International Comcil for the
Exploration of the Sea

C. M. 1962
Distant Northern Seas Committee
No. 111 B

On Bottom Deposits of the Norwegian Sea

by

P. S. Vinogradova

Our knowledge of the bottom deposits of the Norwegian Sea until the middle of our century were based on the works of the Norwegian North-Atlantic Expedition 1876-1878 (Schmelck, 1882) and the Danish "Ingolf" Expedition 1895-1896 (Böggild, 19oo).

The expeditions of the first half of our century were made on board "Belgica" (19o5), "M. Sars" (191o), "Meteor" (1925-27), "Sibiryakov", etc., but observations made by both foreign and Soviet ships were of little importance as far as the Norwegian Sea was concerned. Consequently, the charts of bottom relief made by Böggild (19oo, and 19o1), by Timofeyev (1944), Klenova (1953) and Horst Kola (1954) are all rather schematic and based on incomplete data.

Norwegian scientists (H. Holtedahl, 195o and 1959) have studied bottom deposits of the south-eastern part of the Norwegian Sea since 195o.

In the Soviet Union the research on bottom deposits of the Norwegian Sea was started by the Polar Institute in 1954.[1] This research was extended in 1957-1959 in accordance with the IGY and IY and thereby new and rather extensive data were obtained.

Samples were collected by means of the bottom sampler "Ocean-5o" and single-pass pipe on board the R/V "Sevastopol" (cruises, 2, 3, 5, 8, 9, 1o, 13), "Rossiya"(cruise 2), "Professor Mesyatzev" and the trawler "4225". In total, 45o bottom stations were worked, over 2oo samples taken by the bottom sampler, and about 2oo bottom cores with a maximum length of 391 cm. As a result we managed to get bottom samples from different depths and from almost all areas of the sea.[2] (Figure 1).

These data have been partly treated and their results have been published (Gorshkova, 196o; Vinogradova et al., 1959; Vinogradova & Litvin, 196o).

The present contribution deals with the character and peculiarities of the distribution of the surface layer of the bottom deposits of the Norwegian Sea in connection with dynamics of the water masses and the bottom relief. As shown by recent investigations (Litvin, 196o) the Norwegian Sea has a complicated topography which is reflected in the character and distribution of the bottom sediments.

According to the mechanical composition the sediments of the Norwegian Sea are presented by different types, from coarse fractions (boulders, pebbles, gravel) to very fine ones (clay and silt).

While demonstrating sediment types on the bottom chart (Figure 2) of the mechanical composition, we accepted the dynamic classification of the Oceanographic Institute (Klenova, Avilov, 1933; Klenova, 1948). This classification is based on the pelitic fraction content in sediments (fraction particles, less than o.o1 mm).

Coarse sediments: boulders, broken brick, pebble, gravel and the rest of organisms (skeletons and shells) are shown as admixture, although there may be found their concentrations but the area covered by those kind of sediments is small and it is not always possible to show them on charts of this scale.

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1) Scientific workers of the VNIRO, I. K. Avilov and T. I. Gorshkova took part in expeditions and treatment of the data.

2) with the exception of areas, where the steepness of the slope exceeded 5-1o%.

As the chart (Figure 2) shows, the most common sediment in the Norwegian Sea is clay silt. It covers the bottom of the Lofoten and Norwegian Deeps at depths above 2000 m. At smaller depths it may be found in the Icelandic Hollow (1600-2000 m) and on the Norwegian Plateau (1100-2000 m) where, due to certain peculiarities of the sea bottom and currents, favourable conditions for the setting down of fine particles and small forms of foraminifores are being created. The vortex zones are seen in these areas shown on the scheme of permanent currents made by B. V. Istoshin and Alekseyev, A. P. (1960). Clay silt is a brownish sediment [1] (from light to dark shaded), always with calcified foraminifera shells but sometimes with agglutinative ones, their abundance and species composition varying greatly in the different areas. The content of politic fraction reaches 75% for depths above 3000 m and for smaller depths as well. The sandy fraction is insignificant, reaching about 1%, sometimes it increases to 10-15% (near sub-marine ridges) alevritic fraction varies from 25 to 40%.

These peculiarities of the mechanical composition of clay silt are clearly shown on the histograms. On profiles N 2, 3 (Figure 3) crossing the contral part of the sea we see that there was prevailing only one type of histograms with the maximum in the politic fraction both for depths above 3000 m and less.

Material composition of clay silt taken from different depths has much in common with the mechanical composition. Globigerina shells dominate in the sand and coarse alevritic fractions while in the sand fraction Pyrgo shells are encountered rather frequently.

