Institute of Geology
at Tallinn Technical University

INSTITUTE OF GEOLOGY 2001

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Institute of Geology
at Tallinn Technical University
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Contents

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Director's foreword

The mission of the Institute of Geology at Tallinn Technical University is to play a leading part in the research and development of earth sciences in Estonia. The Institute of Geology maintains its reputation for internationally competitive research across broad fields represented by the existing constituent working groups. Our mission is also to gain a more effective public presence for the geosciences, develop a sufficient stream of well-trained geoscientists, and to allow for the dissemination of ideas between the various geoscience sectors. In addition, increasing the awareness of our work in the earth sciences will be done through the establishment of the Natural Museum with increased exposition and public relations.

The Institute's research encompasses most of geological subjects under the investigation in Estonia. Most of research topics meet international standards of science and the teams carry out their research in collaboration with the international earth sciences communities.

A great importance is placed on upgrading and establishment of new laboratories in collaboration with other institutions. Within the broad areas of lithology, palaeontology and stratigraphy, petrology, geological modelling and mineral sciences the main focus of coming years will be: (1) further development of the Laboratory for Isotope Geology to meet international standards and (2) establishment of the Earth Processes Modelling Laboratory and commencement of numerical and rock analogue experiments.

The main research directions are intimately related with teaching and supervising MSc and PhD students. Since Tartu University plays a major role in teaching undergraduate students, it is envisioned that by expanding the opportunities for postgraduate studies in the Institute of Geology the facilities will be available to meet a wide range of teaching requirements.

For future national and international success a rejuvenation of the staff is given a high priority. Several new appointments are planned in the Institute in order to resolve the potential problem of staff retiring without replacement. In addition, an increase in the number of postgraduate positions will contribute to the overall rejuvenation trend and enhance the quality of research.

Alvar Soesoo, director of the Institute of Geology since 1st January 2002.

Brief history of the Institute

The Institu te of Geology of the Estonian Academy of Sciences, presently at Tallinn Technical University, was founded on April 5, 1946 by a Decree of the Council of Ministers. The first director Prof. Artur Luha was appointed from the 1st January, but the actual work commenced in February when a group of geologists joined the Institute. Thus, in 2002 the Institute celebrates its 55th anniversary.

During the first years, the staff remained small and there were three departments at the Institute – geology, applied geology and geophysics. The main research was focused on stratigraphy and lithology of Palaeozoic and Quaternary sediments and palaeontology. As there was no Geological Survey in Estonia at that time, the Institute was engaged in prospecting and study of mineral resources (oil shale, phosphorite and natural building materials) in addition to some hydrogeological investigations. However, the foundation was also laid to fundamental research.

In the early 1960s, most of the geological research institutes all over the Soviet Union were subordinated to the USSR Ministry of Geology in Moscow. The Institute of Geology in Estonia managed to preserve its affiliation to the Academy of Sciences. This was mainly due to the high level of fundamental research reached by the researchers of the Institute.

From 1960 to 1990, the staff grew rapidly and the structure of the Institute was changed several times. The growth of the staff was partly induced by the increasing role of applied studies on phosphorite and oil shale. From the 29 people in 1947, the number of staff had increased to 193 people in the early 1990s. Shortly after Estonia regained its independence, the Institute underwent great changes. During 1992-1994, the staff was reduced by 54%. In 1996, by a Decree of the Estonian Government, the Institute was affiliated to the Ministry of Education. A year later, the Institute of Geology joined Tallinn Technical University as an independent research and development institution.

The Institute has had close contacts with all Estonian universities, particularly with Tartu University, where most of our staff has graduated from. The Institute also has contacts with other environment and education oriented government and private organisations. During the last decade, all forms of foreign contacts have widened rapidly, including joint projects, organising scientific meetings, training of young researchers abroad, giving lectures etc.

Structure and staff

(as of 1. Jan 2002; positions starting with * stand for part-time jobs; *Canditate of Science* degree is considered here as equal to *PhD*)

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(as of 21. Feb 2002)

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Research projects

Bedrock Geology

The bedrock of Estonia consists of Proterozoic crystalline basement and mainly Palaeozoic sedimentary cover (Vendian–Devonian). The latter is very weakly metamorphized and tectonized, but rich in well preserved fossils. Correspondingly, palaeontology – stratigraphy, lithology – mineralogy, petrography, partly geotectonics and geophysics and in recent years isotope geology have been the main research fields in the bedrock geology of Estonia.

In 2001, these trends were accomplished through four target-financed projects, one postdoctoral project and ten Estonian Science Foundation grants. Main highlights among the year's results were publications on the early Ordovician conodont biostratigraphy (Viira et al., 2001), biodiversity of Ordovician jawed polychaetes (Hints, 2001), Canadian Arctic Wenlock vertebrate palaeontology (Märss & Gagnier, 2001; Soehn et al., 2001), Hirnantian isotope geology (Kaljo et al. 2001) and on the Telychian volcanic ash beds in Estonia and Scandinavia (Kiipli et al., 2001).

Cambrian-Ordovician sequence of the Baltic Klint on the Pakri Peninsula. Photo by H. Pärnaste.

Late Ordovician and Silurian marine ecosystems in the NW part of the Baltica continent and their role in the progress of geology

Target Financed Project No. 0331760s01
Project leader: **D. Kaljo**
Team: R. Einasto, T. Märss, H. Nestor, V. Nestor, T. Martma, M. Mõtus
Duration: 2001–2005

The work under this project is divided between three individual sub-projects co-financed by the Estonian Science Foundation:

1) **Reflection of cyclical climatic changes in the evolution of the Baltic Ordovician / Silurian basin,**
2) **Evolution of communities of Ordovician and early Silurian rugose corals and jawed polychaetes of Estonia and its climatic and oceanic agents based on isotope analysis,**
3) **Early vertebrates (conodonts, agnathans, fishes) of Paadla age in the Palaeobaltic,**

Each of these is described separately below.

Reflection of cyclical climatic changes in the evolution of the Baltic Ordovician/ Silurian basin

Estonian Science Foundation Grant No. 3749
Project leader: **H. Nestor**
Team: R. Einasto, P. Männik, V. Nestor
Duration: 1999–2001

During the last decade, the major role of periodical climate changes in sedimentation pattern is widely recognized. However, less is known, how the changes of different frequences are expressed in sequences, formed in different geological settings. This project analyses some most typical examples, how the cyclic climate changes are expressed in the carbonate sediments of the Baltic Silurian basin, and in the evolution of the stromatoporoid fauna.

A paper was recently published (Nestor & Stock, 2001) on the dynamics of stromatoporoid faunas through the Ordovician–Silurian boundary. It is presumed that a remarkable impoverishment of thermophilic stromatoporoid fauna in the uppermost Ordovician and lowermost Silurian resulted from global cooling (so-called ice-house period), which lasted from the late Caradoc to the end of the Aeronian. During this period, stromatoporoids with aragonitic skeleton were replaced by the forms with calcitic skeleton less sensitive to temperature changes. The results support the idea about the existence of a longer ice-house period in the latest Ordovician and earliest Silurian.

A complicated, hierarchic sedimentary cyclicity, characteristic of the Riksu Formation of the Jaagarahu Stage, was described (Nestor et al., 2001). Four medium- to small-scale categories of cycles (meso-, submeso-, mini-, and submini-cycles) were established and interpreted to be the sedimentary response of 400, 100, 41, and 23 Ka Milankovitch astronomical cycles resulting from the periodical change of the orbital and axial parameters of the Earth. Such a complicated cyclicity was characteristic of the middle shelf setting where deposition was rather continuous, but the amplitude of the relative sea-level change was high enough to be expressed in sedimentary sequence.

Investigation of the Ikla and Staicele drill cores in southeastern Estonia and northern Latvia (Nestor & Nestor, in press) revealed extensive stratigraphical gaps at both boundaries of the Adavere Stage. The gaps probably reflect a global glacio-eustatic fall of sea-level at the end of the Aeronian and Telychian corresponding to the glaciations in South America. The obtained data enables more precise estimation of the time of these glaciations.

Evolution of communities of Ordovician and early Silurian rugose corals and jawed polychaetes of Estonia and its climatic and oceanic agents based on isotope analysis

Estonian Science Foundation Grant No. 3751
Project leader: **D. Kaljo**
Team: O. Hints, T. Martma, M. Mõtus
Duration: 1999–2001

Rugose corals and polychaetes were important faunal groups in the Ordovician–Silurian seas. The main task of this project is elucidation of evolutionary patterns of communities of these groups in the Ordovician and early Silurian of Estonia. This involves considerable taxonomic revision and refinement of stratigraphical ranges of taxa of both groups. Study of carbon and oxygen stable isotopes in the rocks is used to estimate climatic and oceanic parameters, and for chronostratigraphic correlation. This would allow interpretation of integrated palaeontological and geochemical data about the community structure and drawing

A slice of *Bighornia orvikui* Kaljo, a characteristic Late Ordovician rugose coral (3X magnified).

palaeoclimatic and palaeooceanic conclusions on the evolution of the Baltic Basin.

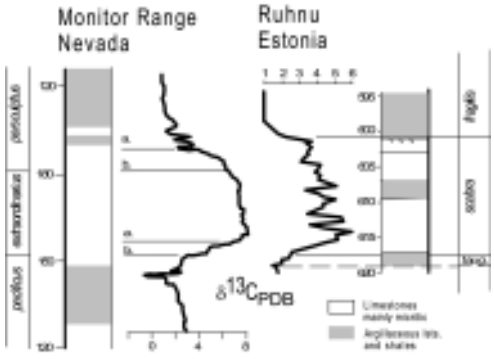
The main results obtained in 2001 can be summarized as follows:

In the framework of the IGCP Project No. 410, The Great Ordovician Biodiversity Event, major diversity patterns of rugose corals (Baltica palaeocontinent) and jawed polychaetes (global) were brought together and analysed according to a common methodology (D. Kaljo and O. Hints). It appeared that the major rise in the diversity of jawed polychaetes occurred in the late Middle Ordovician, while the main lineages originated not later than in the early Middle Ordovician. Rugosans radiated rapidly in the middle Caradoc and beginning with the middle Ashgill. Global number of Ordovicain polychaete genera exceeds 50, and the number of species may reach a thousand. The corresponding numbers for Baltoscandian rugose corals are just above 30 and 90. The end-Ordovician mass extinction is clearly reflected in the diversity drop of the rugose coral species, but not on the genus level.

