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FIRST GEOLOGICAL CONFERENCE OF THE BALTIC SEA STATES

ABSTRACTS

APRIL 15 – 21, 1991

TALLINN – LOHUSALU, ESTONIA

1991 1/1

C O N T E N T S

GEOLOGY AND GEOCHEMISTRY OF THE CRYSTALLINE BASEMENT

QUATERNARY GEOLOGY

GEOLOGY OF DEPOSITS OF MINERAL RAW MATERIALS

ENGINEERING GEOLOGY

HYDROGEOLOGY

P R E F A C E

A man needs the knowledge and skill to master the situation, i.e. to analyse if and in a goal oriented manner. Scientific gatherings and workshops give a scientist an opportunity to share and exchange opinion and information on matters of common interest, to advocate their views. No less important to solve, his problems are informal contacts where a scientist can unhurriedly discuss and find ways to express himself. In order to cope with geological information as well as meet new challenges facing geology in the Nordic area a joint geological conference of scientific explorations and practical research of the recent part was proposed as an information transfer for geological services of the Nordic and Baltic countries.

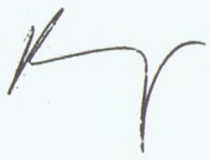
More than 30 papers on a variety of topics involving geological research were presented and discussed at the three-day conference attended by over 60 delegates from Finland, Latvia, Lithuania and Estonia. Unfortunately time was too short for some delegations to attend. Geologists of Sweden, Norway, Denmark, Iceland and Greenland were very much interested in such a meeting, however they could not attend because of previous engagements.

I am confident that use be made of this new geological information for the good of the Nordic and Baltic countries and the prosperity of their inhabitants.

Director General Endel Kasemets

FROM THE EDITOR

There is an urgent need for general purpose geological magazine. It is my experience that hydrogeologists, geophysicists and geochemists find it difficult to publish the results of their research work in the desirable scope and a considerable amount of research has remained a part of a work file as in the form of a manuscript. We make sure that the authors contributing for the new geological magazine will enjoy unreserved support. It will be issued at intervals, such as semiannually and annually focusing on the up-to-date information of the printed matter. Except for the volunteer editor the editorial staff is still incomplete. We hope the whole staff to be completed in the nearest future. The first edition of the new publication will contain the material of the geological conference 'LOHUSALU 1991'. It is necessary to note that papers of the new edition, being as a rule, surveys or abstracts written by specialists were included directly - they did not undergo the reviewing procedure nor could the English be checked completely. Therefore the readers are asked to excuse any deficiencies of this edition which may be due to the above-mentioned reasons.

Research Director  R. Raudsep

MAIN PROBLEMS OF THE BALTIC'S STRATIGRAPHY

A. Grigelis

In the Baltic States stratigraphical investigations are provided by geological institutes (Estonia, Latvia and Lithuania) and universities (Riga, Tartu, Vilnius). These studies are based on the material of field outcrops and deep borings (geological surveys). Their main purpose is stratigraphical substatiation of geological mapping, structure of entrails of earth and geological maps (scale 1:500 000, 1:200 000, 1:50 000) as well. Investigations have been made on the mainland and in the Baltic Sea. They are codified by Stratigraphical Codex of the USSR. The stratigraphers are joined in the Baltic Stratigraphical Assotiation (BSA).

Deep analysis, subdivision of sections and wide regional correlation are typical to stratigraphy of the Baltic Region since long ago. Biostratigraphical, lithostratigraphical, ecostratigraphical (Basin analysis) and climatostratigraphical methods of investigations are methodologically most important. The division of sedimentary series (pre-Quaternary and Quaternary) is based on paleontological, palinological and lithological studies; rocks of crystalline basement are divided with the help of petrographical and geochronometrical methods.

Stratigraphical studies and their methods develop and make progress. International and interregional integration of investigations intensifies. The International Commission of Stratigraphy (ICS), its Subcommissions and Working Groups work actively. Notable is substantiation of Ecostratigraphy, Event-stratigraphy, Sequence-stratigraphy and theory of Quantitative Stratigraphical Correlation. International working groups study geological boundaries of various ranks - from systems to series and zones. It is a work of global significance.

Baltic's stratigraphy has its achievements. Most important of them is the compilation of unified correlated stratigraphical charts of paleobasins based on data of monographical paleontological studies. Now there is a plan to improve them, to supplement them with new data. A seismostratigraphical frame-work of the Baltic Sea and stratigraphical subdivision based on geological facts (boring, draging) has been worked out.

The main stratigraphical problems of the Baltic could be formulated as follows:

- supporting stratigraphical boundaries of geological strata, their isochronallity and diachronallity;
- local and regional markers in lithostratigraphy;
- geological, lithological and biological events and stratal correlation;
- rate of deposition, cycles of accumulation of sediments;
- rate of evolution and development of ecosystems;
- biochronological analysis of breaks in sedimentation;
- evidence of sequence of biostratigraphical zones (biozones) and Sequence-stratigraphy;
- time analysis in regional stratigraphy and chronostratigraphical substantiation of regional standard scale.

And quite a new problem - creation of the Baltic Regional Stratigraphical Standard.

Complex of geological investigations, where stratigraphy is the main method, enables us to compile geological maps on the scale of 1:200 000; synthetic maps of Land, and finally also - maps of the Baltic Sea on the scale of 1:500 000. About 20-25 percent of the territory is covered by mapping on the scale of 1:50 000. It has contributed to the evaluation of the basis of mineral resources. Ecogeological mapping of superficial beds is being carried out in connection with preservation of the environment.

FOSSIL FISHES AND THE CORRELATION OF THE LOWER/MIDDLE DEVONIAN BOUNDARY BEDS

E. Mark-Kurik

The value of fossil fishes for interregional correlation of the Devonian strata has increased significantly with the application of the assemblages of acanthodians, particularly by J.Valiukevičius (1988 etc.). The minute scales of these fishes can be met in the samples of carbonate and terrigenous rocks from many regions, including such vertebrate-dominated sections as East Baltic, Spitsbergen, Severnaya Zemlya and others. Occurring in a number of sequences together with conodonts, the acanthodians have successfully been used for age dating.

There are, however, some intervals, eg, the Emsian/Eifelian (Lower/Middle Devonian) boundary beds, which do not contain characteristic acanthodians, differing below and above the boundary. In such a case the other fossil fishes, represented by macroremains, particularly the placoderms are to be used for interregional correlation. An assemblage, including the petalichthyid Wijdeaspis, phlyctaeniids, buchanosteids, early homostiids and heterostiids and some other fishes appear to characterize the Emsian strata over a very large area. It includes Arctic regions of the USSR,Kazakhstan, Central Asia, New South Wales of Australia and probably also New Zealand, South China, Saoudi Arabia and Nevada.

The occurrence of the above assemblage in the Eifelian Grey Hoek Formation of Spitsbergen has stimulated the revision of the age of this unit. The Grey Hoek fish fauna is quite similar to that of the Albanov Formation of Severnaya Zemlya, dated by conodonts as the Emsian. The acanthodian assemblage VIII (by Valiukevičius) discovered in the Grey Hoek Formation of Spitsbergen occurs in the Rēzekne Regional Stage (further R.S.) of the East Baltic. There are also phlyctaeniids and the thelodont Skamolepis, showing the Emsian age of this stage. Thus, above units of both regions, previously considered as the Eifelian ones, should be included into the Lower Devonian, Emsian. It seems that the Middle Devonian, Eifelian age of the Rēzekne R.S. is sometimes preferred because there occurs a considerable break between this and the underlying Kemeri R.S. In the Eifelian strata the fish assemblages differ markedly. They contain large forms of homostiids and heterostiids, coccosteids and numerous psammosteid heterostracans, some of them huge.Psammosteids are especially characteristic of the Middle Devonian of the East Baltic, Spitsbergen and Severnaya Zemlya.

A correlation chart of the Emsian in selected areas (Mark-Kurik, in press) is presented. Fossils include buchanosteids (B), euleptaspids (E), homostiids (Hm), heterostiids (Ht), phlyctaeniids (P), pteraspids (R), Skamolepis (S) and Wijdeaspis (W).

	SEVERNAYA ZEMLYA	TAIMYR	NW SIBERIAN PLATFORM	SPITSBERGEN	BALTIC	EIFEL HILLS	Conodont zones
EIFELIAN	Vstrechnaya Fm.	Megastrophia uralensis Beds	Manturovskaya Fm. upper mbr.	Wijde Bay Fm.	Pärnu R.S.	Lauch Fm.	partitus
EMSIAN UPPER	Albanov Fm. upper mbr. W B? Ht P	Wijdeaspis arctica W B Beds	lower mbr. W B Ht	Grey Hoek Fm. W B? Hm P	Rēzekne R.S. P S	Heisdorf Fm. E P Wettel-dorf Fm. W?	patulus
						Wiltz Fm. P	serotinus
		Favosites regularissimus Beds W B	Razvedochninskaya Fm. (upper part) W B Ht?	Wood Bay Fm. — Verdalen Mbr. + Stjørdalen f.d. Ht Hm S Hm P E R	Ķemeri R.S. (upper part) P R	Berle Fm.	inversus-laticostatus
EMSIAN LOWER	lower mbr. W B Ht Hm P					Klerf Fm. P R Stadtfeld Fm. R	gronbergi dehiscens

THE UPPER CAMBRIAN OF ESTONIA

K. Mens, V. Viira, I. Paalits, I. Puura

The Upper Cambrian on the East European Platform ranging form the base of the Agnostus pisiformis Zone to the top of the Acerocare Zone, is represented in Estonia by a sequence of terrigenous rocks, mainly quartzose sand- and siltstones of variable grain size. The argillaceous rocks represented by greenish-gray clays in the lower and dark kerogenous argillites ("Dictyonema shales") in the upper part of the section have restricted distribution. "Obolus conglomerate", a coquina of phosphatic inarticulate brachiopods (lingulates) and their fragments occur in the upper part of the sequence. These beds of shelly phosphorites are still commercially mined in Maardu, but the mines will be closed within the next few years for environmental reasons.

Estonian Upper Cambrian has been subdivided into three formations: Petseri, Ülgase, Tsitre. According to the recent biostratigraphical correlations, also the lowermost part of the Kallavere Formation is included to the Cambrian (Table).

Because of the lack of the trilobites, a key group for zonation, the Upper Cambrian biostratigraphy of Estonia is based on acritarchs (studied by I. Paalits), conodonts (V. Viira) and lingulates (I. Puura). In the lower part of the section, acritarch zonation gives the best result. In the upper part, conodont zonation is more reliable. Lingulates occurring in abundance in some parts of the sequence are useful for tracing certain levels. Using the successions of acritarchs and conodonts, the stratigraphic units of the Estonian upper Cambrian have been tentatively correlated with the Scandinavian trilobite zones (Table).

UPPER CAMBRIAN STRATIGRAPHY OF ESTONIA
AND CORRELATION OF LOCAL UNITS WITH TRILOBITE ZONES

Trilobite zones	Selected zonal species: Conodonts	Brachiopods	Acritarchs	Parts of Estonia: NW	North	SE
Acerocare	Cordylodus proavus / Cordylodus andresi	O. apollinis	Acanthodiacr. angustum		Kallavere Fm.	
Peltura scarabeoides	Proconodontus	Ungula ingrica	Elenia armillata, Vogtlandia notabilis		Tsitre Fm.	
Peltura minor	Westergaardodina moessebergensis	Ungula convexa	?			
Protopeltura praecursor	?	?	Lusetia dendroidea			
Leptoplastus			Trunculumarinum revinum			
Parabolina spinulosa			Impluviculus multiangularis		Ülgase Fm.	
Olenus & Agnostus	W.bicuspidata	Ungula-inornata & Angulotreta postapicalis	Veryhachium setuensis sp.n.			
Agnostus pisiformis			-			Petseri Fm.
Underlying units				ϵ_1 Irben Fm.	ϵ_1 Tiskre Fm.	ϵ_2 Pada beds

Westergaardodina

Legend:
- sandstone
- siltstone
- argillaceous rocks
- kerogen-bearing argillites
- "Obolus conglomerate"
- brachiopod valves

TYPES OF FOSSIL FISH TAPHOCENOSES OF THE LODE FORMATION IN LATVIA

I. Upeniece

In Latvia the rocks of the Gauja Stage represent the earliest Frasnian terrigenous sedimentation. Lode Formation, which is consisting of finely dispersed clays, sandstones and siltstones occurs in the Northern part of the distribution area of Gauja stage. The formation became widely known owing to the unique preservation of the fossil fishes discovered in clays. Clayey mud has accumulated in the slump depressions on the submarine delta slope. The meridionally arranged depressions are from several tens up to 200-300 meters long. The preservation state of the organic matter depends mainly on the hydrodynamic conditions. Particularly favourable were stagnant water and finely dispersed deposits but also the reducing condition of bottom water and rapid sedimentation.

