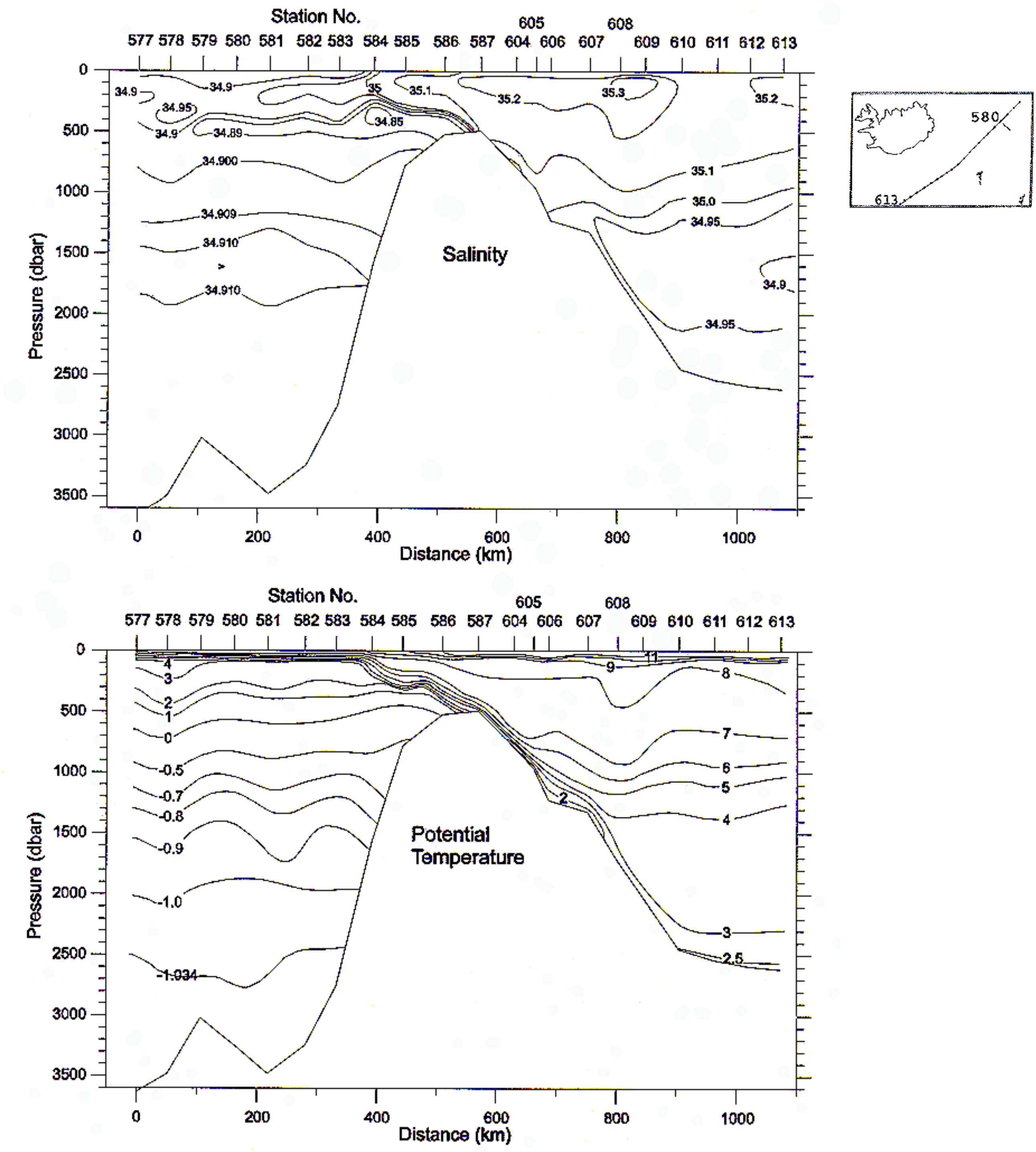


Figure 13. Salinity and temperature on a section across the Iceland-Faroe Ridge; July-August 1994 (Blindheim et al. 1996).

13. mynd. Lóðrétt seltu- og hitasnið yfir Íslands-Færeyjahrygg í júlí/ágúst 1994 (Blindheim og fél. 1996).

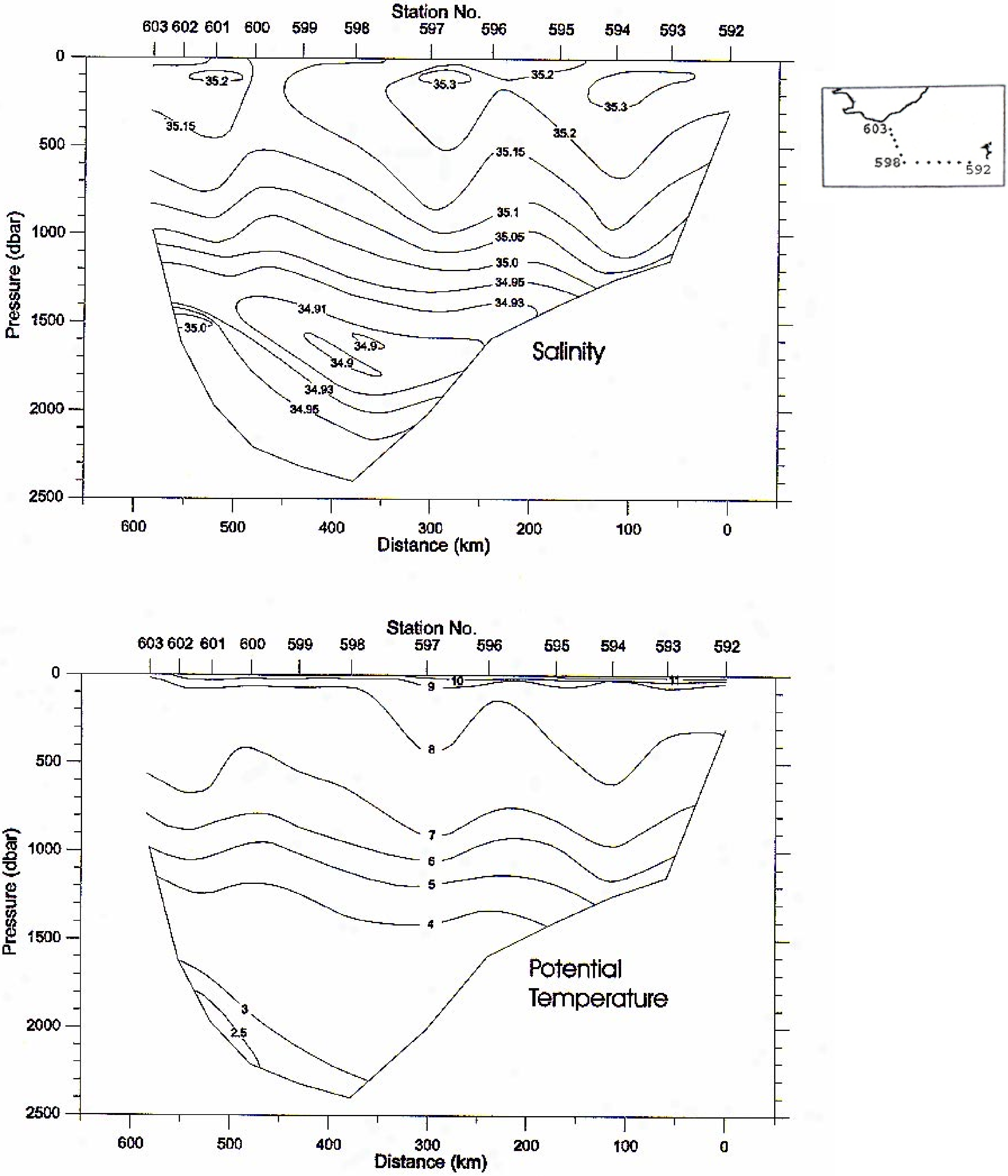


Figure 14. Salinity and temperature sections in the Iceland Basin Proper; July-August 1994 (Blindheim et al. 1996).

14. mynd. Lóðrétt seltu- og hitasnið í Suðurdjúpi í júlí/ágúst 1994 (Blindheim og fél. 1996).

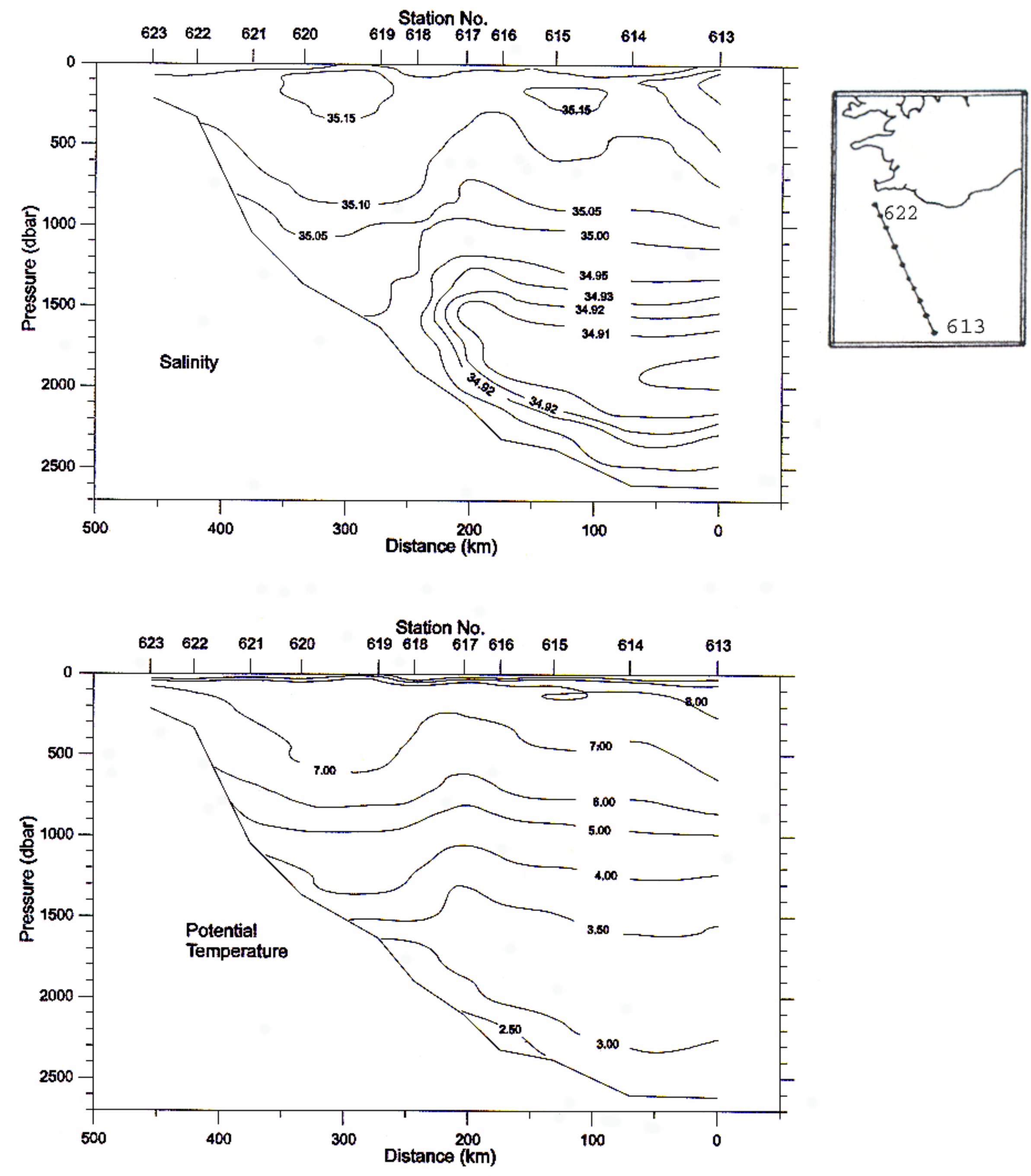


Figure 15. Salinity and temperature sections in the western part of the Iceland Basin; July-August 1994 (Blindheim et al. 1996).