The silt bordering the zone of clay silt is deposited by a narrow band along the slope of the Norwegian coast at depths of 700-1200 m. From the south where the steepness is greater the silt goes down to a depth of 3000 m and penetrates into the Norwegian Sea Deep by seperate tongues and covers the bottom of the elevated parts (Figure 2).

In the regions of the Mohn's Threshold and Jan Mayen Ridge and westwards the silt was found at depths of 1100-2000 m.

A great amount of brown and brownish-grey silt with Foraminifera was found. The mechanical and material composition has much in common with grey silt. Besides the normal curve of mechanical composition (i.e. regularly increase from sandy to politic fraction) samples with a two-peaked curve were observed. The examination of fractions of these samples proved that in some cases it depends on the wash - in the fraction there were lumps of ground layed below (stations 1358, 1709); in other cases, it it due to the presence of the great amount of coarse Foraminifera forms (stations 1364, 1709). In some cases, for example at station 1994 (1629 m deep) in the upper sediment layer the sand fraction makes out 50% and Foraminifera shells and politic fractions make out 30%.

The silt between Iceland and Jan Mayen is characterised by a high content of alevritic fraction from 50-65%, small amount of Foraminifera shells, a great percentage of fragments of volcanogenous sediments, but the stations situated in the area of 20°W.L (1222, 1220, 1219 and others) gave samples with a peak for fine alevritic fractions (Figure 3, profile I).

As is well-known, the presence of silt sediment of brown colour points to the oxidising medium characterised by the minimum of hydrodynamic activity near the bottom, low water temperature, low quantity of organic matter and enrichment of sediment with ferric and manganese oxide which is confirmed by the data of mechanical analyse and hydrochemical survey for the zone of silt and clay silt as well.

Sediments of greenish-grey colour are characteristic for the reduction medium and testifies the great intensity of hydrochemical processes near the bottom. They are present in sandy silt, silty sand and sand.

In the Norwegian Sea sediments of greenish-grey colour are met with in the Jan Mayen area, on the Faroe-Iceland and Uavill Thompson ridges, in the Denmark Strait (its northern part), in the Faroe-Scotland Strait and on the Norwegian Shelf and Greenland as well.

The mosaic distribution of sediments is observed on the Faroe-Iceland Ridge where the thickness of deposits is low: there is a predominance of clay silt of a greenish-grey colour, this area being interrupted with parts of rocky and stony bottom patches, of sand and sandy silt enriched with gravel, pebble and boulders. Sometimes sediments are of brown colour (mineral grain and biogen residua are overlaid with the ferriferous cover). These "ferriferous" areas coincide with boundary zones of different water masses. The mixed mechanical composition of sediments, the presence

[1] The only station 1976 at a depth of 3260 m gave a clay silt sample of grey colour.

of particles more than 1.0 mm and sandy particles about 50% and more are clearly seen on the histograms (Figure 3, profile 5). Coarse shell sand is met with at greater depths (1500 m) along the south-western slope of the ridge. A more detailed characteristic of the bottom sediments on the Faroe-Iceland Ridge is given in our joint work (1958).

The bottom of the Faroe-Shetland Strait in its deepest part (where the main stream of Atlantic water passes) is covered with clay silt, but sandy silt is found to the east and west of it and in smaller depths.

The island shallow near the Shetland from its eastern side is covered with well-sized sand.

The thickness of sediments with great content of Foraminifera varies from 5 to 25 sm. In some parts on the shelf and slopes the currents are so strong that rocks underneath appear on the surface.

The peculiarities of distribution and the character of the mechanical composition of the surface layer of bottom sediments of the Norwegian Sea are rather clearly shown on the profiles (Figure 3). It is seen that the same type of curve is met with at different depths. But at the same time there are distinguished deposits in the different areas at the same depths.

Examination of fractions of the mechanical analysis showed that the sediments are distinguished by their material composition, grade of rolling of grain and other reasons besides their mechanical composition. Thus, the stations located in Jan Mayen and Icelandic areas gave sediments enriched with debris of volcanic origin. The sediments under the passing warm Atlantic waters and particularly in the zone of convergence of Atlantic and Arctic waters are saturated with shells of calcareous Foriminifera. According to T. I. Gorshkova the same sediments gave an increased content of carbonates ($CaCO_3$, more than 55%). Favourable conditions for the dying off and setting down of Foraminifera are apparently being formed in the boundary layer of the sharply opposite water masses.