In the Lode quarry four taphocenosis types can be distinguished:

1st type occurs in lenses of sandstones of variable grain size. Sand was transported by strong underwater currents and, consequently, the situation was not favourable for preservation of organic remains: only isolated fish bones and fragments have been recorded.

2nd type is distinguished in cross-bedded and ripple-drift cross-bedded sandstone layers in red siltstones. Fish remains are abundant. Well-preserved plates of the placoderm Asterolepis ornata and bones, teeth and scales of the crossopterygian Laccognathus panderi concentrate on the bedding planes. Sometimes articulated skeletal parts occur.

3rd type is established in claysand silty clays. The corresponding deposits have accumulated under the influence of weak bottom currents. The taphocenosis contains numerous articulated skeletons of the placoderm Asterolepis ornata and the crossopterygians Laccognathus panderi and Panderichthys rhombolepis. Before the excavations carried out by L. Lyarskaya in the 70s the above forms were known only by isolated skeletal elements. The preservation of the skeletons of A. ornata varies in this taphocenosis according to the different decomposition degree of fish cadavers. First of all the orbital and nasal plates and jaw elements were separated, then the skullroof and tail portion of the bodies, finally only isolated skeletal parts or plates remained of the trunk-shield.

4th type was recently discovered in the central part of the depressions in the finest dispersed clayey muds. The taphocenosis includes juveniles of Asterolepis with variable length of the armour (1-4 cm) as well as juvenile and adult specimen of the acanthodian Mesacanthuts sp., crossopterygians, fossil plants (Archaeopteris fissilis, Svalbardia polymorpha), crustaceans (Conchostraca, Ostracoda and, particularly, Mysidae) and coprolites containing Mysidae remains.

COMPARISON OF CAMBRIAN AND VENDIAN SECTIONS OF THE EASTERN BALTIC

A. Zabelo, A. Fridrichsone

In the eighties during the exploration of the eastern part of the Baltic Sea 12 wells were drilled by CO PETROBALTIC. The stratigraphic subdivision of Vendian and Cambrian sections is based upon well logging and, first of all, on gamma-ray logging. The composition of fragmentary cores and cuttings were used and acritarchs analyses were carried out. As a whole, the sections of Vendian-Cambrian deposits of the eastern Baltic are well comparable with the sections of Cambrian ones from the western part, in particular with the well H-54-Ventspils section.

The depth of the top of the described terrigenous rock mass increases from 875 m (well E6) in the north-east to 2720 m (well C8) in the southern part of the studied region. Distribution of Vendian deposits is limited and their thickness does not exceed 15 m. The thickness of Cambrian deposits fluctuates from 170 m (well E6) to 307 m (well C8) increasing in south-west direction.

Vendian deposits have been covered by 2 wells only (E6 and P6) in the northern part of the area represented by alternating, poor sorted, red and variegated sandstones, siltstones and clays. They can be compared with the Zurass unit of the north-western Latvia.

Dominopol, Vergale and Rausve horizons are singled out in the Lower Cambrian composition. There are three parts of the Dominopol horizon in most complete sections. The lower part is represented by alternation of greyish and greyish-brown different size sandstones with greenish-grey clays and siltstones. The glauconite presence is very typical for this member. White fine grained sandstones are in the very top of the section. The horizon section completeness rises in the north-western direction and thickness increases from 12 m (well D6) to 112 m (well P6), respectively. The deposits of Vergale and Rausve horizons are distributed everywhere and represented by the most monotonous and clayey part of the section. The thickness of Vergale fluctuates from 30 m (wells D6, D5, E6, E7) to 50 m (well C8), the Rausve one - from 22 m (wells E6, P6) in the north to 52 m (well C8) and 54 m (well D1) in the south-west.

The Middle Cambrian part of the section begins from the heterogeneous alternating sandstones, siltstones and clays of Kibartay horizon, the thickness of which ranges from 28 m (wells E6, D1) to 55 m (well C8). Deymena subhorizon is represented by homogeneous unit of light quartz sandstones with occasional thin layers of black mudstones. The thickness of sandstones fluctuates from 52 m (well E6) to 96 m (well C8).

The Upper Cambrian deposits have been uncovered by one well (only C8) and consist of alternation of clayey-carbonate sediments with the total thickness of 6,8 m.

THE GEOLOGICAL MAPPING OF THE LITHUANIAN REPUBLIC

V. Baltrūnas, M. Repechka, A. Shliaupa, A. Saulėnas

The activities of geological mapping in Lithuania began in 1947. The project was completed in 1952. In the process of geological mapping, 1:200 000, upper Quaternary deposits were investigated and a geolithological and geomorphological map of the Quaternary deposits was completed. It was followed by the second stage: geological-hydrogeological mapping. This completed geological mapping of the whole territory of Lithuania in 1978. This work was summarized in the form of the published maps with explanatory notes:

Map of Quaternary deposits
Map of Pre-Quaternary Rocks
Hydrogeological map
Geomorphological map

Those maps serve as bases for future geological projects in Lithuania including 10 geological and hydrogeological maps (1:500 000), which were published in the period of three years (1978-1981).

Gravity and aeromagneting mapping (1:200 000) of the whole territory of Lithuania can be viewed as preliminary stage of the general geological mapping.

One of the functions of the geological survey was the mapping of the crystalline basement (1:200 000). This project covering 7,9% of the Lithuanian territory is based on the material of gravity mapping (1:50 000) and drilling. In 1970 with the aid of the general geological map we started working on specialized geological, hydrogeological and engineer-geological maps (1:50 000). In the course of the project we carry out a specified study of the structure of the Quaternary deposits in order to determine the distribution of the natural building materials and water-bearing horizons. Geological mapping today covers 14,8% of the Lithuanian territory. Mapping is used for land reclamation (8% of the whole territory). The first land reclamation project was in the district of Ignalina. Another project of geological and hydrogeological mapping was launced in the region of health resorts of Druskininkai, Birshtonas and Likenai. The purpose of the aerophotogeological and aerophotogeomorphological mapping (26,9% of the territory) is to determine the distribution of natural building material. Complex geological-hydrogeological mapping of the coastal area of the Baltic Sea with the ecogeological bias has been completed. Construction of tall building blocks has drawn attention to the ecogeological aspect especially when buildings are erected in ecologically sensitive areas. We have started work on ecogeological mapping (1:50 000) on the territory with precise geological data about distribution of geological structures and water-bearing horizons.

Ecogeological mapping (1:200 000) is designed for the whole territory of Lithuania.

In 1980 we started the geological mapping of the Baltic Sea bottom (1:200 000) in the aquatory west of Klaipeda. We started the project with the map of Quaternary deposits, lithological map of bottom surface sediments and geomorphological map.

In 1990 we started work on a ecogeological map of the Baltic Sea (1:50 000). In the course of this particular geological mapping

special attention is given to geochemical aspect and technogenic research, with the help of monitoring.

We have completed a geological map of bedrock, a geological map of Quaternary deposits and a geomorphological map of the Baltic Sea and its adjacent areas (1:500 000). These maps with explanatory notes will be available in 1992 at the map sales offices. The mapping (1:500 000) of the upper layers of the bottom sediments of the Baltic Sea was started in 1989 and will be finished by 1992. Bulletins of geological maps of the Baltic Sea will be used for the geological research of mineral resources, their distribution and utilization.

EARLY PERMIAN DIABASIC SILLS IN THE BALTIC SEA

A. Birkis, S. Kanev

Offshore wells drilled in the axial part of the Baltic Syneclise had revealed diabasic sills 6-25 m thick, which occur within clayey sediments of Ludlovian and Wenlokian stage of Silurian. They are distinquished by the Sambian complex.

Mapping by seismic survey of the field of intrusive distribution extends from the Klaipeda latitude to the Visla, spit, its extent is approximately 180 km with the width of 20-25 km. The occurrence of several independent diabasic intrusive bodies was supposed, two of which were drilled. One of the intrusives is composed from two pyroxene olivine-rich diabases, the second - olivine clinopyroxene diabases.

The definition of radiogenic age of diabase total samples by K-Ar methods shows the following figures: 330+12 and 370+12g million years, that corresponds to Early - Middle Carboniferous and Late Devonian. But geological data about the age of similar diabase in NE Poland and dolerite geochronological study results in South Sweden suggest to consider the age of the studied diabases to be Early Permian.

Petrographic and petrochemical diabases characteristics of Sambian complex is given, basite resemblance of both intrusives revealed by drilling was established. Diabases according to their petrochemical peculiarities are similar to the low- and middle-alumina toleit basalts of continents and platforms, and also have much in common with subalkali basalts of continents and oceans.

All this defines the peculiarity of platform basite magmatism manifestations in the central (axial) part of the Baltic Syneclise and its belonging to the subalkali basalt-trachybasalt formation.

ATLAS OF THE LITHOLOGIC-PALEOGEOGRAPHICAL MAPS OF THE BALTIC REGION SC. 1:500 000

V. Katinas, V. Narbutaš, A. Radzevičius,
P. Suveizdis, P. Šimkevičius

In 1986 in the Lithuanian Geological Institute an atlas consisting of 13 lithological-paleogeographical maps and 21 structural-geological maps of the pre-Permian surface including profiles and explanatory notes, was compiled and published for the first time.

The complete set of the lithological-paleogeographical maps include maps of the following: the map of Upper Devonian (Frašnian time, Pasvalys strata) - alteration of facies and epigenetic dissolution of gypsum; early Permian (late Saxonian time) - continental arkoses; late Permian (late Werra time) - carbonates and saline deposits; early Triassic (Bundsandstein time) - red beds, of terrigenous sediments; middle and late Jurassic (Bajocian - early Callovian time) - shallow freshened-water carboniferous terrigenous sediments; late Jurassic (Oxfordian time) - marine terrigenous-carbonate deposits; Cretaceous (Albian, Cenomanian and Campanian times) - marine terrigenous glauconite and carbonate sediments; middle and late Eocenian - marine terrigenous amber-bearing sediments; Neogene - continental (lacustrine) sediments.

Mineral resources, accumulations of minerals and geochemical elements, findings of fauna and tectonic elements of above times are presented on the maps.

SOME PROBLEMS OF THE GENESIS OF THE PHOSPHORITE OF THE EAST BALTIC PHOSPHORITE BASIN

V. Petersell

The East Baltic phosphorite basin lies sublatitudinally as a narrow, 600 km long and 60 km wide stripe of land along the southern coast of the Gulf of Finland. Phosphorites in the basin are made up of phosphatic minerals and terrigenous components. Locally phosphorites are more or less dolomitized. The former is represented by inarticulate brachiopod (obolid) shells or their fragments (detritus) consisting of phosphatic minerals of the fluorine-carbonate-apatite group, rarely with homogenic phosphorite interlayers. Films of the latter sometimes surround also quartz grains (Raudsep, 1984).

Phosphorites of the East Baltic basin are characterized by the increased F, Sr, REE, also U content (Петерселль и др., 1986). These elements belong to phosphatic minerals isomorphically. Due to this the distribution of F, Sr, REE and U generally corresponds to the areal as well as vertical distribution of P2O5 in the phosphorite area. Yet, depending on the total content of phosphatic minerals in phosphorites, considerable differences in the sections containing any of these elements are observed.

Shelly phosphorites constitute an independent ore formation of specific genesis and paleogeographical conditions of accumulation. One of the most complicated and yet unsolved problems is the source of P, F, Sr, REE and U and other trace elements. Undoubtedly these elements have concentrated in obolid shells due to their increased content in the paleobasin.

Observations of the F/P2O5, Sr/P2O5, TR/P2O5 and U/P2O5 ratio show that they are specific. The F/P2O5 ratio is very stable in this large basin. It does not depend on the absolute P2O5 content in phosphorites and fluctuates only slightly, from 0,082 - 0,098, whereas Sr/P2O5 ratio (ppm/%) in this area is stable. It is more changeable than by fluorine.