15. mynd. Lóðrétt seltu- og hitasnið í vesturhluta Suðurdjúps í júlí/ágúst 1994 (Blindheim og fél. 1996).

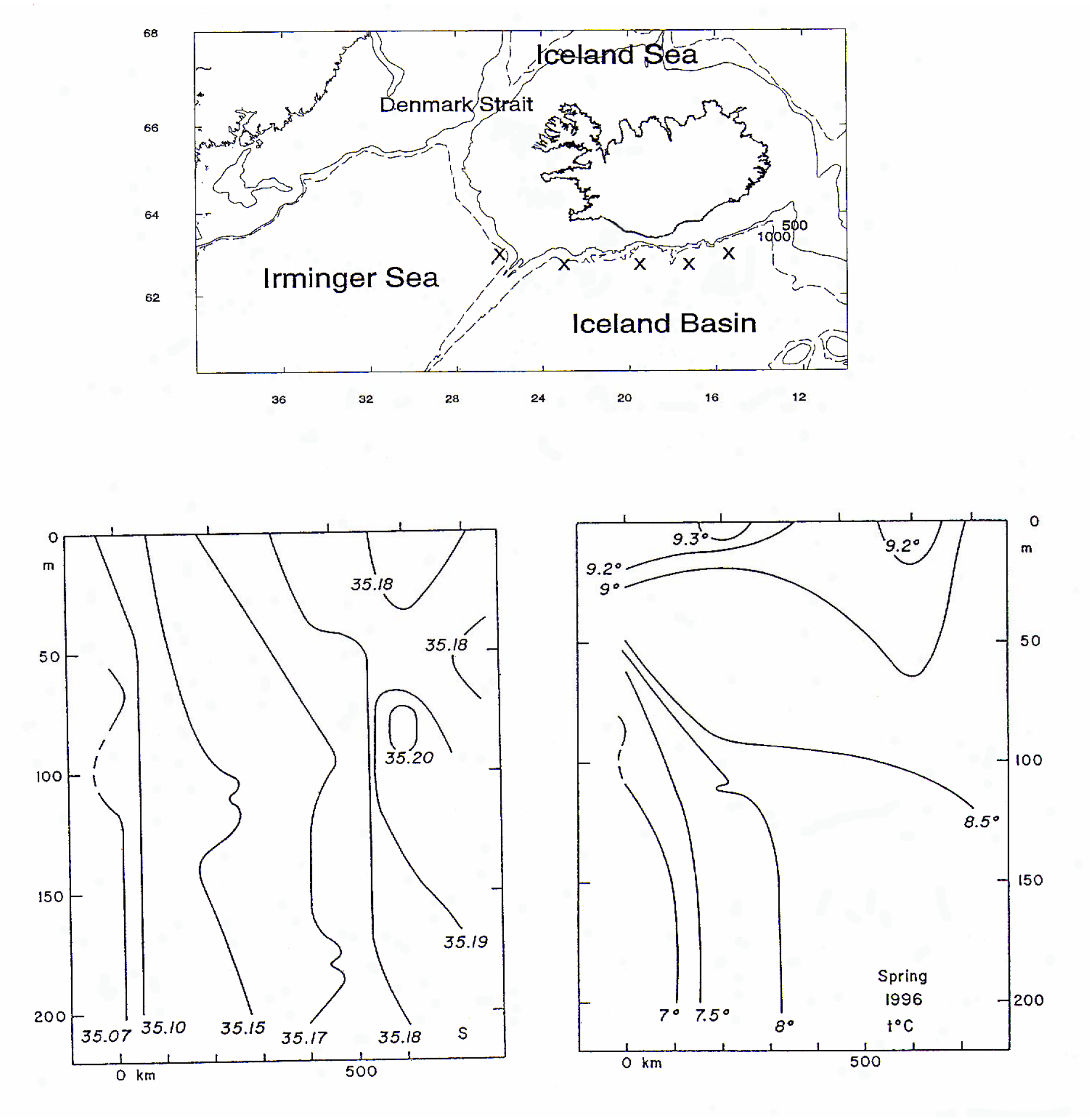


Figure 16. A W-E salinity and temperature sections (0-200 m) along 63°N through the Iceland Basin from the western slope of the Reykjanes Ridge to southeast of Iceland in spring 1996 (Malmberg, unpublished).

16. mynd. Lóðrétt vestur/austur seltu- og hitasnið, 0-200 m, vorið 1996 í Suðurdjúpi eftir 63°N, nánar frá vesturhlíðum Reykjaneshryggjar, yfir hrygginn til austurs í Suðurdjúp austur á móts við SA-strönd Íslands (Malmberg, óbirt).

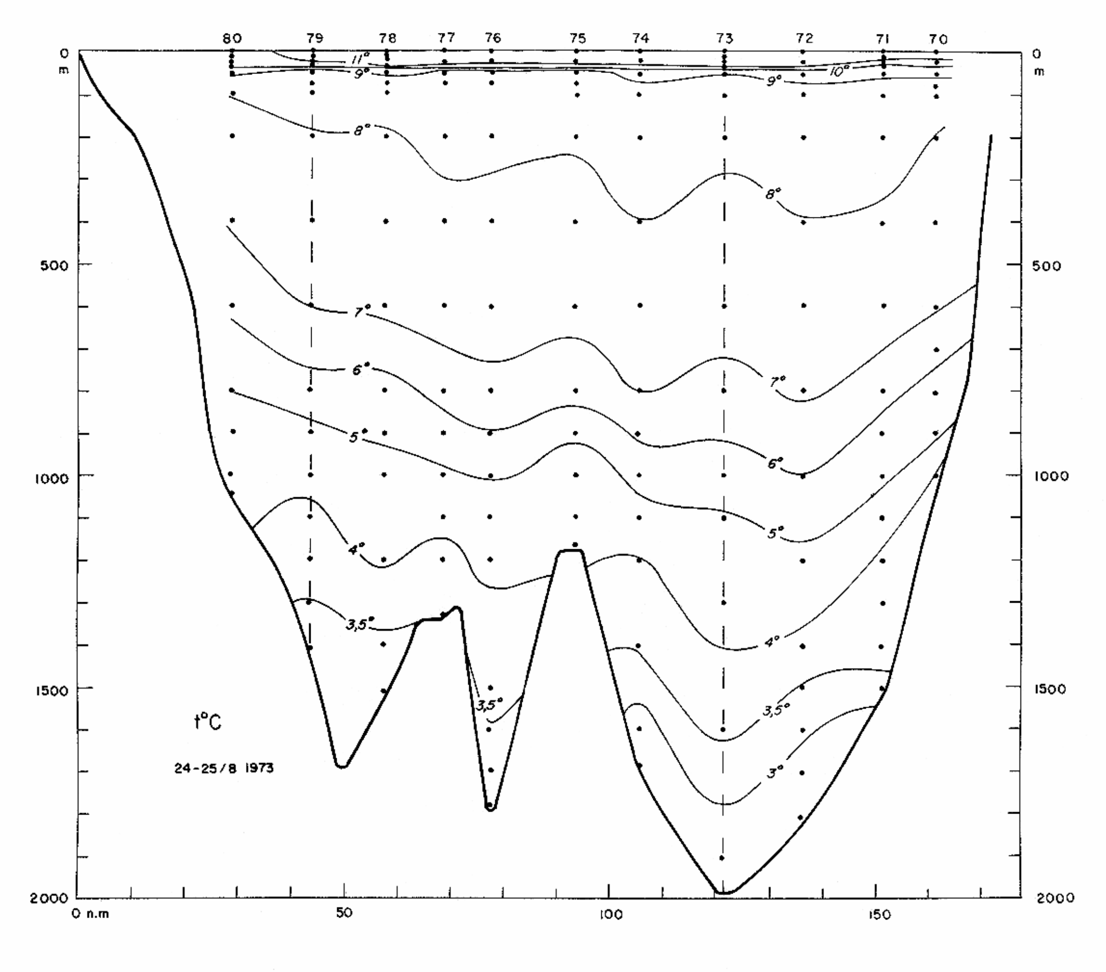


Figure 17. a) Temperature section across the Katla Ridges; August 1973. For location see Fig. 9 (Malmberg 1974).

17 mynd a). Lóðrétt V-A hitasnið yfir Kötluhryggi í ágúst 1973. Lega er sýnd á 9. mynd (Malmberg 1974).

