

Seafloor Structure in the North Atlantic Region between the Kolbeinsey Ridge and the Jan Mayen Microcontinent

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Abstract—Deep seismic sounding, continuous seismic profiling, and bathymetric data are used to discuss the structure of the Iceland Plateau and adjacent areas of the Norway–Greenland region. We tentatively suggest the existence of regional nearly NS-trending tectonic discontinuities; these are normal faults that make up the stepwise character of the Iceland Plateau. The steps are successively descending westward. The fault zones contain magmatic features in the form of dikes that penetrate the sediment in several cases, thus providing evidence of their young age. A rift feature confined to magnetic anomaly C5b is tentatively identified in the central Iceland Plateau based on some crustal peculiarities. The central Iceland Plateau and the southern Jan Mayen Basin show an increased heat flow (92–217 mW/m²) whose lateral distribution suggests a boundary between the regions of increased and normal values. The boundary passes through the center of the Jan Mayen Basin and trends nearly NS. It seems to bound the zone of influence due to the Iceland mantle plume from the northeast at present.

Keywords: seismic surveys, Earth's crust, rifting, heat flow, Iceland plume, magnetic anomalies

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INTRODUCTION

The studied area is located to the northeast of the coastal margin of the Iceland Island and extends to the West Jan Mayen fault zone. The Kolbeinsey spreading ridge and Jan Mayen Ridge are its western and eastern boundaries (Fig. 1). Major morphostructures of the ocean floor include Kolbeinsey spreading ridge, Iceland Plateau, Jan Mayen Basin, and Jan Mayen Ridge. The studies based on compilation of geological and geophysical data (Blischke et al., 2017) clarified and expanded the concept of “Jan Mayen microcontinent”, which united the Jan Mayen Basin, Jan Mayen Ridge, South Jan Mayen Basin, Jan Mayen trough and a number of smaller tectonic structures formed during successive tectonic and volcanic events in its southern region.

The study of (Blischke et al., 2017) consolidating the geological and geophysical data involves the results of seismic surveys starting from 1970, including continuous seismic profiling, diving wave sounding, multichannel reflection seismic survey, and deep seismic studies using bottom three-component seismographs. These results made it possible to construct a tectonic stratigraphic model for the Jan Mayen microcontinent and to propose the kinematic sequence for development of the region under study. However, despite the use of voluminous geophysical data in this work, we

consider it necessary to discuss some features of the deep crust in the Iceland Plateau and Jan Mayen Basin, and also to consider a structure of the ocean floor and the latest tectonics of the region.

The investigation involved the continuous seismic profiling (CSP) sections obtained during trips 10 and 15 of the Akademik Kurchatov research vessel in 1971 and 1973, respectively, (*Islandiya...*, 1977; Beresnev and Udintsev, 2006), some time sections obtained by the Vema research vessel of the Lamont–Doherty Earth Observatory (LDEO), Columbia University, United States, in 1973 (URL: <http://www.ldeo.columbia.edu/>) (Eldholm and Windsch, 1974). When discussing a deep structure of the Iceland Plateau and Jan Mayen Basin, we used the published deep sections of the profiles L3, L4, L5, L6 (Kodaira et al., 1998a, 1998b), and KRISE (Brandsdottir et al., 2015) (Fig. 1).

It is currently believed that the Jan Mayen Ridge and the Jan Mayen Basin are characterized by a continental crust type and represent the East Greenland fragments. Their complete separation from the Greenland margin as a result of spreading in the Kolbeinsey Ridge falls on the time of the seventh and sixth magnetic anomalies. The Iceland Plateau located between the Jan Mayen microcontinent and the Kolbeinsey spreading ridge consists of oceanic crust and is of rift