For the first time the Silurian scolecodonts were studied in Estonia (Viirelaid drill core, western Estonia). 30 species were identified, of those most are common with Gotland fauna and several occurred also on Severnaya Zemlya and in the Canadian Arctic (O. Hints).

Environmental influence on the morphological variability of the early Silurian tabulate corals was analysed by M.-A. Mõtus (2001). The Llandovery tabulate community of Jemtland shows close relationships and similarity to coeval Estonian ones.

The main focus of isotope studies was on the Hirnantian glaciation, especially on the correlation of the corresponding sequences in Baltic and also with the graptolitic Dob's Linn section in Scotland (Kaljo et al., 2001). A manuscript was submitted, which analyses possible influence of the different episodes of the Gondwana glaciation in the Baltic carbon isotope trends. Another manuscript was submitted together with Liverpool colleagues which summarizes the results of the isotope studies performed during the last 5–6 years. A generalized carbon isotope curve was compiled and earlier published data from many sites located in different countries were critically evaluated. Sequence of environmental and biotic events was shown at their position on the above curve.



Carbon isotope correlation of the shallow marine Ruhnu core (SW Estonia) and a graptolitic Monitor Range section in Nevada (from Brenchley et al. in press).

Early vertebrates (conodonts, agnathans, fishes) of Paadla age in the Palaeobaltic

Estonian Science Foundation Grant No. 4160
Project leader: **T. Märss**
Team: J. Nemliher, V. Viira
Duration: 2000–2003

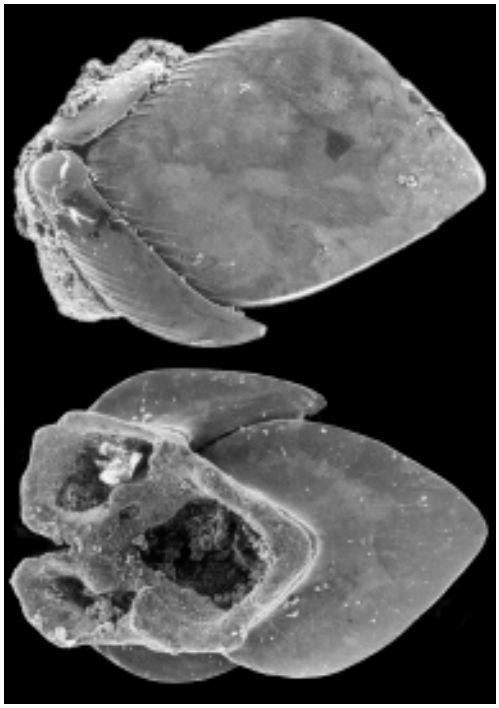
The Paadla age in the Palaeobaltic Silurian comprises a very distinct faunal turnover within different groups of fossils including conodonts, agnathans and fishes. Phosphatic exoskeletons of thelodonts, osteostracans and anaspids are very well preserved in the sediments of that age. Moreover, the actinopterygians first appear in Paadla time and the largest conodonts in Europe are also known from this interval.

In 2001, the study was concentrated on the four main topics:

Mineralogy of Palaeozoic conodonts. It was found that conodonts are composed of low-carbonate F-apatite having XRD patterns very close to these of recent vertebrate teeth, especially the enamel. There was apparently no variation between the apatite of different conodont species.

Taxonomy and distribution of conodonts. Data on conodonts from 25 outcrops and 10 bore core sections of Paadla Stage, Ludlow, of

Saaremaa was assembled. Several new species, having geographically limited distribution, were established. Endemic fauna supports the idea of the specific shallow water shelf that existed during the Paadla age on Saaremaa. Two *Ozarkodina* species, *O. confluens* and *O. excavata*, are the most common taxa in the conodont fauna at that time. The first one is a nearshore inhabitant and is morphologically a very variable taxon; the second one dwelled in the deeper water – near the slope. The morphology of *Oulodus siluricus* also depends on the depth of the basin. The most specific in the conodont fauna of Paadla age is still the genus *Ctenognathodus* with its Wenlock nearshore species *C. murchisoni*, and new species *C. curtatus* sp. n. and *C. paadlicus* sp. n. *Ozarkodina orbicula* sp. n. and *O. wimani soeginensis* ssp. n. occurred among the numerous species of genus *Ozarkodina*. All new species allow very detail correlations with Gotland Island sections, especially with its eastern part.



Scales of *Kannathalepis milleri* Märss et Gagnier, an early chondrichtyan from the Wenlock, Lower Silurian, of Baillie-Hamilton Island, the Canadian Arctic.

Ozarkodina bohemica – O. snajdri – O. crispa evolutionary lineage and *Kockelella* species that are distributed in the deeper water sediments, help the correlations with other regions.

Morphology, taxonomy and distribution of andreolepidids. Localities with the actinopterygian *Andreolepis* in the northern part of Eurasia have been revised. *Andreolepis petri* sp. nov. is established on the basis of distinct morphology and sculpture of the scales, and exoskeletal platelets, in the Tabuska Beds, upper Ludlow or lower Pridoli of the Ufa River section, the Central Urals. The discovery of closed lateral line canal system was especially important. It differs from the open canals in *Lophosteus* Gross, providing a basis to exclude *Andreolepis* from the family Lophosteidae Gross, 1969, placing it into a separate family Andreolepididae fam. nov. (Märss, 2001).

The Riksu section. Lithology, and distribution of stromatoporoids, conodonts, chitinozoans and agnathans were studied from the lower Wenlock up to middle part of Ludlow on Saaremaa. The stratotype section of Riksu Formation was described, and correlated with neighbouring areas (Nestor et al., 2001).

Comparative mineralogy of fossil and recent vertebrates

Estonian Science Foundation Grant No. 3499
Project leader: **E. Kurik**
Team: T. Kallaste, J. Nemliher
Duration: 1998–2001

The project represents the first attempt to create a database of vertebrate skeletal apatite mineralogy, based on a wide range of taxa. Its aim was to evaluate phylogenetic implication of apatite and to study possible diagenetic changes in skeletons of fossil vertebrates. It also included basic biostratigraphical and palaeontological investigations of the Devonian fishes. In 2001, apatite XRD properties of the Upper Cambrian, Middle Ordovician and Lower Silurian conodonts were studied. It appeared that apatite lattice parameters were not influenced by the surrounding rocks. Crystallinity of apatite in conodonts was rather similar to that of teeth of the other vertebrates. Mineralogy of recent hu-

***Carolowilhelmina*, a large and long-snouted toothless pelagic arthrodire from the Devonian of Spain has so far no relatives in the world. Skull reconstructed by E. Kurik.**

man teeth from Estonia and medieval citizens of Tallinn and Tartu were studied. In spite of the similar composition of drinking water, tooth health of medieval people was much better than that of current people. This phenomenon can be explained as a result of differences in dietary habits. Several general problems of fossil fish morphology (development of fins, buoyancy of exoskeleton in ostracoderms and placoderms) were studied. A new representative of the rare placoderm group, Rhenanida was discovered in the Lower Devonian of NW of the Siberian Platform and two new arthrodire genera described: *Carolowilhelmina* (Middle Devonian, Spain) and *Uralosteus* (Lower Devonian, Bashkortostan). *Uralosteus* is significant for the study of arthrodire microremains as the fish has both exoskeletal plates and scales belonging to the same individual.

Early Palaeozoic faunas: comparison, high-resolution stratigraphy and databases

Target Financed Project No. 0330360s98
Project leader: **L. Hints**
Team: O. Hints, K. Mens, P. Männik, J. Nõlvak, A. Oraspõld, H. Pärnaste, V. Viira
Duration: 1998–2002

The work under this project is divided between three individual sub-projects co-financed by the Estonian Science Foundation. These are:
1) **The Baltic faunal province and development of its biota in the Ordovician,**
2) **Upper Llandovery K-bentonites – composition, distribution and application in high-resolution stratigraphy,**
3) **Biostratigraphy, palaeoecology and taphonomy of the Cambrian–Ordovician boundary beds.**
Each of these is described separately below.

Biostratigraphy, palaeoecology and taphonomy of Cambrian–Ordovician boundary beds of Estonia

Estonian Science Foundation Grant No. 3498
Project leader: **I. Puura (Tartu University)**
Team: V. Viira, H. Heinsalu
Duration: 1998–2001

The main topic of this collaborative project is biostratigraphy of the Cambrian and Ordovician boundary beds and establishment of the position of the boundary of these global stratigraphical units in Estonian sections. At the Institute of Geology at TTU, the evolutionary lineages of conodonts and their significance in the high-resolution stratigraphy are studied. Mineralogical and petrological characters of the boundary beds and their influence on the biotas are also under study. The main results in 2001:

The study of the conodonts of the Orasoja Member revealed new data for the establishing of the Cambrian–Ordovician boundary in the siliclastic sections where the lithological criteria are missing. By the conodont biozonation the most complete sequences of the Varangu and Hunneberg stages were established in the Varangu stratotype and Pakri sections, which is notable as in many other sections (for example in Mäekalda) this part of sequence comprises essential gaps.

Upper Llandovery K-bentonites – composition, distribution and application in high-resolution stratigraphy

Estonian Science Foundation Grant No. 4070
Project leader: **P. Männik**
Team: E. Kiipli
Duration: 2000–2002

K-bentonites (beds of fossil volcanic ash) as possible datums for stratigraphical correlations have aroused interest among researchers for

many decades. Theoretically, as each K-bentonite represents an extremely short event in the Earth's history (one volcanic eruption), these beds are perfect levels for correlations. However, due to several reasons (e.g. sorting of material during transportation, changes in the chemical composition during and after sedimentation, etc.), the traditional correlations of K-bentonites, based on their geochemical composition cannot be trusted. A reliable correlation requires that all beds should be characterised in detail and distinct criteria to identify them should be found out. Also, it is essential to test the distribution (correlation) of K-bentonites using other stratigraphical, preferably biostratigraphical, methods. The main aim of the project is to work out such criteria and to test them in the correlations of Baltic sections.
The main results in 2001:

In total, 31 K-bentonites representing 31 different volcanic eruptions were recognised in the Adavere and in the lowermost Jaani stages. K-bentonites are most common in the Rumba Formation, the P. eopennatus, P. a. lithuanicus and upper P. a. amorphognathoides biozones.

The geochemical composition of K-bentonites is strongly influenced by the sedimentary environment (facies) and, as a rule, cannot be used in correlations.

Better results can be achieved by X-ray diffractometric studies of K–Na feldspar occurring in K-bentonites.

It appeared that also mica can be used to identify K-bentonite.

