Annual report 1973

Translation by C. M. Robson

The Geological Survey of Denmark was established in 1888 in order to carry out the geological mapping of the country, to collect all relevant geological information concerning Denmark and the Faeroe Islands, and to process this material scientifically. The role of geology in the advancement of society has resulted in directed research also becoming a significant function, which now constitutes a large proportion of the work at the institute.

The Geological Survey of Denmark is led by a scientifically trained director, and immediately under him come the administrative, book-keeping, and similar functions. The remainder of the institute is divided up into 6 scientific departments, each under the leadership of a Chief Geologist.

Direction and administration

The director, dr. phil. Ole Berthelsen, controls all the administrative functions and supervises the scientific and practical work of the institute. He is chairman of the Danish Hydrological Decade Committee. The Danish Decade programme is part of a large international hydrological work programme, extending over a 10-year period and under the auspices of UNESCO.

At its general assembly in the autumn of 1972, UNESCO decided to follow up the Hydrological Decade programme with a long-term hydrological programme, to commence 1st Jan. 1975. The preparations for a possible Danish participation and the working out of the Danish contribution to the long-term programme have been supervised by the Decade Committee.

As a member of the Danish National Committee for Oceanology and as chairman of the Scandinavian Committee under the International Oceanographic Commission, the director has taken part in the discussions and preparatory work in connection with a planned oceanographic research programme, to extend over a period of 10 years.

The director is chairman of the Raw Materials Council set up by the Minister of Public Works, and in this capacity and as member of an interdepartmental working group set up by the Ministry of Public Works, he has taken part in the preparation of guidelines and directives regarding the administration of the Raw Materials Act. He has furthermore been

responsible for the preparation of suggestions for the mapping of the country's raw material resources, both on land and on the territorial sea-bed.

As chairman of the Scandinavian Marine Geological Commission the director has taken part in the preparations for the Commission's next meeting, to be held in Denmark in April 1974.

The director has participated as member of two committees under the Danish Federation of Engineers in the preparation of guidelines for the establishment of water supply plant and sewage disposal plant conforming to the requirements of the new Water Supplies Act and the Environmental Protection Act. He has also given a number of lectures on water planning and the utilization of raw materials, and has been consultant in connection with the regional water planning programme for the Aalborg area.

The annual meeting of the directors of the Scandinavian Geological Surveys was held in Denmark in 1973, whilst the meeting of the directors of the Geological Institutes of Western Europe was held in London.

The Geological Survey of Denmark co-operates in the running of the Carbon-14 Dating Laboratory at the National Museum, and bears half of the operational costs of the laboratory.

Department of Quaternary Geology

The principal tasks of this department are to carry out the geological mapping of the country, and to advise in national and regional planning problems, including nature conservation and pollution problems. The department is also expected to perform work of applied geological nature (partly in the form of investigations and partly on the basis of archive material), to give advice regarding raw materials, i.e. sand, gravel, clay and lignite, and to make scientific investigations in this connection.

The institute's drilling equipment and personnel belong under this department.

The following geologists are employed in the department:

Chief geologist, dr. phil. Helge Gry, dr. phil. Viggo Münther, Bent Søndergaard, Erik Heller, Arne Vagn Nielsen, Ib Marcussen, Peter Konradi, Kaj Strand Petersen, and Henner Bahnson.

The systematic geological mapping of the country has been continued in a large number of districts. Thus Arne Vagn Nielsen has been in charge of the mapping of the Sakskøbing map-sheet, Henner Bahnson of the Stavnshoved map-sheet, Gunner Larsen (Århus University) of the Randers map-sheet, Arne Vagn Nielsen of the Nibe map-sheet, Erik Heller of the Dau-

bjerg map-sheet, Viggo Münther of the Skjern map-sheet, Helge Gry (assisted by Kaj Strand Petersen) of the Løgstør map-sheet, and Helge Gry (assisted by Peter Konradi and Knud Binzer) of the Thisted map-sheet. In connection with the cartographic work the texture, structure, fossil content, etc. of the glacial deposits have been studied intensively.