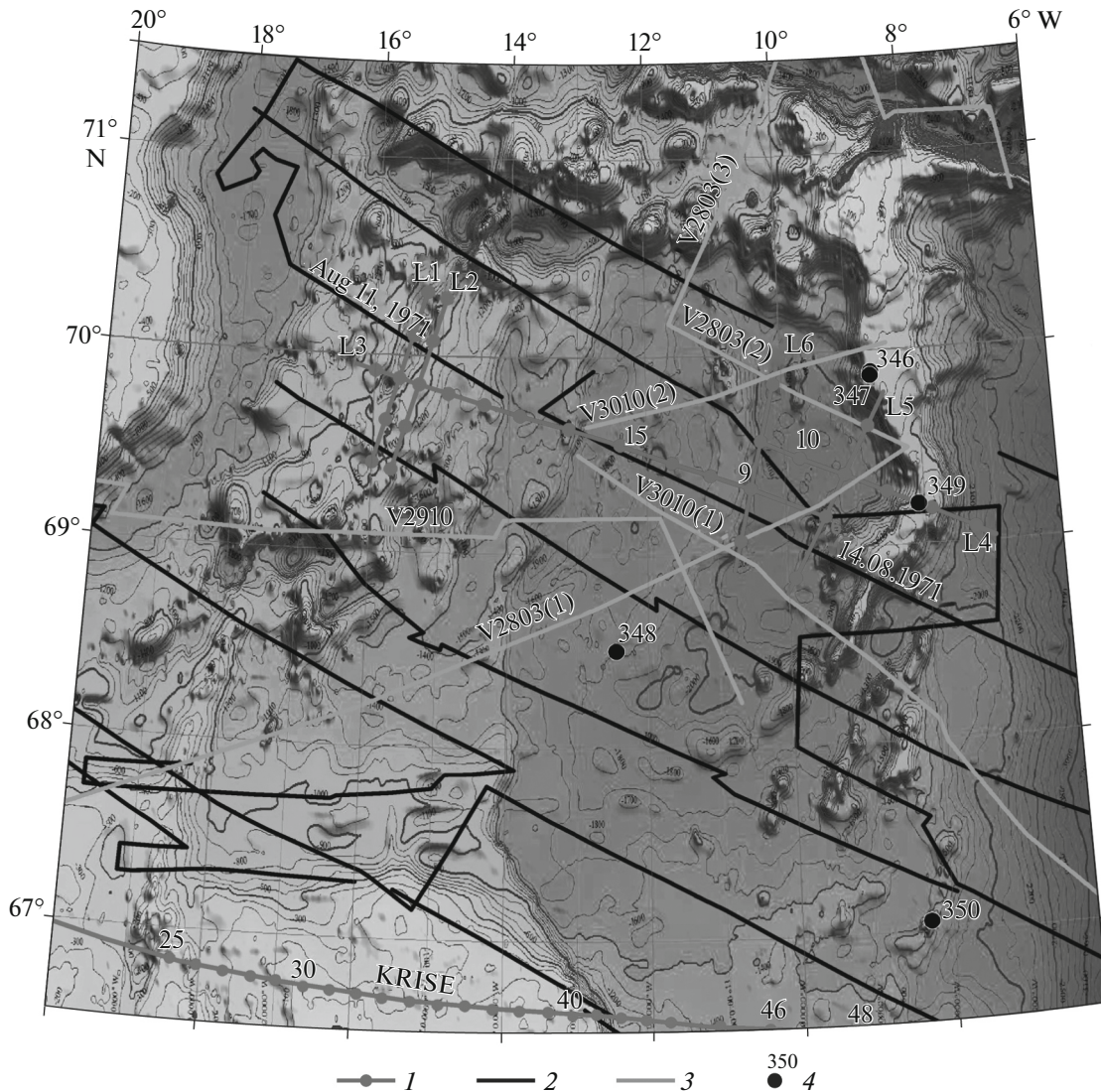


Fig. 1. Overview map of the investigation area. (1) Deep seismic sounding profiles (after (Kodaira et al., 1997, 1998a, 1998b; Brei-vik et al., 2006)); (2, 3) continuous seismic profiling traces: (2) Akademik Kurchatov research vessel (after (Beresnev and Udintsev, 2006)); (3) Vema research vessel (after (Eldholm, Windisch, 1974; GeoMapApp // URL: <http://www.ldeo.columbia.edu/>)); (4) deepwater drilling wells (Glomar Challenger research vessel, trip 38). Bathymetric basis: SRTM30.v.4 (Becker et al., 2009). For the bottom relief contrast purposes, a water depth in SRTM30.v.4 was reduced by 1500 m.

origin (Johnson and Heezen, 1967; Johnson, 1972). The intermediate bottom expansion zone was suggested there. This zone was assumed to have developed in the period of 24–18 Ma, between the decay of the Norwegian Sea rift and formation of the Kolbeinsey Ridge. The idea of the intermediate bottom expansion axis within the Iceland Plateau was also suggested later (Gronlie et al., 1979; Vogt et al., 1980). Meanwhile, the results of deep seismic studies using three-component bottom seismographs (Kodaira et al., 1998a; Mjelde et al., 2002), from the standpoint of these authors, do not confirm the previously made assumptions.

A specific feature of the studied region is a “hot spot” under the Iceland Island, affecting geodynamic

processes in the lithosphere of this part of the North Atlantic. According to the seismic data, in the Iceland Island at a depth of 175 km there is a low-velocity mantle zone (Bijwaard and Spakman, 1999; Verzhbitskii and Kononov, 2010) affecting a distance of over 1000–2000 km. This phenomenon is due to the Iceland plume likely involved in the formation not only of the Iceland Island, but also of many regional structures. The plume effect is dated at the Paleocene–Eocene. When analyzing the tectonic models of ocean formation in the studied region, E.V. Verzhbitskii and M.V. Kononov (2010) conclude that the North Atlantic, Greenland and Eurasian plates split due to the rifting processes, rather than due to the mantle plume effect.

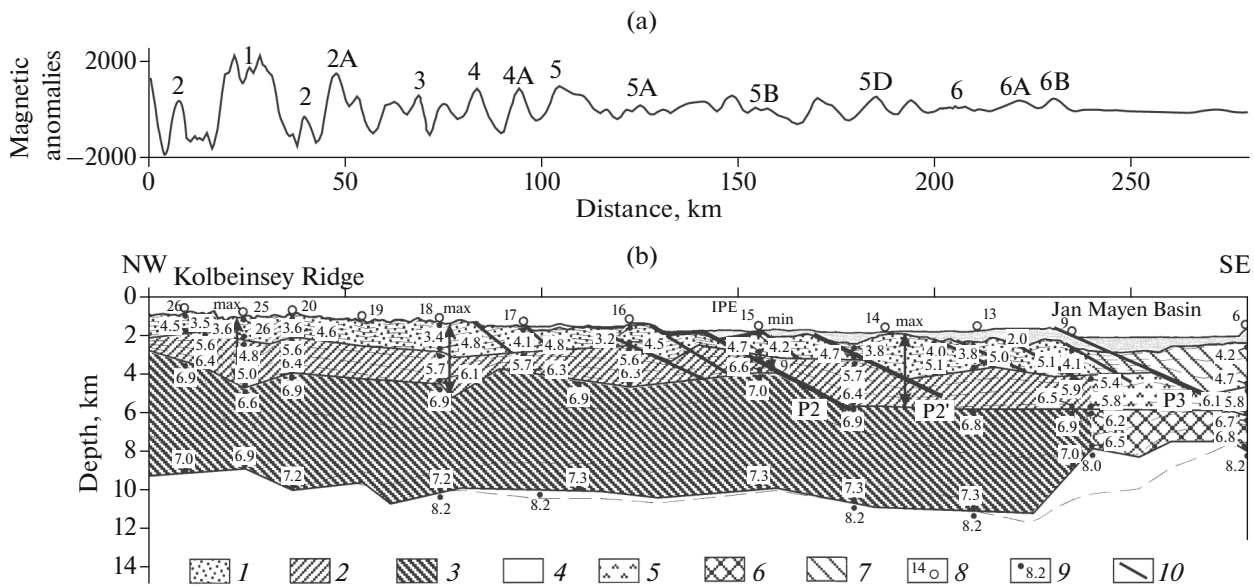


Fig. 2. Magnetic anomalies (after (Vogt et al., 1980)) (a) and the Earth's crust section based on the DSS data (after (Kodaira et al., 1998a) as amended) (b) in the studied area of the North Atlantic Region. (1–3) Oceanic crust: (1) top (oceanic layer 2A); (2) middle part (oceanic layer 2B); (3) bottom (oceanic layer 3); (4) Cenozoic sediments; (5) upper continental crust; (6) lower continental crust; (7) Mesozoic sediments; (8) bottom stations; (9) longitudinal wave velocities, km/s; (10) tectonic faults; (IPE) expansion paleo-axis (after (Gronlie et al., 1979)). Other explanations are given in the text.

DEEP STRUCTURE OF THE ICELAND PLATEAU AND JAN MAYEN BASIN

The Earth's crust models in this region were obtained by seismic sounding with bottom three-component seismographs (BS) in six profiles: in the Kolbeinsey Ridge, Iceland Plateau (L1, L2, and L3), and in the Jan Mayen Basin (L4, L5, and L6) (Kodaira et al., 1997, 1998a, 1998b; Mjelde et al., 2007), and also along the profile KRISE2000 located in the southern part of this region (Fig. 1) (Brandsdottir et al., 2015).

The Earth's crust in the central part of the Kolbeinsey Ridge and Iceland Plateau, according to (Kodaira et al., 1997, 1998a, 1998b), has a three-layer structure. Lateral variations in seismic velocity (V_p) are noted in the profiles along and across the ridge strike. Along the rift valley, the Earth's crust top is characterized by $V_p = 3.0$ – 4.0 km/s, the middle part is $V_p = 4.0$ – 6.0 km/s, and the bottom is $V_p = 6.6$ – 7.0 km/s. The southwestern part of the profile L1 is marked by anomalous values of $V_p = 2.2$ km/s at the crust top and $V_p = 6.3$ km/s at the bottom. In terms of composition, the Earth's crust top, middle part, and bottom are interpreted as pillow lava, dike complex, and plutonic complex, respectively (layers 2A, 2B, and 3).