The Baltic faunal province and development of its biota in the Ordovician

Estonian Science Foundation Grant No. 4674
Project leader: **L. Hints**
Team: O. Hints, J. Nõlvak, H. Pärnaste
Duration: 2001–2003

The term Baltic faunal province has more than 30-years history and was established to mark one of the biogeographical regions with a specific composition of the Ordovician faunas. The understanding of that province is based mainly on macrofossil data from the northernmost East-Baltic. Data from the other parts of the basin representing different faunas are involved incompletely. The main goal of this project is to contribute for a better understanding of the entire Baltic faunal province as defined by its geographical extent. For that it is essential to reveal relationships of faunas of the epicontinental and pericontinental parts of the palaeobasin, incorporate other fossil groups including microfossils, find out facies relationship of immigrants, and to compare the faunas of the Baltic province with those of other Ordovician biogeographic regions.
The main results in 2001:

The studies of brachiopod diversity revealed three distinct diversification episodes in the Baltic region. There appeared to be a temporal shift between the maximum diversity values in different parts of the palaeobasin. As a rule, the maximum diversity occurred earlier in North Estonia. It was also found that the diversity achieved maximum values some time after the intervals with the highest appearance rate, and this shift corresponds approximately to two regional stages.
The study of chitinozoan successions in the

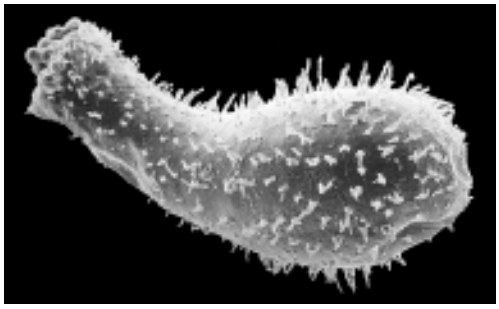
***Plectothyrella crassicosta* (Dalman), from Adze Borehole, depth 838.5 m, Porkuni Stage. This brachiopod is a typical representative of the cosmopolitan *Hirnantia* fauna widespread during the end Ordodvician glaciation.**

marginal areas of Baltica (Poland and West Ukraine) revealed a taxonomic composition very similar to that in Estonia, though with some specific characteristics. It appears that the chitinozoan biozonation worked out in Estonia

can be successfully applied for dating of rocks in these regions.

Chitinozoan data from Baltoscandia was also integrated into a global diversity analyses under IGCP Project No. 410, The Great Ordovician Biodiversification Event. The major radiation of chitinozoans appeared to fall into the late Middle Ordovician though the first chitinozoans appeared already in the Early Ordovician.

A collaborative research on scolecodonts from



***Angochitina curvata* Nõlvak et Grahn, 1993, a zonal chitinozoan typical of the lowermost part of the Haljala Stage (Ordovician) of Baltoscandia (370X magnified).**

Baltica and Laurentia (North America) revealed a slightly higher diversity in Baltica and a notable taxonomic similarity at the genus level between the faunas of both continents.

Two new species of Cyrtometopininae trilobites are described and the need for a revision of the diagnostic features on the family and subfamily levels is stressed.

Among Early Ordovician conodonts some common elements with the North American faunas were established.

Baltoscandian crust: changeability and processes

Target Financed Project No. 0180551Bs98
Project leader: **V. Puura (Tartu University)**
Team: L. Bitjukova, M. Konsa, A. Shogenova, R. Vaher
Duration: 1998–2002

It was found that physical properties of the studied 60 samples of the Estonian Cambrian siliciclastic rocks depended on the proportion of quartz to other minerals. Density, porosity and electrical properties depend on cementation. Secondary cementation was found to have a greater effect on the porosity than the grain-size composition. Magnetic susceptibility is controlled by ferrous and ferric iron minerals, which also influence grain and bulk density (Shogenova, Kirsimäe et al., 2001).

Lithology and cementation are the main factors controlling the properties of the studied 273 samples of Cambrian sandstone and siltstone in the Baltic Basin. It appears that one and the same process may change the porosity in a variety of ways. For example, dolomitization decreases the porosity in the shallow part of the basin (Estonia) and increases the porosity in its deeper parts (Western Lithuania) (Shogenova, Sliaupa et al., 2001).

It has been found that within the magnetic fraction separated from the suevite-like impactites of several craters in Estonia, Scandinavia and Ghana, a rare admixture of magnetic particles shaped like sticklet, platelet or blocklet, ca. 0.1–3 mm in diameter, occurs. A general similarity of morphology and composition of the particles was found, but also distinctive differences between their composition in different craters were discovered. Typical features of particles shape, internal structure and composition were defined and a lithological name "estolites" for such particles was proposed (Puura, Kärki et al. 2001).

As a result of a joint international project, Magnetic and Bouguer Anomaly Maps of the Fennoscandian Shield 1 : 2 000 000 were published (Korhonen et al. 2001).

Physical properties of Palaeozoic sedimentary rocks of Estonia: complex study and systematic database

Estonian Science Foundation Grant No. 4157
Project leader: **A. Shogenova**
Team: L. Bitjukova, R. Einasto, R. Vaher
Duration: 2000–2002

During the current research an approach towards the petrophysical model of the lower Palaeozoic sedimentary cover of Estonia was elaborated. Classification of geological processes and factors influencing the physical rock properties was formulated for carbonate and siliciclastic rocks. About 1000 rock samples were collected and studied during the last years

from 32 boreholes and 6 outcrops located all over Estonia. Porosity, density, electrical, acoustic, reservoir, thermal and magnetic properties of carbonate and siliciclastic rocks were analysed together with bulk chemical and mineralogical composition, iron forms and typical thin-sections.

Properties of the studied sedimentary rocks depend on their composition and are controlled by early and late diagenetic processes. Properties of carbonate rocks significantly depend on their primary proportion of carbonate and fine siliciclastic+clay content and diagenetic dolomitization. Primary porosity of Ordovician and Silurian carbonate rocks increases with increasing of fine siliciclastic+clay content. The properties of Cambrian siliciclastic rocks are controlled by the proportion between quartz content and other minerals represented by K-feldspar, clay and iron minerals. Porosity decreases with cementation represented mainly by dolomite and clay.

The database and scientific conclusions are of great importance not only as basic knowledge, but also applicable for geophysical and geological interpretation and modelling and may be used for construction and geothermal projects.

Mineralization in fault zones, discontinuity layers and meteorite craters: alternative geohistorical evidence for the Baltic Sea region

Estonian Science Foundation Grant No. 4417
Project leader: **V. Puura (Tartu University)**
Team: A. Kleesment, M. Konsa
Duration: 2001–2003

Mineralogical study of magnetic fraction from impact breccias of several craters (Kärdla and Neugrund in Estonia; Sääksjärvi and Lappajärvi in Finland; Jänisjärvi in Russia; Dellen, Tvären, Lockne, Avike and Björkö in Sweden; Dardnos in Norway and Lake Bosumtwi in Ghana) was carried out. Suevites from breccias were sampled, photographed and studied using immersion method (M. Konsa). A rare admixture of magnetic particles shaped like sticklet, platelet or blocklet, ca. 0.1–3 mm in diameter, occurs. A general similarity of morphology and composition of the particles was found, but also distinctive differences between their composition in different craters occurred. This makes it possible to estimate temperature and oxygen fugacity within impact cloud. Typical features of particles shape, internal structure and composition were defined. On the 64th Annual Meeting of Meteoritical Society in Vatican City, a lithological name "estolites" for such particles was proposed (Puura, Kärki et al., 2001).

Lithological and mineralogical preconditions for rational use of the bowels of the earth in Estonia

Target Financed Project No. 0140226Bs98
Project leader: **E. Pirrus (Department of Mining, TTU)**
Team: T. Kallaste, E. Kiipli, A. Kleesment, A. Teedumäe
Duration: 1997–2001

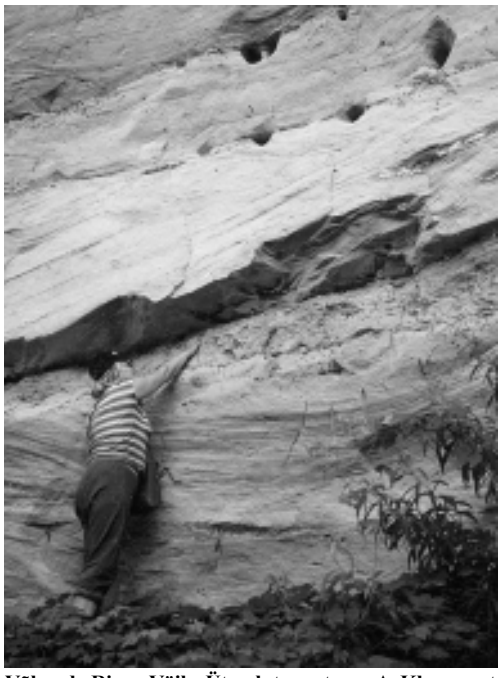
This project is devoted to different mineralogical-petrological-geochemical aspects of Estonian Proterozoic and Palaeozoic sediments and rocks. The main focus is on Silurian and Devonian fissures, secondary carbonate cementation in primarily carbonate-free Cambrian and Vendian sediments, geochemical environment at the formation of Fe-Cu minerals and Mg mineralisation in the dolomitization process, mineralogy and correlation of volcanic metabentonite beds.

The main results obtained during 2001 can be summarized as follows:

Detailed measurements of the orientation and frequency of fissures in Devonian sandstones were obtained from Ahja River Bank, South Estonia. A clear effect of fissures to suffosion and movement of surface waters was recognised. It was suggested that most of the Devonian fissures in South Estonia were closed. The opened ones got filled during the Middle Devonian, which is an important implication for better understanding of the entire tectonic history of Estonian area.

On the Silurian outcrop area, the fissures were influenced by facies alteration and dolomitization. The main orientation of the Silurian fissures studied appeared to coincide well with the common major NW-SE and NE-SW fault and fissure systems.

The comparative study of the dolomites of dif-



Võhandu River, Väike Ütsealutse outcrop, A. Kleesment points to a conglomeratic lens reflecting specific sediment accumulation conditions of Devonian sandstones (Burtnieki Stage) in South Estonia. Photo by E. Pirrus.

ferent geneses revealed that Ca/Mg ratio and lattice parameters result from genesis. The primary (syngenetic) lagoonal dolomite has expanded lattice. The secondary (replacive) dolomite, originating from normal marine calcareous sediments, is nearly stoichiometric. It proves that complete dissolution and recrystallization of precursor calcite is an essential prerequisite for the formation of stoichiometric dolomite.