On the basis of glacial-geological and morphological investigations, Ib Marcussen has constructed a map of the landscape structures in south-east Denmark. Per Baand has registered and described a great number of localities on the Daubjerg map-sheet showing periglacial phenomena. Kaj Strand Petersen has amongst other things collected molluscs in order to shed light upon the environmental conditions in the *Litorina* Sea.

Peter Konradi has investigated the foraminifera fauna from the Eem deposits at Stensig Bog. The material from the new borehole, Skærumhede No. II, has been prepared for publication; Henner Bahnson has described the lithology, Kaj Strand Petersen the macrofossils, and Karen Luise Knudsen (Århus University) and Peter Konradi the foraminiferal fauna.

The passing of the Raw Materials Act has placed new responsibilities upon the department. The work of planning and coordination in this respect has been led by Erik Heller and Arne Vagn Nielsen. The Act requires the department, among other things, to register all raw material excavation sites throughout the country, and to obtain information concerning the nature and quantities of the raw materials extracted.

The Raw Materials Act allows for control over the exploitation of raw materials, and in connection with this, Erik Heller has prepared maps showing easily accessible occurrences of raw materials in North Jutland and other areas.

The department has recorded profile diagrams and relevant geological information from a great number of sites around the country. Thus Arne Vagn Nielsen has taken profiles at major road works and excavations at e.g. Sdr. Tranders, Ålborg University, and the Rørdal cement factory (Ålborg). Mention must also be made of the investigations carried out (until his death on October 19th, 1973) by Sigurd Hansen on the marine Eem deposits in South Jutland, and on the distribution of glacial deposits in South and Mid-Jutland during the last Glacial.

Palaeobotanical Department

The department carries out research in the fields of vegetational history, biostratigraphy, palaeoecology, and palaeoclimatology, with especial reference to Quaternary and Tertiary deposits. Other areas of interest are sea level changes, forest ecology, soil evolution, pollen dispersal and pollen

morphology, and the records of air pollution in raised bogs. The department advises on dating problems and conservation cases.

The following geologists are employed in this department:

Chief geologist, dr. phil. Svend Th. Andersen, Peter Ingwersen, Harald Krog, Inger Brandt, Jóhs. Jóhansen (stationed on the Faeroe Islands), Jens Stockmarr, and Bent Aaby.

The pollen analytical investigations of samples from the Upper Permian salt clay from DAPCO's oil test well Tønder By I have been continued. The photographic work has been completed, and descriptions of the fossil pollen types are in preparation (Peter Ingwersen).

The submarine bog from the Eem Interglacial outside Egernsund has now been fully investigated (Svend Th. Andersen). Work on the Late Glacial profile from Nørre Lyngby has also been completed (Harald Krog).

Pollen analytical examination of Late Glacial and Postglacial sediments from Elsborg Bog, Djursland, has been completed (Svend Th. Andersen and C. Vang Nielsen). Work has been started on the 43 m deep annually stratified, Late Glacial and Postglacial sediment series from the Gravlev valley in North Jutland; X-ray photographs have been made of the entire core, in co-operation with the Institute for Technical Geology, The Technical University of Denmark (Jens Stockmarr). The glacial sediments and mor layers in the research area in Eldrup Forest, Djursland, have been mapped (Svend Th. Andersen in co-operation with Henner Bahnson) and the pollen analytical examination of the mor layers has been commenced (Svend Th. Andersen). Pollen analytical investigations have been carried out in the raised bog Draved Kongsmose to shed light on the developmental history of the bog and on the Postglacial climatic changes – the latter in co-operation with the Carbon–14 Dating Laboratory. Peat layers under the shifting sand cover on Læsø have been investigated (Jens Stockmarr).

Continuous determinations are being made of the pollen sedimentation in Draved Forest to examine the changes in annual pollen production connected with climatic variations (Svend Th. Andersen), and the investigations of forest dynamics have been continued. The first 20-year observation period has now been completed and the material has been processed in part (Inger Brandt with the assistance of K. Havemann). Determinations are being made in the raised bog Draved Kongsmose of heavy metal fallout resulting from air pollution, and investigations of natural heavy metal fallout in pre-industrial times are in progress (Bent Aaby in co-operation with Arne Villumsen and the Isotope Centre).

Pollen morphological investigations have been carried out using the scanning electron microscope (Jens Stockmarr).