The profile L3 crosses the Kolbeinsey Ridge, Iceland Plateau, and Jan Mayen Basin (Fig. 1). The velocity model includes the following layers: 1) $V_p = 2.6$ – 3.6 km/s (crust top), 2) $V_p = 4.7$ – 6.0 km/s (middle crust), and 3) $V_p = 6.6$ – 6.9 km/s (crust bottom). At a distance of 12 km from the ridge axis, longitudinal

wave velocities increase to 3.2–4.8, 5.6–6.6, and 6.9–7.3 km/s, respectively (Kodaira et al., 1997; Mjelde et al., 2002). Higher velocity values V_p in the central part of the ridge were explained by higher porosity and fracturing at the Earth's crust top, high temperature and fracturing at the middle and lower parts (Fig. 2). According to the abovementioned authors, the profile L3 is generally characterized by a relatively stable total thickness of the erupted crust 8.0–9.5 km, which is thicker by 1.0–2.5 km than the average value commonly accepted for the oceanic crust (7 km).

However, when analyzing the lateral characteristics of the oceanic crust structure along the profile L3, some features can be noted. The lowest thickness of layer 3 (~4 km) is confined to the Kolbeinsey Ridge axis; a trough in the lower crust surface and a rise in the Moho boundary are observed there. Longitudinal wave velocities (V_p) under the ridge are anomalously low, and variations along the lateral reach 0.3–0.4 km/s (Fig. 2). The total thickness of layer 2 (2A + 2B) is 4 km; it is the maximum. The same anomalous thickness is also observed under the bottom stations 18 and 14 (Figs. 1, 2).

An uplift (70 km in width along the profile) is observed in the lower crust surface between the bottom stations 17 and 15. The difference in depth is 2 km in the eastern slope and about 1.8 km in the western slope. A thickness of layer 3 within the uplift increases by 1 km. The thickness of layer 2 above the uplift is reduced, the lowest values confined to the eastern part of this uplift reach about 2 km (Fig. 2, DS15); an

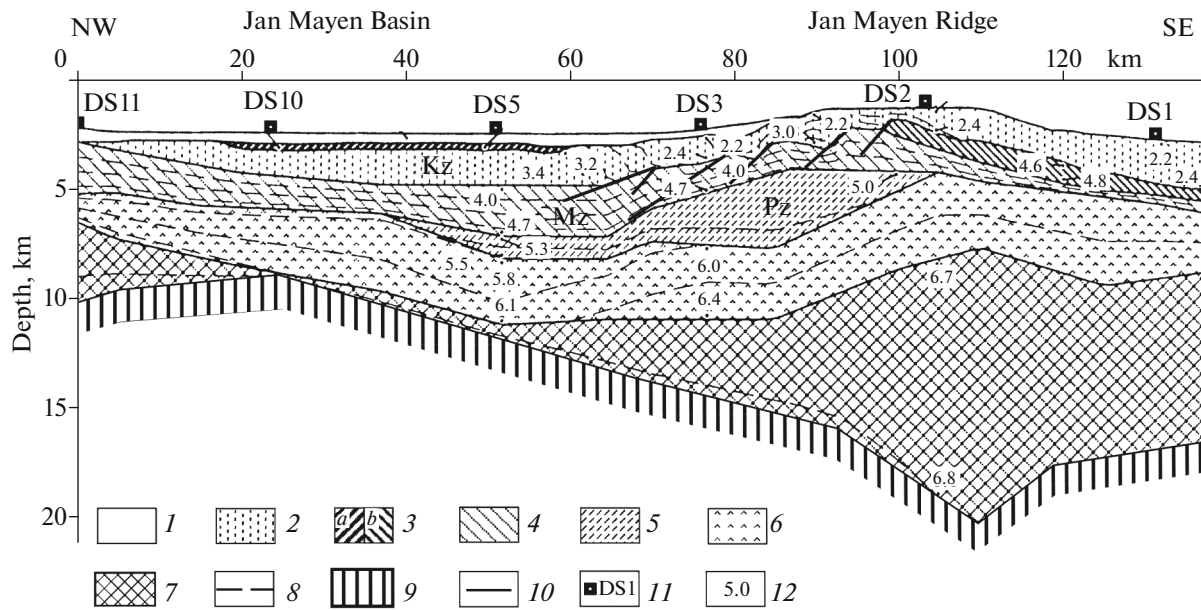


Fig. 3. A structure of the Earth's crust along the profile L4 in the studied area of the North Atlantic Region (after (Kodaira et al., 1998a) as amended). (1, 2) Cenozoic deposits: (1) Neogene–Quaternary, (2) Eocene–Quaternary; (3) sills ((a) Late Cenozoic, (b) Early Cenozoic); (4) Mesozoic sediments; (5) Paleozoic sediments; (6) upper continental crust; (7) lower continental crust; (8) intraplacental boundaries; (9) upper mantle; (10) inclined blocks in the Cenozoic base relief (explanations are given in the text); (11) bottom three-component seismographs; (12) longitudinal wave velocities, km/s.

increase in the layer 2 thickness along the lateral to the west and east of the uplift reaches about 2 km (i.e., the thickness of layer 2 becomes twice as high). Above the uplift of the layer 3 surface from DS16 in the eastward direction, layer 2 has a pronounced block structure. The upper crust surface is stepwise dipping eastwards to the Jan Mayen Basin along the inclined faults. An inclination of the blocks along the profile is 10° – 11° . To the east of DS16, the Cenozoic sediments begin to appear, their thickness gradually increases and reaches about 900 m in the Jan Mayen Basin.

The Jan Mayen Basin is located west of the Jan Mayen Ridge and is adjacent to the eastern part of the Iceland Plateau. In the ocean floor relief, within the isobath of 2000 m, this depression is about 208 km in size from the north to the south and 50–74 km from the west to the east, in the widest area (Fig. 1). The depression has an extremely thin continental crust (Kodaira et al., 1998a, 1998b) (Fig. 3), deep sedimentary basin, and two-layer (upper and lower) continental crust. Longitudinal wave velocities (V_p) reach 5.8–6.1 and 7–6.8 km/s in the upper and lower crust, respectively. An interesting feature of the lateral thickness variations in the lower crust is its thinning from the center of the Jan Mayen Ridge, where it is from 12 km to almost complete disappearance in the central part of the depression (Fig. 3).

The sedimentary cover of the Jan Mayen Basin near DS5 along the profile L4 is about 5.8 km in thickness and is composed of Cenozoic ($V_p = 2.2$ – 3.4 km/s),

Mesozoic ($V_p = 4.0$ – 4.8 km/s), and Paleozoic ($V_p = 5.0$ – 5.3 km/s) rocks. Some lateral specific features in distribution of their thickness are noted within the depression. The sedimentation depocenters (maximum thickness values), with a higher age of sediments, shift eastward to the Jan Mayen Ridge at a distance of more than 40 km. The distance between depocenters of different ages is approximately the same, about 20 km. The maximum thickness (along the profile L4) of the Cenozoic deposits is 2 km, the Mesozoic is 3 km, and the Paleozoic is ~ 3 km. The thinnest segment of the lower crust (almost completely disappearing) along the profile L4 profile (Fig. 3) coincides with a recent depocenter of the Jan Mayen Basin.