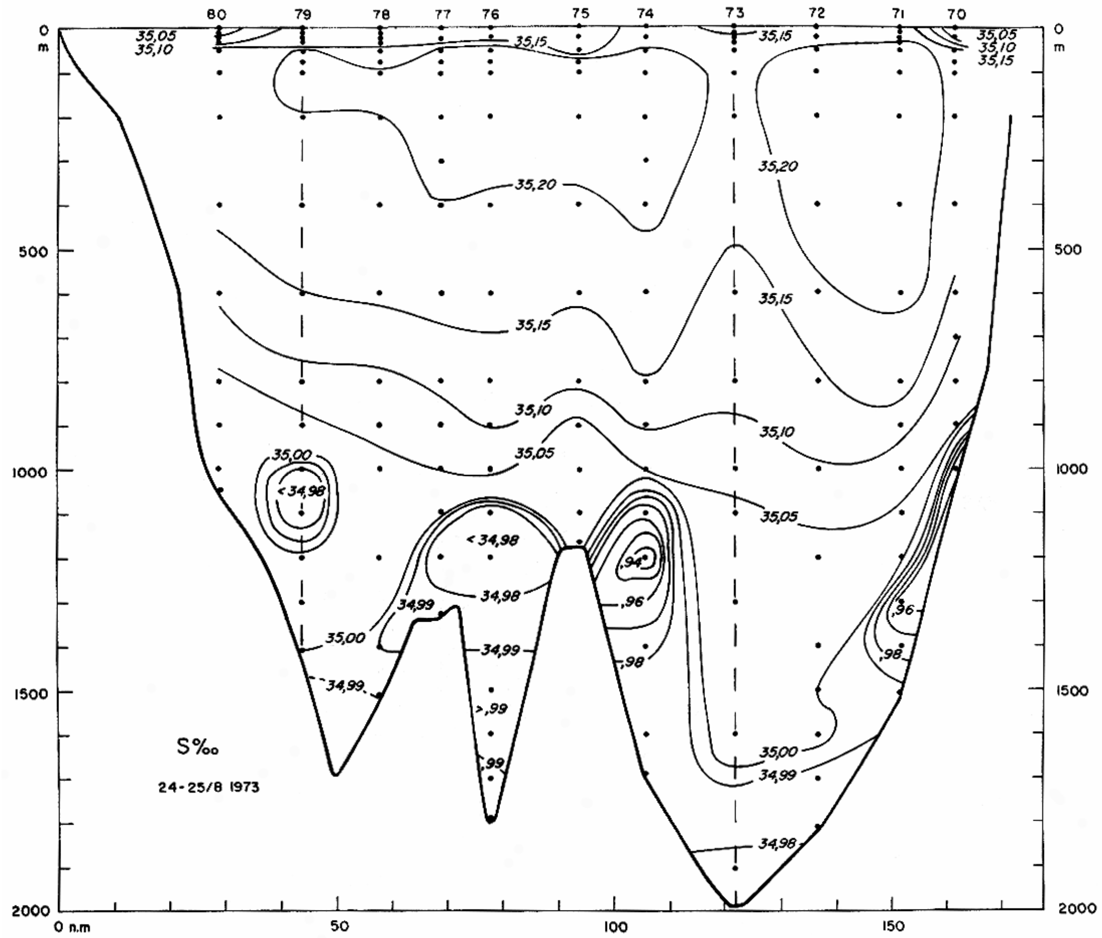
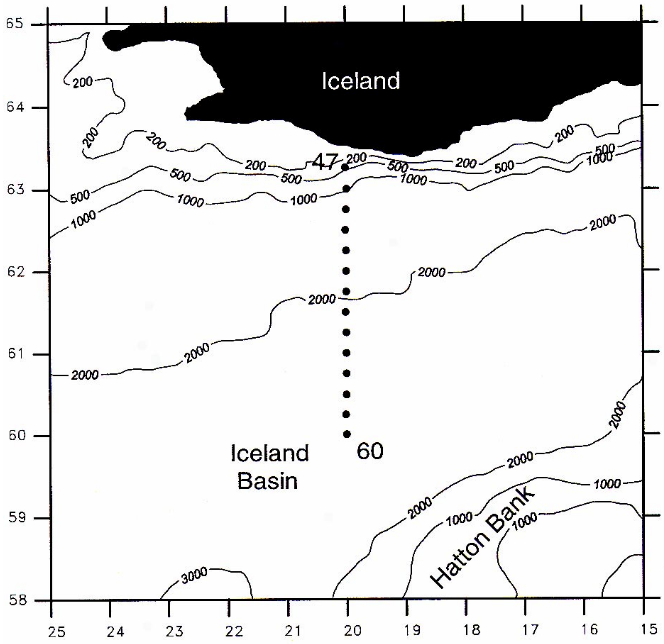


Figure 17. b) Salinity section across the Katla Ridges; August 1973. For location see Fig. 9 (Malmberg 1974).

17 mynd b). Lóðrétt V-A seltusnið yfir Kötluhryggi í ágúst 1973. Lega er sýnd á 9. mynd (Malmberg 1974).



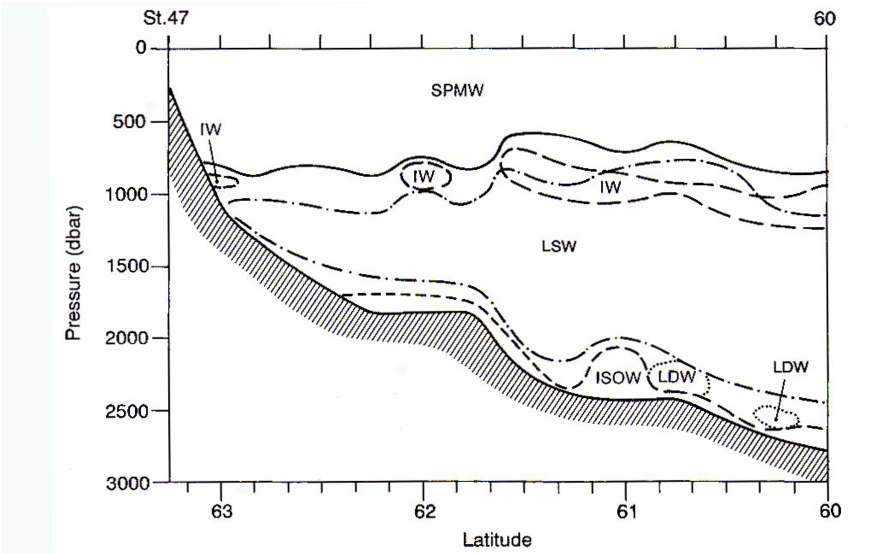


Figure 18. Positions of cores of water masses in a section in the Iceland Basin.

SPMW/IW	: North Atlantic Water
LSW	: Labrador Sea Water.
ISOW	: Iceland-Scotland Overflow Water.
LDW	: Antarctic Water

(de Boer and van Aken 1995).

18. mynd. Kjarnar sjógerða á N-S lóðréttu sniði á 20°V í Suðurdjúpi í apríl 1991.

SPMW/IW	*: Atlantískur hlýsjór*
LDW	*: Labrador sjór*
ISOW	*: Kaldur Overflow botnsjór, sem streymir yfir Íslands-Færeyjahrygg og um Færeyjasund úr Norðurhafi.*
LDW	*: Kaldur Suðurskautssjór.*

(de Boer og van Aken 1995).

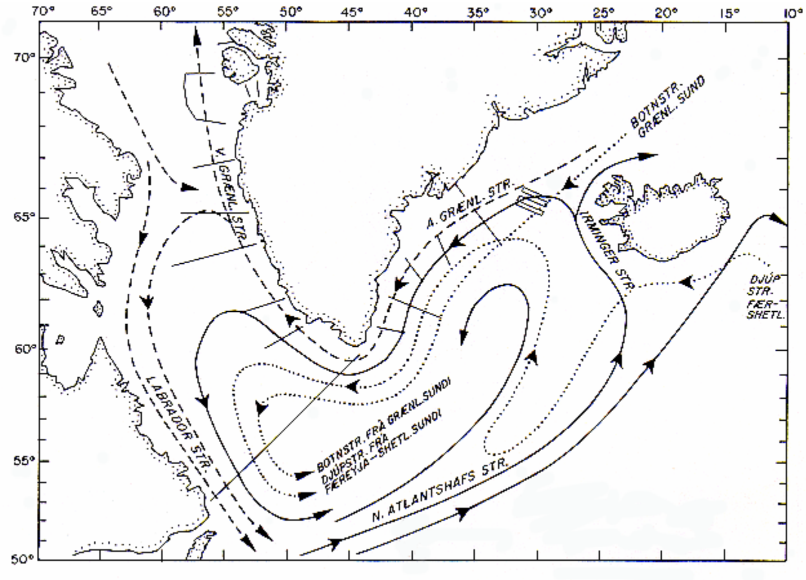


Figure 19. General ocean circulation, both in near-surface as in deep and bottom layers in the seas around Iceland, Greenland and Labrador.
→ warm near-surface circulation.
--> cold near-surface circulation.
···> deep and near-bottom circulation.
(Malmberg 1985).

19. mynd. Meginstaumar, bæði grunnt og djúpt, í hafinu við Ísland, Grænland og Labrador.
→ heitur yfirborðssjór (Atlantssjór).
--> kaldur yfirborðssjór (Pólsjór).
···> djúp og botnsjór (Labrador og Overflow sjór).
(Malmberg 1985).

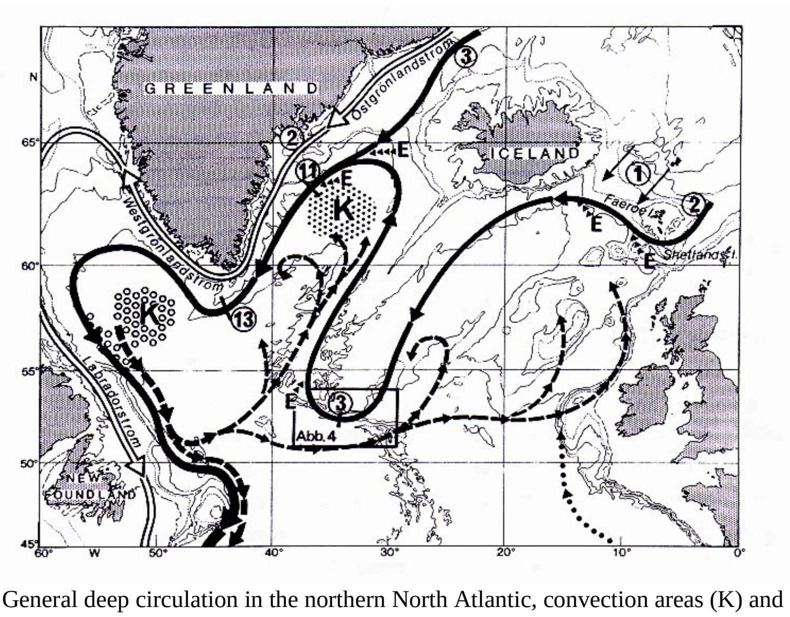


Figure 20. General deep circulation in the northern North Atlantic, convection areas (K) and cold surface currents off Greenland and Labrador (Anon 1995).

20. mynd. Megindjúpstraumar nyrst í Norður-Atlantshafi, (m.a. Labrador og Overflow sjór) og kaldir yfirborðsstraumar (Pólsjór) við Grænland og Labrador. (Anon 1995).