A natural stand of the elm species *Ulmus lævis* has been found on the Krenkerup Estate on Lolland; this species was not previously thought to grow wild in Denmark. It may possibly be a relic from the warm Postglacial period. The history of the stand is being investigated pollen analytically (Svend Th. Andersen).

Investigations have been made of bogs in South Jutland in connection with preservation cases (Bent Aaby). The department has also dated samples both for other departments of the institute, and as commissioned investigations.

The Carbon–14 Dating Laboratory has dated 54 samples for the Geological Survey of Denmark, and 14 samples for the Geological Survey of Greenland.

Department of Subsurface Geology

The chief tasks of this department are as follows:

1) Geological supervision and contact with the prospecting activities of the concessionaire (Dansk Undergrunds Consortium) for oil and natural gas in Denmark and on the Danish part of the continental shelf.
2) Scientific analysis of the biostratigraphical conditions in the Prequaternary in Denmark.
3) Systematic mapping of the Danish Prequaternary – both the individual formations and the present-day Prequaternary surface relief.
4) Advisory and research work in connection with major construction works affecting Prequaternary strata, such as activities in salt domes, preliminary studies for major bridge and tunnel construction, etc.
5) Archiving and ordering of sample material, etc., arising from the activities of the Dansk Undergrunds Consortium and from important boreholes penetrating the Prequaternary, made in connection with geotechnical pilot studies.

The following geologists are employed in this department:

Chief geologist, dr. phil. Leif Banke Rasmussen, Arne Buch, Arne Dinesen, Inger Bang, Erik Stenestad, Fritz Lyngsie Jacobsen, Ole Bruun Christensen, Finn Nyhuus Kristoffersen, Olaf Michelsen, Finn Bertelsen, Johannes Carl Baartman, Svend Erik Henriksen, and Lars Madsen.

The lithological and technical description of the Dansk Nordsø P–1 borehole has been made by Finn Bertelsen. Preliminary biostratigraphical in-

vestigations of the oil test wells drilled by the Dansk Undergrunds Consortium are being carried out by the eight micropalaeontologists in the department (A. Buch, A. Dinesen, I. Bang, E. Stenestad, O. Bruun Christensen, F. Nyhuus Kristoffersen, O. Michelsen, and F. Bertelsen). The results of these investigations are confidential at present, since in accordance with the agreement between the concessionaire and the State, the material received from the concessionaire must not be made public until 5 years after the date of receipt.

17 reports have been published in 1973 containing the research results from one of the deep boreholes made by the Consortium (Nøvling No. 1). Leif Banke Rasmussen has prepared a description of five North Sea boreholes for publication in 1974.

Work has been carried out on Lower Carboniferous microfloras (Finn Bertelsen), and Lower Carboniferous and Permian ostracods (Ole Bruun Christensen).

Work on the ostracod faunas from Triassic, Upper Jurassic, and Lower Cretaceous has been continued (Ole Bruun Christensen). The description of the Lower Jurassic ostracoda has been completed, providing a foundation for a biostratigraphical subdivision of the series (Olaf Michelsen). The microflora from the Haldager Formation (Middle Jurassic) has been studied in material from the older deep boreholes, and in foreign type collections (Finn Bertelsen). The foraminifera faunas from the Upper Cretaceous in the deep boreholes are still under investigation, and work on the samples from Arnager and from Hvidskud on Møn has been continued (Erik Stenestad).

Analyses of the foraminifera from the Danian-Selandian have been continued, and include extensive electron microscopy work and phylogenetic-taxonomic studies (Inger Bang). Description of the Eocene foraminifera has been continued with the diagnosis of the individual species, biometrical analyses, and photography, assisted by the scanning electron microscope (Arne Dinesen). Ostracods from the Upper Eocene and Oligocene have been investigated with a view to a stratigraphic subdivision (Kirsten Lieberkind). Work on the Miocene foraminifera from the North Sea boreholes continues, whilst treatment of the less deep boreholes near Gram has been completed (Finn Nyhuus Kristoffersen). Work on the Miocene mollusc faunas from the Lille Tønde and other borings continues (Leif Banke Rasmussen). Electron microscopic studies have been made of Younger Tertiary *Azolla* species (Finn Bertelsen).