The TR2O3/P2O5 ratio (ppm/%) in phosphorites of the basin is greatly variable ranging from 26 to 93 in separate layers. The coefficient of their ratio variation is very high (V=24-56%). Areally, as well as along the section, the TR2O3/P2O5 ratio decreases relatively with the increase in the P2O5 content in phosphorite, the higher is P2O5 content in ore, the lower is the TR/P2O5 ratio. Although the distribution pattern of U in phosphate ore generally coincides with that of P2o5, the U/P2O5 ratio (ppm/%) is very variable.

Spectrum of TR is monotypical and unchangeable in the whole area. Y2O3 in TR2O3 makes 19-28% and does not depend on the absolute P2O5 content in phosphorite ore. The Ln spectrum in phosphorites differs greatly from that characterizing ocean water, but also from the average spectrum of sedimentary rocks and lithosphere.

From the aforesaid it can be concluded that, apart from P, the F content and generally also the Sr content were high everywhere in the paleobasin and they completely filled the crystal framework of shells during their growth even in the phase of their maximum accumulation.

Occurrence of regular TR/P2O5 and U/P2O5 ratios and stable TR spectrum in phosphorite evidences that phosphatic shells were not transported and displaced noticeably in the paleobasin during the growth stage and life of brachiopods, also in the process of sediment accumulation. Undoubtedly the paleobasin was deficient in TR and U regarding to P and crystal framework of obolid shells in their growth stage was not filled with these elements.

The isotopic composition of oxygen in phosphatic shells coming from the epicentre of the greatest ore body of the East Baltic basin (Rakvere deposit) shows that oxygen of obolid shells is lighter as compared to that of above-lying carbonate rocks. In the section of the phosphorite layer 18 fluctuates from +12,6 to +16,6‰ . If the fluctuation of $\delta^{18}O$ is caused by temperature changes in the paleobasin, it takes place in interval at about 10-28 +4° C (Longinelli, 1966).

The isotopic composition of C which is relevant in the cement or the dolomitized rock (δ13 C=-6,0-(-)8,7‰), shows that, C is lighter and resembles the isotopoic composition of subsurface C. Rather similar to it is δ13C of C from homogenic phosphorite of the Narva deposit. The isotopic composition of pyrite sulphur from the underlying same section Tiskre sandstone from the overlying Dictyonema shale (Петерселль и др., 1987) is also of subsurface character.

The above given factual material cannot be explained by normal sediment accumulation and by upwelling. It suggests the flow of subwater hydrothermas from deep springs into the East Baltic phosphorite basin at the period of phosphorite accumulation, enriched with P, F, Sr, TR, U, Fe and other elements.

These subwater hydrothermas caused the formation of specific short-term paleogeographical conditions in the paleobasin favourable for anomalous massive appearance of poor monotonous fauna of inarticulate brachiopods, shells of which were composed of minerals of the fluorine-carbonate-apatite group. The most probable sources of hydrothermas were deep springs opening during the Caledonian tectonic activization, which were genetically connected with evolutionary Proterozoic subplatform magmatic hearths of granitoids and gabbroids of anortosite rapakivi formation (Петерселль и др., 1986).

ORDOVICIAN IMPACT CRATER AT KÄRDLA, ISLAND OF HIIUMAA, ESTONIA

V. Puura, K. Suuroja

The buried Kärdla crater with a diameter of approximately 4 km was discovered in 1967. The subsurface structure of the crater has been studied by means of gravimetry and airborn magnetometry and by drilling more than 300 boreholes in the crater proper, on the rim ("ring wall") and in surroundings of the crater. The recent reaching 800 m has revealed that the crater is deep and has up to 100 m high central peak.

Hardly visible in the present day topography, the crater proper filled by Palaeozoic and Quaternary deposits represents mostly low marshy land surrounded by low ridge along the ring wall. Quaternary accumulative landforms such as eskers and postglacial seashore banks also complicate the topography. In the buried sub-Quaternary bedrock relief the crater proper occurs as a roundish depression bordered with two 10-30 m high horseshoe-shaped elevations above the buried ring wall. The bedrock topography has been slightly drumlinized during the glacial exaration.

In the subsurface structure of the crater site quite well preserved elements have been distinguished: in vertical section from the top - a) normally an approximately 100 m thick cover of Ordovician sedimentary rocks hiding all the elements of the crater, b) strata of different kinds of allochtonous breccias filling the lower part of the crater proper, and beds of fall-out breccia and ring wall rocks occuring in the surroundings of the crater, d) a body of autochtonous and subautochtonous breccias forming the bottom and the central peak of the crater and also remnants of its rim.

Shocked rocks and minerals from autochtonous and allochtonous breccias have been revealed by light microscopy.

Among the Early Palaeozoic impact structures, the Kärdla crater is one of the best preserved.

MARINE GEOLOGY INVESTIGATIONS OF THE BALTIC SEA

P.Tammik, A. Talpas

The marine section of the Geological Survey of Estonia has been active approximately 10 years. During this period of time we have been carrying out research works in the southern side of the Gulf of Finland and also in the Estonian territorial waters of the Baltic Sea. Our main base has been the research vessel "Marina". The whole aquatorium has been divided into research regions which have been explored one by one for periods of 2 to 5 years. The easternmost border is the meridian 27 e.l. which runs through the Hogland island.

Main research methods were continuous seismic reflection profiling, echosounding, probing of bottom sediments with a gravitational tube (length up to 12 m) or scoop and drilling on the islands of the Gulf of Finland. Bottom probing, which was at times accompanied by taking samples from near bottom water, was carried out following the earlier completed seismic reflection profiles in grids measuring 2 by 2 km. Additionally bottom samples were taken according to the geological situation. The scoop was used in shallow waters and also for getting larger amount of ferro-manganese nodules for analysis.

Gathered samples were taken to various laboratories, mainly to spectral, chemical, granulometrical, mineralogical labs, and also for pollen analysis. The chemical composition of near bottom waters was analysed as well.

As a result of interpreting gathered data, sets of geological maps were created. In the Gulf of Finland the scale of the maps was 1:200 000. Although in the Baltic Sea the grids corresponded to 1:500 000, maps were drawn in 1:200 000 scale. A set of maps included:

- a geological map of Quaternary deposits;
- a geological map of sedimentary rocks;
- a schematic map of crystalline basement;
- a lithological map;
- a geomorphological map;

additionally:

- a bathymetrical map;
- a map of factual material;
- a schematic map of the surface of bedrock;
- a schematic tectonical map;
- a schematic map of mineral deposits (ferro-manganese nodules and sand-gravel);
- schematic maps of distribution of chemical elements in bottom sediments;
- the same in near bottom water.

Gathered data, maps, explanations for the maps, conclusions and illustrative material were dessiminated, but not formally published.

The shortcomings of our work should be mentioned also. Up to now we have not been able to make a working vibrotube. Sampling methods for bedrock are deficient. Geological data from near coast regions with water depth less than 30 m are rather modest, partly due to the above mentioned and partly connected with the lack of geophysical methods in shallow waters. Use of side scan sonar has practically ceased due to poor results.

MAIN FEATURES OF GEOCHEMICAL SPECIALIZATION OF THE CRYSTALLINE BASEMENT OF ESTONIA

J. Kivisilla

Studies of geochemical specialization of the crystalline basement of Estonia are mainly based on spectral analysis of over than 20 000 rock samples from the core material. Specialization becomes evident in the first place as the result of comparison of average contents of major and minor elements in rocks with corresponding (according to SiO2 contents) Clarke values. Positive specialization usually is accompanied by high-level heterogenity in the distribution of elements, frequent occurring of geochemichal anomalies and high level contrastity and productivity of these anomalies.

Average chemical composition of the crystalline basement of Estonia is generally similar to the average composition of the earth's crust: but positive specialization on sulphophylic elements (S, Pb, Zn, Mo) and REE, prevalence of K in comparison with Na and deficiency of Na, Al, Be and siderophylic elements (Ti, Ni, Co) is characteristic to almost all rock groups and districts. According to the behaviour of major and minor elements the following rock complexes are distinguished:

1. SW-Estonian lithophylic district, rich in Fe, Ca, P, Ba, Sr. The ordinary rocks of Jõhvi block from the neighbouring NE-Estonian district are also geochemically similar to the SW Estonian district, especially to the S-Estonian block.

2. NE-Estonian chalcophylic district, rich in S, Zn, Pb, Mo and also Si and K. Deficiency of Ca, P, Ba and Sr is characteristic.

3. Jõhvi-Uljaste sidero-chalcophylic anomalous zone belongs to the NE-Estonia chalcophylic district but in comparison with the latter it is enriched with Fe, Mg, V, Cr from the siderophylic and S, Zn, Cu, Mo, Ag, Pb, Ge, Sn from the chalcophylic groups of elements. Especially characteristic to Jõhvi subzone are high contents of Fe, Mn, Cr, to Uljaste subzone - Cu.

According to geochemical features two different genetic types to quartzites are distinguished - terrigenous-sedimentary type, comparatively rich in K, Na, Al, Cr, Ti, Ga, Zr, Ba and presumably exhalation-sedimentary type, rich in Si, Mg, S, Mn, Cu, Zn. The latter type is geochemically and mineralogically very similar to the ore-bearing quartz rocks of the Outokumpu district, Finland.

Magnetitic quartzites (Jõhvi subzone and Tallinn block) are rich in Fe, Mn, Zn, Mo, S, Sn, Co, Cu and poor in Al, Si, Na, K. According to the models of recent sedimentation in the Atlantic ocean and the contents of minor elements in the rocks of Jõhvi zone, tuffaceous material as well as submarine hydrothermal exhalations played an important role in the formation of the quartzites.

4. Postorogenic potassium granites and rapakivi granites are geochemically clearly different from other rock groups of Estonia. Deficiency of Mg, Ca, Al, Sc, V, Cr, Mn, Co, Ni, Cu is connected with positive specialization on Pb, Mo, Sn, Zr and REE. In the chemical composition of the potassium granites we find all the main tendencies of evolution and specific features of chemical composition of huge blocks of the earth's crust and the upper part of the

mantle. In this connection the tectono-magmatic activization of the crystalline basement of Estonia may be considered perspective for ore deposition of chalcophylic (Mo, Pb, Zn) and lithophylic (REE, P, Zr, Nb, Sn) elements.

ON THE GEOLOGICAL AGE OF THE CRYSTALLINE BASEMENT OF THE SOUTHERN SLOPE OF THE BALTIC SHIELD (SSBS)

V. Petersell

The northern border of the SSBS proceeds from the contact of the Russian Plate along the southern part of the Gulf of Finland. Here the crystalline basement has subsided by 20-40 m. The southern boundary of the slope has not been defined precisely. At present it proceeds by the zone of sublatitudinal subsurface tectonic faults along the slopes of the Lokno-Valmiera basement dome.

The basement rocks on the SSBS are widely varied from the acid to basic metavolcanites and intrusives; by biotite and aluminiferous, more rarely biotite-amphibolite gneisses; quartzites and other types. In the rocks of N and NE Estonia the interbedding of the "black shale" is common.

The geological and geophysical data available permits subdivision of the SSBS into two different structural-facies regions - Tallinn-Novgorod and Estonian-Latvian regions. Considering the geophysical fields, composition, genesis and degree of metamorphism of the rocks, these regions are subdivided into zones and other structural units. In the first region the Tallinn, Alutaguse, Jõhvi and Tapa zones are distinguished, the latter region is subdivided into the Paldiski-Pskov zone, West and South Estonia.

In 1936 A. Öpik and later many other authors suggested the extension of Svecofennian structures and rocks on the territory of Estonia from Central Sweden and South Finland. In 1974- 1976 several publications appeared, edited by V. Puura where for the first time rocks of the crystalline basement of South and West Estonia, but also of the Paldiski-Pskov, Tapa and Jõhvi zones are attributed to the Archean. It should be noted that those "Archean" complexes contain svecofennid-like rocks of the Baltic Shield that are not known from other areas of the Russian Plate.

Results of U-Pb dating show that metavolcanites of the amphibolite facies of metamorphism from West and South Estonia, as well as synorogenic granodiorites, are similar in age, their age ranging from 1889-1820 million years. Thus, the rocks (or metamorphism of rocks) in West and South Estonia are of Svecofennian age and there is no reason to attribute these rocks to the Archean. By zircon the U-Pb age of aluminiferous gneisses is close to that of greywacke from Tampere region and of quartzite from South-East Sweden, being also Svecofennian.