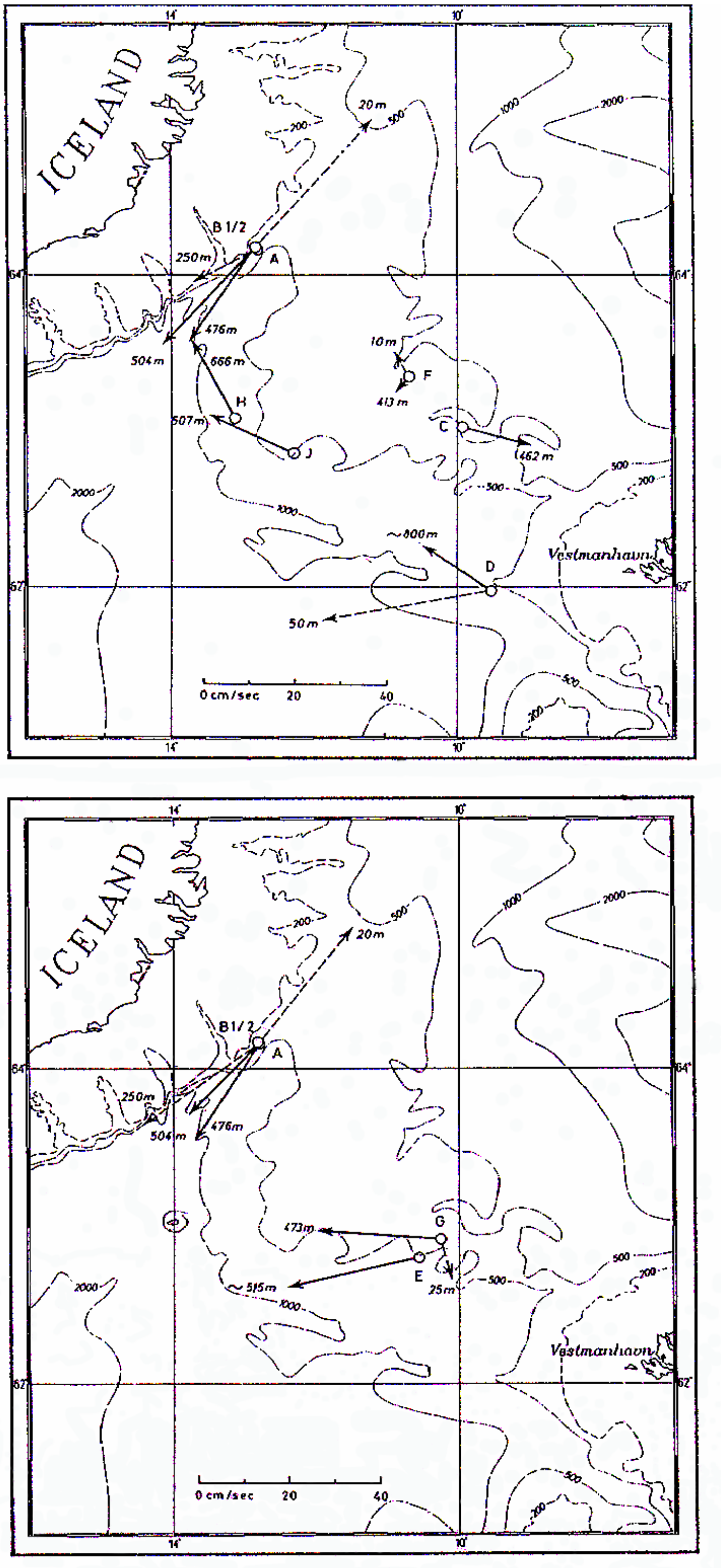


Figure 21. Residual currents 9.-12.6. and 17.-18.6. 1960 at different depths and locations on the Iceland Faroe Ridge. ICES Overflow Project, June 1960 (Joseph 1967).

21. mynd. Endanlegur meðalstraumur 9.-12.6 og 17.-18.6.1960 á mismunandi stöðum og dýpi á Íslands-Færeyjahrygg. ICES Overflow verkefni í júní 1960 (Joseph 1967).

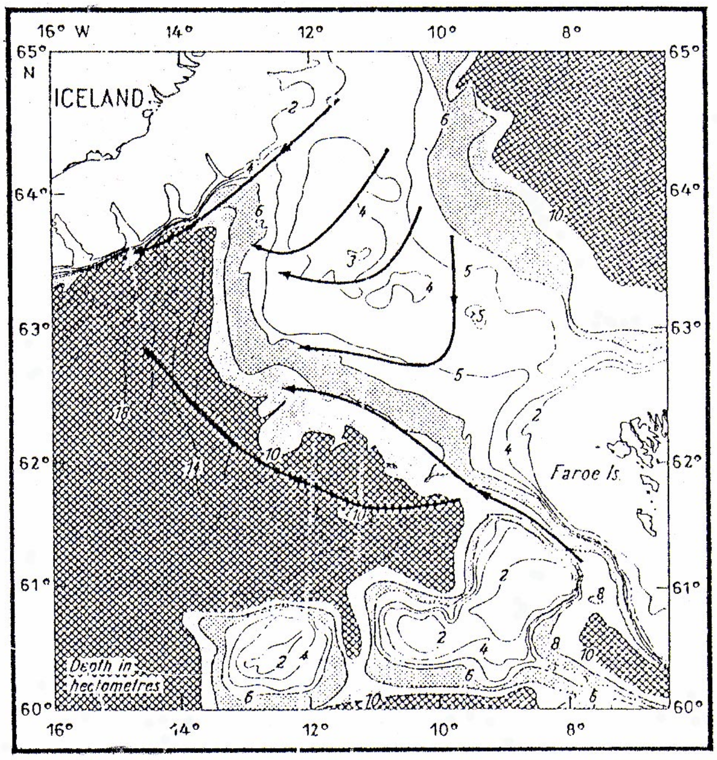


Figure 22. Cores of main overflow branches across and along the Iceland-Faroe Ridge. ICES Overflow Project, June 1960 (Joseph 1967).

22. mynd. Meginferlar botnstraums yfir og meðfram Íslands-Færeyjahrygg. ICES Overflow verkefni í júní 1960 (Joseph 1967).

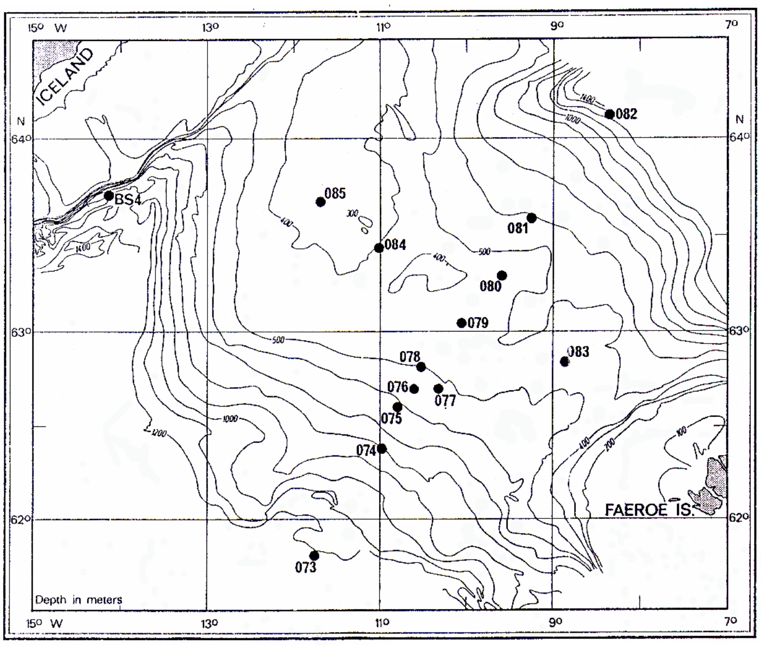


Figure 23. Location of stations, Iceland-Faroe Ridge. ICES Overflow Project August-September 1973 (Koltermann et al. 1976).

23. mynd. Mælistaðir straummælinga á Íslands-Færeyjahrygg. ICES Overflow verkefni í ágúst-september 1973 (Koltermann og fél. 1976).

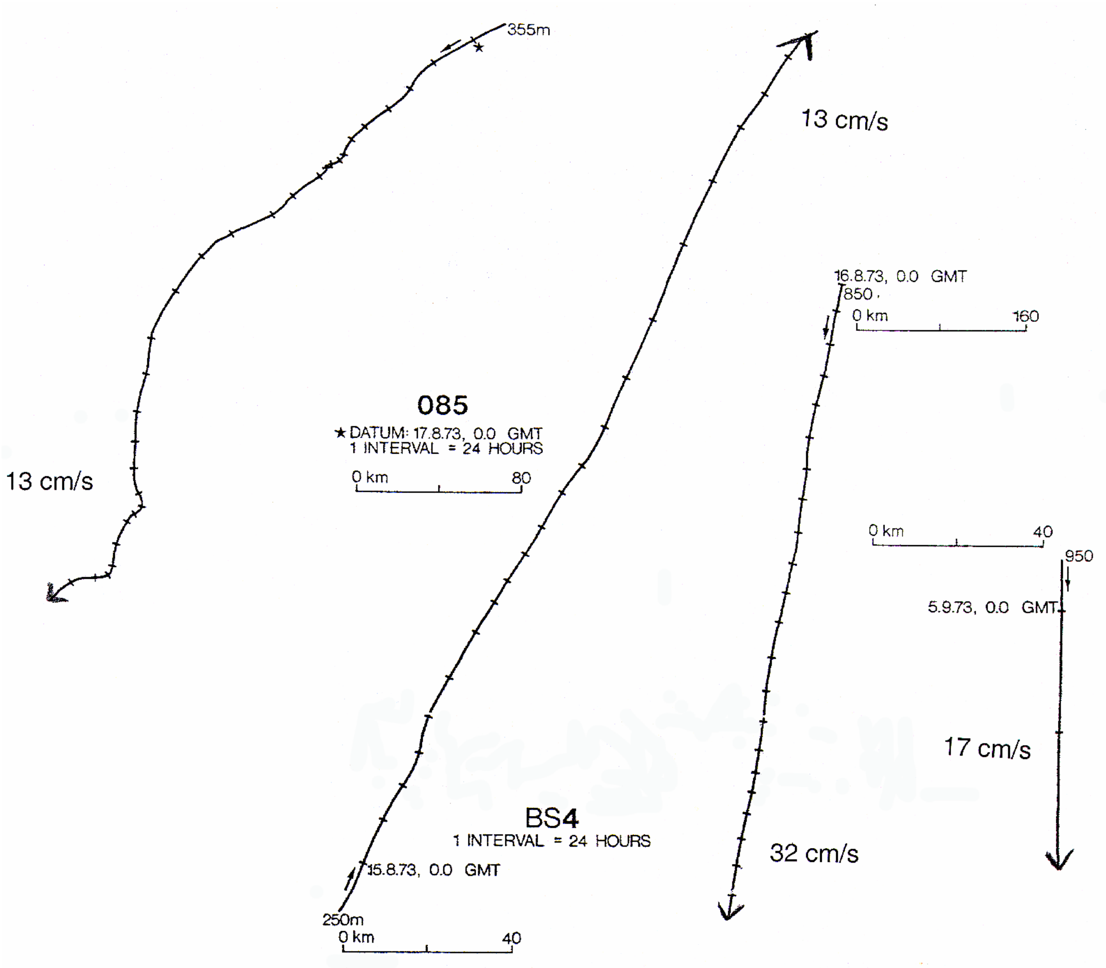


Figure 24. Progressive current vectors at stations 85 (to the left) and BS4 (three vectors to the right), Iceland Faroe Ridge. ICES Overflow Project August-September 1973. For locations see Fig. 23 (Koltermann et al. 1976).

24. mynd. Framskreiðir straumvektorar á stöðvum 85 (lengst t.v.) og BS4 (þrír ferlar t.h.) í ágúst-september 1973. Staðir sýndir á 23. mynd. ICES Overflow verkefni (Koltermann og fél. 1976).