Studies on the Quaternary foraminifera have been continued, using material both from deep boreholes and from surface localities; work on the material from Holmstrup is in print (Arne Buch).

Microscopy of the evaporites has been continued, and a few eruptives have been examined (Fritz Lyngsie Jacobsen).

Extensive studies of the Fennoscandian Border Zone have been commenced, starting with comparisons of the published geological data (Ole Bruun Christensen) and analyses of seismic profiles combined with mapping of selected seismic horizons (Johannes Carl Baartman and Lars Madsen).

Mapping of the Prequaternary surface relief and of the individual formations has been carried out on East Fyn (Inger Bang), in the Ålborg area and in Copenhagen (Erik Stenestad). Development of computing techniques and theoretical studies relating to cartographic work has been continued (Ole Bruun Christensen).

The institute's photographic laboratory and scanning electron microscope both belong under this department.

Hydrogeological Department

This department has the following areas of work:

1) Storage and retrieval of well records in accordance with the Water Supplies Act (Well Record Archive).
2) Archive of the permissions for extraction of ground water (LVK Archives).
3) Replies to enquiries and other consultative work.
4) Commissioned investigations, including, for example, hydrogeological mapping, test pumping investigations, and geoelectrical surveys.
5) The carrying out of ground water survey activities under the International Hydrological Decade programme.
6) Research and teaching on hydrogeological subjects.

The following geologists and civil engineers are employed in this department:

Chief geologist Lars Jørgen Andersen, Niels Viggo Jessen, Bent Bagge, Niels Kelstrup, Zvonimir Haman, Kurt Ambo Nielsen, Knud Højgaard, and Villy Krogh.

The drilling archives, which are attached to the department, contain information from a total of ca. 125,000 boreholes. Borehole profiles record information on borehole depth, strata penetrated, ground water level, technical details, etc., together with descriptions of the samples taken. The position of the boreholes is recorded on maps of scale 1:20,000 or 1:25,000.

The systematic measuring of the ground water level has been continued by the DGU's network of measuring stations. At present 78 stations are in operation, covering a total of 90 observation points. 21 measuring stations covering 27 observation points are included in the observation network of the International Hydrological Decade. Measurements of the level of the ground water are also carried out in connection with borehole localisation work.

The information in the department's archives is used to a great extent in the advisory work of the department, which deals with problems of water supplies, disposal of sewage wastes, pollution problems, etc.

The work of the department in connection with commissioned investigations can be summed up as follows:

Mapping of basic hydrogeological data has been carried out in numerous areas. The "Søhund" report (covering the area around lake Arresø and Hundested) was produced early in the year, and mapping of basic data in the Viborg Amt area was initiated in connection with a water planning programme there. Basic data maps have been produced in connection with other commissioned investigations, to serve as a foundation for the evaluation of the geological and hydrogeological conditions in the areas in question (the Tolne area, the Lake Esrum area, the Langeskov area, and the Ringsted-Haslev area).

Test pumping investigations have been made in connection with a number of water supply projects, in order to determine the water extraction possibilities and the effects resulting from pumping. Corresponding investigations have been carried out in connection with plans to excavate chalk to great depths at two sites in the Aalborg-Nørresundby area. Investigations have also been made to evaluate the danger of seepage of polluted ground water from an upper to a lower ground water reservoir (Rørvig), to establish safety precautions for above-ground oil storage tanks (Hedehusene), and to evaluate the pollution hazards associated with septic tank systems.

17 geoelectric surveys have been made in the course of the year – 16 in water supply investigations and 1 with the object of localising occurrences of gravel.

In addition to work with the archives, which forms more than a third of the work of the department, a considerable proportion of the staff has been engaged on work associated with municipal and country water planning. According to the new Water Supplies Act, the overall planning for water supplies becomes the responsibility of the county councils, and as a result there have been requests from numerous county councils for assistance with this planning in one form or another. Since a clear picture is needed of

the extent to which DGU's assistance will be required in the planning problems for which the Environmental Directorate is the controlling body, a working group was set up in 1973 to evaluate the Environmental Directorate's need for the assistance of the institute. The working group, composed of representatives from the Ministry of the Environment, the Environmental Directorate and the Geological Survey of Denmark, produced a report at the end of the year, which called for a considerable expansion of the department in order to deal with the following tasks:

1) Data-processing of the material in the Drilling Archives.
2) Basic data mapping of the entire country.
3) Establishment of the ability to take part in concrete projects aiming at development of methods and establishment of guidelines for the carrying out of hydrogeological projects.
4) Establishment of an environment section having hydrological expertise in the problems of water supplies, waste water and sewage disposal, disposal of solid wastes, placing of oil storage centres, etc.