The determination of isotopic composition of Pb in acid metavolcanites, aluminiferous gneisses and migmatite plagiomicrocline granites shows that the most reasonable is their correlation with migmatite and pegmatite plagio-microcline post-folded Svecofennian granites of the Baltic Shield, intrusion of which took place after the main stage of folding.

U-Pb dating of the age of Svecofennian metavolcanic and synorogenic granodiorite-gabbroids of the Baltic Shield has shown that the age of these rocks decreases from the NE to the SW, from 1950-2100 million years in Outokumpu-Oravere region to 1930-1840 million

years in West and South Estonia. This was caused by the south-westward increase of svecofennides also on the southern slope of the Baltic Shield. The estimated rate of the formation of the Svecofennian crust of the Baltic Shield was about 1 cm per year.

Small intrusions of gabbroids and granitoids are of great interest for establishing geological evidences of SSBS. This group includes gabbro-norites of Sigula, gabbrodiorites of Abja, granodiorites of Taadikvere, Virtsu and Märjamaa massifs, but also granites from Naissaare, Jägala (Neeme) and Ereda. Gebbrodiorites of the Taadikvere and Virtsu massif are weakly gneissic. The age-dating by U-Pb method, however, has shown that granodiorites are of Svecofennian, gabbrodiorites of rapakivi age. In accordance with the age and by petrochemical and geochemical data gabbrodiorites correlate with anorthosite-rapakivi gabbroids of the Baltic Shield. The occurrence of veins of plagiomicrocline granites in gabbrodiorites of Abja massif, in its turn, gives evidence of Hoglandian intrusion taking place in South Estonia.

GEODYNAMICAL MODEL OF THE CRYSTALLINE BASEMENT STRUCTURES OF THE BALTIC AREA AND ADJACENT TERRITORY OF THE WESTERN PART OF THE RUSSIAN PLATE

V.Vetrennikov

Based on recent formation, petrologic, geochemical and geophysical data characteristics were evaluated from the view reflective of the peculiarities of tectonics. The analysis of Pre-Cambrian structure of the Baltic area and adjoining territory of the Western part of the Russian Plate was carried out. The methods of crystalline basement geodynamical model compilation and the sequence of methods application of tectonic zoning and geodynamical reconstructions were used in the tectonic plate analysis process. Within basement structural fragments with the ocean type of crust, ancient island arcs, marginal seas of the geological past, collision zones, terrains, intraplate troughs were distinguished. The analysis shows that in every interval of regional tectonic history in the Early Pre-Cambrian, areas of protocontinental crust revealed the following history which includes: their break-up, moving apart of adjacent lithosphere blocks on the early stages of development and the following approach - at the late stages, with the formation of microcontinents (geoblocks) and finally - their joining and the formation of a single continent. The tectonic zoning and the geodynamic model on the plate-tectonic basis will facilitate ore-genetic mapping, metallogenic forecasts, seismic studies and directions of exploration for diamonds, ferrous and other ores, and as well as possibly to define more precisely Phanerozoic history and to reinterpret the distribution peculiarities of heat flow and hydrothermal anomalies.

STUDY OF THE LITHUANIAN QUATERNARY DEPOSITS

A.Jurgaitis, G.Juozapavičius, D.Kondratiene, V.Vonsavičius

The whole territory of Lithuania has been studied at 1:200 000 scale, and 19,7 percent of its area - at 1:50 000 scale. 1500 of wells are bored taking core throughout the whole Quaternary strata. Its average thickness is 92 m. According to the thickness parametre of the deposits the territory of the Republic can be devided into different zones. The latter occupies about 21 percent of the whole territory. The average of the thickness of the Quaternary deposits reaches 20 m. The first two zones are of greatest importance for the knowledge of the structure and stratigraphy. Six glacial sedimentation complexes have been determined. Their correlation features require a better grounding. At the same time it is necessary to pay attention to the age of the burried erosion system with the purpose of revealing the development regularities of interglacial and glacial basins.

The stratigraphic distribution of the Lithuanian Quaternary deposits is mainly based on paleobotanical data. From the stratigraphical point of view more thoroughly are studied those deposits which have the age of 0,78 mln years. Chronostratigrafically they are divided into five glacial and four interglacial periods and Holocene. The regularities of the development of forests and peculiar features of flora of all interglacial periods are determined, paleogeographical conditions are restored. At present the following succession of interglacial periods is accepted: the oldest is the Turgeliai period, which is followed by Butenai, Snaigupėlė and Merkinė as the youngest. Chronostratigraphy and correlation of Merkinė (Eemian, Mikulino) and Butėnai (Holstein, Lichvin) interglacials create no problems. There is a good deal of confusion about the Snaigupėlė and Turgeliai interglacials. The deposits of an age from 0,78 to 1,8 mln years have been studied to a limited extent. No detailed stratigraphical distribution of the deposits of this age has been carried out. On the basis of the available paleobotanical data it is observed that the climate of this Quaternary interval has changed considerably.

The following studies have been carried out to outline the stratigraphy and paleogeography of the Lithuanian Quaternary system:

- petrographical and mineralogical orientation;
- orientation of long axes of peculiar boulder;
- textures or morainic deposits;
- pebbles of gravel;

The analysis of sand and gravel textures, of granulometric and mineral composition of surface Quaternary deposits and geochemical studies of the deposits which make a separate field of lithological investigation enable us to determine compositional differences between separate stages, phases, and genetic types of deposits and paleogeographical conditions of their formation.

Genetic classifications of moraines, of glaciofluvial, limnoglacial, alluvial and eolian deposits are worked out. The regularities of the distribution of the deposits of separate genetic types are determined.

In the Quaternary deposits the resources of 2,1 bill. of cubic meters of gravel and sand are found. The distribution of these deposits in Lithuania is irregular. The largest quantities of gravel and sand are determined in sandurs, glaciofluvial terraces and surface deposits of continental dunes in South-Lithuania.

Small in size and changing in quality parameters of clay deposits were formed in the former inner and marginal glacier basins. A little more important clay layers were formed in the glaciodepressions of the slopes of the hills but the largest and thus most important clay strata are found in the Suvalkija and South Žemaitija Lowlands.

COOPERATION OF NORDIC COUNTRIES, AIMED AT SOLVING THE PROBLEMS OF LATE GLACIAL PALEOGEOGRAPHY. A MOTIVATION BY ANALYSIS OF PRESENT CONDITION

R. Karukäpp

The Holocene - Pleistocene boundary is the most important overthrow in the course of the whole Late Quaternary history. The importance of the period is accented by special research programms, as for example IGCP Programm 253 "Termination of Pleistocene" with numerous working groups dealing with glacial modelling, paleoclimate, drainage of large ice-dammed lakes, permafrost conditions etc.

The late glacial time is the most important period of morphogenesis for the whole area of Scandinavian glaciation. The present relief and soils are mostly the products of the late glacial time. In spite of the fact that Scandinavian continental ice sheet had a definite tendency to diminish, the correlation of local events in space and time is rather complicated. On the one hand this is due to variable natural conditions, such as differences in glacial dynamics and climate. On the other hand, complications are caused by methodical differences, traditions and possibilities of investigation.

The cooperation in the field of paleogeographical investigation in Nordic countries is aimed at separating local differences, actually existing during glacial retreat from those caused by methodical differences. The coordinated methods, joint field work and dublicated analyses will garantee comparable results for plausible conclusions.

The main zones of late glacial marginal formation are well developed and can be clearly followed in all Nordic countries. A great number of attempts to date these zones have been done during the last 100 years. The most promising method for limited areas has been varvochronology as a direct method of dating. Long term studies in Sweden have enabled the compilation of exact scale of varvochronology and its connection with calender chronology. By the time being, the connection between late glacial part of Swedish and Finnish varvochronologies has been established (Strömberg, 1990). The varvochronology in other regions has not been so successful.

Other methods for dating of glacier retreat are more or less indirect. The late glacial interstadial (warmer) periods, as Bølling and Allerød, have got a quite detailed local biostratigraphical characteristics, as have also the alternating cold periods.

Abundant 14 C dates have an important role in reconsturction of the late glacial history. However, considering physical potentialities and errors of dating the results should be taken with great caution.

Joint use of paleomagnetic investigations and varvochronology has yielded good results for the areas, where it is not possible to correlate varve series immediately. The method enables also to control the results of varve teleconnections. The paleomagnetic scale compiled for Leningrad district and Karelia covers 6000 years of late glacial time (Экман, Бахмутов, Загний, 1987) which is the longest for this period and can be used as a reference curve.

Careful revision of the earlier obtained dates, unified methodics, cooperation in field work and analyses help us to reach the real correlation of the late glacial events and reconstruct an authentic paleogeography of Scandinavian glaciation area for late glacial time.

LITHOLOGICAL-MINING TYPES OF DEVONIAN DOLOMITES IN LATVIA

V. Khodireva

Dolomitic layers, belonging to Plavinas and Daugava series of the Upper Devonian form the main dolomitic raw-material base in Latvia. The sections of these productive series of dolomites are variable. Dolomite variations have amalgamated in form with lithological-mining types after the detailed investigations of Plavinas and Daugava series. Characterization of lithological-mining types of dolomites is based on a number of lithological and morphological features, physical and mechanical properties, as well as the use of different mining methods and technology.

There are good prospects for industrial use of dolomites of lithological mining type, e.g. for surfacing roads, building material, decorative tiles.

We have determined prospective sites of dolomite raw materials as well as the distribution of different types of dolomites.

QUATERNARY RESOURCES OF FINLAND

J. Niemelä

1. Economic importance

Quaternary mineral raw materials are of great economic importance as they are needed in all sectors of construction. The building and renovation of industrial and commercial facilities, houses, public premises, roads and railway lines are the basis of the prosperity and functioning of the whole society. The following are some examples of the contribution made by aggregates to the Finnsh national economy (Karjalainen & Pajakkala, 1985; Niemelä & Suominen, 1991):

- the value of soil and water engineering came to about FIM 15 billion in 1985
- in the same year the products of soil and water engineering accounted for 60% of the country's assets, or FIM 2 200 billion
- soil and water engineering provided employment for about 70 000 people
- about 6 000 entrepreneurs work in the field
- the transport of aggregates is currently by far the biggest segment of land transport in Finland, accounting for 200 million tons a year
- although the value of the crushed rock, gravel, sand, clay and till used annually is only FIM 200 - 300 million in geological formations, when processed and at the site of use, their value is many times higher.

2. Amounts of aggregate used in Finland

Finnish law does not yet require a declaration of the amounts of aggregate extracted. However, monitoring of these amounts will probably be made mandatory once the Extractable Land Resources Act has been amended. The quantities listed below are grand totals.

Tabele 1.

Use of aggregates	1985	1992 (estim.)
Glaciofluvial gravel and sand	28 mill. m3	25 mill. m3
Crushed gravel	17 mill. m3	14 mill. m3
Crushed rock	9.5 mill. m3	13 mill. m3
Crushed till	0.5 mill. m3	1 mill. m3
Clay	0.2 mill. m3	0.2 mill. m3
Total	55.2 mill. m3	53.2 mill. m3

The use of esker material (crushed rock, gravel and sand) in Finland has remained around 40-50 mill. m3 a year since the early 1960s, but a slight drop in this amount is expected in the near future. The use of quarred rock for crushing is increasing and already accounts for 17% of total sand and gravel consumption. Consumption of till material will probably increase while that of clay will remain constant.

3. The Quaternary raw-material resources of Finland

3.1. Gravel and sand

The resources of esker material were assessed in the 1970s as a joint venture of the Geological Survey of Finland and the National Board of Roads and Waterways. Over 20 000 esker formations, with a total of almost 50 billion m3 of gravel and sand above the groundwater table were recorded. About 20 billion m3 are estimated to be under the groundwater table and possibly another 10 billion m3 in submarine deposits, implying that Finland's gross gravel and sand resources are about 80 billion m3. The results of the inventory (Niemelä, 1979) are stored at the GSF on maps at 1:20 000 and 1:200 000 scale covering the whole country. The material has also been compiled into a general map at 1:1 000 000 scale (Fig. 1). Most of the descriptions of the deposits are stored in computer files. A computer-based system is currently being developed, as there are numerous restrictions on the use of occurrences, and customers need information about those from which gravel and sand can be extracted. The restrictions are mainly enforced by the Water Act (groundwater) and by the Extractable Land Resources Act, which is very much a protective act.