The upper consolidated part of the Earth's crust is characterized by a lateral decrease in longitudinal velocity of 0.2–0.3 km/s, which is confined to the thickest Cenozoic and Mesozoic sedimentation area. The Paleozoic deposits with $V_p = 5.0$ – 5.5 km/s in the profile L4, occurring in the eastern border zone of the Jan Mayen Basin, in this section (Fig. 3), represent a sedimentation body as a biconvex lens. The authors of (Kodaira et al., 1998a) following (Weigel et al., 1995) compare this deep sedimentary basin (with $V_p \geq 5.5$ km/s) with the Devonian–Permian basin on the eastern edge of Greenland. The sedimentary lens is inclined towards the Jan Mayen Basin; the Paleozoic sediments thin out in the same direction, and at a distance of about 20 km, their thickness becomes similar within the recent crystalline foundation depocenter.

The layer with $V_p = 4.6\text{--}5.0$ km/s interpreted as a sill is recorded at the top of the Cenozoic section by reflection seismic data (Kodaira et al., 1998a) and refraction wave sounding (Olafsson and Gunnarson, 1989); down the section, $V_p = 2.6\text{--}3.2$ km/s (Fig. 3). The age of this sill is estimated at 30 Ma, and its thickness is about 500 m.

In the western flank of the Jan Mayen Ridge, a surface relief of the layer with $V_p = 4.0$ km/s is represented by the blocks inclined towards the depression along the faults, which are mapped by multichannel seismic survey (Kodaira et al., 1998a, 1998b). The surface with $V_p = 4.0$ km/s separates the Cenozoic and Mesozoic sediments (Myhre et al., 1984). It is assumed that this surface discrepancy is of rift nature and correlates with the Norwegian–Greenland Sea opening. In the deep section of the profile L4 (Fig. 1), in the interpretation by (Kodaira et al., 1998a, 1998b), the inclined blocks with $V_p = 4.0$ km/s are also traced in the western slope of the Jan Mayen Ridge (Fig. 3). According to our estimates, the inclination angle of the blocks along the faults is about 24° .

Analogous thinning of the Paleozoic sediments up to their complete absence is observed in the southwestern direction along the profile L5 (Kodaira et al., 1998a) located perpendicular to the profile L4, near the recent trough in the surface relief of all Earth's crust layers in the Jan Mayen Basin (Figs. 1, 3). Taking into account the nature of surfaces underlying the Paleozoic sediments, it can be assumed that the Paleozoic sediments were formed under subsidence of the paleobasin bottom, uncompensated by sedimentation, on the surface that was characterized by a presedimentation inclination, whose depocenter was near DS5 (Fig. 3).

SEAFLOOR RELIEF AND TECTONIC FEATURES OF THE ICELAND PLATEAU

To analyze morphological features of the seafloor relief, we used the SRTM30.v.4 bathymetric maps (Shuttle Radar Topography Mission) (Smith and Sandwell, 1997; Becker et al., 2009; URL: http://topex.ucsd.edu/WWW_html/mar_topo.html).

Ten morphostructural elements can be identified in the bottom relief of the region under study (Fig. 4); the range of variations in the ocean depth is 100–2200 m. The shore margin of the Iceland Island and the southern part of the Kolbeinsey Ridge were studied earlier in (Usenko et al., 2015). The asymmetric location of the coastal slope of the Iceland Island to the west and east of the ridge is due to a specific thickness distribution of the Cenozoic sedimentary cover. The Iceland Island and its coastal margin were high-standing throughout the Cenozoic. The northern part of the ridge is represented by a wide block with a rift valley at its northern end (Figs. 4, 5).

Northern and southern blocks of the Kolbeinsey Ridge are divided by the “Spar” fault system (Fig. 4, III), to which narrow SW–NE depressions in the bottom relief are confined (Figs. 4, 5). The southern block of the Kolbeinsey spreading ridge has a narrow pyramidal shape and extends from the south to the north; a rift valley is absent there. The deepest part of the rift valley (in the northern part of the ridge) is commensurate in depth with the Jan Mayen Basin in this section, ~2250 m.

The Iceland Plateau relief (IV) is stepwise in nature, while the Jan Mayen Basin (V) is the eastern, most submerged step in this range. The depth difference between steps is 250–500 m. To the west of the Jan Mayen Basin there are three steps in the bottom relief, while eastern slopes of the steps IVb and IVc are complicated by marginal uplifts. In the central part of the widest step (IVc) there is a local rounded depression with a width of about 21–22 km and a relative depth (from the step surface) of ~250 m. In all near-EW bottom relief profiles, we can see a block structure of the Iceland Plateau bottom, while eastern boundaries of the blocks are inclined towards the Jan Mayen Ridge (Fig. 5).

The Northern structural block (NSB) (Fig. 4, X), characterized by a NW–SE strike and adjacent from the west to the Jan Mayen Ridge, is located in the northern part of the region. It borders on the Western Jan Mayen fault zone (WJMFZ) in the north and on the WJMFZ-parallel fault zone in the south. Between the northern block of the Kolbeinsey Ridge and NSB there is a narrow depression extending from the northwest to the southeast (Figs. 4, 5), perpendicular to the rift valley (Fig. 4, IX). This depression is confined to the transform part of the fault, limiting the NSB from the south. Further east, the fault can be traced to the Jan Mayen Ridge. The width of NSB in the profile V2803(3) section (Figs. 1, 6a) is 160 km. In general, it is an uplifted block with a depth difference from 950 m in the south to 1000 m in the north.

Both slopes make up magmatic bodies, possibly dikes, whose width in the section plane is about 38 km. These bodies pierce through the sediments, thus indicating their young age. A sediment thickness within the elevated block reaches 1000 m. Two complexes can be identified in the CSP section (Fig. 6a) in the sedimentary cover: upper, dynamically expressed (Neogene–Quaternary) and lower, “transparent” (Eocene–Quaternary). A sediment thickness at the southern foot of the elevated NSB is about 400 m; only the upper complex can be traced there. The NSB northern ledge as a dike occurs as a West Jan Mayen transform fault with the left slip nature. The NSB southern boundary can also be considered as a large fault zone in its structural features (Figs. 5, 6a).