Research and methodological activities have gone on primarily in connection with the test pumping investigations, and as part of the Danish decade programme within the International Hydrological Decade. Considerable work has also been done on the rationalisation of data-processing, by utilizing computing techniques in the production of the hydrogeological basic data maps (cyclogram maps).

Finally, programmes have been produced for the processing of water-level observations, soil humidity measurements and geoelectrical measurements.

The hydrogeological department has prepared the Danish section of map-sheet C 4, Hydrogeological Map of Europe, 1:1,5 mill., covering the southern part of Denmark.

The department houses the secretariate of the Danish Committee for the International Hydrological Decade. This has co-operated in joint Scandinavian publications of hydrological basic data, descriptions of the representative areas, and of Scandinavian Hydrological Terminology.

Geochemical Department

The task of the geochemical department is to carry out geochemical investigations and the necessary analyses, including chemical analyses for other departments, and, to a certain extent, to carry out geochemical investigations and analyses commissioned from elsewhere.

The following geologists are employed in the department:

Chief geologist Werner Christensen, Henning Kristiansen, and Arne Villumsen.

The great majority of investigations are related to practical problems, first and foremost concerning the exploitation of raw materials, environmental investigations, etc.

The chief task of the department continues to be the investigation of both surface and ground water.

Chemical analyses of a number of concretions and a considerable number of determinations of calcium carbonate have been made under the leadership of Henning Kristiansen for the Department of Quaternary Geology. In co-operation with the Palaeobotanical Department, analyses have been made of lake sediments (core series) from Gravlev and the Faeroes, and determinations have been made of heavy metals in sphagnum, etc. A number of analyses have been carried out in connection with Arne Villumsen's investigations of Randers Fjord, which now have been completed.

Preparations for the printing of the I.H.D. water analyses for 1967–72 are largely complete and ready for data-processing.

The department has continued its investigations of postglacial sediments and their geochemical development. (Arne Villumsen has in this connection completed the mapping of the extensive postglacial occurrences of chalk and iron sediments etc. on the Aastrup estate near Tølløse, and has taken a series of samples there). Investigations and samplings have been made to study the geochemical developments around the lignite deposits at Nørrekær (near Ikast), where the Dutch geology student, Dieke Postma, is making investigations of iron and manganese sediments under the supervision of the department.

A number of supplementary investigations have been made of the fluorine content of the ground water in relation to the geological deposits.

Faeroe Department

The following geologists are employed in the department:

Chief geologist Jóannes Rasmussen and Jóhannes Jóhansen (see Palaeobotanical Department).

The sea-bed investigations have been continued, and the Lagting's research and auxiliary ship "J. C. Svabo" was again used. The work in 1973 has consisted exclusively of collecting loose boulders from the sea-bed. On the 17th and 18th of April 266 boulders were taken from the north and south

sides of the Shetland Channel, whilst 225 boulders were collected from the area between Sandoy and the Faeroe Bank in the period May 28th–31st.

Treatment of the material from the sea-bed investigations has been commenced under Jóannes Rasmussen's leadership. Echo sounder records and position lists have been processed and then handed over to the Sea Chart Archives in Copenhagen. The collected boulders are being investigated by R. Waagstein. Macroscopic descriptions have been completed, and microscopic analysis has been commenced.

The Quaternary geological investigations have been continued with the measurement of profiles through moraine deposits, registration of striations, and determinations of ice-sheds.

Jóhannes Jóhansen has continued the pollen analytical investigations. Samples have been taken from the Saksun material for pollen analysis, diatom analysis, chemical analysis, and for C–14 determination.