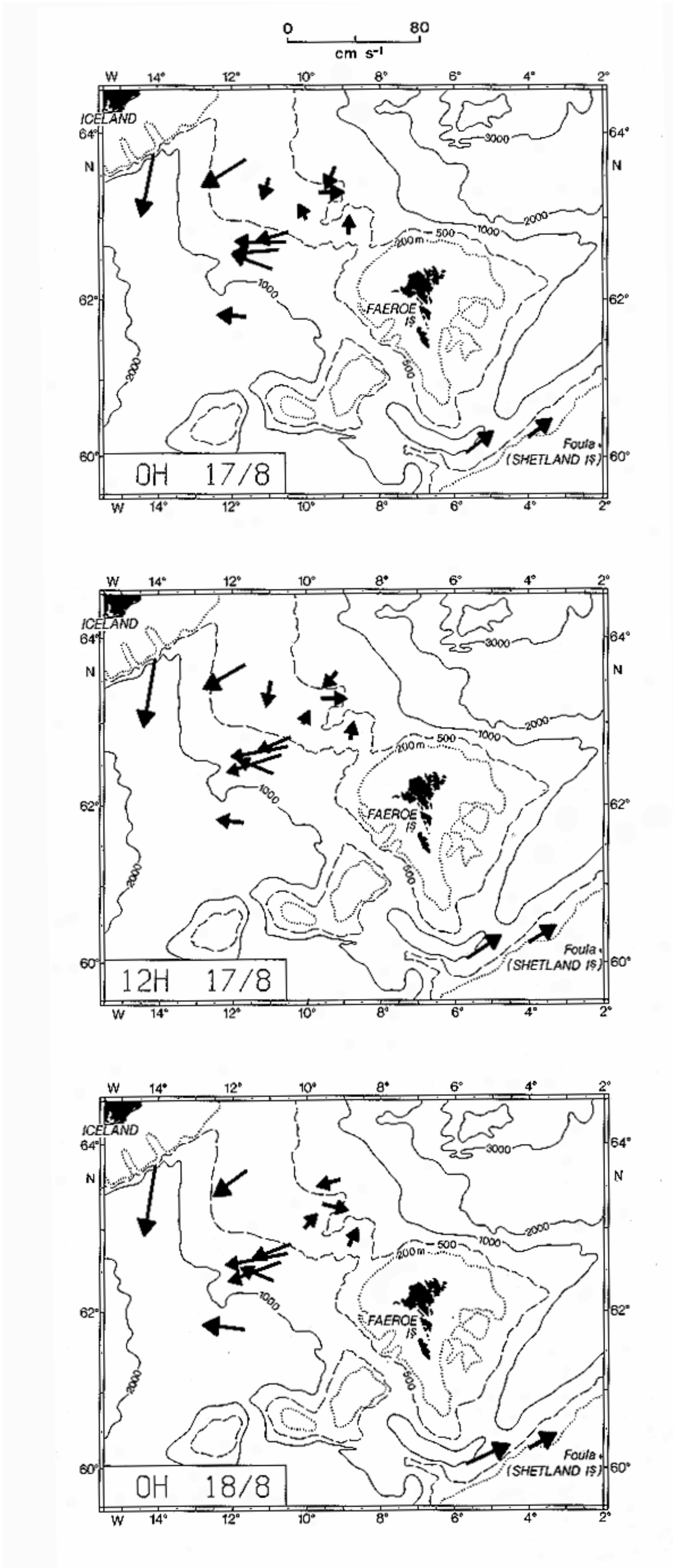


Figure 25. Chosen examples of near-bottom currents from the ICES Overflow August-September 1973 Project in the Iceland-Faroe Ridge area (Ross and Meincke 1976).

25. mynd. Valin dæmi um botnlæga strauma á Íslands-Færeyjahrygg. ICES Overflow verkefni í ágúst-september 1973 (Ross og Meincke 1976).

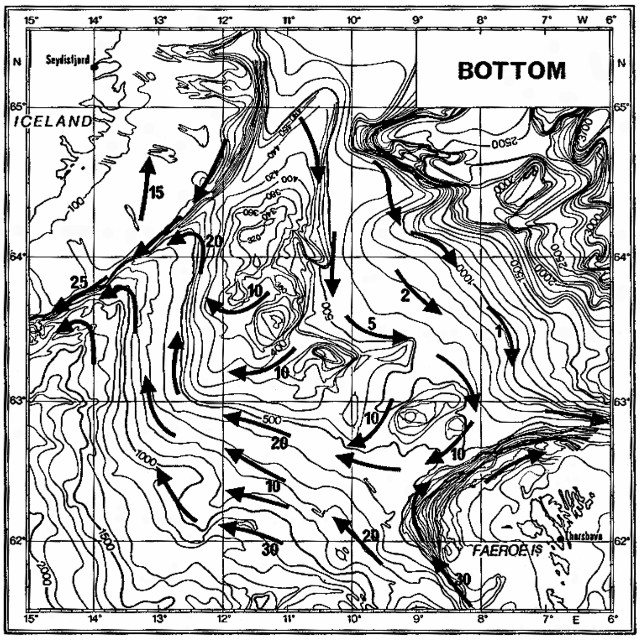


Figure 26. Bathymetry, and scheme of velocities (cm s^{-1}) of near-bottom currents in the Iceland-Faroe Ridge area. ICES Overflow Project, August-September 1973 (Hansen and Meincke 1979).

26. mynd. Dýpi og botnlægir straumar (cm sek^{-1}) á Íslands-Færeyjahrygg. ICES Overflow verkefni í ágúst-september 1973 (Hansen og Meincke 1979).

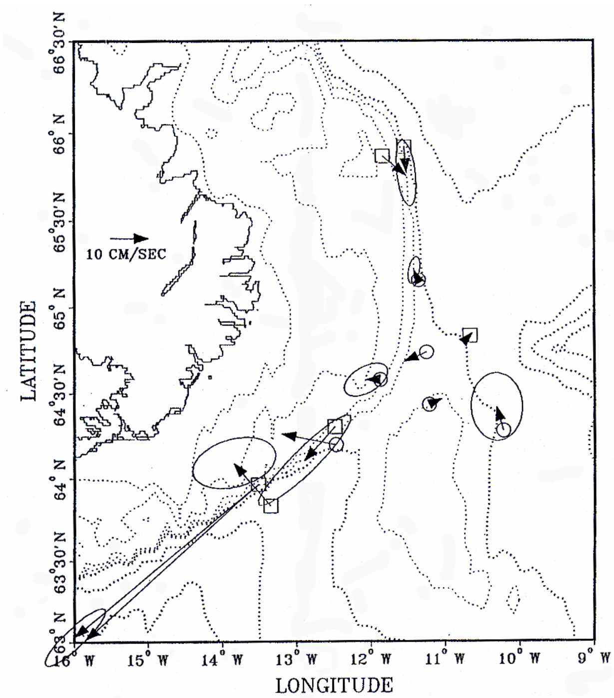


Figure 27. Mean currents and variance ellipses some 50 m above the bottom east and southeast of Iceland, SACLANT 1989-1992 (Perkins et al. 1996).

27. mynd. Meðalstraumur 50 m frá botni fyrir Suðaustur- og Austurlandi. SACLANT verkefni 1989-1992 (Perkins og fél. 1996).

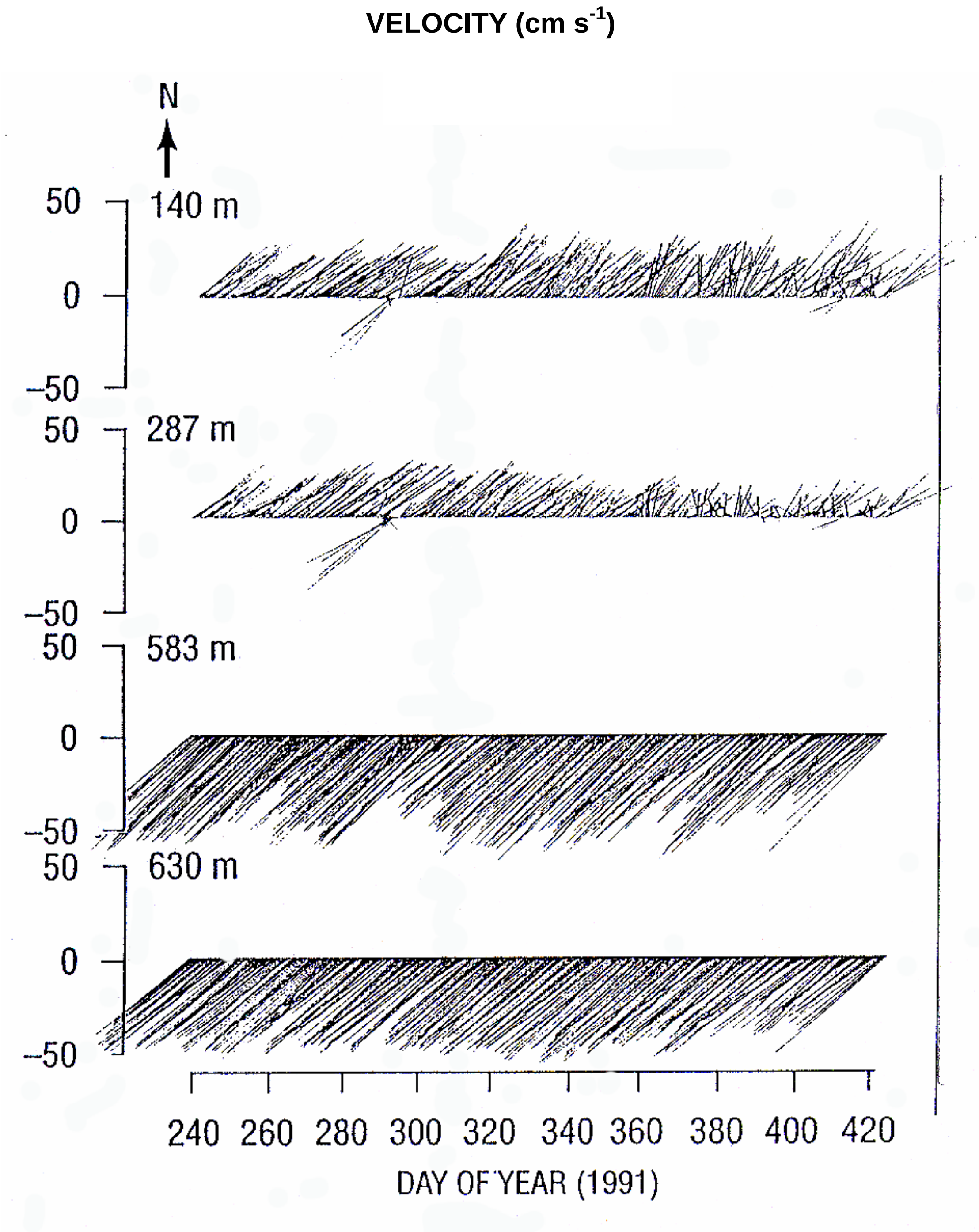


Figure 28. Time-series of current vectors at site x at different depths southeast of Iceland. SACLANT 1989-1992. For location see Figure 27 (Perkins et al. 1996).