We marked and traced regional faults along the network of CSP regional time sections (*Islandiya...*, 1977; Beresnev, 2006), which are identified both along

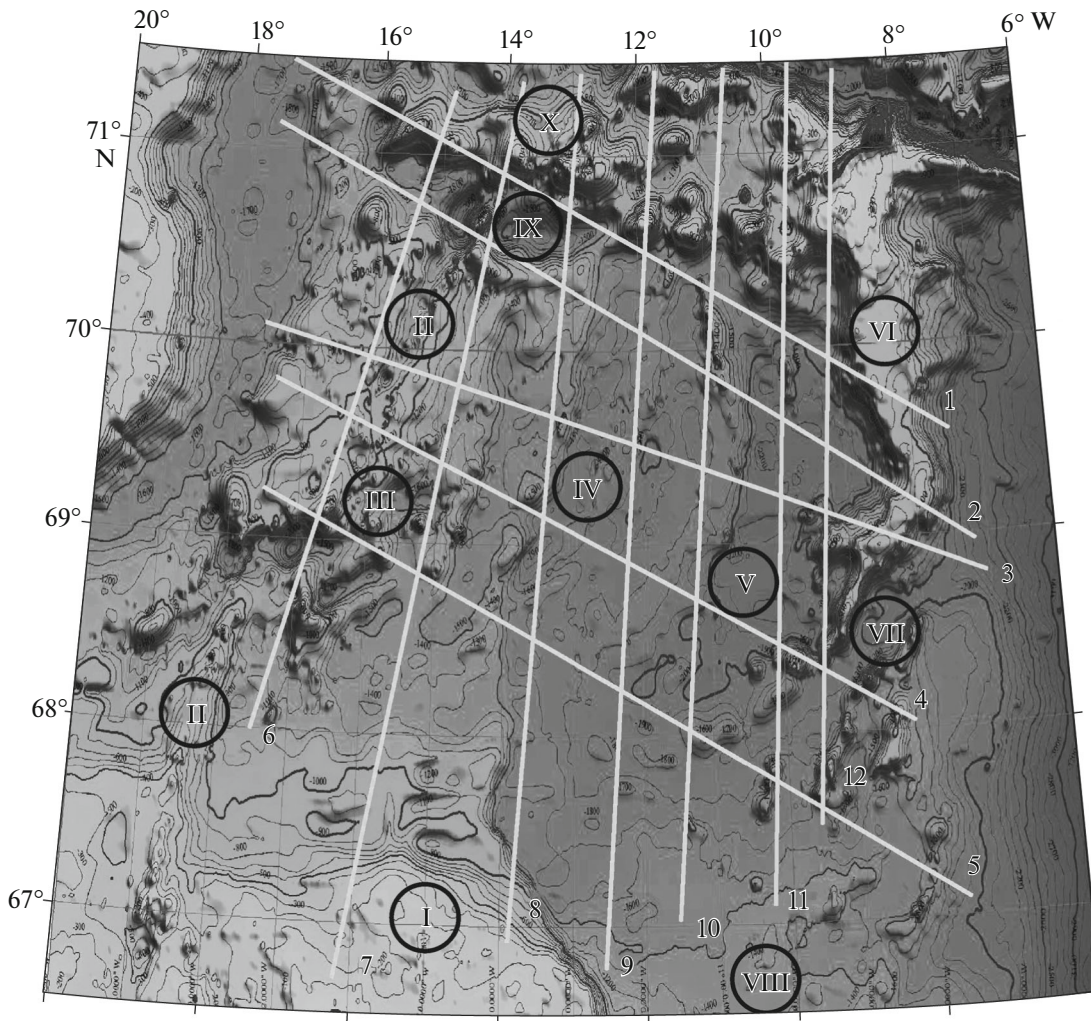


Fig. 4. Location of the bottom relief profiles (1–12) in the studied area of the North Atlantic Region. Roman numerals in circles indicate the seafloor morphostructures: (I) Iceland Island shelf; (II) Kolbeinsey Ridge; (III) Spar fault zone; (IV) Iceland Plateau; (V) Jan Mayen Basin; (VI) Jan Mayen Ridge; (VII) Jan Mayen trough; (VIII) flank of the Iceland–Faroese sill; (IX) depression confined to a transform part of the fault; (X) Northern structural block. The bathymetric basis: SRTM30.v.4 (Becker et al., 2009).

the acoustic foundation surface and in the seafloor surface relief of the Iceland Plateau (Figs. 5, 6b); they are normal faults with an amplitude of 500 m. According to the CSP time sections (Fig. 6), these faults are related to magmatic bodies as dikes that limit steps in the seafloor relief and break through young sediments. We discussed earlier analogous phenomena of recent intraplate tectonics in the Greenland–Lofoten Region (Usenko et al., 2017). In the CSP sections, a thickness of sediments (Late Cenozoic) reaches 1000 m, and their distribution from the east to the west is limited by the regional nearly NS-trending fault P2 (Figs. 6, 7).

In the recent bottom relief, the Jan Mayen Basin as a morphostructure is considered within an isobath of 2000 m, the continental crust area. According to the time section (Fig. 6d) along the profile V2803(1) (the profile location is shown in Fig. 1), the Late Cenozoic sediments are traced further to the west, and their dep-

ocenter is outside of a deepwater part of the depression, within the Iceland Plateau, on the oceanic crust.

CONCLUSIONS

This paper considers three sets of data on the structure of the Earth's crust in the region under study, characterizing different depth levels: (1) deep seismic sounding (DSS) results; (2) continuous seismic profiling (CSP) data; and (3) bathymetric data. According to the deep seismic sounding data, within the Iceland Plateau, the Earth's crust (upper and lower parts) is regionally inclined from the west to the east (Fig. 2). The Earth's crust bottom relief is marked by a dome-shaped uplift (DS17–DS15), above which the thickness of the crust top (layer 2) is the lowest, while the thickness of layer 3 is elevated. To the west and east of the uplift, at the crust bottom, layer 2 is characterized