In the Laboratory of Petrology new diffractometric methodologies were developed and implemented for measuring volcanogenic sanidine in complex systems and biotic aragonite in recent mollusc shells. The study of volcanogenic sanidine was successfully used for detail correlations in the Silurian palaeobasin. Most importantly, this methodology allows correlation of distant sections within different facies, something which has always been a complicated task using fossils only.

Variations and diagenetic alteration of phosphatic skeletons

Target Financed Project No. 0331427s00
Project leader: **J. Nemliher**
Duration: 2000–2001

Together with calcite, aragonite and silica the apatite of biological origin is one of the most common minerals of sedimentary rocks. In the framework of current programme the properties of Recent bioapatite are studied as well as the pathways of their diagenetic alteration. The basic method for studies was X-ray diffraction. Main attention of studies during last year was focused on the comparative studies of apatite of Palaezoic conodonts and Recent/fossil vertebrate teeth.

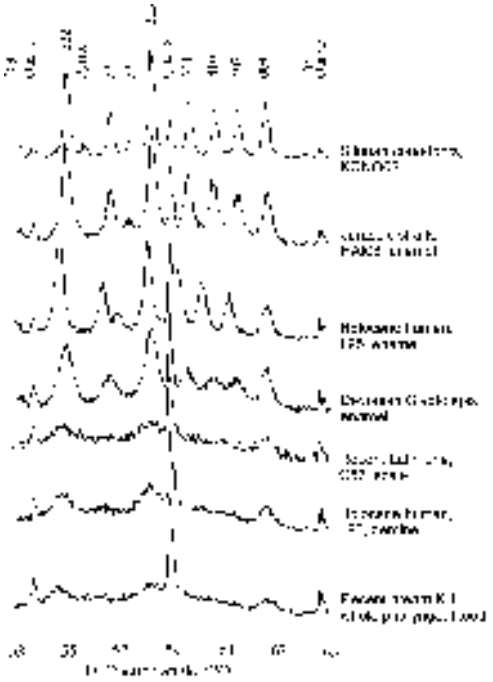
It is found that the lattice parameters values of conodont apatite were not influenced by surrounding rock type (Upper Cambrian – siliciclastic, Middle Ordovician – carbonate and Lower Silurian – alumosilicate) which can be interpreted as low-carbonate F-apatite. Due to primarily high content of tissue type, close to enamel, the influence of methasomatic alteration estimated as very low. Using deconvolution of XRD patterns it became evident that:

1. Crystallinity of apatite in conodonts is quite similar to that of vertebrate teeth; differences are in action in the enamel/dentine ratio.
2. The main feature of diagenetical maturation of conodont apatite is aggregation of crystals. The main crystallinity pattern is quite similar to Recent enamel in spite of 10–100 times larger particules.
3. There is no intraspecific variations of conodont apatite found. Differences of lattice parameters values interpreted as result of methasomatic process.

Studies of medieval exhumed and Recent human teeth are shown that:

1. Teeth from St. Barbara (14th century) and Lillemägi (17th century) Cemeteries have crystallinity, similar to those of Recent samples. The post mortem diagenetical changes found in dentine while enamel estimated as equal to fresh one.

2. EDX chemical studies of Recent teeth shows that Cl can be found in enamel. However, on the material, coming from habilitation regions of Estonia with high F content in drinking water (e.g. SW and W Estonia) the Cl was not found in enamel. On the other hand, on the material, coming from Tallinn and Tartu Regions the content of chlorine can be high as 0.8 mol%. The health of teeth is straightly bounded with Cl amount in enamel.



XRD patterns of some different aged bioapatites showing the range of crystallinity differences.

3. In spite of the same source drinking water, used on 14th century in Tallinn, there was no caries as well as Cl presence found in teeth of medieval humans.

Considering the carbonate biomineralization, the aragonite XRD properties of Recent bivalved mollusks (*Macoma baltica* and *Mytilus edulis*) and its content of Sr of Baltic Sea was studied. It is estimated possibility of use this biomineral as palaeosalinity or palaeo-thermometer indicator. It is found that:

1. In spite of differences in salinity more than 10 times, the differences in aragonite lattice parameters are less than 1/10000 Å; unit cell volume changes are rather accidental than towards salinity gradient.
2. Content of Sr is in well correlation with unit cell volume.
3. Cont ent of heavy metals in bioaragonite of Baltic Sea can be rather attributed by local pollution (or conditions, e.g. content of U and exposition of black shale) than overall ions content in seawater.

Quaternary Geology

In the Quaternary, Estonia has been repeatedly covered by continental ice which left behind a diverse complex of clearly developed relief forms and deposits. In the Late Glacial and Holocene Estonia was to a great extent subjected to the action of the different stages of the Baltic Sea. Complicated is the formation of the network of streams and rivers (including karst phenomena in the carbonate bedrock area), bogging process and history of more than 1500 lakes.

Depending on these natural preconditions the main attention in the Quaternary scientific research is focused on the study of the last continental glaciation and the deposits and the coastal forms of the Baltic Sea and lake basins. The palaeo-shorelines of the Baltic Sea were collected into a new comprehensive database and shorelines for the Baltic Ice Lake, Ancylus Lake and Litorina Sea were modelled. Sediment diatom studies revealed that the saline bottom current penetrating into the Baltic Sea basin was strong enough to break up the water column stratification during the brackish Yoldia Sea stage. During the last years more attention has been paid to the stratigraphy of the Holocene deposits: immigration of species, changes in the vegetation and prehistoric human impact upon the environment being the most important topics. The impact of the Mesolithic man on the vegetation was proven by means of pollen analyses, in spite of the restricted and short time imprints on the environment. Palynological richness served as the best indicator of pre-agrarian human impact (doctoral thesis of Anneli Poska).

Studies of annually laminated lake sediments in a network varved sediments in Europe present the opportunity to provide new high-resolution palaeo data from unique and precise environmental archives. A rather substantial attention was paid to the investigation of meteoritic craters such as Kaali and Ilumetsa. The last year's investigations have also contributed to elucidating the detailed history of Lake Peipsi and Holocene rivers and foreseeing the future development of the lakes and the network of rivers. One of our tasks has been the compilation of the "Book of Primeval Nature".

The Quaternary geologists of the institute are in close contacts with the researchers of the neighbouring countries.

Although the Kaali meteorite craters (Saaremaa Island, West Estonia) are among the best known and best preserved craters in the world, opinions still differ as to their age. This aerial photograph (from Estonian Land Board) shows the main crater (110m in diameter) and one of the eight smaller craters.

Late Quaternary environment dynamics in the northwestern part of the East-European Platform: stratigraphy, geochronology, correlation

Target Financed Project No. 0331759s01
Project leader: **A. Raukas**
Team: R. Karukäpp, H. Kink, A. Miidel, A. Molodkov, E. Tavast
Duration: 2001–2005

Based on the m ultidisciplinary study of key sections in the northwestern part of the East-European Platform, preliminary interregional stratigraphic and geochronological correlation will be given and the dynamics of the Late Quaternary palaeoenvironment elucidated. The duration, time limits and synchronity or asynchronity of marine and lake transgressions in the glaciation centres of Fennoscandia and Arctic and marginal areas of northern Eurasia will be determined. The results obtained will be correlated with the information stored in deep sedi-

ments, ice cores and loesses. The composition and morphology of fine cosmic matter and the age of meteorite craters will be studied. Based mainly on the geology of big lakes (Peipsi, Võrtsjärv, Ladoga, Onega) and rivers of Estonia and neighbouring areas, postglacial hydrographic reconstruction of Estonia and neighbouring areas will be given. The evolution of the Baltic Sea mollusc fauna complexes in time will be studied.

The main results obtained in 2001:

Human impact on the composition and regime of groundwater in the Estonian oil-shale deposit and in the three geologically different type areas - Pakri Peninsula, Kunda industrial area and Kurtna Kame Field - was assessed. Recommendations for the improvement of environmental conditions and arrangement of monitoring system in these regions were given. The effect of underground mining on the topography in dependence of the size and shape of chambers was studied and a nomogram for calculating optimal dimensions of chambers was presented. The age of the Ilumetsa meteorite craters (6600 years) was determined. The work in introducing the method, based on the study of meteoritic fine matter, in neighbouring areas was continued. On the basis of multidisciplinary study of Estonian rivers, the evolution of Late- and Post-glacial hydrographic network was described in more detail. A survey of the changes in the environmental state of the coastal area of Lake Peipsi was presented. The effect of water-level fluctuations in Lake Peipsi on its shores and the resulting damage were analysed.

Based on the morphology of Late Pleistocene ice lobe depressions and the heights separating these depressions, it was elucidated that the ice flows which drained the SE sector of the Scandinavian Ice Sheet in the Late-glacial were up to 400...500 km long extending, thus, much father than assumed so far. Their age was at least 5000...6000 years, dating back to the period prior to the culmination of the glacier.

The results of luminescence analysis were used to determine the age of the sediments originating from the Baltic Sea transgressions in Venties Ragas, Karkli and Nemirseta (Lithuania) sections. The first data were obtained on the problematic marine sediments in the SE part of the Fennoscandian Ice Sheet. The obtained age – ca 103 000 years – shows that these sediments were formed during the last interglacial and that their bedding at higher absolute heights may be due to glaciotectonics. On the basis of statistical distribution of the ESR-dates, there were at least five transgressions on the North Eurasian palaeoshelf during isotope stage 5. Their ages are ca 135, 125–120, 110–105, 95–80 and 70 thousand years, respectively. It was established that the problematic Snaigupele interglacial sediments in the Valakampiai section in Lithuania actually belong to the Eemian interglacial. In cooperation with the Institute of Physics of the Earth, Russia, phenomena of recent tectonic activity in NE Estonia were described. They were associated with the possible earthquakes in this region. In cooperation with the Institute of Ecology of Tallinn Pedagogical University it was found that during the last 4000 years the rate of land uplift has not changed in Estonia, which refers to the tectonic origin of the uplift

Geologcial development of Lake Võrtsjärv

Estonian Science Foundation Grant No. 4046
Project leader: **A. Raukas**
Team: R. Karukäpp, A. Miidel, E. Tavast
Duration: 2000–2002

Owing to its central position in the territory of Estonia, Lake Võrtsjärv has played an important role in solving of many Late- and Post-Glacial palaeogeographic problems. Until recently, its earlier stages – Ice Võrtsjärv, Ancient Võrtsjärv and Big Võrtsjärv – were not precisely determined and their contours were a subject of many discussions. Based on the research results derived within this project, the distribution of these water bodies was determined in particular detail, and time limits of all the stages were presented. The heights of thresholds were measured and used in a distance diagram. The beginning of Contemporary Võrtsjärv goes back about 7500 years when an outflow from L. Võrtsjärv developed towards L. Peipsi. The great thickness of lacustrine lime (8m) and sapropel (9 m) in the southern part of the lake

Lake Võrtsjärv near Petseri Village. Photo by A. Raukas.

basin suggests a gradual water-level rise in this part of the lake during the whole of Holocene. A map showing the carbonate content of bottom deposits was compiled.