The above inventory has been revised for many areas by the GSF. Regional inventories of gravel resources have been made only in the Oulu urban district. However, such inventories are very important because numerous areas in Finland are deficient in gravel and sand, and these materials have to be transported long distances, as much as 60 - 80 km. The GSF also makes inventories of individual occurrences on commission.

3.2. Clay resources

The inventory of clay resources in Finland was started in the early 1980s, and within ten years most of the area with plants using clay as a raw material had been assessed (Fig. 2). The inventories were financed jointly with plants. The purpose of most of the inventories was to discover clay appropriate for brick making but, in a couple of areas, also to find clay for manufacturing light-weight aggregates. At present the GSF is not engaged in making any clay inventories.

The estimated resources of brick clays in Finland are about 8 billion m3. The raw material of brick clay is taken from the dry crust of glacial clays, which is 0.5 - 4 m thick. Light-weight aggregates are mainly manufactured from young, humus-bearing post-glacial clays. Resources of these have not yet been assessed.

3.3. Till resources

The GSF has assessed till resources in different parts of Finland mainly for the Finnish National Road Administration (Fig. 3). The inventories focus on areas poor in esker material and where crushed till can be used as a material for surfacing old gravel roads. Stony till occurrences appropriate for crushing are estimated to amount to about 20 billion m3 in Finland.

Wet-sieving of till may develop into an important technique in some areas where substitutes for esker material have to be found. Dry-sieving, much used in Sweden to obtain material for crushing, has not found favour in Finland

3.4. Studies on the quality of esker material, clay and till

The emphasis of the inventories made by the GSF has been on quantity. The quality and usability of the material have been studied only to a limited extent, usually by a customer of or a partner.

The quality of the esker material has been estimated only on the basis of grain size, determined either visually or granulometrically. Properties affecting the usability of the material, such as sludge content and over-sized clasts, are observed for each occurrence.

The thickness of the dry crust, grain size and humus content are always determined as factors affecting the applicability of the clays.

The clast content (usability for crushing) and the fines content of tills are determined in test pits. The granulometric curve thus obtained shows the amounts of crushable material, gravel, sand and fines (clay and silt).

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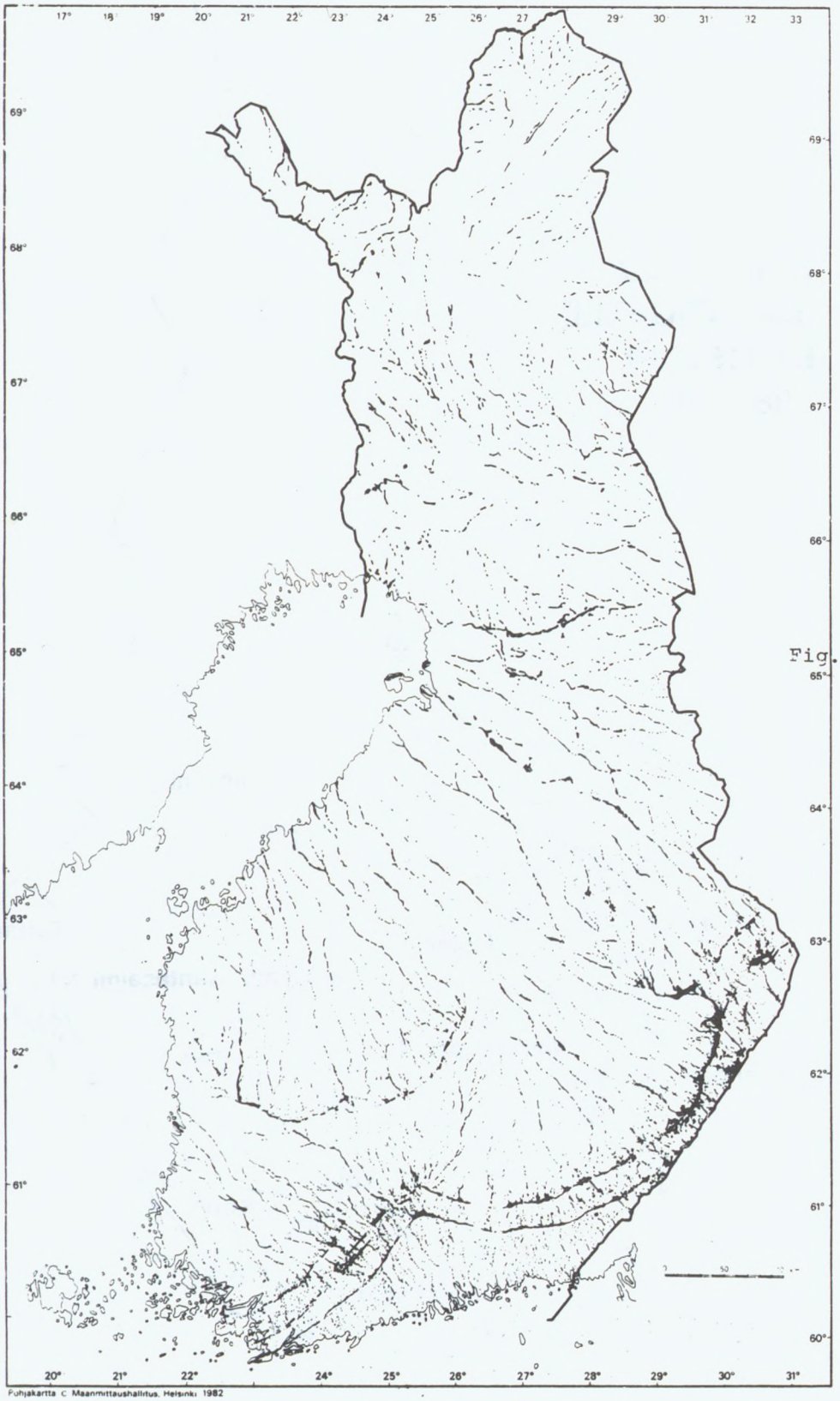
Fig. 1. The gravel and sand occurrences of Finland.
Fig. 2. The assessed clay occurrences.
Fig. 3. The assessed till occurrences.


17° 18° 19° 20° 21° 22° 23° 24° 25° 26° 27° 29° 30° 31° 32° 33°
69°
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Pohjakartta © Maanmittaushallitus, Helsinki 1982

Fig. 1

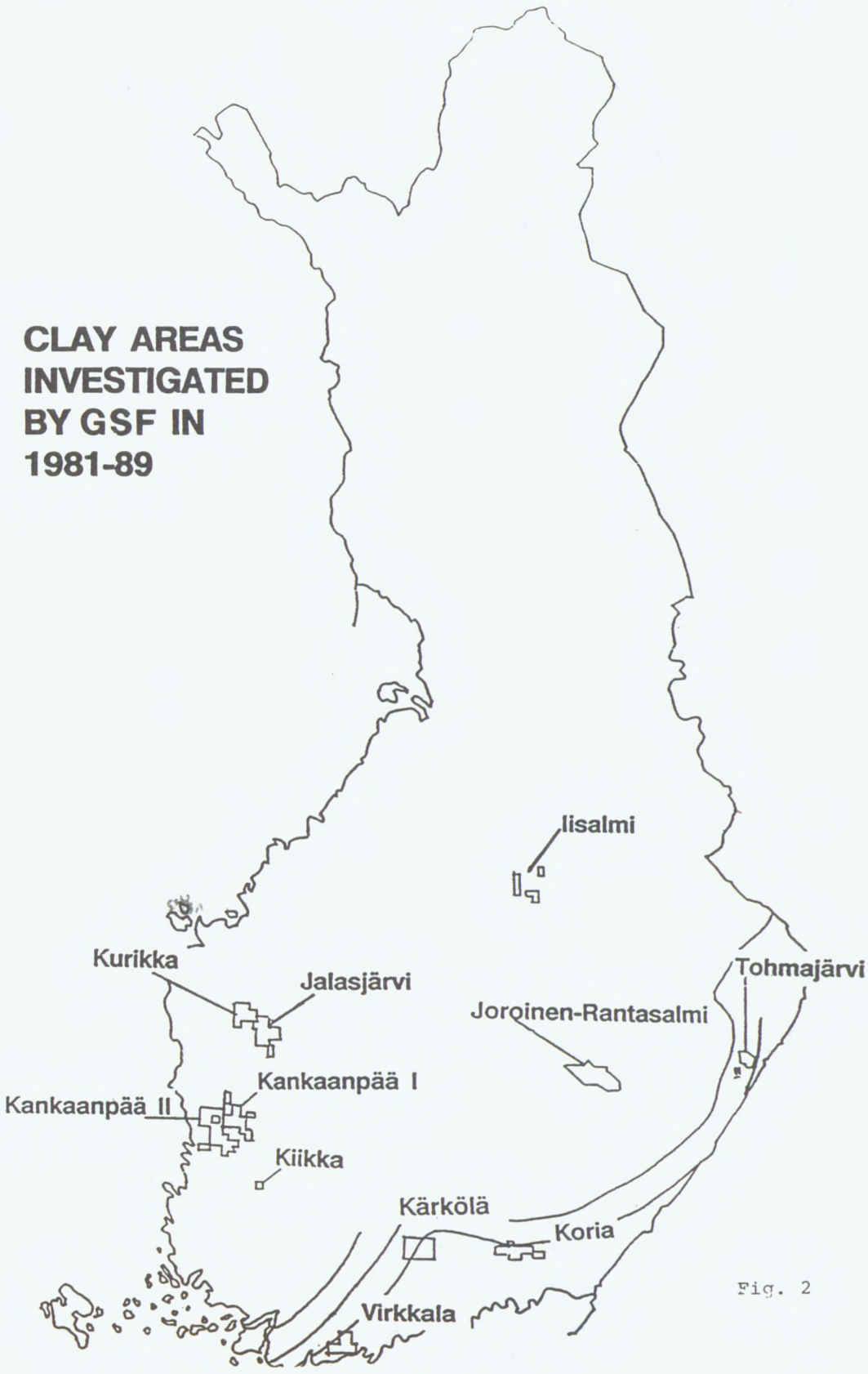

CLAY AREAS
INVESTIGATED
BY GSF IN
1981-89
Iisalmi
Kurikka
Jalasjärvi
Tohmajärvi
Joroinen-Rantasalmi
Kankaanpää I
Kankaanpää II
Kiikka
Kärkölä
Koria
Virkkala