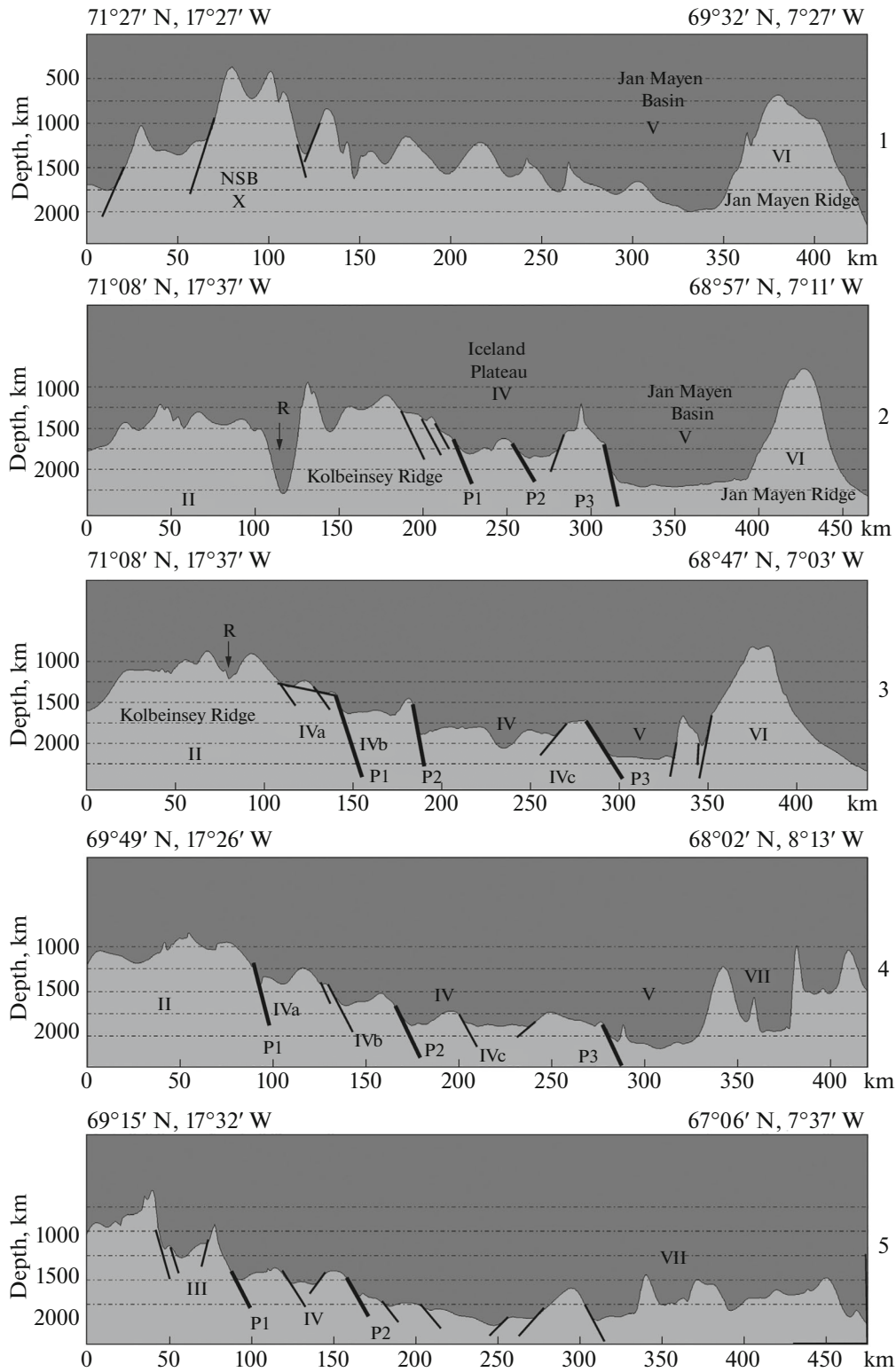


Fig. 5. Profiles of the ocean bottom relief in the studied area of the North Atlantic Region: (1–5) near EW; (6–12) near NS. Roman numerals indicate the seafloor morphostructures; (P1–P3) tectonic faults. A position of profiles and morphostructures is shown in Fig. 4. Other explanations are given in the text.

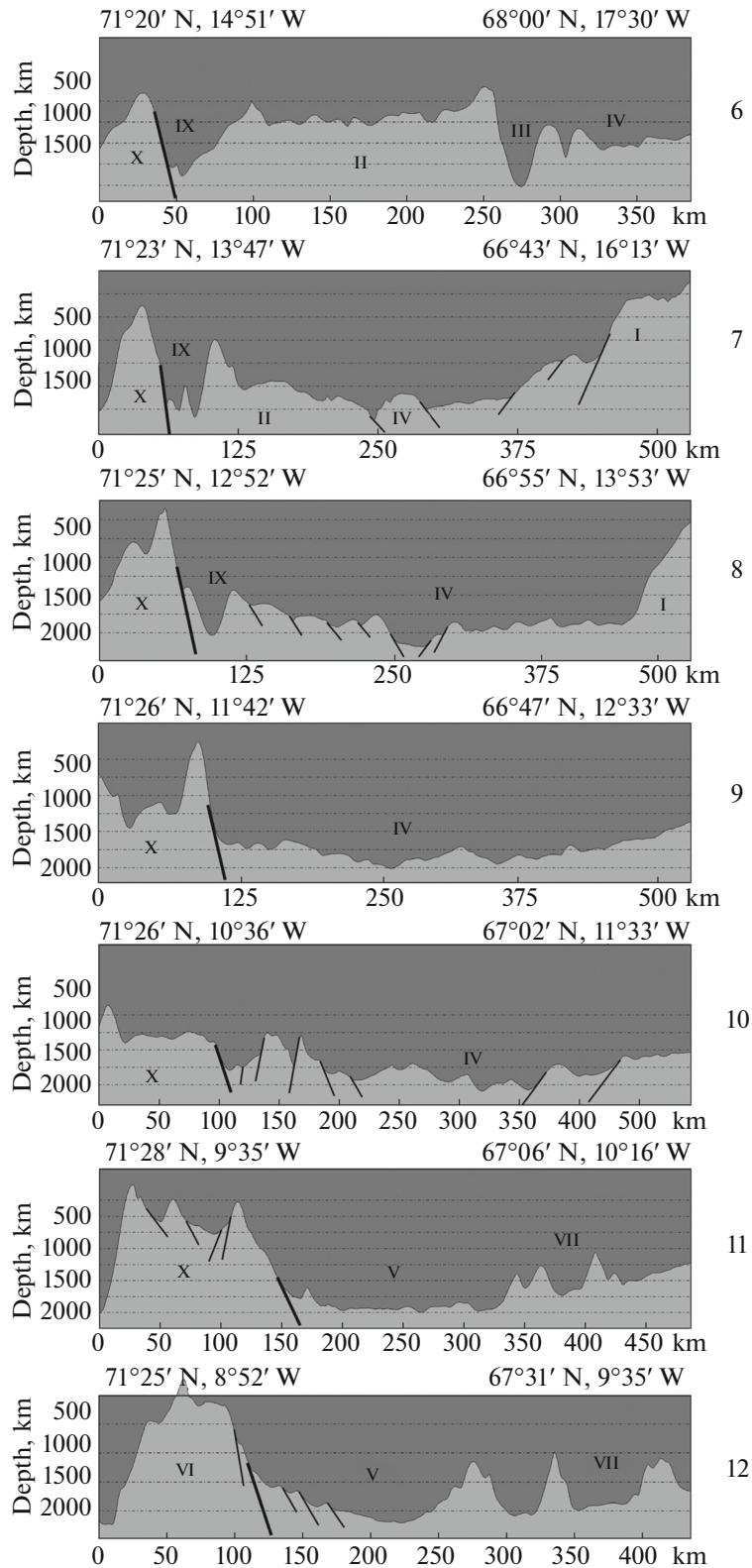


Fig. 5. (Contd.)