Abrupt water level changes and the distribution of the lake during different stages of its evolution was controlled by the tectonic movements of the Earth's crust, which opened and closed the earlier outflows and inflows. The water-level fluctuations in L. Võrtsjärv have always been significant; this hampers the correlation of shorelines and river terraces. The geomorphological schemes and maps compiled on the Võrtsjärv basin furnish a basis for the reconstruction of glacial processes and allow to estimate their role in the formation of the topography.

Timing and duration of the last interglacial seas as deduced from ESR-analysis of marine shells

Estonian Science Foundation Grant No. 3625
Project leader: **A. Molodkov**
Team: E. Tavast
Duration: 1999–2001

The project is dedicated to the important problems of the Late Quaternary geology of the Baltic sphere: temporal extent of the last interglacial seas, their interregional and global correlation with the events recorded in different environments, sea-level changes during interglacial cycle, etc. The proposed project concerns one of the critical aspects of the research – the chronostratigraphical one.

The numerical OSL ages obtained in 2001 on highly problematic marine interglacial deposits sandwiched between the tills of the Saalian and Weichselian glaciations on Kola Peninsula indicate that the investigated deposits dated at 103.8 ± 8.8 ka were formed, most likely, during the warm climatic period (between 114–102 ka) recorded on last interglacial speleothem in the adjacent coastal area of northern Norway. The datings obtained together with other independent environmental indications may be regarded as an evidence supporting the relatively high post-Substage 5e sea-level stand and interglacial landscape development in this region. Macro- and microfauna composition together with *in situ* pollen encountered in the dated layer indicate the climate similar to that of present day, although initially somewhat drier.

The dating frequency analysis of the whole collection of shells taken in Northern Eurasia displays peaks and troughs that can be correlated with climatic variations during isotope Stage 5: low frequency intervals (ca. 130, 115, 100 and 75 ka ago) indicate cold events during which the submerged area was substantially reduced.

The penultimate (Snaigupele, OIS 7) interglacial has proved controversial because of similarities between some palynological signatures of Holsteinian, Snaigupele and Eemian interglacial deposits. Chronological studies of freshwater mollusc fauna from the bed of organogenous deposits, attributed to the

penultimate Snaigupele (=Drente-Warthe) Interglacial demonstrated that mutually consistent dates of 116.0 ± 10.8 and 110.0 ± 12.1 ka with an average age of about 113.0 ka allow to link the deposits studied with the Merkine/Eemian (s.lato) Interglacial. To estimate the opportunity of the existence of this penultimate (late mid-Pleistocene) interglacial episode in the Baltic countries palynologically based proxy record of the late mid-Pleistocene climate change exceeding 220 ka duration is considered using pollen data from three type sections situated to the east and south at the same and lower altitudes.

On the basis of mollusc fauna, ecological conditions and the boundaries of different aged water basins during the Baltic Sea evolution are adjusted. The study of recent mollusc shells of the Väinameri Sea shows a decrease in the salinity of this Baltic Sea region which has to be confirmed by further studies.

Sediment coring on Lake Rõuge Tõugjärv. From left to right A. Heinsalu and J. Vassiljev. Photo by S. Veski.

The varvo-chronological time-scale of Holocene Geoevents

Target Financed Project No. 0331758s01
Project leader: **S. Veski**
Team: K. Erg, A. Heinsalu, A. Lepland, E. Niinemets, A. Poska, L. Saarse, J. Vassiljev
Duration: 2001–2005

A major aim of the Earth Sciences is to improve the predictive power of scenarios produced by climate models. Instrumental records of the climate change are too short to elucidate the full range of climatic variability. Therefore, it is necessary to reconstruct climate from geological archives with a high-temporal resolution.

The project delivers reconstructions of lake ecosystems, climate change and environmental dynamics at seasonal to decadal resolution in Estonia during the last 10,000 years through a multidisciplinary study of annually laminated lake sediments. The network of annually laminated (varved) sediments in Europe and Estonia presents the opportunity to provide new high-resolution palaeodata from unique and precise environmental archives. The predicted temporal range of annually laminated sediments in Estonia can extend to 14,000 years. Accurate varve counts, verification of their annual nature and documentation of each individual varve thickness from Estonian sediment sequences will be made using high-resolution techniques (thin section investigation, image analysis, X-ray densitometry, scanning electron microscopy). Varve thickness variations of the last centuries will be compared to meteorological data of the same period to obtain a varve-climate link, which then could be extrapolated to the past. These procedures will provide quantitative estimates of short- and long-term climate variability. Post-glacial climatic variability and environmental changes are established using diatom-inferred reconstruction. Abrupt transitions between time periods of stable climatic conditions (e.g. the Younger Dryas – Holocene transition, the early Preboreal Oscillation, a cooling events at ca. 8200 years BP and at ca. 2800–2700 years BP, the Little Ice Age) are studied at a high-temporal (an annual and possibly seasonal) resolution. An accurate calendar year chronology provided by sediment sequences enables to objectively compare variations in palaeoclimatic proxy data with each other and alternative palaeodata sets of similar resolution (e.g. ice-cores and tree-rings). The time-series data sets produced are for the benefit of global change community and can be used to validate predictive climate models.

Biostratigraphy of the coastal Estonia and early human impact

Estonian Science Foundation Grant No. 3621
Project leader: **L. Saarse**
Team: A. Heinsalu, A. Poska, S. Veski
Duration: 1999–2001

The project aims to describe and explain the Early and Mid-Holocene biostratigraphy, palaeoecology, climate and human impact within coastal areas of Estonia exploring the representative stratigraphic sequences and unique buried organic deposits. Based on detail taxonomic analyses and AMS dates, to determine the timing of transgressive and regressive phases of human impact. To reconstruct regional climatic changes with emphasis on abrupt changes within long-term climate change envelope. To compare the results obtained with the existing geological, palaeoecological and archaeological records and to analyse reasons for similarities and differences. New data on the stratigraphy, vegetation history, forest clearances and early land-use are used as proxies for palaeogeographical and climate reconstructions and to complement local and international databases.

Main results in 2001:

Methodical improvement of the zonation of pollen and human impact diagrams was done using special statistical approaches and computer programs (Poska, 2001). The impact of the Mesolithic man on the vegetation was proven by means of pollen analyses, in spite of restricted and short time imprints on the environment. Palynological richness served as the best indicator of pre-agrarian human impact. Low frequencies of cerealia pollen show that arable farming did not become the main economic base until the end of the Neolithic.

Immigration and spread of broad-leaved trees into Estonia was clarified, and earlier published data on this subject were critically evaluated (Saarse & Veski, 2001). A new buried organic deposits site was discovered and studied (Saarse et al., 2001).

The Baltic Sea shoreline database was created and shorelines for the Baltic Ice Lake, Ancylus Lake and Litorina Sea were simulated (Saarse et al., 2001). Diatom studies revealed that the saline bottom current penetrating into the Baltic Sea basin was strong enough to break up the water column stratification during the brackish Yoldia Sea stage (Heinsalu, 2001). The littoral diatom assemblages in northern Estonia indicate that saline water reached the Gulf of Finland during the Yoldia Sea stage and the short-lived brackish Yoldia phase is a synchronous event in the western and eastern Baltic Sea and can be used for correlation purposes (Heinsalu, 2001).

Hydrogeoecological studies – state and prospects

Estonian Academy of Sciences grant for monongraphic studies
Project leader: **H. Kink**
Duration: 2001–2001

In 1965, in the Institute of Geology of the Estonian Academy of Sciences hydrogeoecological research was started with ameliorative-hydrogeological studies. In the 1970s, water protection became the priority.

In the 1980s, much attention was paid to the quality of water. In the protected areas, where monitoring was carried out, the parameters needed for hydrogeoecological studies in dependence of the environment and landscapes were determined. At the end of the 1980s, investigation of hydrogeoecological conditions relating with the mining of mineral resources (oil shale, phosphorite, peat) was started.

In the 1990s, attention focused on landfills, towns and military objects of the former Soviet Union. At the same time, the foundation was laid to the study of water objects as nature monuments and to their assessment. The results obtained in this field have been recorded in 155 accounts stored at the Institute of Geology of Tallinn Technical University.

Based on the results of hydrogeoecological studies, 57 diploma papers, two candidate's theses and one M.A. thesis were compiled. Owing to the support from the Estonian Academy of Sciences, the most valuable part of the material derived through the studies is ready for publication; the book will appear in print in 2002. It enables to use the scientific results obtained during the course of 30 years in planning envi-

Isotope-Palaeoclimatology

As the laboratory of isotope-palaeoclimatology is the only complex research unit in the field of isotope-geochemistry and radiometric dating in the Eastern Baltic area, the main research direction has been the development and application of physical and geochemical methods in the study of the Quaternary palaeoclimate and palaeoenvironment. The main research fields of the laboratory are: isotope-palaeoclimatology, -palaeocryology and palaeohydrology; application of isotopic methods in Palaeozoic stratigraphy, climatology and oceanology; development and application of radiometric dating methods (TL, OSL and OSA) for Quaternary geochronology; retrospective dosimetry on the basis of natural materials.

One of the main research objectives is water and especially Estonian groundwater. The quality and quantity of available drinking water is a key issue globally and also one of the major concerns in the Estonian Environmental Strategy. The laboratory is part of the ongoing EC 5th Framework Project "BASELINE" (1999-2006) and groundwater research will be an important issue also in the EC next, 6th FP. Further studies will concentrate mainly on the genesis and distribution of palaeowaters in northern Estonia, baseline geochemistry and quality of water in different water complexes.

Isotope-geochemical analyses of ice cores, permafrost and ground ice as indicators of palaeoclimate and palaeoenvironment have been and will be one of the main research trends for the laboratory.