Fig. 2

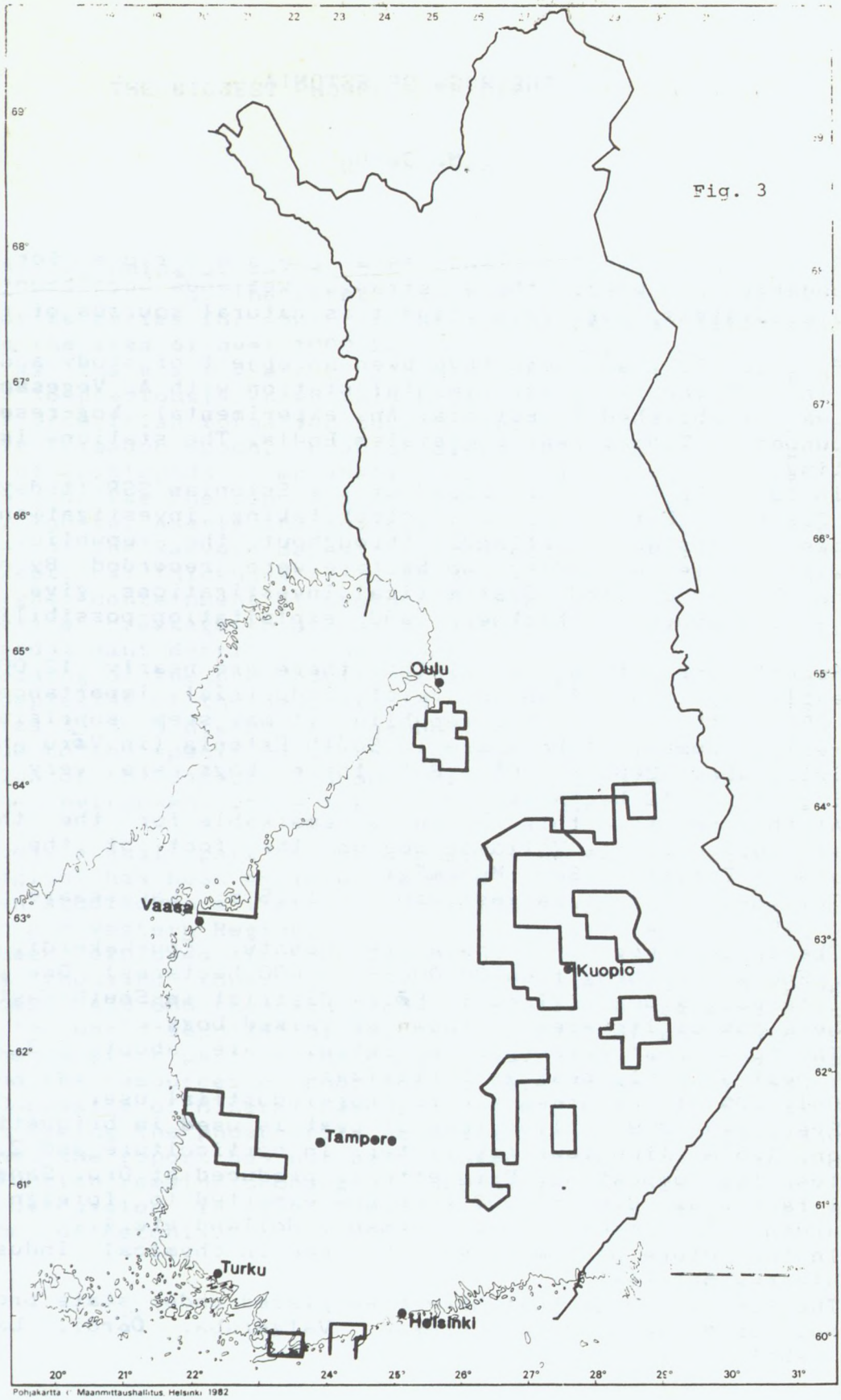


Fig. 3

THE BOGS OF ESTONIA

M. Orru

Because of their importance as a r e s o u r c e for surface and underground water these strange wetlands-bogs-haunt us as unique ecosystems. Bogs gain respect as natural sourses of fuel as well.

For over 80 years bogs have been an object of study and interest. In 1910 the first experimental station with A. Vegesack as a chief was established in Estonia. An experimental bog-reservation was founded in Tooma, near bog-system Endla. The station is still operating.

In 1971 the Geological Board of the Estonian SSR (today Geological Survey of Estonia) started stock-taking investigations into the bogs, swamps and peatlands throughout the republic. All the bogs with an area exceeding one hectare were recorded. By now this work has been completed. Systematical investigations give precise data about amount, thickness and exploitation-possibilities of peats.

Recent observations reveal that there are nearly 12 000 bogs and peatlands, 1 505 of which are of industrial importance. Bogs cover 25% of the area of the republic. It may seem suprising that the greatest number of bogs are in South-Estonia (in Võru and Valga districts, about 2000 - 2100). But these bogs are very small - covering only 2-12 hectares.

At the same time this region is remarkable for the thickness of peat (16,7 m). It's Võllamäe bog on the foot of the highest mountain of Estonia - Suur-Munamägi.

Thickness of peat varies: Napsi - 12,5 m; Lavassaare - 10,2 ; Puhatu - 8,6 m.

The largest bogs in Estonia are Puhatu, Epu-Kakerdi, Lavassaare, Endla (reaching from 30 000 - 50 000 hectares). One of the most interesting bog-regions is Põlva district in South-East Estonia where 85% of its area is known as raised bogs.

The total peat resources in Estonia are about 2,2 billion tons - peat as fuel, peat as fertilizer.

Only 10% of resources are fit for industrial use.

Every year 0,9 million tons of peat is used in briquette production, 1,6 million tons for litter, in horticulture and 2,4 million tons for composting. Briquette is produced at Oru, Sangla and Tootsi factories. Over 50 000 tons are exported to foreign markets for gardening purposes (Italy, Germany, Holland etc.).

In the future peat moss will be used in chemical industry as valuable raw material.

The largest bogs that have been placed under state protection are those of Muraka, Võlla, Kuresoo, Valgeraba, Öördi, Laukasoo, Sõmi, Kabala etc.

THE BIGGEST PHOSPHORITE DEPOSIT OF EUROPE

R. Raudsep

The beginning of 1970s was crucial for explorers of phosphorite in Estonia. For the first time the spread of a thick enough phosphorite series for south of the North-Estonia cliff all together on the area of over 1000 km2 became known. Later it became known as the Rakvere phosphorite deposit. Similar to previously known this phosphorite presents itself in the Earlier Ordovician formation together with sandy sediments accumulated in Tremadoc epoch, in which different amounts of phosphatic valves of brahiopods (lamp shells) or pieces of them (detritus) can be found. Unlike the deposits off the North-Estonia cliff (Maardu, Tsitre, Toolse, Aseri) the following characteristics of the phosphorite of the Rakvere deposit can be pointed out:

- exeptional thickness (7-12 m) of the phosphorite series;
- higher containment of phosphate (P205 - up to 15-25%);
- greater breakage to pieces of valves (phosphatic material);
- predominant detritic-sandy sediments;
- bedding of the phosphorite series in greater depth (50-210 m);
- complexity of the deposit: in profile the oil-shale series lies 30-35 m higher of phosphorite;
- due to the specifics of the geological profile and the location of the deposit a number of unfavourable effects spread on the environment while taking it into use.

Today a small part of the deposit (the western part of the Kabala region) has been explored in detail, the greater part of it has been studied to a limited extent (Rägavere, Assamalla, South-Eastern and Western Region, Sonda). All in all the deposits of P205 have been explored in the following way: categories A+B+C1 - 100 444 thousand tons, C2 - 167 779 thousand tons and prognostic resources - 458 666 thousand tons. These resources make up ca 1-2% out of the world supplies of the raw material of phosphate (P205).

The western part of the Kabala region was explored from 1982-1989 and the resources of phosphorite were to be certified in the State Comission of Mineral Resources of U.S.S.R. But a mighty fight against taking the phosphorite deposits into use brought about the fact that the report has not been looked through up to this day and the situation remains unchanged. Hopefully the matter will come under discussion in the newly- formed Comission of Mineral Resources of Estonia.

HARD ROCK AGGREGATE STUDIES AT THE GEOLOGICAL SURVEY OF FINLAND

V. Suominen

In Finland, over 15% of all the aggregates used are produced by crushing Precambrian rocks. In places where the gravel resources are lacking or where their use is not permitted this figure exceeds 35%. The material from crystalline bedrock is well suited for most applications.

Apart from replacing gravel, rock aggregates are used for purposes in wich the durability of the material is crucial, for example, for surfacing roads. In 1980 the cost of surfacing public roads was almost FIM 500 million, i.e. 0.4% of the annual budget. Studded tyres, which are permitted in Finland in winter, impose special demands on the quality of aggregates in asphalt. The national programme executed by the Geological Survey of Finland for the appraisal of rock materials in rocky terrains (1989-1998) will assess resources of high quality rock, thus enabling authorities to issue permits for extraction, ensuring that the resources are used sensibly and economically. At the same time, the rocky areas will be assessed for their landscape and ecological values. The use of rocky terrains will then be planned on the basis of the information gathered.

The nation-wide assessment will within ten years cover some 30% of the country's area. The work will concentrate to the surroundings of densely populated areas, on the most important road and railway lines and on the vicinity of large building sites. All bedrock geological information is collected, and an interpreted map will be compiled before the field work begins. The quality estimation made by the geologist, based on observations of outcrops, is verified with microscopic petrography and by testing of the technical properties, determined with the Los Angeles test, the Swedish impact test, the abrasion test and the point load test. The Finnish macadam classification of the National Board of Roads is based on values from the above tests, mainly for aggregate in asphalt, but the same can be applied for railway building and maintenance, and also for other constructions.

Macadam quality can be controlled with blasting and crushing procedures. Every rock type has its in-situ strength, and the macadam made of it cannot have a higher durability than the source rock. The macadam quality is inherited from the source rock and its durability depends on the mineral composition, texture and microfissures of the source rock or caused by the blasting and crushing. The durability of crystalline rock seems to depend on texture more than on mineral composition. It is very difficult, if not impossible, to predict macadam quality from lithological maps only.

Finland is a sparsely populated country with a large surface area. To keep transport costs at a reasonable level, a nationwide network of extraction sites of natural aggregate material is required for the construction and maintenance of roads and railways. Even so, an effort is made to focus the extraction of rock aggregates on fewer sites, where the applicability of rocky terrains depends on by the quality of the rock.

The Precambrian bedrock of Finland is an almost ubiquitous source of rock aggregates. The properties of late-Precambrian siltstones and sandstones, however, have not encouraged the use of these rocks for building. Black schists, other schists and gneisses rich in sulphides, micas and possibly graphite also have to be rejected because of their properties. Even rocks containing asbestos minerals must be rejected as a source of asphalt aggregate. The best aggregates for asphalt are finegrained, poorly foliated volcanic rocks, and cataclastic metavolcanites, gneisses and granitoids. The extensive areas of coarse-grained granitoids and rapakivi granites typical of southern Finland are also problematic, at least when used as agregate materials, as these rock types cannot withstand the impact and scratching caused by the studs in tyres. However, they are suitable for aggregate in concrete and they can be used in all unbound construction layers in road building. Being hard and often attractive in colour and texture, they have found extensive use as dimension stones. The waste from dimension stones can often be used as aggregates, but the financial wisdom of doing so depends on the transport distances.

The Geological Survey of Finland compiles and maintains a national register of rock resources on the basis of which it writes reports and produces maps for the authorities. This register is kept up-to-date.

Reference Niemelä, J. and Suominen, V., 1991. Environmental aspects of gravel, sand and hard rock aggregate extraction in the metropolitan area of Finland (in press)

INDRUSTRIAL TYPES OF CARBONATE ROCKS OF ESTONIA

A. Teedumäe

The main part of the Ordovician and Silurian section of Estonia is composed of carbonate rocks - limestones, marls and dolomites of great structural and textural variety, containing an abundance of fossils. The primary dolomites are of restricted distribution, but secondary dolomitization is very widespread. The main rockforming components are: crypto- to microcrystalline calcium carbonate (lime mud) and dolomite (dolomite mud); fine-grained and pelitic terrigenous (detritus); oolites; interclasts of earlier carbonate rocks. Those components occur in rocks of different proportions which form a great variety of rock types in the section and area.

Carbonate rocks belong to universal mineral raw materials. They can be used in various industries after mechanical, thermal and chemical treatment as well as in natural form.

The industrial importance of carbonate rocks of Estonia is determined not only by their material composition and physical properties but also by the character of their spatial distribution especially the thickness of rocks of constant material composition. Considering all these qualities as well as genesis, 7 general types of carbonate rocks can be considered as industrial rocks: primary dolomites (S2pd, S2rk), biomorphous and coarse detritic limestone(S1jr), biohermal limestone (O2on, O3pk, S1jr, S1jg, S2pd), biodetritic limestone (O2on, S1jr, S1rk, S1jg), muddy-biodetritic limestone (O2as, O2ls, O2kl, S1jr), crypto-to fine(ly) crystalline (muddy) limestone (O2rk, O2-3nb, S1jr, S1rk), secondary dolomites, attributed to corresponding limestones of O2as, O2ls, O3pk, S1rk, S1jg, S2pd.

All types of limestones, excluding the muddy-biodetritic one, excel in chemical purity and can be used for lime kiln feed, pulp and paper industry, soil improvement etc. Secondary dolomites and muddy biodetritic limestones in general can be used for macadam and building stone. The purest dolomites (dolomitized biohermal and biodetritic limestones) can be used in glass and metal industries. Primary dolomites - argillaceous dolomite with fine-grained pyrite - have very special patterns and are known as raw material for producing facing slabs.

ENGINEERING GEOLOGY IN FINLAND

V. Lappalainen

In most of my previous visits to Estonia I was representing the engineering geology or the Quaternary geology that was taught and studied at the University of Turku. Now, however, I come as a representative of the Geological Survey of Finland, which, half a year ago, appointed me to the post of research director to help our big institute meet the new challenges facing it.