28. mynd. Tímaseríur straumvektora 1991-1992 á mismunandi dýpi á stöð x sunnan í rennunni fyrir Suðausturlandi á Íslands-Færeyjahrygg. Mælistaður er sýndur á 27. mynd. SACLANT verkefni 1989-1992 (Perkins og fél. 1996).

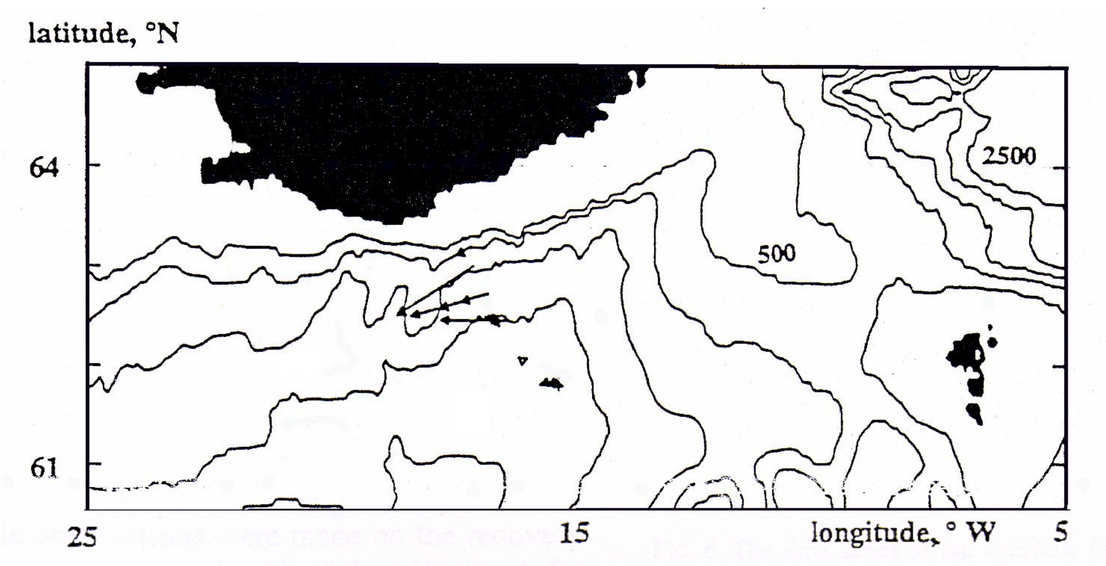


Figure 29. Current meter stations and mean near-bottom currents in 1990-1991 in South Icelandic waters. Largest current vector is 20 cm/s. (Saunders 1996).

29. mynd. Mælistaðir straums og meðal botnlægir straumar í Suðurdjúpi 1990-1991. Mesti straumvektor er 20 cm/s. (Saunders 1996).

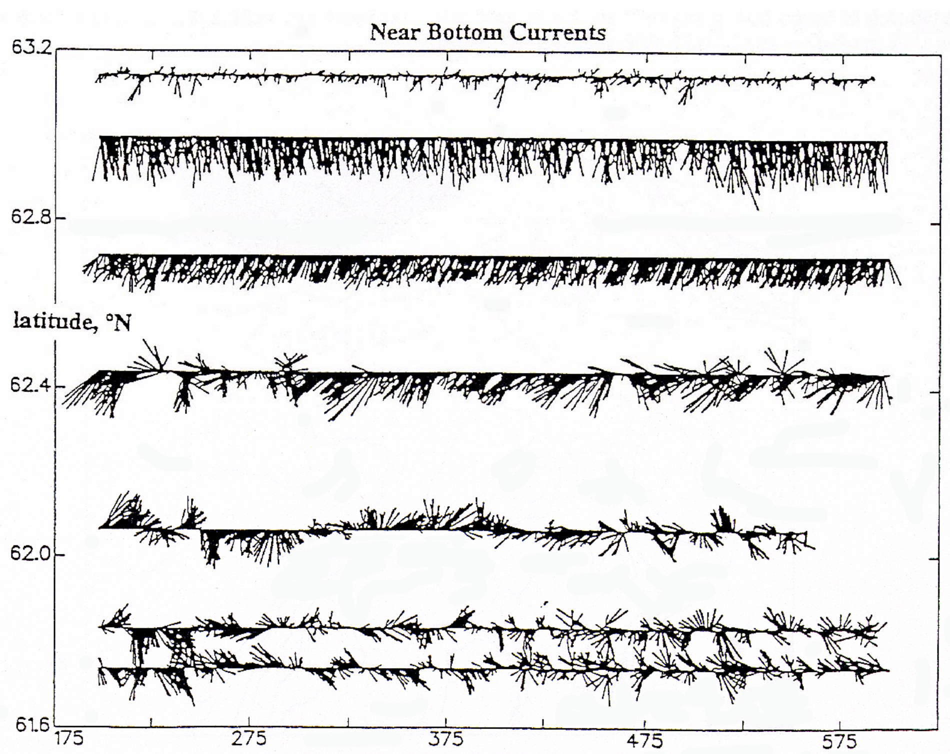


Figure 30. Time series of current vectors 10 m above the bottom in 1990-1991 on stations with increasing depth southwards from Iceland shown in Fig. 29. Downward on the Figure represents 240° (Saunders 1996).

31. mynd. Tímaseríur straumvektora 10 m frá botni 1990-1991. Lóðrétt stefna niðurávið samsvarar 240°. Mælistaðir eru sýndir á 29. mynd (Saunders 1996).

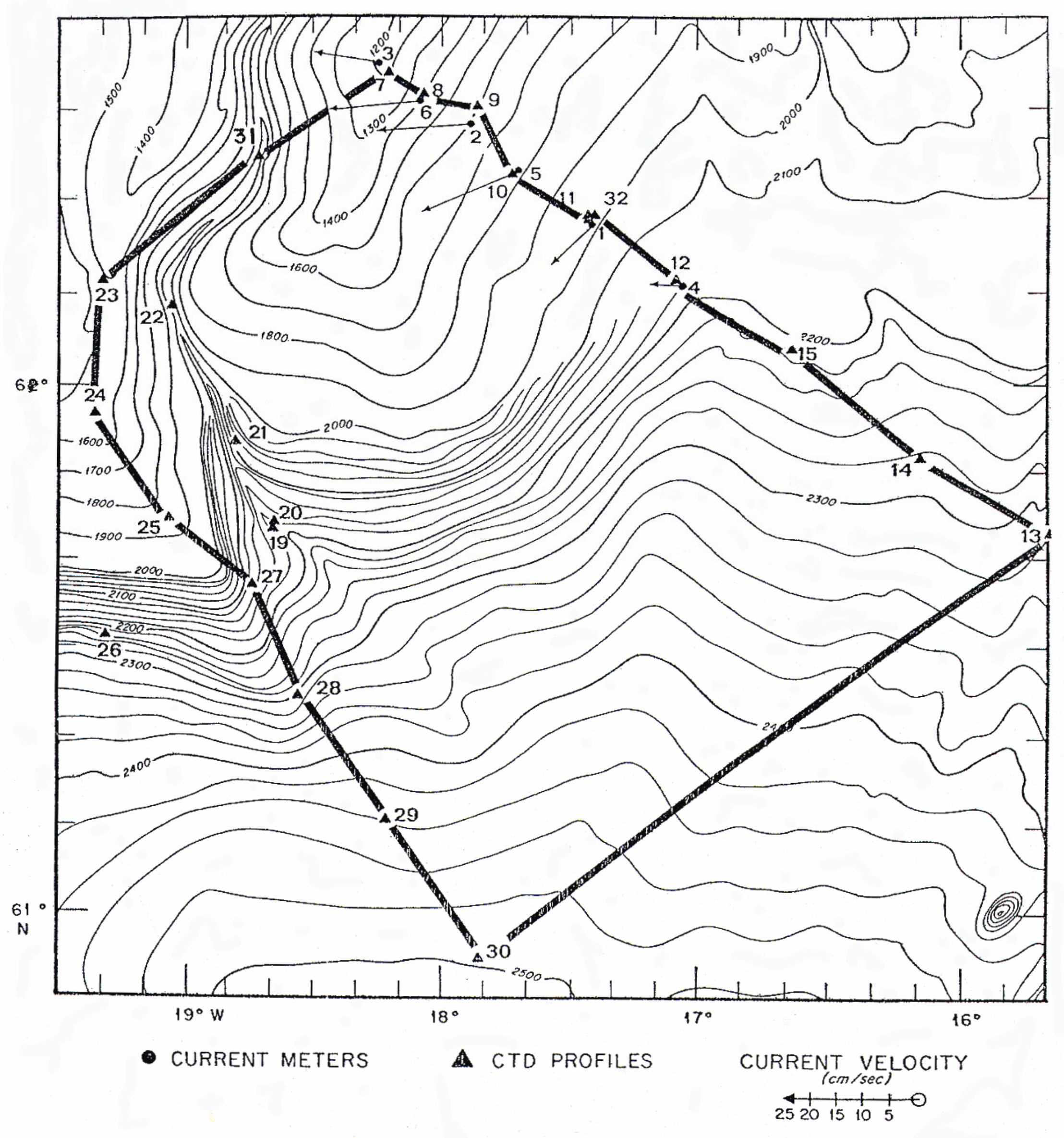


Figure 31. Location of stations in summer 1977 in the Katla Ridges region south of Iceland and near-bottom current velocity vectors (Shore 1978).

31. mynd. Mælistaðir hita og seltu sumarið 1977 á Kötluhryggjasvæðinu fyrir Suðurlandi og straumvektorar botnlægra strauma (Shore 1978).

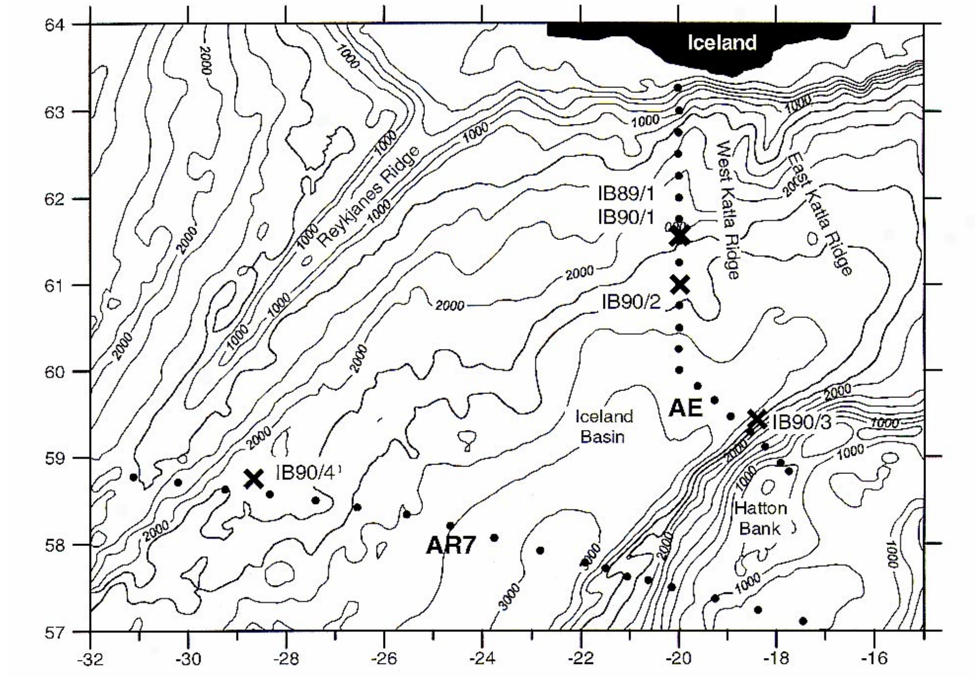


Figure 32. Bathymetry, hydrographic stations and mooring stations (x) in the Iceland Basin 1990-1991 (van Aken 1995).