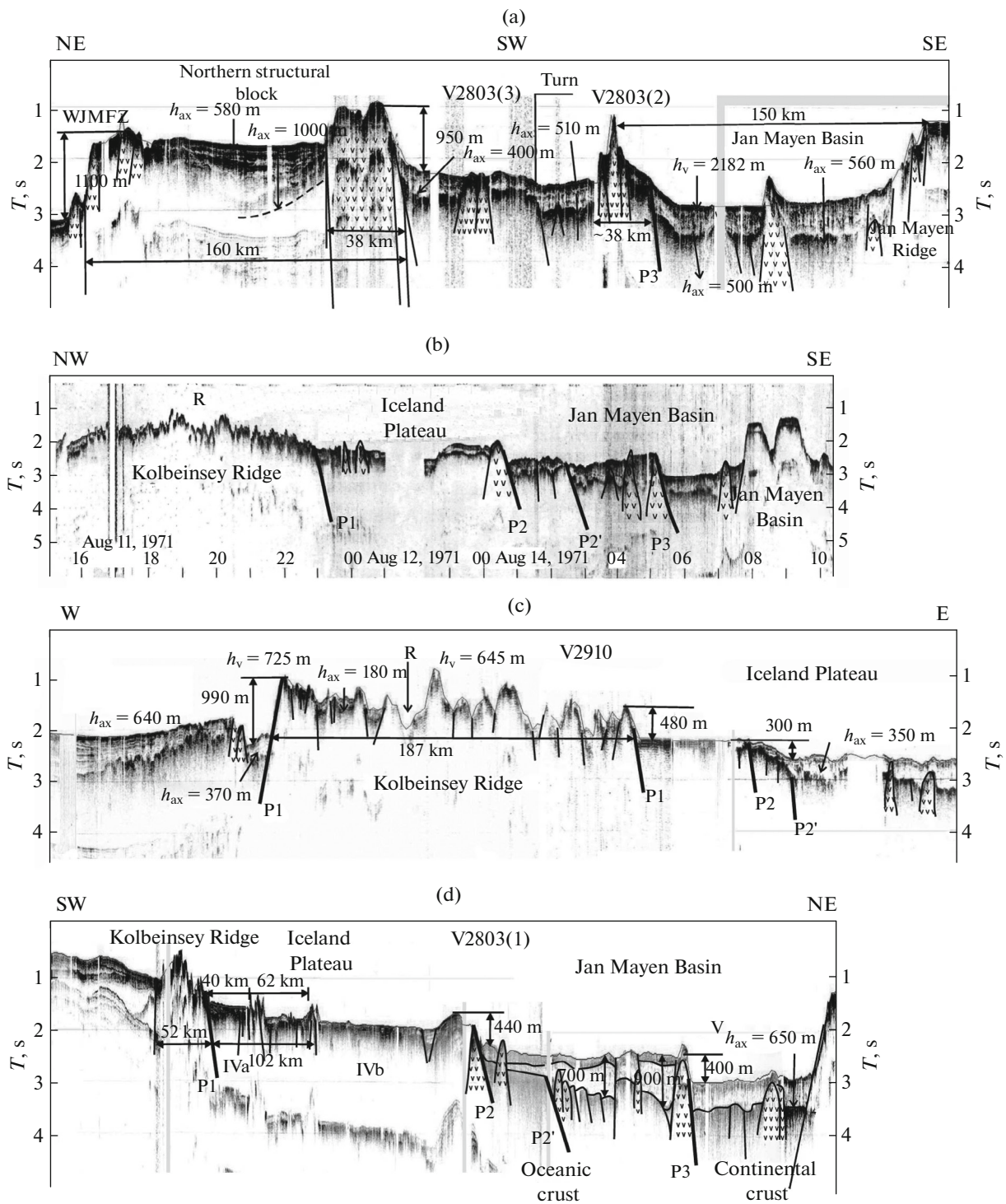


Fig. 6. Seismic time sections along the continuous profiling traces in the studied area of the North Atlantic Region. A location of the sections is shown in Fig. 1. Explanations are given in the text.

by maximum values along the DSS profile (Fig. 2); in addition, a higher thickness value is confined to the rift valley of the Kolbeinsey Ridge. In the upper crust surface relief there are blocks which gradually descend

along the faults from the west to the east and mark the Earth's crustal extension.

A dome-shaped uplift in the lower crust surface relief is located between the magnetic anomalies C5

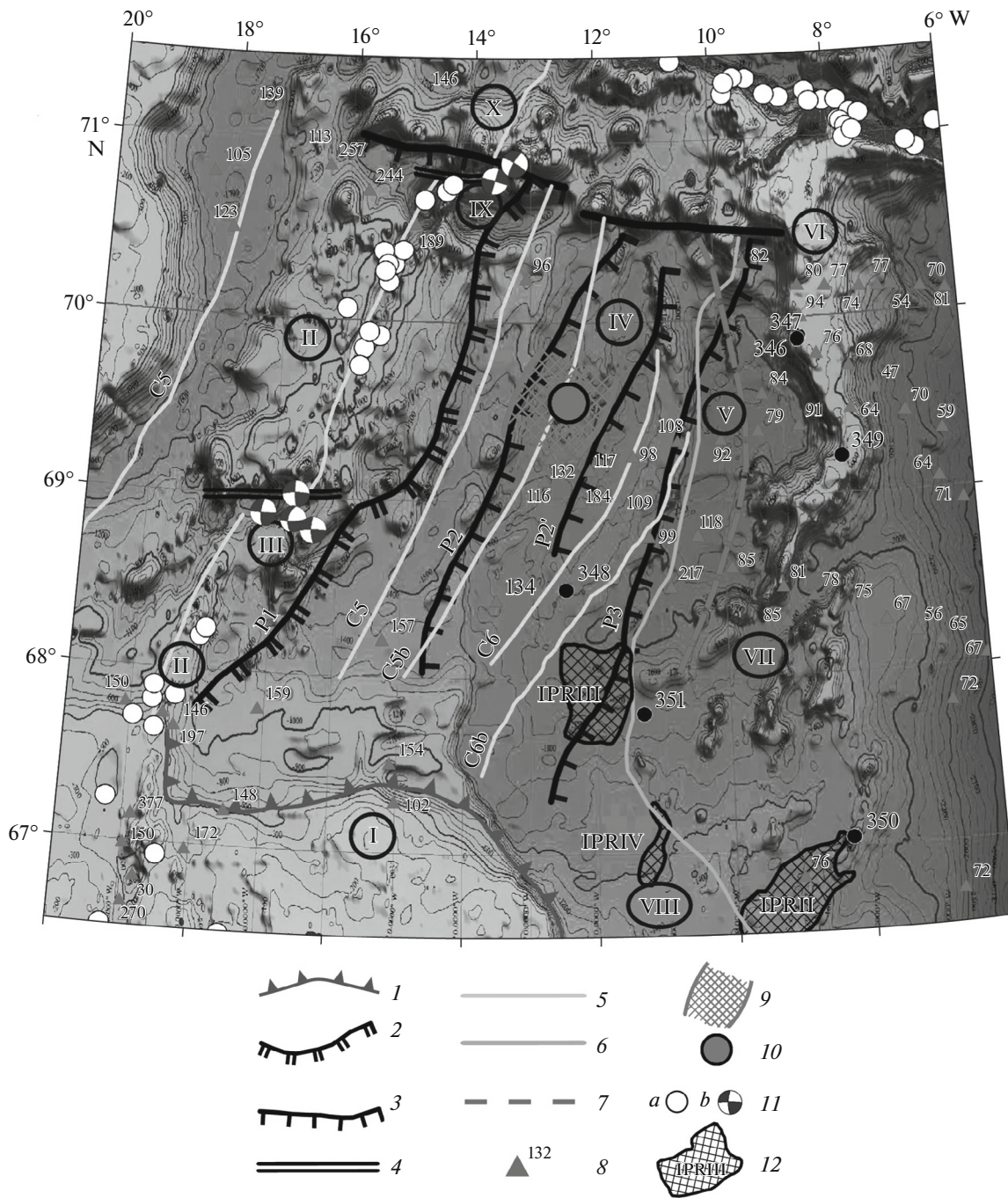


Fig. 7. Correlation diagram of the research results obtained in the North Atlantic seafloor. (I) Iceland Island shelf boundary; (2) Ridge morphological boundary (P1); (3) faults (normal faults P2, P2', P3); (4) transform faults; (5) magnetic anomaly axes; (6) continent–ocean boundary (Blischke et al., 2017); (7) boundary between areas of higher and normal heat flow values; (8) heat flow values, mW/m² (after (Pollack et al., 1992)); (9) assumed rift structure; (10) region of the lowest thickness of the oceanic crust top; (11) earthquake epicenters with $M \geq 4$ (a) and focal mechanisms (after (Ekström et al., 2012) and website: <http://www.globalcmt.org/>) (b); (12) rift centers (after (Blischke et al., 2017)).