Many of my Estonian colleagues will be aware that the Geological Survey of Finland, the GSF for short, has been reorganized. Major changes have taken place, and more can be expected as members of the management reach retirement age (picture 1).

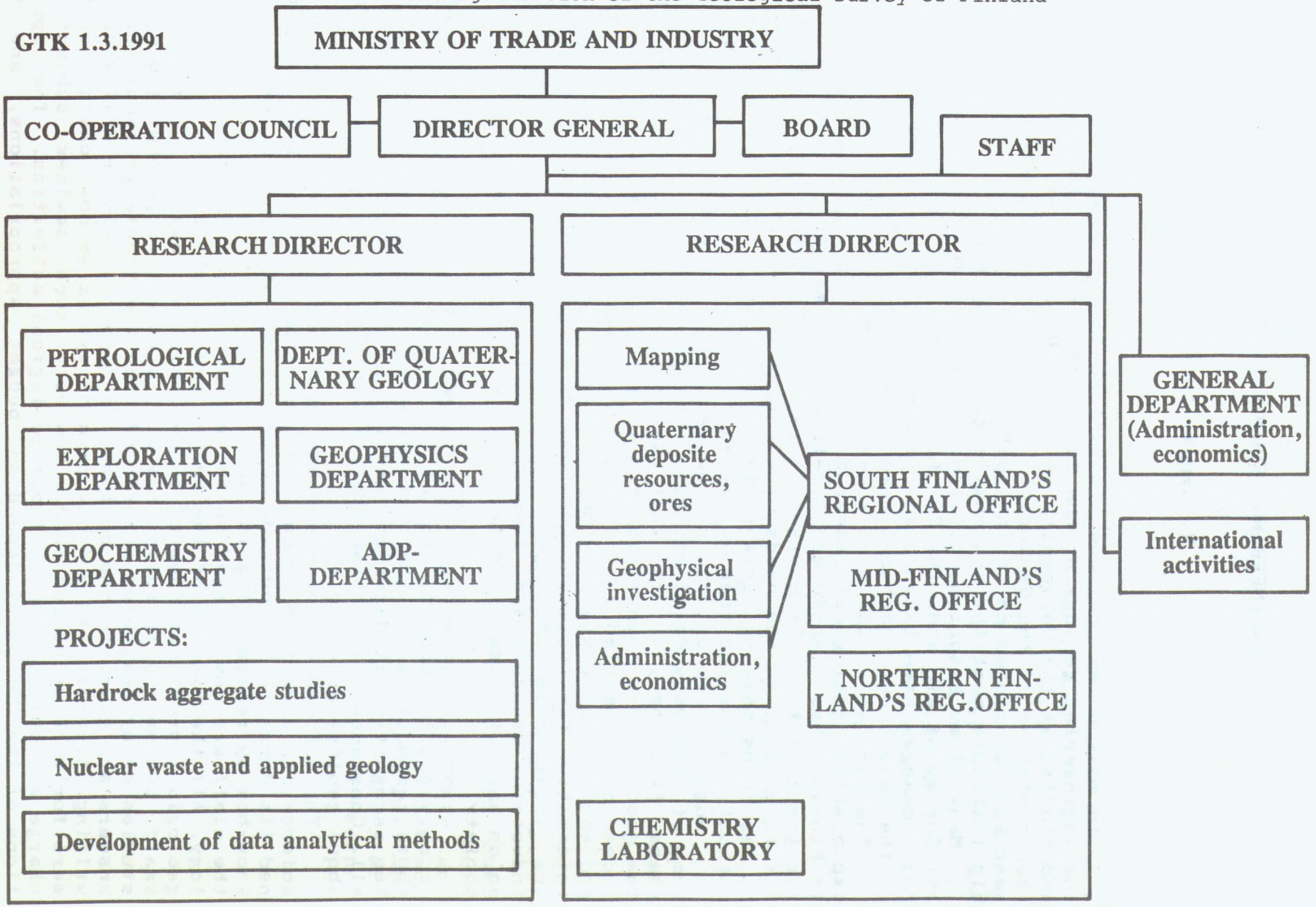
The GSF, which for over a century has been responsible for exploration, geological research and, above all, geological mapping in Finland, has transformed itself with remarkable speed into a service institute. Of course, it is still a scientific institute, but to respond to the needs of our time and the changes in society it has to be able to answer many questions related to geology without considering them merely as scientific and academic issues.

Huge volumes of data on the geological structure of Finland, some of them very detailed, have been deposited in the GSF over the years. It is only natural that use be made of this information for the good of this country and its inhabitants. These activities have indeed been carried on for decades, because the geological maps and the maps of Quaternary deposits are an invaluable source of information for those who know how to exploit them. Establishing the location and tonnage of gravel resources, ores and other industrial minerals and stones, locating groundwater resources and so on have all clearly contributed to advances made in Finnish society.

However, this work, useful though it has been for our country, is only poorly known to most of the people living there, including those responsible for the national economy. Geology is not given the recognition it deserves, and it is not taught in our schools at all. Consequently, Finnish politicians have only very vague ideas about geology as a whole.

The GSF, which for years has been working in the realm of science, to a certain extent isolated from everyday life, has opened its doors to the outside world. It has started to market its know-how by reorganizing its activities, and as a result some of the staff are now engaged in the various service branches of geology. All the experts of the Survey can be called on to help solve geological problems. Some of these problems may be big, others small, but we try to solve them all, either through new geological studies or by searching our records for the knowledge required. The answers are given to the customer as reports, either orally or in writing. According to our new payment system we now charge customers for work we do for them. However, such sevices subject to charge are only one part of our geological activities. The operations of the GSF still depend on budget appropriations, and the bulk of its work is basic scientific research, increasingly, however, with a practical bias.

Picture 1. The Organisation of the Geological Survey of Finland



Engineering geology has been a latent component of Finnish geology for many years. However, it was not firmly established as a competent branch of geology in the service of the nation until the 1960s. This trend is not uniquely Finnish, but has taken place elsewhere in Europe, too. Although, the roots of Finnish engineering geology can be traced back to the 1930s, to the Finnish State Railways, the discipline did not really start to make progress until the 1960s, with the rapid construction of roads and rebuilding of railways. The teaching of engineering geology started at Tampere University of Technology in the 1970s and at about the same time at the University of Turku. To-day the discipline is of paramount importance for community planning, and the number of engineering geologists has grown considerably in Finland. Almost all of them work for private or communal engineering companies or the Finnish National Road Administration.

In its new role in service research, the Geological Survey of Finland was made aware of its shortcomings in this sector by the fact that the first big commissions from the Finnish government were heavily geared towards engineering geology. Although we are confident that we shall cope admirably with these tasks, we have to admit that, to succeed in Finland, a geologist should have a good understanding of the economic and technical principles underlying engineering geology.

What, then, is engineering geology? To begin with, it is a branch of science that is soundly based on geology, both in theory and in practice. In 1990, GEOTIMES, and American journal with a worldwide distribution, published a review article on the subject of geology. Geology was divided into nine major branches and 42 subbranches. The first two major branches were economic geology and a combination of engineering geology, environmental geology and hydrology. These three latter, together with economic geology, are what we understand by engineering geology in Finland. It includes the principles of soil mechanics and rock mechanics as well as the ability to make use of information obtained from drilling and sampling. Engineering geology is the application of the geological sciences to engineering practice for the purpose of assuring that the geological factors affecting the location, design, construction, operation and maintenance of engineering works are recognized and adequately provided for.

It is obvious that geological research, which the GSF is obliged by decree to undertake in Finland, cannot neglect internal training, in this case, in engineering geology. I myself am a Quaternary geologist by training and started my career as a geologist in the old Geological Survey of Finland in the 1950s. The employment situation being what it was, prospects for advancement with the GSF were limited. Thus, in the course of my career I have served both government and private companies in a variety of demanding posts and also universities as a professor. I have seen, so to speak, the world and come to the conclusion that the successful geologist must have expertise in some sector important for the nation's prosperity. One of these, and currently a very important one, is engineering geology.

Engineering geology has developed in different countries along the lines dictated by national characteristics. Estonia is in a special position, as your engineering geology is highly advanced, even in theory, and from the Finnish point of view your engineering geologists are to a great extent geotechnicians, i.e. soil and foundation engineers. In Finland, geotechnology is included in the engineering sciences. We might say that the task of the Finnish

engineering geologist comes to an end when it is time to start dealing with stresses and their effects on a geological formation and technical constructions. Geologists consider the geological mass as material produced by geological processes, whereas engineers see the geological mass as a mechanical mass characterized by certain mechanical properties. The differences in approach are largely philosophical.

This is briefly what I mean by engineering geology. In my opinion, it covers a wide field in today's technologically oriented society. However, engineering geology should not be defined too narrowly. It is closely associated with hydrogeology and environmental geology. Generally speaking, we might say that all the planning and construction dealing with the geological mass, the geological formation. are engineering geology of a kind. Therefore, engineering geology needs the continuous support of the geological information produced by geological and other basic research.

GEOTECHNOLOGICAL PROBLEMS OF GROUND WATER MANAGEMENT IN LITHUANIA

E. Bendoraitis, K. Dumčius, J. Diliūnas

Geotechnological problems connected with ground water withdrawal and estimation of its safe yield are determined by natural and technogenic factors: lithology of aquifers, chemical water composition, bottom deposits of surface filtration installations, material and constructive elements of captage installations, work regime, anthropogenic disturbance of water quality. Under their effect colmatage processes of captage filters and surface infiltration reserves are manifested intensively. They determine an incomplete assimilation of the estimable ground water resources. Under intensive exploitation rather often unconditioned water adjacent aquifers are intruded.

A second group of geotechnological problems is connected with the concentration of ground water withdrawal stimulated by economics of the withdrawal and the deficit of the resources.

For the solution of these problems variuous geotechnological methods are used in Lithuania. They can be devided into three groups:

- get a maximum productivity of captage installations and to maintain it stable for a long time;
- concentrate the withdrawal of ground water resources;
- improve the ground water quality "in situ".

To reach effective and stable productivity of captage installations various filters are used associating their construction with mechanical and chemical characteristics of hydrogeological environment. A new method of the perforation of laser tubes meant for the production of fissure filters is patented. Widely used are pneumoimpulsive, reagentic and combined well filter regeneration methods.

For the concentation of ground water withdrawal in coastal water intakes direct and indirect methods of the artificial recharge of their resources are used. Direct methods are realized by directing water of rivers to special infiltration basins, canals and wells. Indirect methods are realized by choosing such a captage scheme which guarantees the most optimum infiltration of river water to aquifers. To realize this artificial ground water recharge method a radial well of original construction is installed under the Nemunas bed. Horizontal drains are bored using rotatory method which is rarely used in a world hydrogeotechnical practice. On the whole in Lithuania about 60 percent of ground water is obtained from infiltration water intakes.

To improve ground water quality "in situ" the VIREDOX method is being used. It is realized in water wells according to cyslic infiltration-pumping scheme. The possibilites of the use of biodegradation and hydrodynamic methods for the redistribution of the balance of resources are being studied.

GROUND WATER RESOURCES IN LITHUANIA: SAFE YIELD ESTIMATION AND QUALITY PREDICTION

J. Diliūnas, A. Zuzevičius, A. Klimas

Hygienically, technologically and economically speaking the quality of drinking water from underground water sources is more rational than processing drinking water from surface water sources. Safe yield of fresh ground water for Lithyania is estimated 3,2 million cubic metres per day. Fresh ground water constitutes the upper hydrodynamic zone of the artesian basin, the thickness of which ranges from several metres to several hundred metres. Mineralized water lies deeper. Ground water, forming the first unconfined aquifer is to some extent regionally polluted as a result of economic activity. That explains why supplying the population with drinking multi high quality drinking water from underground sources becomes problematic.

Hydrodynamic balance of layer hydrogeological system is disturbed by intensive exploiting of ground water. Reducing hydraulic pressure in the exploited aquifer results in its replenishment by water from nearby aquifers and surface waters. Thus, safe ground water yield (Qs) is formed with the help of different sources which can be presented as the sum of natural resources (Qr), natural reserves (Vr) and replenished resources (Qrr).