Considering the number of interesting scientific results obtained during recent years in the application of isotope methods in the study of Palaeozoic stratigraphy, this research direction should be of high priority in coming years. Further investigations in this field should be oriented more on the geochemical explanation of isotope variations in Palaeozoic sediments in order to find more reliable correlation between palaeoenvironmental changes and corresponding variations in the isotopic composition.

Throughout its existence, an important part of the laboratory activities has been devoted to the improvement of the parameters of commercially produced analytical technique and to the development of new techniques, especially in the field of luminescence dating. In recent years, a new promising optically stimulated afterglow (OSA) method was developed.

Geological fieldwork in Svalbard, midnight in April. Photo by T. Martma.

Late Quaternary climate and environmental changes and formation of groundwater in the sphere of influence of the Scandinavian glaciation: isotope-geochemical reconstructions

Target Financed Project No. 0330357s98
Project leader: **R. Vaikmäe**
Team: J. Ivask, I. Jaek, E. Kaup, T. Martma, L. Vallner
Duration: 1997–2001

It was established that the strongly depleted stable isotope composition and low radiocarbon concentration are the main indicators of glacial origin of groundwater in the Cambrian-Vendian aquifer in northern Estonia. This is confirmed by the absence of 3H in most of sampled wells. The intrusion of modern water into the Cambrian–Vendian aquifer system has been detected through the changes in the isotopic composition and increasing concentration of radiocarbon near the buried valleys. The noble gas analyses allowed to conclude that palaeorecharge took place at temperatures around the freezing point. In some places, unexpectedly high gas concentrations have been found. Excess air up to about 50 % is common, but factors 2 to 5 for the oversaturation are very unusual and need special processes and explanations. One explanation could be that oversaturation indicates recharge in high pressure conditions, e.g. by subglacial meltwater recharge through aquifers.

For a better understanding of global climate change high resolution, multiple proxy records from ice cores are needed. A 124-m-deep ice core was retrieved from Lomonosovfonna, Svalbard (1250 m a.s.l). High resolution sampling was performed on the core. The results suggest that pseudo-annual signals have preserved along most of the vertical profile. The 1963 radioactive layer is situated at a depth of 18.7 m, giving a mean annual accumulation of 0.38 m w.eq. for the period 1963–1996. The well-known anthropogenic influence on Svalbard environment is illustrated by increased levels of sulfate, nitrate and acidity. Both nitrate and sulfate levels started to increase in the late 1940s and remained high until the late 1980s. They have been decreasing during the last 15 years, in agreement with more controlled anthropogenic pollution release. The possibility to use the variations in the concentration of methanesulfonic acid contained in the glacier ice as an indicator of climate changes was studied. The chemical analysis of ice core from the Lomonosovfonna Plateau on Spitsbergen established that the concentration of MSH is related to the rise of sea-water temperature, which, in its turn, is due to the increasing amount of warm water carried from the tropics into the northern Atlantic. Thus, alterations of MSH concentrations in the glacial profile reflect climate changes of the past.

In the field of developing radiometrical dating methods a new device for measuring the optically stimulted after-glow (OSA) was designed and built. The device is more sensitive and allows the time of quenching of after-glow to be measured. In the course of testing of the device, OSA spectra were measured in some manganese-bearing materials, used in the ESR and luminescence dosimetry. The results obtained are of scientific significance, demonstrating also the potentials of the new device. OSL datings were used for stratigraphic correlation of Late Weichselian and Holocene sediments in the Lithuanian maritime regions.

The influence of the last glacial ice sheet on the formation of Estonian groundwater

Estonian Science Foundation Grant No. 4161
Project leader: **R. Vaikmäe**
Team: J. Ivask, E. Kaup, T. Martma, V. Raidla, L. Vallner
Duration: 2000–2003

The aim of the project is to elucidate to which extent the ice sheet, which covered Estonia during the last glaciation, has influenced groundwater formation in this area. The character of the influence of the ice sheet and its extent in space and time are studied. It is attempted to find out whether the hypothesis basing on recent studies in Germany, the Netherlands and Scandinavian states and suggesting subglacial meltwater discharge through aquifers and tunnel valleys (Boulton et al., 1995; Piotrowski, 1997) might explain, considering the geological structure of Estonia, the formation of the

groundwater here during the ice age and the present distribution of palaeogroundwater. With this in view, the origin of buried valleys is studied. The approximate age of these valleys will be determined by means of luminescent datings. To elucidate the conditions of subglacial meltwater discharge, the distribution and dynamics of permafrost will be reconstructed by means of model calculations on the basis of the most recent palaeoclimatic evidence. Isotope-geochemical methods and hydrogeological models are used to determine more precisely the spread of palaeogroundwaters in Estonia and its neighbourhood. The reasons for the extraordinarily high gas content in the Cambrian–Vendian aquifer are studied and the composition of gases is determined. The possibility is checked whether it might be atmospheric air of the last glacial age which got trapped in the continental ice, reached with subglacial meltwater discharge the aquifer system and has preserved there in several places up to the present. The results arising from the project will serve as a basis for elucidating the mechanism of groundwater formation in Estonia during the last ice age, for determining the limits of palaeogroundwater distribution and its dynamics during the post-glacial period up to the present.

The natural baseline quality in European aquifers: a basis for aquifer management

European Commission Project No. EVK1-CT-1999-0006
Project leader: **R. Vaikmäe**
Team: J. Ivask, E. Kaup, T. Martma, V. Raidla, A. Marandi, L. Vallner
Duration: 2000–2003

There is currently no standard to assess the natural baseline quality of groundwater. This is required a) as a basis for defining pollution and b) because the existing limits are breached by entirely natural processes. The present-day baseline inorganic and organic geochemistry will be investigated using selected reference aquifers as well as historical water quality trends in these aquifers. State-of-the-art chemical, isotopic and radiometric tracer techniques and geochemical modelling will be used to define timescales of the natural geochemical processes. The results will be used as a scientific basis for underpinning the emerging EU Water Framework Directive and for making recommendations for monitoring natural aquifer systems. This will be achieved by working closely with an advisory group drawn from regulatory bodies in the consortium. The results will be presented through scientific channels, for use by policy makers and legislators.

Energy accumulation, creation of defects and relaxation processes in solids with quartz and feldspars crystal lattice

Estonian Science Foundation Grant No. 4049
Project leader: **I. Jaek**
Team: A. Molodkov, V. Vassiltshenko
Duration: 2000–2002

Studying the processes of energy accumulation and relaxation by means of the luminescence method extremely deep traps were detected in the quartz. These traps empty at ca 900°C and, in connection with the great stability of the accumulated energy, are of great interest in both radiodosimetry and palaeodosimetry. Some specific characteristics of the corresponding centers became apparant; no specific spectral bands appear in the spectral distribution of the light sensitivity of these levels, the thermal emptying of these levels takes quartz to a highly sensibilized state where its dose sensitivity has grown nearly 100 times. The probable formation mechanisms of sensibilization were analyzed.

Dose dependence of the optically stimulated afterglow (OSA) were measured in different samples of natural quartz, but also in a series of synthetic materials (mainly in thermoluminescence dosimeters). The results prove that the OSA-method is indeed applicable in dating of quartz-bearing sediments; synthetic materials are in this way usable as flash dosimeters. Thus, under the semblance of the OSA-method, an alternative source providing information about energy accumulation processes in luminescence dosimeters, including palaeodosimeters, has

been created. A variant of OSA-equipment especially for dosimetric measurements was built. In this variant, integral stimulation is used and the unidentified background radiation (parasitic phosphorescence) that had occurred before, has been eliminated.

The research in the frame of the grant was submitted to the development of the physical basis of the methods of optical dating of sediments and via this to the development of new dating

Participation in international research projects

Response of the Ocean/Atmosphere System to Past Global Changes, International Geological Correlation Programme (IGCP) Project No 386, leader: H. Strauss (Münster, Germany), partners in Estonia: *D. Kaljo, T. Martma*

Circum-Arctic Lower-Middle Palaeozoic Vertebrate Palaeontology and Biostratigraphy, International Geological Correlation Programme (IGCP) Project No 406, leaders: M. Wilson (Canada), *P. Männik* and *T. Märss*, other staff involved: *T. Martma, O. Hints, E. Kurik, H. Nestor*.

The Great Ordovician Biodiversification Event, International Geological Correlation Programme (IGCP) Project No 410, leaders: B.D. Webby (Australia), M. Droser (USA) and F. Paris (France), partners in Estonia: *D. Kaljo, O. Hints, J. Nõlvak, L. Hints*.

Coastal Environmental Change During Sea-Level Highstands: A Global Synthesis With Implications For Management of Future Coastal Change, International Geological Correlation Programme (IGCP) Project No 437, leader: Colin V. Murray-Wallace (University of Wollongong, Australia), partners in Estonia: *A. Molodkov, A. Raukas.*

Glaciation and Reorganization of Asia's Network of Drainage (GRAND), International Geological Correlation Programme (IGCP) Project No 415, co-leaders: J.Teller (Canada) and *R. Vaikmäe* (Estonia).

Natural Baseline Quality in European Aquifers: a Basis for Aquifer Management, EC Framework V Project EVK1-CT1999-0006, coordinator: W.M. Edmunds (UK), partners in Estonia : *R. Vaikmäe, A. Marandi, J. Ivask, E. Kaup, T. Martma, L. Vallner.*

Groundwater Inflow from Coastal Aquifers to the Baltic Sea, European Science Foundation Project, leader: K. Peltonen (Finland), Estonian co-ordinator: *A. Raukas*.

Investigation of Extraterrestrial Spherules, Co-operative project between Estonian and Hungarian Academies of Sciences, Estonian co-ordinator: *A. Raukas*.

Terrestrial and Cosmic Spherules (TECOS), international research program, leader: A. Colombetti (Italy), members in Estonia: *A. Raukas, R. Tiirmaa, H. Pohl*.

Investigation of Rapid Climate Change Using Svalbard Ice Cores, Nordic Arctic Research Programme (NARP) project, leader: E. Isaksson (Norway), partners in Estonia: *R. Vaikmäe, J. Ivask, T. Martma*.

Ice climatology of Okhotsk and Baltic Seas, Finnish-Japanese cooperative research programme, leaders: M. Leppäranta (Finland) and T. Kawamura (Japan), partners in Estonia: *T. Martma, R. Vaikmäe.*

ETNET 21 Environment-Water, EC SOCRATES Programme Thematic Network of Education and Training for Environment-Water, coordinator: A. Van der Beken (Belgium), partners in Estonia: *R. Vaikmäe, A. Marandi.*

Recovery of Stromatoporoids from the End-Ordovician Mass Extinction, Twinning Program (National Science Foundation, USA) Project, partner in Estonia: *H. Nestor*.