Summary

As a result of the works carried out by the scientific staff of the Polar Research Institute in 1954-59 a great deal of extensive and valuable data was collected but their treatment is far from being finished yet.

A new chart of the Norwegian Sea grounds for the surface layer gives a better notion of the character and distribution of the different types of deposits compared with charts published earlier. This chart is made on the basis of more detailed materials and precise bathymetric records.

The gray silt and partly silt covering the greater part of the Norwegian Sea bottom are carbonate sediments, in which carbonate of calcium is of biogenic origin. This sediment was determined by Schmelck (1882) - Biloculina clay, and by Böggild (1900, 1907) and Murray (1912) - Globigerina clay and by Holtedahl (1959) Foraminifera sediment (marl.) The later determination is more admissible because there are parallels with plankton forms of Foraminifera species of the genus of Globigerina are the most mass form in great depths bottom forms in sediments (considerably varying according to species composition). Quantity correlation between plankton and bottom species vary according to depths, temperature and presence of current.

The terrigene deposits are formed on ridges and shallows. They are characterised by a greater number of coarse material and its petrographical composition is not identical. In regions near Iceland, the Faroes and Jan Mayen the fragments of rocks of volcanic origin predominate.

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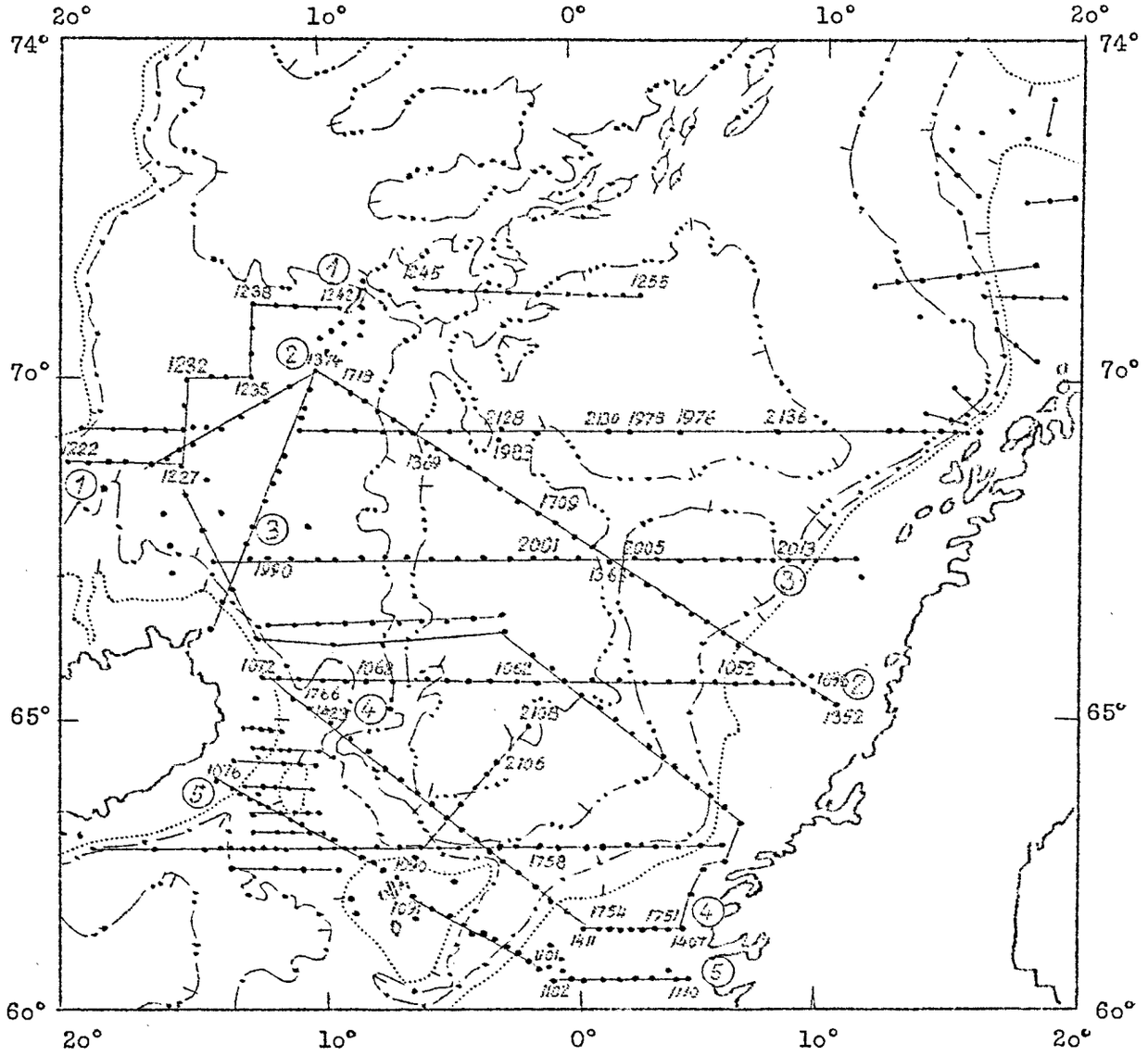
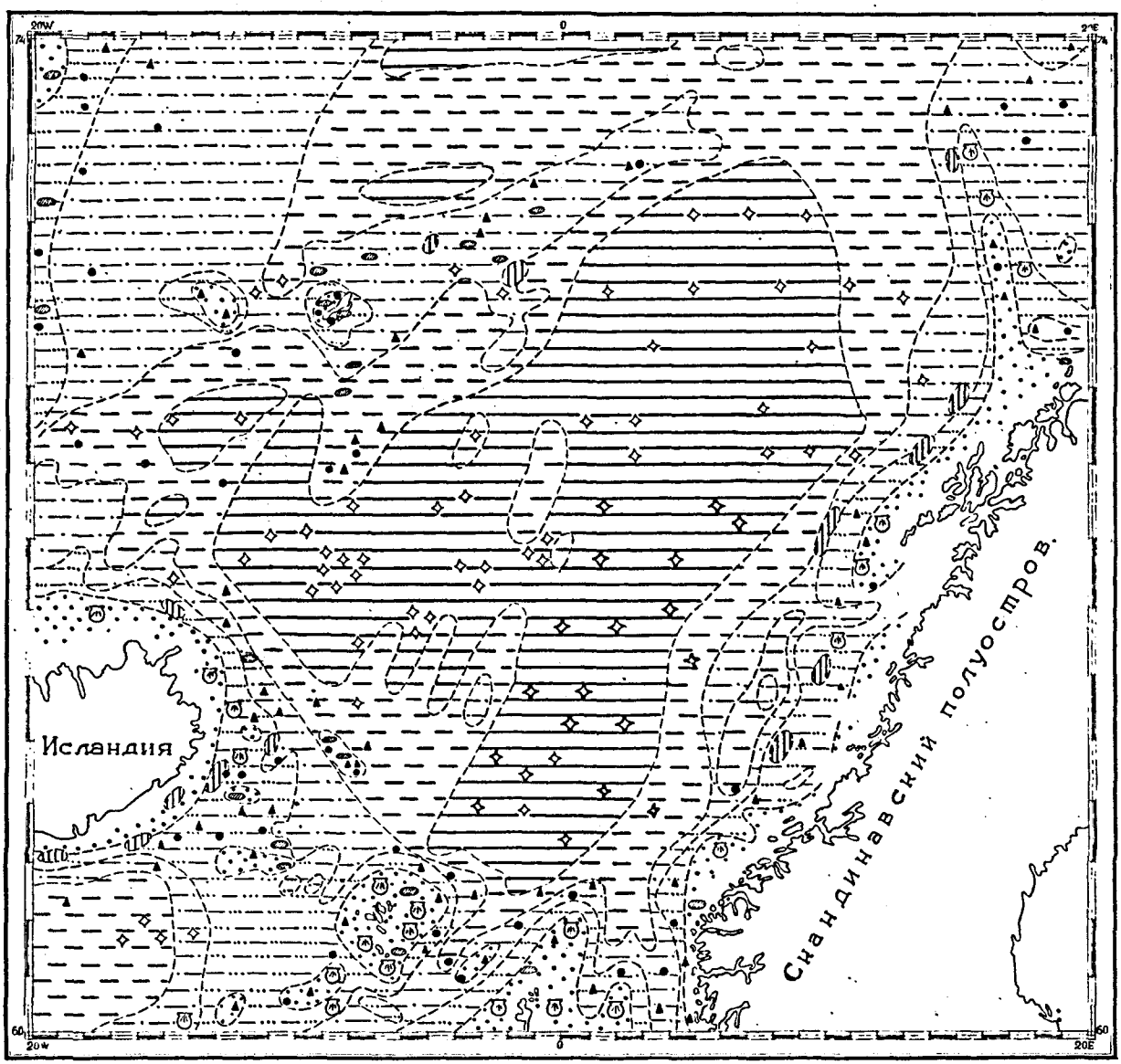


Figure 1. Survey of stations worked in the area and of depths, where samples were taken. Situation of profiles.