Advisory work for public institutions, private firms, and others has been continued in the same extent as in previous years. Additional work has included participation in planning work in connection with the granting of permission to make preliminary surveys, etc., for possible occurrences of oil or natural gas.

Publications issued 1972–1973

II. Række – II. Series

85. *Viggo Münther:* Dominerende forkastningszoner på Bornholm baseret på anomalierne af den vertikale magnetiske intensitet. English summary: The main fault zones of Bornholm based upon anomalies of the vertical magnetic intensity. 1973. 161 s. 25 tvl.
99. *Finn Bertelsen:* A Lower Carboniferous microflora from the Ørslev No. 1 borehole, island of Falster, Denmark. Dansk sammendrag: En nedre karbon mikroflora fra boringen Ørslev nr. 1, Falster, Danmark. 1972. 78 s. 24 tvl.
100. *Arne Villumsen:* Geochemical and sedimentological investigations of the Rosenholm depression. Dansk sammendrag: Geokemisk-sedimentologisk undersøgelse af Rosenholm lavningen. 1973. 66 s. 2 tvl.

III. Række – III. Series

40. *Leif Banke Rasmussen, J. C. Baartman, Svend E. Henriksen, Finn Nyhuus Kristoffersen, Arne Dinesen, Inger Bang, Erik Stenestad, Arne Buch, Ole Bruun Christensen, Olaf Michelsen, Torben Juul Hansen* og *Fritz Lyngsie Jacobsen:* Dybdeboringen Nøvling nr. 1 i Midtjylland. Resultaterne af de geologiske undersøgelser. Red. af *Leif Banke Rasmussen.* English summaries: The deep test well Nøvling No. 1 in Central Jutland, Denmark. The results of the geological investigations. 1973. 164 s. 8 tvl., 1 bilag.
41. *Lars Jørgen Andersen:* Cyclogram technique for geological mapping of borehole data. Cirkeldiagram-teknik for geologisk kortlægning af boredata. 1973. 25 s. 1 kort.

V. Række – V. Series

7–A. Geology of Denmark I. (In preparation).
7–B. Geology of Denmark II. (In preparation).
7–C. Geology of Denmark III. *Johs. Iversen:* The development of Denmark's nature since the Last Glacial. Translation from Danmarks Natur, vol. 1, pp. 345–445, 1967, by *Michael Robson.* Editor: *Svend Th. Andersen.* 1973. 126 s.

Årbog – Yearbook

1972. Redaktion: *Leif Banke Rasmussen* og *Olaf Michelsen.* 1973. 89 s. 10 tvl.
Contents: *Andersen, Svend Th.*: On the occurrence of pollen similar to Bruckenthalia spiculifolia (Salisb.) Reichenb. in Danish Quaternary deposits, pp. 5–6. – *Bahnson, Henner:* Spor af muldflugt i keltisk jernalder påvist i højmoseprofiler, pp. 7–12. – *Christensen, Ole Bruun:* Aktuelle geologiske dokumentationsproble-

mer, pp. 13–18. – *Haman, Zvonimir:* Plot of s versus t/r^2 on semilogarithmic paper by using a simple stencil, pp. 19–24. – *Kristoffersen, Finn Nyhuus:* Studies on some Elphidiidae (foraminifera) from the Miocene of Denmark, pp. 25–36. – *Krog, Harald:* The early Post-glacial development of the Store Belt as reflected in a former fresh water basin, pp. 37–47. – *Michelsen, Olaf:* On Liassic holothurian and ostracod assemblages from the Danish Embayment, pp. 49–68. – *Petersen, Kaj Strand:* Some features in Clay with Tuff beds from Lower Eocene on Røsnæs, Danmark, pp. 69–78. – *Petersen, Kaj Strand, Ella Hoch* and *Niels Bonde:* A new species of mytilid bivalve, and vertebrate remains from Lower Eocene marine deposits on Røsnæs, Danmark, pp. 79–86. – *Stockmarr, Jens:* Determination of spore concentration with an electronic particle counter, pp. 87–89.

Rapporter – Reports

8. *Ellen Louise Mertz:* Kalundborg og omegns jordbundsforhold. En ingeniør-geologisk beskrivelse. (By-geologi nr. 5). 1972. 41 s. 2 tvl.