Evaluation of Proposed Silurian Global Oceanic Episodes and Events Using Conodonts, Twinning Program (National Science Foundation, USA) Project, partner in Estonia: *P. Männik.*

Comparing Upper Ordovician-Lower Silurian Carbonate Platforms in Estonia and the Great Basin: A Test of the Synchrony of Sequences and Faunal Changes, National Science Foundation (USA) Project, leader: P. Sheehan (USA), partners in Estonia: *L. Hints, P. Männik* and *J. Nõlvak.*

The Early Palaeozoic Northern Baltic Sea Area Based on Fossils from Åland, Finland and Hiiumaa, Estonia, Project funded by the Finnish Museum of Natural History, University of Helsinki, leader: A. Uutela, partner in Estonia: *J. Nõlvak.*

Comparative Biostratigraphical Study of Cambrian and Ordovician Sequences in Polish and Estonian Part of the East-European Platform, collaborative project funded by the Polish Geological Institute, leaders: Z. Modlinski and B. Szymanski, partner in Estonia: *J. Nõlvak.*

Quaternary Environment of the Eurasian North (QUEEN), International Research Programme, leader: Henning Bauch (GEOMAR, Kiel, Germany), partner in Estonia: *A. Molodkov.*

East European Vegetation Assemblages on a South-North Transect 10000 to 5000 BP, International Project, leader: S. Hicks (Finland), partners in Estonia: *S. Veski, L. Saarse, A. Poska.*

Pollen Monitoring Program, International Project, leaders: S. Hicks, H. Tinsley, H. Pardoe and P. Cundill, partner in Estonia: *A. Poska.*

Quantitative Diatom Analysis in Environmental Studies, International Project, leader: V.-P. Salonen (Turku, Finland), partner in Estonia: *A. Heinsalu*.

Pollen/Landscape Calibration, International Project, partners in Estonia: *S. Veski, A. Poska* and *E. Niinemets*.

Palaeoseismic Events in the Sediments near Olkiluoto Island, the Bothnian Sea, International Project, partner in Estonia: *A. Heinsalu*.

Applied research

Categorisation of geological heritage, Estonian Ministry of the Environment, by E. Pirrus (leader, Department of Mining, TTU), A. Miidel, R. Karukäpp, R. Tiirmaa.

Study and protection of unique geological objects, Center of Environmental Investment, by L. Hints (leader), O. Hints, K. Mens, P. Männik, J. Nõlvak, H. Pärnaste.

Geochronological (ESR and OSL) investigations in the Baltic countries, Geological Survey of Lithuania and Tartu University, by A. Molodkov.

The palaeohydrogeology of the Upper Proterozoic and Palaeozoic aquiferous systems, a subprogramme of the Lithuanian state programme LITOSPHERE, Lithuanian Institute of Geology, by R. Vaikmäe and T. Martma.

Radiocarbon datings, various contractors, by E. Kaup.

Hydrogeoecological investigation of the Kunda mining and industrial area, Joint-Stock Company Kunda Nordic Cement Ltd., by H. Kink (leader), K. Erg and T. Metslang.

Booklets "Nature Monuments 10. Lahemaa" and "Nature Monuments 7. Rakvere, Kunda", Center of Environmental Investment, by H. Kink (compiler).

Conservation Management Plan of the Pakri Landscape Reserve, Environmental Survey of the Harju County, by H. Kink (leader), J. Nõlvak, K. Erg, A. Miidel

Nature monuments in the Estonian Nature Information System (EELIS). Hiiu and Järva Counties, Estonian Ministry of the Environment, by H. Kink (leader), K. Erg, U. Maspuran.

Environment expertise in geology and hydrogeology, ALARA Ltd., by H. Kink.

Verijärve information desk, Environmental Survey of the Võru County, by S. Veski

Training and education

PhD and MSc theses defended

Atko Heinsalu defended his PhD thesis "Diatom stratigraphy and the palaeoenvironment of the Yoldia Sea in the Gulf of Finland, Baltic Sea" on 10 May 2001 at the University of Turku, supervisor: Prof. V.-P. Salonen.

Senior researcher Atko Heinsalu (to the left) just after his PhD dissertation examination on May 10th in Turku University. The opponent Professor Matti Eronen is in the middle and the supervisor professor Veli-Pekka Salonen stands to the right.

Anneli Poska defended her PhD thesis "Human impact on the vegetation of coastal Estonia during the Stone Age" on 28 Sept. 2001 at the Uppsala University, supervisors: Prof. K. Bennett and PhD **L. Saarse**.

Arvo Käärd defended his MSc thesis "Naftasaaduste ja põlevkiviõli levik Eesti kvaternaarisetetes ja põhjavees" [Distribution of oil products and oil-shale oil in the Estonian Quaternary sediments and groundwater] on 15 June 2001 at Tartu University, supervisor: Prof. **A. Raukas**.

PhD and MSc projects in progress

Katrin Erg, PhD project, "Suletud ja tegutsevate põlevkivikaevanduste veere•iim" [Water regime of working and closed oil shale mines], supervisors: Prof. E. Reinsalu and Prof. **A. Raukas**.

Olle Hints, PhD project, "Ordovician scolecodonts of Estonia and neighbouring areas: taxonomy, distribution and application", supervisors: Prof. **D. Kaljo** and Prof. E. Pirrus.

Mari-Ann Mõtus PhD project at Tartu University, "Taxonomy, palaeoeclogy and distribution of Ordovician and Silurian tabulate corals in Baltoscandia", supervisor: Prof. T. Meidla.

Helje Pärnaste, PhD project at Tartu University, "Systematics and biozonation of the Arenigian trilobites of Northern East Baltic", supervisor: Prof. T. Meidla.

Eve Niinemets, PhD project at Tartu University, "High resolution climatic changes in the Late Pleistocene and Holocene", supervisors: Prof. T. Meidla and Prof. **R. Vaikmäe**.

Andres Marandi, PhD project at Tartu University, "Formation of the chemical composition of the Cambrian-Vendian groundwater in Estonia", supervisors: Prof. V. Kalm and PhD **R. Vaikmäe**.

Toomas Metslang, MSc project, "Keemilise koostise näitajate ja vooluhulkade vahelised korrelatiivsed seosed Toolse ja Kunda jõe näitel" [Correlation between the chemical composition and water discharge on the example of the Kunda and Toolse rivers], supervisors: PhD **H. Kink** and Prof. **A. Raukas**.

Valle Raidla, MSc project, "Modelling of carbon migration in the Cambrian-Vendian water-complex in Estonia", supervisors: Prof. E. Pirrus and Prof. **R. Vaikmäe**.

Triin Uudeväli, MSc project at Tallinn Pedagogical University, "Pääsküla ja Humala raketijuhtimiskeskuse jääkreostuse likvideerimine ning keskkonnaseisundi prognoos territooriumi edasiseks kasutamiseks" [Pollution on the military areas at Pääsküla and Humala, prognosis for future environmental conditions and possible use of the area], supervisors: PhD H. Kukk and Prof. **A. Raukas**.

Courses and lectures

Global climate and environmental changes, Institute of Geology, University of Tartu, lecture course by R. Vaikmäe.

Isotope geology and hydrology, Institute of Geology, University of Tartu, lecture course by R. Vaikmäe.

Diatom- and pollen analysis, University of Turku, lecture course and practical work was given by A. Heinsalu and S. Veski

Biomineralization, Department of Mining TTU, lecture course by J. Nemliher

Groundwater dynamics and water reservation, Department of Mining TTU, part of the course was taught by K. Erg

Micropalaeontology, Institute of Geology University of Tartu - specific parts of the course were taught by T. Märss, J. Nõlvak, V. Viira and O. Hints

Marine geology, Estonian Maritime Academy, lecture course by A. Raukas

Geology and geophysics, Estonian Maritime Academy, lecture course by A. Raukas

Palaeoclimatology, Estonian Maritime Academy, lecture course by A. Raukas

Environmental technology, Estonian Maritime Academy, lecture course by A. Raukas

Geology and mineral resources of Estonia, Eurouniversity, lecture course by A. Raukas

Geophysics and dynamical geology, Eurouniversity, lecture course by A. Raukas

Wetlands, Eurouniversity, Tallinn, lecture course by E. Kaup.

Ecology and limnology, Eurouniversity, Tallinn, lecture course by E. Kaup.

Geological and palaeontological collections

The Institute of Geology at TTU possesses the largest geological and palaeontological collections in Estonia. They comprise fossils, rocks, minerals and meteorites from all over the World, the emphasis being, however, on the Estonian and former Soviet Union material. The collections include historical specimens collected already in the 1850s by, e.g., Fr. Schmidt and J. Nieszkowski. Most of the material has still been accumulated since the 1950s until present. The 1960–1980s were especially productive since borehole material was extensively studied and also many expeditions were organised to various regions of the former Soviet Union during these years.

The total number of items deposited at the Institute is estimated to be several hundreds of thousands. Unfortunately, only a relatively small part of that is appropriately documented and catalogued which reduces usability of the material.

The Institute has also bedrock cores of more than 300 boreholes from Estonia and neighbouring areas. Since bedrock drilling has almost been stopped in Estonia, the core material is especially valuable providing samples and primary data for different studies run at the Institute as well as for several international collaborative projects. In addition, some 0.5km of core of varved clays is deposited and studied at the Institute.

The collections, drill cores and rock samples are stored in the Institute's building in Tallinn and at the Särghaua field-station in central Estonia.

Our collections form an integral part of the scientific work carried out at the Institute. Besides, many foreign geologists visit our institute with a primary task to study the collections, type-, figured- and cited specimens in particular. Also drill cores are frequently showed to researchers outside our institute. Every year some drill cores are studied by geology students of Tartu and Latvian universities during their teaching practice.

Geolgists from Estonia and USA studying drillcores at institute's Särghaua field-station. Photo by G. Baranov.

At the present time, the Institute has no publicly available expositions. However, specimens from our collections – meteorites, Ordovician, Silurian and Devonian fossils – have been exposed at many different exhibitions in Estonia and also in some other countries (particularly

Holotype of Ordovician trilobite *Ptychopyge truncata* (Nieszkowski) and its labels, showing different stages of research and curation. From left to right original illustration by Nieszkowski, 1859; illustration by Schmidt, 1902 and a recent photograph.