Figure 2. Map of surface layer of bottom deposits of the Norwegian Sea (according to content the fraction less than o.ol mm). I - clay silt; 2 - silt; 3 - sand silt; 4 - silt sand; 5 - sand; 6 - gravel; 7 - pebble and broken brick; 8 - boulders; 9 - shell; lo - Foraminifera; ll - zones of wash-off.

Figure 3. Profiles of bottom and histogram. (situation - see Figure 1).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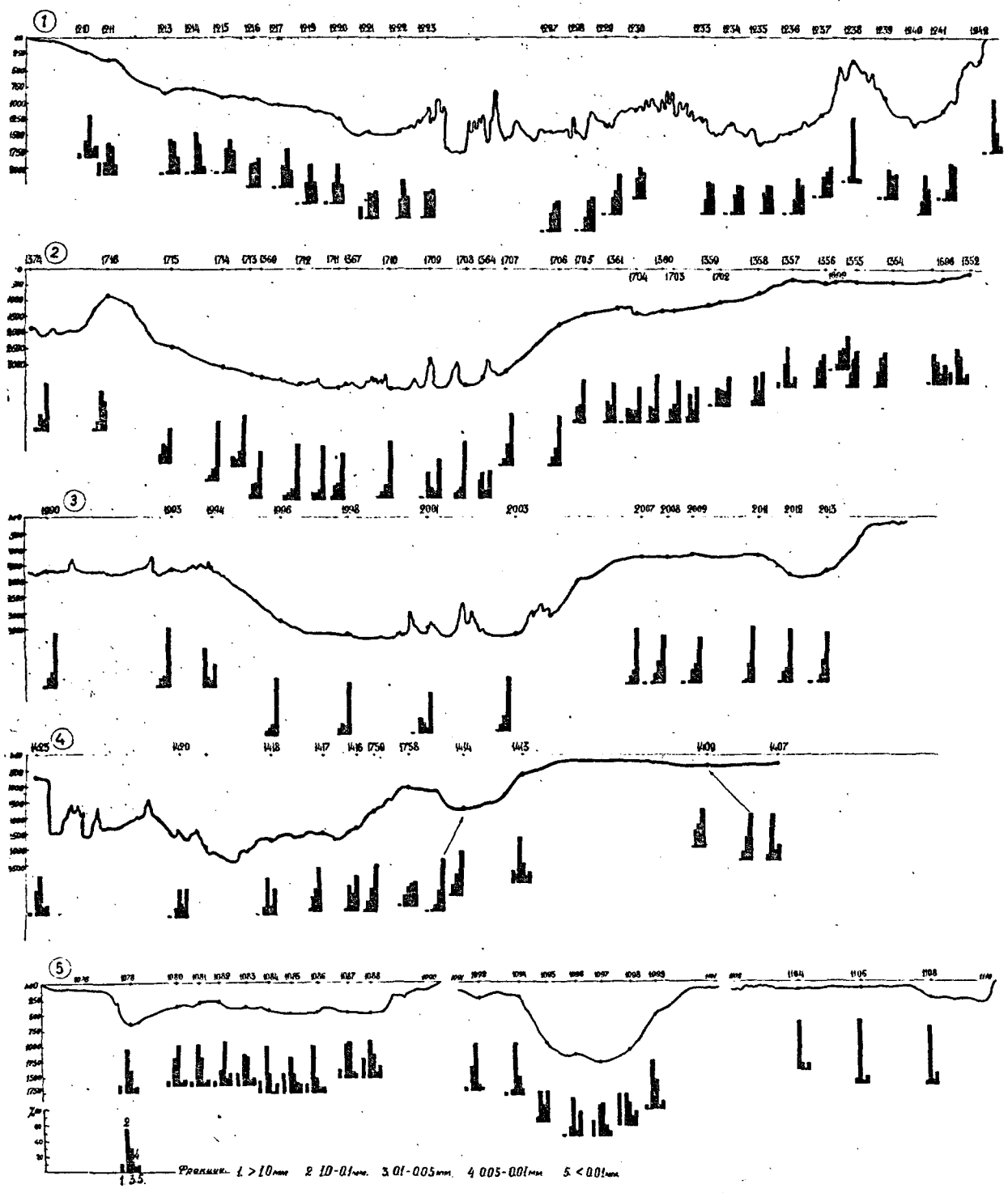
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