32. mynd. Dýpi, hita-, seltu- og straummælingastaðir (X) í Suðurdjúpi 1990-1991 (van Aken 1995).

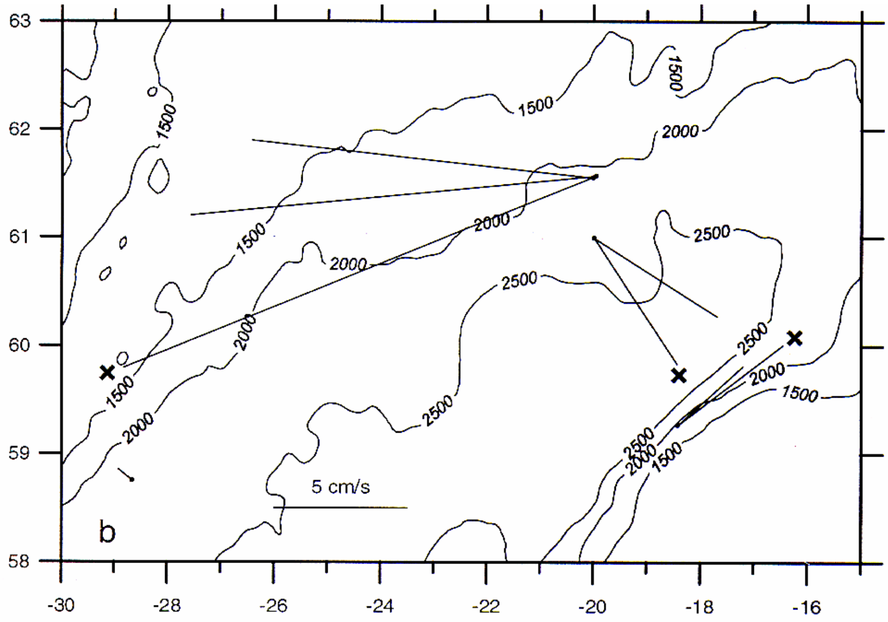


Figure 33. Mean current vectors from the lowest 200 m above the bottom (1990-1991) at the stations shown in Fig. 33. Currents at 40 m from the bottom are marked with a cross (van Aken 1995).

33. mynd. Meðal straumvektorar frá neðstu 200 m frá botni, 1990-1991, á mælistöðum sýndum á 33. mynd. Straumar 40 m frá botni eru markaðir með X (van Aken 1995).

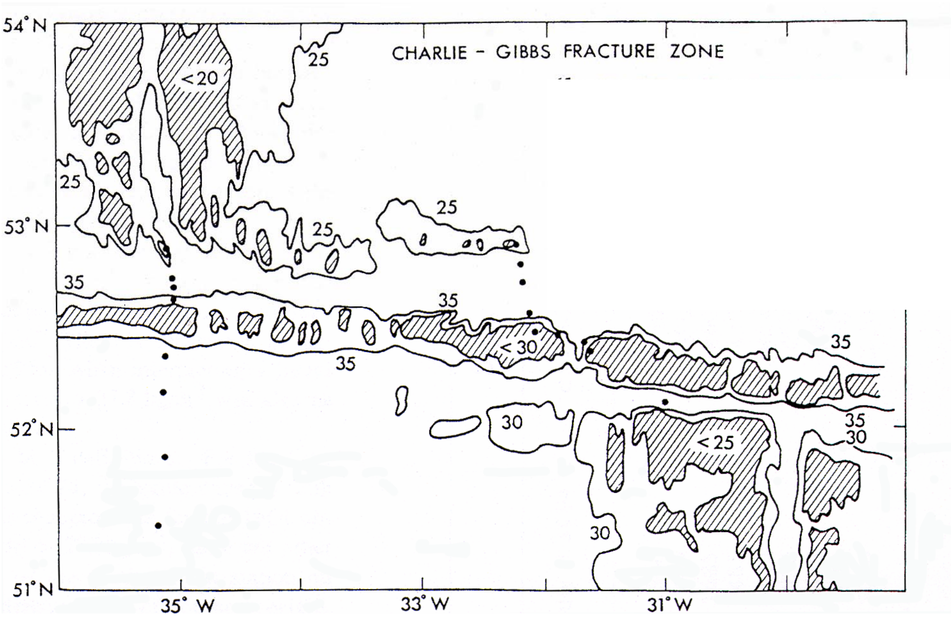


Figure 34. Bathymetry of the Charlie-Gibbs Fracture Zone. Contours are labelled in hundreds of meters and high ground is shaded. Mooring positions along 35°W (1988-1989) are indicated (Saunders 1994).

34. mynd. Dýpi á Charlie-Gibbs svæðinu í hundruðum metra ásamt nánari staðsetningu þess. Grynnstu slóðir eru skyggðar. Straummælingastaðir á 35°V, 1988-1989, eru auðkenndir (Saunders 1994).

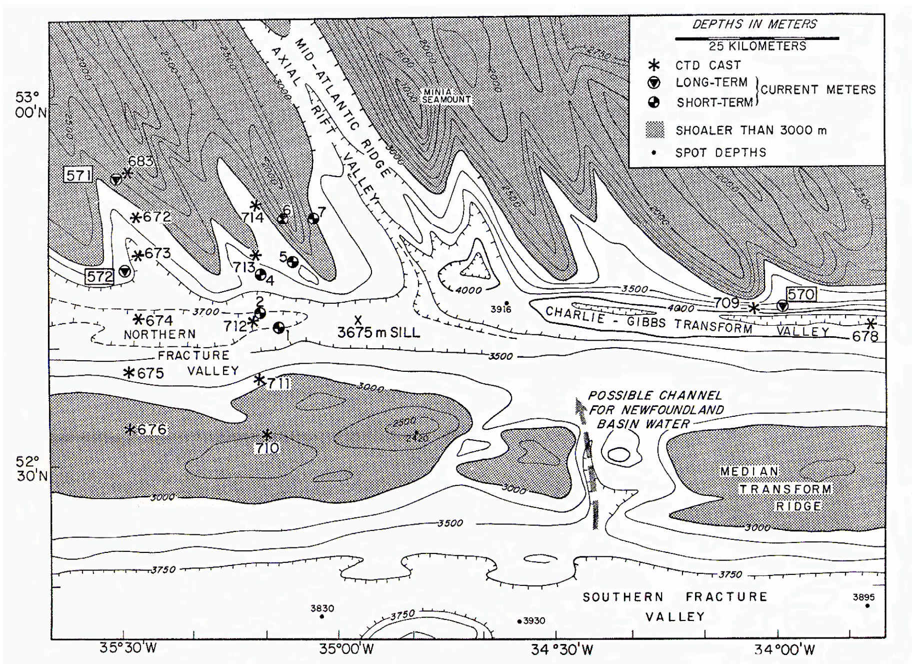


Figure 35. Bathymetry of the Charlie-Gibbs Fracture Zone (northern channel and partly southern channel). High ground above 3000 m is shaded (Shore et al. 1976).

*35. mynd. Dýpi á Charlie-Gibbs svæðinu - nyrðra skarðið og syðra skarðið að hluta. Dýpi minna en 3000 m er skyggt. * eru hita- og seltumælingar og ○○ straummælingastaðir (Shore og fél. 1976).*

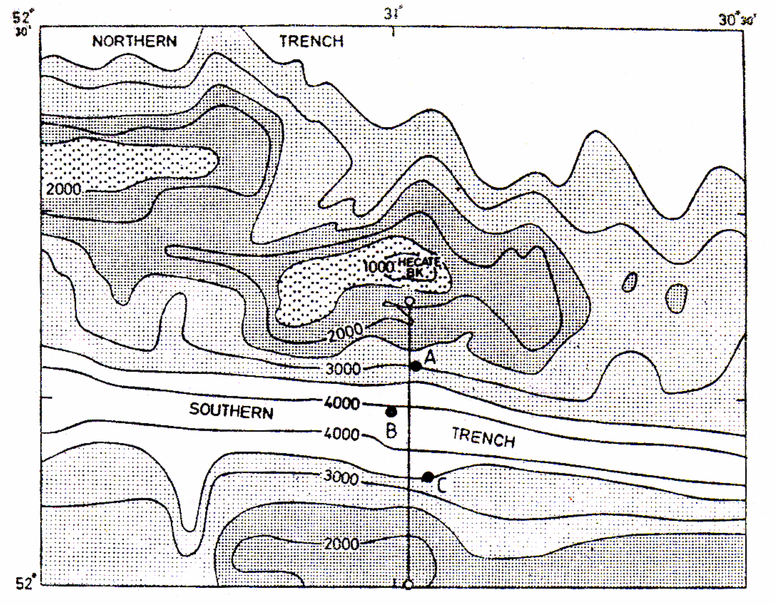


Figure 36. Bathymetry in the southern trough of the Charlie-Gibbs Fracture Zone, 1977-1978. Position of moorings A, B and C are shown by solid circles and the location of a detailed bathymetric transect along 30°59'W is also indicated (Dickson et al. 1980).

36. mynd. Dýpi og straummælingastaðir A, B og C á sniði í syðra skarði Charlie-Gibbs brota belti 1977-1978 (Dickson og fél. 1980).

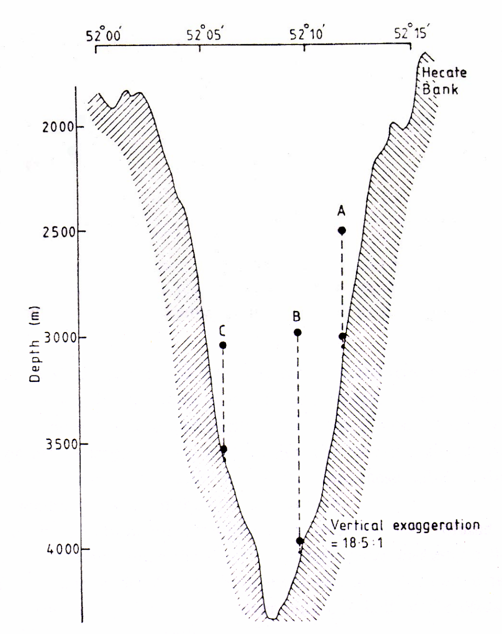


Figure 37. North-south bathymetric transect of the southern trough at 30°59'W with mooring positions and instrument depths superimposed (1977-1978). Locations of moorings are shown in Fig. 36 (Dickson et al. 1980).