Disturbances of hydrodynamic balance, however, are often followed by the disturbances of hydrochemical balance. As a result of the above-mentioned change we get "new" water with new chemical composition which in interaction with rocks changes the composion of the received water. This change may sometimes be positive - e. g. freshening of saline water. But in most cases it leads to abnormal deterioration of intensively exploited ground water quality.

The quantity of any qualitative index in the exploited water can be estimated according to the equation:

$$Cs = \frac{(Qr+Vr) \times Cr + Qrr \times Crr}{Qs}$$

where Cs - quantity of the unknown quality index in the exploited water; Cr and Crr - quality index of the above - mentioned sources, forming the safe yield.

The quality of water in natural reserves and resources (Cr) is dependant on natural factors determining ground water's chemical composition. The only source of ground water pollution in isolated confined aquifers is natural unconditional (mineralized) water, available in the exploited aquifer.

The threat to water quality at such water intakes arises only when they are located too near to the boundaries ofunconditional water. Natural reserves and resources of ground waters in the Baltic, being poorly protected from anthropogenic pollution, as it has already been mentioned, cannot everywhere be used for consumption. Water quality at the intake replenished by resources from the neighbouring aquifer and surface waters is problematic too. Chemical composition of exploited waters may change due to natural unconditional water flow from beneath or anthropogenically polluted ground water from above. The quality of surface water is decisive for coastal water intakes.

THE ECOHYDROGEOLOGICAL ESTIMATION OF INFILTRATING WATER INTAKE OF KLAIPEDA

M.Gregorauskas, A. Kondratas, R. Mokrik

The third water intake of Klaipeda is an infiltrating one with artificial supply of exploiting resources. The Klaipeda canal water is characterized by high contents of organic stuffs and also of other organic and technogenic ingredients. It is used for filling up the ground water resources. The results of mathematical modelling indicate that the main part of ground water resources (90%) of the third water intake of Klaipeda is formed at the expence of influx from the canal, and almost all of the rest (9%) - at the expence of infiltrating feeding. Thus, the formation of ground water quality mainly takes place in the zone of infiltrating canals, that is why all the pollution investigation should be concentrated just there.

The ground water of the water intake is unreliable from the bacteriological point of view and therefore it should be chlorinated. The secondary chlorinated hydrocarbons are formed as the result of water processing with the chlorine and they are harmful to human health. The removal of these hydrocarbons from drinking water is connected with great difficulties, that is why it is necessary to process it and to introduce optium technologies of water preparation instead of the traditional method of chlorination.

The analysis of organic hydrocarbon in the samples of surface water show the usual concentration of dissolved organic stuffs - 8 - 10 mg/l for this seashore region. The humus stuffs, including humus acids, fluctuate within the limits of 0,1 to 0,25 mg/l and fulvo acids - from 0,4 to 0,92 mg/l. The chlorinated hydrocarbons are present in all the samples of ground water in the third water intake that undergo chlorination. These are presented in the samples of chlorinated hydrocarbons, mainly chloroform and methylenchloride, bensol and tuloul in some cases.

A number of samples contain metane in increased quantities, low aromatic hydrocarbons and heavier combinations. Phenols do not exceed MCL. Experiments showed that technology of chlorinating should be abandoned while substituting it by ozonization and filtration through the membranes of activated carbon or reolites.

The modelling also showed that only the upper part of the aquifer (4-5 m) takes part in a more active water exchange in the zone of Kurshiu Marios Gulf. This explains the existance of heterogeneous hydrochemical background in the ground water - the water in the lower part of the aquifer is more metamorphisized than that in the upper one.

We meet intensive pollution with increased mineralization where sediments are taken from the sea; sulphates and chlorides get into aquifer from organogenic sediments and increase the mineralization of the ground water. With the change of hypergenic conditions the concentration of sulphate and nitrate ions in aquifer changes.

GROUND WATER MONITORING IN LITHUANIA

V. Juodkazis, K.Kadūnas, B. Paukštys, V. Žemaitis

Fresh groundwater is the main source of the drinking water for urban communities, industry and agriculture of Lithuania. At present consumption of drinking water reaches 1,4 mill.m3/d., 14 1000 wells are drilled for water, including 1300 at municipal water intake stations. Management of the present water supply structure as well as protection of groundwater resources from contamination and depletion requires a well - organized monitoring system.

From the functional point of view monitoring is the system of observations recurring in time and space of the components of the natural spheres. It pursues a specific aim and has a programme made beforehand. Monitoring involves observation of hydrogeological parametres, systematization and accumulation of information, evaluation of the current situation and forecast of what is expected to happen. Monitoring in relation to hydrosphere is subdivided into global, regional and local.

There are several levels of observation systems. The lowest level includes single points of observation like wells, springs. Observation points, intended for observation of different aquifers form a post. A system of single points and posts forms a poligon. There are two types of poligons: local and regional.

Local poligons deal with specific problems whereas regional are set up for accomplishing complex hydrogeological investigations. In Lithuania there is one regional poligon (Vilnius) and four local poligons which are the following: karst region of North Lithuania, Ignalina nuclear power station, Karsakiskis and Klaipeda municipal water intake stations.

The authors intend to give an overview of the investigations on poligons, structure of the observation network, objectives and results as well as suggestions to apply the results in regions with similar nature and technogenic conditions.

CHANGES OF HYDROGEOLOGICAL CONDITIONS IN ESTONIA UNDER INFLUENCES OF TECHNOGENOUS FACTORS

L. Savitskaja

It is taken for granted that as a result of human activity in hydrosphere there are processes which change the balance being established thousands of years ago.

The hydrogeological conditions in Estonia have the following features:

- monoclinal descending of waterbearing rocks southwards all aquifers come to the surface in North Estonia (and at the bottom of the Gulf of Finland) and immerse under young deposits towards South;
- in North Estonia bissured and karstificated carbonatic Silurian and Ordovician rocks are widespread, which are also the main agricultural water supply source;
- aquifers keep in touch with the sea for a distance of 1200 km.

It's possible to divide technogenous load on the area of Estonia into two groups:

- water intake plants, dewatering, land reclamation;
- sources of water pollution.

Total water consumption of underground water consists of 1,37 million m3 per day. Operational load occures to be in the North 204,8 m3 per day, in the South 10 m3 per day, average 25 m3 per day on 1 km2.

Average technogenous load from the sources of pollution is 73,9 thousand tons per year on 1 km2, including up 830 thousand tons per year on 1 km2 in the North.

The influence of technogenous factors has caused the following changes of hydrogeological conditions on the territory of Estonia:

- extensive depression cones of lower aquifers have appeared;
- a potential possibility of saline water flow to water intakes;
- land subsidence is taking place in Tallinn;
- groundwaters from surface aquifers consist of nitrate contents to 45 mg/l on the area.

Hydrogeological conditions of Estonia have been studied well. However, with the purpose of the human activity regulation it is necessary to perform more detail investigation in geoecology for trustworthy forecasting and drawing up the measures, which will diminish the influence of technogenous factors on the geological environment.

It is necessary to create constant models of ecologically unfavourable areas to make large-scale hydrogeological surveys, further study of water-gas-rock's processes by various methods, underground water regime observations as a base information of their state.

It is necessary to work out methods of drawing maps of maximum permissible technogenous loads for various hydrogeological conditons.

MINERAL WATERS OF KURESSAARE

V.Tassa

Research into the deposits of mineral water was started in 1959 when the geological-hydrogeological mapping of Estonia was launched on a scale of 1:200 000. Since that period up to now nearly 25 sites of mineral water have been investigated.

12 sites have gone through detailed investigation and been recommended for usage.

In 1989-1990 hydrogeological investigations were carried out the results of which enable to start using two types of mineral water in Saaremaa.

In the K-3 borehole in the depth of 540-555 m the Sõru water layer of the Lower Cambrium ground water complex was opened. The delivery of the borehole was 3.363 l/s (287 m3/d), after the fall of water level 13.4 m. Static water level reaches 14.0 metres above sea level.

By chemical consistence it is a chloridic-calcium-natrium water with a mineralization level of 3.7-4.0 g/l of microcomponents the water contains considerable amounts of Br (14 mg/l) and B (18 mg/l). The water does not contain any harmful elements and its bacteriological consistence meets the standards established.

During long-time observing spontaneous gas removal which icluded 94% of nitrogen, 2.6% of helium and 1.2% of argon was perceived. The share of other gases was not remarkable.

The consistence of uranium and radium in the water did not exceed their corresponding background values. Interesting data related to the isotopic consistence of the uranium found in the water has been obtained. The water of the Sõru layer contains U 234. The ratio of uranium protons γ=234 U/238 U exceeds 53.5. Such kind of ratio does not verify the share of seawater in the formation of groundwater but enables to admit that its formation is connected with a deep regional tectonic fault.

The ratio of isotopes determined in the water derived from the K-3 borehole is quite unique being the first of its kind in the history of isotope research.

The water of the Sõru layer is recommended for curative purpose for people who suffer from chronic gastritis, enteritis, enterocolitis as well as from different liver and bilary diseases (normal or subnormal acidity).

Mineral water can also be used as bath water when treating different reumatic, nervous system and other diseases.

In the K-4 borehole the depth of which was 502 metres the Soela water layer (between 458-502 m) was opened. The delivery of this layer was during a long run 1.20 l/s (109 m3/d), after the fall of water level 3.9 m. The static level of the water reaches 10.4 m above the surface of the soil. The mineralization level of the slightly salty water is 2.07-2.13 g/l. By its chemical consistence it is hydrocarbonate-chloride-calcium-natrium water. The water of the Soela layer does not contain any detrimental elements. Bacteriologically it's also clean. The water meets the requirements set for people with chronic gastritis, enteritis, enterocolitis, liver and bilaty diseases (normal or subnormal acidity).

On the basis of investigations conducted the amounts of water

usable for consumption purposes were calculated both for the K-3 ("Kuressaare 1 " water) (297 m3/d) and the K-4 ("Kuressaare 2" water) (109 m3/d) boreholes. The supplies were registered in the territorial commission of supplies where they were classed to belong to the category A.

CONCLUSIONS

of the first Geological Conference of the Baltic Sea States held at Lohusalu, Estonia April 15-19 1991

We, the participants of the Baltic Sea States (representing Estonia, Latvia, Lithuania and Finland) Geological Conference applaud the idea of cooperation as timely and necessary and propose the following guidelines:

- exchange of timely information
- agreements on proposed research
- support for the independence of Estonia, Latvia and Lithuania

We propose to invite representatives of geological organization and individual scientists having an interest in the Baltic Sea Countries, such as Finland, Sweden, Norway, Denmark, Germany, Poland, Estonia, Latvia, Lithuania and Russia (Leningrad, Kaliningrad).

We propose to organize a conference each odd year with attendance limited to 100 participants. The theme shall be the prerogative of the host country, taking into consideration proposals of other participating countries.

The next conference will take place in April 1993 in Lithuania as proposed by the Lithuanian delegation.

We also encourage the exchange of current research information among Geological Survey and research organization chiefs each even year. The primary purpose of these meetings would be the exchange of technical information and coordination of research projects. Such a meeting could be held in Tallinn Estonia in Aprill 1992.

"Bit".1991.19-774.700

THE GEOLOGICAL SURVEY OF ESTONIA published in 1991:

- annual of the Geological Survey of Estonia 1990.

In 1991-1992 will be published:

- state of groundwater (Estonian and Russian versions), bulletin of Hydrogeological Department of Estonia;
- advertising bulletin in two versions (Estonian and English);
- instructions for the liquidation of boreholes;
- set of geological maps of Estonia at 1:2 500 000 with explanatory notes (Estonian, Russian and English);
- annual of the Geological Survey of Estonia 1991;
- bulletin of the Geological Survey of Estonia 1 and 2.

RE EESTI GEOLOOGIAKESKUSESes ilmus 1991.a.:

- Eesti Geoloogiakeskuse aastaraamat 1990.

1991-1992 ilmuvad veel:

- Eesti Hüdrogeoloogia Töökonna bülletään põhjavee seisundist (eesti- ja venekeelne variant);
- Eesti Geoloogiakeskuse reklaamprospekt kahes variandis (eesti- ja ingliskeelne);
- puuraukude likvideerimise juhend;
- 1:2 500 000 geoloogiliste kaartide komplekt koos seletuskirjaga (eesti-, vene- ja ingliskeelne);
- Eesti Geoloogiakeskuse aastaraamat 1991;
- Eesti Geoloogiakeskuse Toimetised nr. 1 ja 2.