and C5B (Fig. 7). The lowest thickness of the crust top and the most elevated area at the crust bottom coincide with the anomaly C5B and fault zones P2 and P2', which we outlined according to the DSS, CSP data and the seafloor relief (Figs. 2, 5–7). It is notable

that the bottom expansion intermediate axis within the Iceland Plateau outlined earlier (Gronlie et al., 1979; Vogt et al., 1980) and rejected later (Kodaira et al., 1998a, 1998b) correlates with uplifting of the lower crust surface, a minimum thickness of the

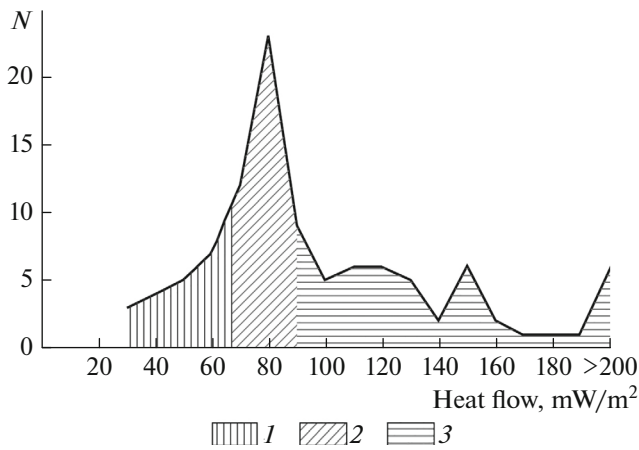


Fig. 8. Distribution of heat flow values in the studied region: (1) lower; (2) normal; (3) higher. Explanations are given in the text.

upper crust, thickening of the lower crust, magnetic anomaly C5B, and the regional fault zone P2 – P2' (Fig. 7). We believe that all rift structure features are observed there.

The studies along the profile KRISE (Brandsdottir et al., 2015) in the southeastern part of the Iceland Plateau (Fig. 1) suggest an ancient spreading center in this area, which coexisted with the Aegir Ridge until formation of the Kolbeinsey Ridge beginning 26 Ma ago. The Iceland shelf (300 km along the western part of the profile) was formed due to activity of the Kolbeinsey Ridge, while the eastern part of the Iceland Plateau and the western part of the Norwegian basin were formed due to earlier rifting; they likely contain fragments of the ancient oceanic or continental crust separated from the central part of the East Greenland margin. The crustal thickness of the Iceland Plateau is 12–15 km in this area, increasing to the west on the shelf to 24–28 km. These ancient rift bodies are outlined by high seismic velocities at the Earth's crust bottom and correlations with higher gravity anomalies.

A step is noted in the foundation relief in the time seismic section along the profile KRISE (Brandsdottir et al., 2015), in the profile area with the bottom stations 48–50. This step is related to a peak in the acoustic foundation relief with a relative height of 600 m and a higher sediment thickness above the east adjacent step. The morphology of the foundation surface, according to (Brandsdottir et al., 2015), is similar to the Kolbeinsey and Reykjanes ridges; this fact is indicative of the crust stretching and an ancient rift occurrence there. Thickening (12–15 km) of the oceanic crust formed within this rift is explained by upwelling processes under the influence of the Iceland plume since the Early Eocene. It is also noted that the ancient rifts in the south of the Iceland Plateau were formed in the course of rifting along the continent–ocean boundary during for-

mation of the central part of the East Greenland continental margin and the Jan Mayen Ridge (Fig. 7).

Following (Brandsdottir et al., 2015), the rift centers (IPRII–IPRIV) within the southern part of the Iceland Plateau are distinguished in (Blischke et al., 2017) by a range of echeloned magnetic anomalies (Fig. 7).

Two Cenozoic rifting phases are distinguished in the considered region: Early Eocene and Late Oligocene (Brevik et al., 2012). During the first phase, the Jan Mayen microcontinent was detached from the Northwest Europe, remaining a part of East Greenland. This stage was accompanied by extensive magmatism. Then, in the Later Oligocene, the long-term extension of the western margin of this microcontinent was followed by its detachment from Greenland. In the Early Eocene, as a result of magmatism in the eastern margin of Jan Mayen, a thickness of igneous rocks reached 7–9 km in the north and 12–14 km in the south (Brevik et al., 2012). In the southern part of the Iceland Plateau, a total thickness of the crust reached 14–17 km.

Large volumes of the igneous rocks and a relative stability of the melts are indicative of a large magmatic reservoir in the East Greenland margin (Melankholina, 2008). Hot plume was needed for this purpose. The Iceland plume was confirmed by seismic tomography (Bijwaard and Spakman, 1999), and today its existence is generally recognized.

The distribution of heat flow values in the studied region to the north and northeast of Iceland ((Pollack et al., 1992) and URL: <http://www.datapages.com/gis-map-publishing-program/gis-open-files/global-framework/global-heat-flow-database>) is indicative of the fact that about 40% of them are similar to the average for the oceans (~ 70 mW/m²). Despite a small number of heat flow measurements (100 values in the sample set), we can note the regularity in lateral distribution of normal, low, and high (≥ 90 mW/m²) values (Fig. 8). At the first approximation, it is possible to outline a boundary between their distribution areas (Fig. 7). It passes along the central region of the Jan Mayen Basin and is nearly NS-trending. We assume that this boundary characterizes the northeastward effect of the Iceland plume (at present). The rift structure we have outlined (see above) is located in the region of higher heat flow values. In this case, magmatism in the form of dikes is confined to the fault zones (P2, P2', and P3), which form the recent stepwise relief of the ocean bottom. The young age of these dikes suggests rifting processes in this area of the Iceland Plateau at the present geological stage.

SUMMARY

In the course of studying the seafloor structural features in the North Atlantic Region, we obtained the following results:

(1) Identification of the regional fault zones as normal faults which form the recent stepwise relief of the Iceland Plateau bottom.

(2) Establishment of the faults that magmatic bodies in the form of young dikes are confined to.

(3) Identification of the rift structure of the Earth's crust in the center of the northern part of the Iceland Plateau, whose center is located near the magnetic anomaly C5b.

(4) Assumption of the NE effect of the Iceland mantle plume based on the lateral distribution of heat flow values in the region.

These studies suggest complex geophysical processes in the lithosphere of the studied region are occurring in the most recent geological time.

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