37. mynd. Norður-suður dýptarsnið í syðra Charlie-Gibbs skarði ásamt straummælingaslóðunum A, B og C (sbr. 36. mynd) og stöðu straummæla, 1977-1978 (Dickson og fél. 1980).

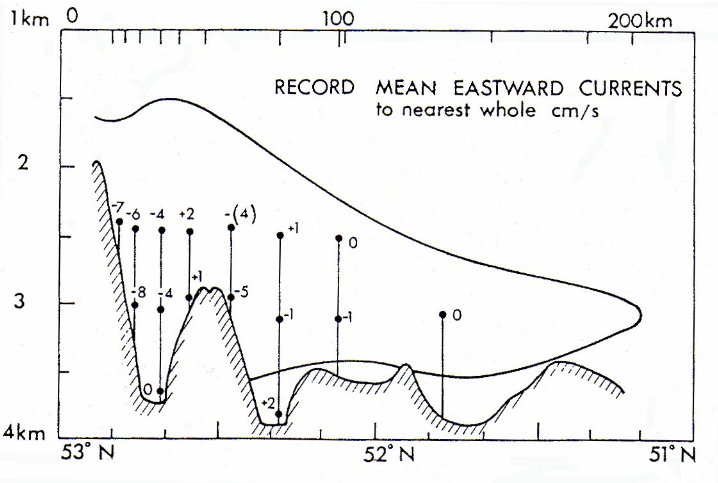


Figure 38. Recorded mean east component, direct current measurements on a N-S section along 35°W across the northern and southern valleys of the Charlie-Gibbs Fracture Zone 1988-1989. East is positive and West negative. The isohaline 34.94 is shown. For location see Fig. 34 (Saunders 1994).

38. mynd. Meðal austur þáttur straums á N-S sniði á 35° V yfir nyrðra og syðra skarð Charlie-Gibbs brotabeltisins 1988-1989. Lega sniðsins er sýnd er á 34. mynd. Austur er pósitíft og vestur þá negatíft. Jafnseltulínan 34,94 er einnig sýnd (Saunders 1994).

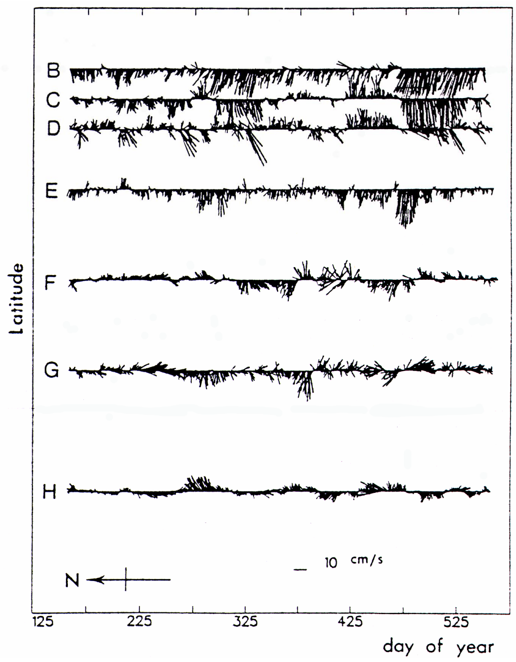


Figure 39. Currents at 3000 m on 35°W; 1988-1989. The moorings are lettered and positioned according to latitude, (B North and H south) and the current vectors are rotated with north directed at the left margin. For location see Figs. 34 and 38 (Saunders 1994).

39. mynd. Straumvektorar (1988-1989) á 3000 dýpi á sniðinu 35°V (sjá 34. og 38. myndir). Straummælingastaðirnir eru merktir bókstöfunum B-H og raðað eftir breidd staða. B er nyrst og H syðst. Straumvektorar sýna norður til vinstri (Saunders 1994).

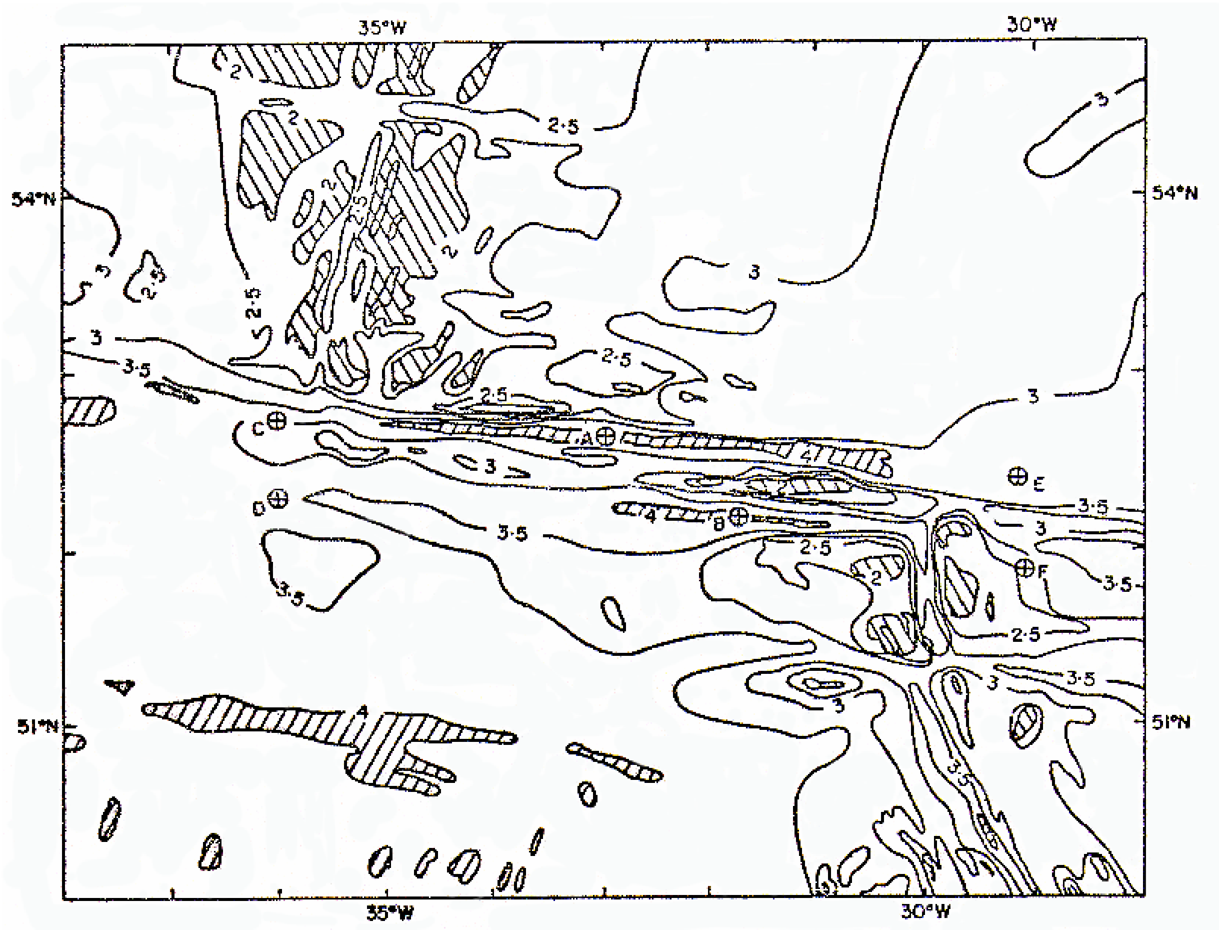


Figure 40. Bathymetry of the Charlie-Gibbs Fracture Zone, isobaths in km. Cross-hatching upwards to the left indicates areas shallower than 2 km, but upwards to the right areas deeper than 4 km. Current meter moorings (June 1970) were at sites A and B (Garner 1972).

40. mynd. Dýpi á Charlie-Gibbs svæðinu í km. Skástrik upp til vinstri sýna svæði grynnri en 2 km, en upp til hægri svæði dýpri en 4 km. Straummælingastaðir - Júní 1970 - eru merktir A og B (Garner 1972).

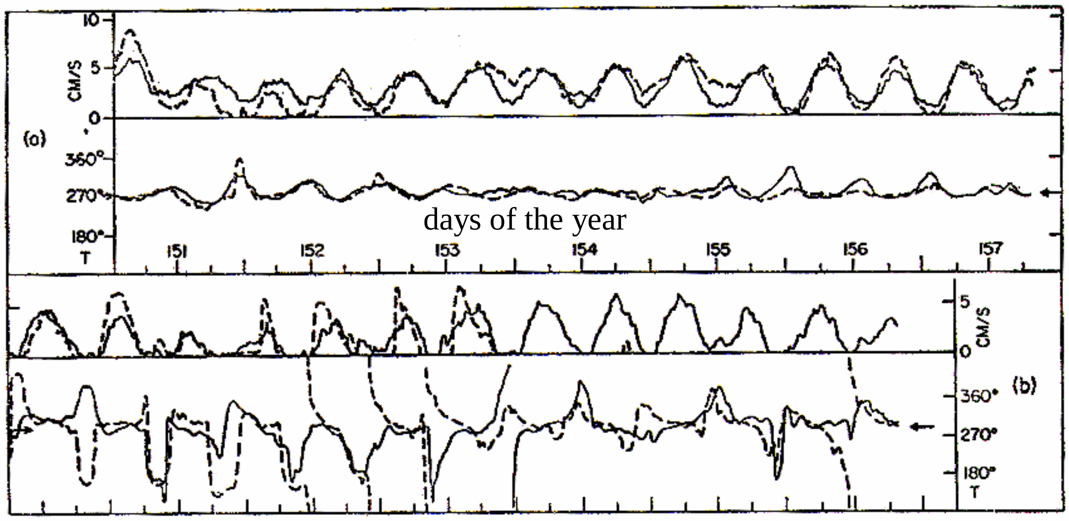


Figure 41. Current meter records, velocity and direction during seven days in June 1970, from the Charlie-Gibbs Fracture Zone, (a) northern channel, (b) southern channel. For location of moorings see Fig. 40. Full line upper meter 650 m above bottom, and broken line lower meter at 50 m above bottom (Garner 1972).

41. mynd. Niðurstöður straummælinga á stöðum A og B – í sjö daga í júní 1970 - (sjá 40. mynd), þ.e. hraði og stefna í a) nyrðra Charlie-Gibbs skarði og b) syðra skarði. Heil lína sýnir mælingar 650 m frá botni en brotin lína mælingar 50 m frá botni (Garner 1972).

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