Finland and Germany). The most recent exhibitions, at which we displayed our material, were those in the Natural History Museum in Tallinn and in Tallinn Botanical Garden in 2001. Many specimens are also housed at Tartu University and in the Estonian Natural History Museum as long-term loans for research or exhibition.

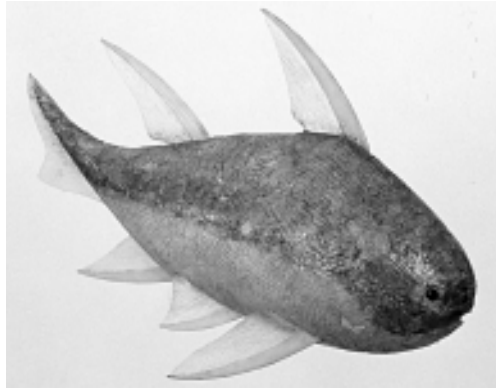
In 2001, a small structural unit, the Department of Scientific Collections, charged with the curation of the collections was founded at the Institute.

With respect to the curation of the collections, year 2001 was consequential: first time in institute's history, a small with curation being its main task was formed.

The staff of this department consists of the head (presently Linda Hints), chief curator (Ursula Toom) and four part-time technicians working on curation of the collections, registration and arrangement in particular.

Considering the small number of individual items properly registered, one of the main goals has been, and still is, routine cataloguing of specimens, the type-, figured-, and cited specimens given a priority. An in-house software application based on 'MS Access', open-source 'MySQL' and other components was developed, and is still being improved, to insert, query and hold the electronic data and to provide labels, specimen lists, etc.

During 2001, over 7300 items, including more than 4200 type-, figured-, and cited specimens were entered into the electronic catalogue. In addition, some 5000 rock- and micro-



Model of Late Devonian acanthodian *Culmacanthus stewardi.* Author: E. Kurik

palaeontological samples were recorded. As of the end of 2001, over 18000 items, 19000 samples and the accompanying information on persons, localities, publications etc are catalogued. This information is accessible through institute's LAN as well as the Internet at http://collections.gi.ee/ (user authentication is needed to access other than type-, figured- and cited material).

Alongside with electronic registration, these specimens were reordered, reboxed where necessary, and provided with new labels.

Members of the Department have been responsible for the development of a small exposition at the Institute's field-station introducing Estonian geology and highlighting some aspects of the geological work. Thay have alse guided many excursions in the Kaali meteorite crater field on Saaremaa Island.

Participation in conferences, workshops and excursions

17th International Mining Congress (18–24 June; Ankara, Turkey)
1st Nordic-Baltic Geo-Energy Seminar (15 September; Jagersborg-Genofte, Denmark)
20. Internationale Polartagung (26–30 March; Dresden, Germany)
2nd European Archaeomagnetic Meeting (23–27 September; Leoben, Austria)
35th Annual Conference of the Mid-North Section of the American Geological Society (23–24 April; Bloomington-Normal, Illinois, USA)
63rd EAGE Conference and Technical Exhibition (11–15 June; Amsterdam, Netherlands)
64th Annual Meeting, Meteoritical Society (10–14 September; Rome, Italy)
6th ESF-IMPACT Workshop, Impact Markers in the Stratigraphic Record (19–25 May; Granada, Spain)
6th International Drumlin Symposium (17–23 January; Torun, Poland)
6th Nordic Symposium on Petrophysics (15–16 May; Trondheim, Norway)
Arctic Feedback To Global Change (25–27 October; Rovaniemi, Finland)
Baltic and Nordic Countries: Common Future, Common Security (16–17 January; Tallinn, Estonia)
Baltic Sea Science Congress 2001 (24–29 November; Stockholm, Sweden)
Climate and Environment during the Last Glaciation and Holocene in the NW Russia and around the Baltic (23 March–2 April; St. Petersburg, Russia)
Colloquium of the Department of Climate and Environmental Physics, University of Bern (20 April; Bern, Swizerland)
Conference of Estonian Mining Society (9 November; Jäneda, Estonia)
Conference on Marine Geology (6 December; Tartu, Estonia)
Conference on Semi-Natural Biotopes and their Protection (15 May; Tartu, Estonia)
Conference on the Development of Kohtla-Järve City (17 December; Kohtla-Järve, Estonia)
Cooperation Event Natural Attenuation (11–12 December; Freising, Germany)
Early Palaeozoic palaeogeographies and Biogeographies of Western Europe and North Africa (24–26 January; Lille, France)
Environmental Impact and Water Management in a Catchment Area Perspective (24–26 July; Tallinn, Estonia)
Estonian Science Reform, Plusses and Minuses (5 October; Tallinn, Estonia)
European Union of Geosciences XI (8–12 April; Strasbourg, France)
Expert Group Meeting on Isotope Indicators of Sustainability in Groundwater Systems (15–18 October; Vienna, Austria)
Field Symposium on Quaternary Geology in Lithuania (19–25 May; Vilnius, Lithuania)
Final Meeting of the IGCP Project 415 GRAND (22–25 September; Aachen, Germany)
Final Workshop of German-Baltic Project GEOBALTICA (8–9 March; Potsdam, Germany)
First Baltic Symposium on Environmental Chemistry (26–29 September; Tartu, Estonia)
Fourth Plenary Meeting of the EC 5th Framework Programme Project "BASELINE" (29 September–2 October; Krakow, Poland)
Gesellschaft für Geschiebeforscchung, 17. Jahrestagung (6–8 April; Greifswald, Germany)
Glacial-Interglacial Sea-level Changes in Four Dimensions (31 March–5 April; St. Andrews, Scotland, UK)
Global Meeting on Earth System Processes (24–28 June; Edinburgh, Scotland, UK)
Groundwater Inflow from Coastal Aquifers to the Baltic Sea (5 April–5 May; Tallinn, Estonia)
Human Impact on the Environment of Tallinn (22 November; Tallinn, Estonia)
Hydrogeochemical Study and Assessment of Contamination in the Areas of Exploration of Oil Shale (Northeast Estonia) (27 September; Tallinn, Estonia)

Ice and Optic Worksop (11–13 November; Tallinn, Estonia)

Interdisciplinary Methods Studying Ancient Human Activity (17 February; Tartu, Estonia)

International Conference on Luminescence, Devoted to the 110th Anniversary of Birth of S.I.Vavilov (17–19 October; Moscow, Russia)

International Conference on the Study of Environmental Change Using Isotope Techniques (23–27 April; Vienna, Austria)

International Cooperation of Marine and Nature Museums in the Baltic Region: Looking Forward in the Making of a New Europe (16–19 May; Stralsund, Germany)

International Symposium on Ice Core and Climate (19–23 August; Kangerlussuaq, Greenland)

Life in the Past and Recent Seas (15 December–15 February; Tallinn, Estonia)

Life on the Earth (12–15 November; Tomsk, Russia)

Lomonosovfonna Workshop (24 October; Rovaniemi, Finland)

Meeting of the Microvertebrate Group of the Micropalaeontological Society, Friday 14th December 2001 (14 December; Ystad, Sweden)

Nordic IGS Annual Meeting 2001 (27–28 October; Rovaniemi, Finland)

NordSoil's 2nd Nordic-Baltic Conference (24–27 October; Tallinn, Estonia)

NorFA Workshop: Building Bridges Between Archaeology and Palaeoecology (3–8 April; Tartu, Estonia)

NorFA Workshop: Water in Africa, South Asia and the Middle East (13–17 August; Bergen, Norway)

Northern Research Basins. 13th International Symposium & Workshop (19–24 August; Saariselka, Finland)

Obruchev Symposium "Evolutionary Palaeoichthyology" (13–16 March; Moscow, Russia)

Palaeo-Ice Stream International Symposium (16–20 October; Aarhus, Denmark)

Palaeontological Association, 45th Annual Meeting (15–19 September; Copenhagen, Denmark)

Past Climate Variability Through Europe and Africa (27–31 August; Aix-en-Provence, France)

Planning of Interdisciplinary Projects in the Field of Archaeo-Geo-Biology (13–15 October; Pärnu, Estonia)

Possibilities for Co-Operation between the Nordic and the Baltic Countries in Solving Soil and Groundwater Problems - R&D Projects and Business Opportunity (24–27 October; Tallinn, Estonia)

Remote Sensing and GIS for Pollen/Vegetation Calibration Studies (2–6 May; Soome, Turku)

Research Progress and New Methodological Tools (16–20 August; Oulu/Hailuoto, Finland)

Sea Ice Climate and Marine Environments in the Okhotsk and Baltic Seas-The Present Status and Prospects (11–13 September; Seili, Nauvo, Finland)

The 13th Annual Meeting of the Academia Europaea (14–17 June; Rotterdam, Netherlands)

The 13th International Conference on Solid State Dosimetry (9–13 July; Ateena, Greece)

The April Conference in the Geological Survey of Estonia (30 March; Tallinn, Estonia)

The Baltic States in EU 5th Framework Programme (20–22 April; Riga, Latvia)

The Same Sea in All of Us (8 May–30 September; Helsingi, Finland)

The Society of Vertebrate Paleontology 61st Annual Meeting. (3–6 October; Bozeman, Canada)

The Way of Estonia - Our Possibilities (22 November; Tallinn, Estonia)

Third International Conference on Trilobites and their Relatives (2–6 April; Oxford, UK)

Third Plenary Meeting of the EC 5th Framework Programme Project "BASELINE" (10–13 March; Barcelona, Spain)

VII Nordic Energy Research Conference (28–30 November; Espoo, Finland)

VIII SCAR International Biology Symposium (27 August–1 September; Amsterdam, Netherlands)

Working Group on Ordovician Geology of Baltoscandia Conference (WOGOGOB) (16–20 May; Copenhagen, Denmark)

XI Conference of European Union of Geosciences (8–12 April; Strasbourg, France)

XXVII Days of Chemistry (14–16 November; Tallinn, Estonia)

International travels and visits

Erg, K. (10–12 December; Freising, Germany)
Heinsalu, A. (22–27 January; University of Turku Turku, Finland)
Heinsalu, A. (12–16 March; University of Turku Turku, Finland)
Heinsalu, A. (9–11 May; University of Turku Turku, Finland)
Heinsalu, A. (23–25 October; Finland)
Heinsalu, A. (9–13 November; Finland)
Heinsalu, A. (24–29 November; Stockholm University Stockholm, Sweden)
Hints, O. (3–17 October; The Natural History Museum London, UK)
Kaljo, D. (9–12 June; Stockholm, Sweden)
Kaljo, D. (15–16 October; Parainen, Finland)
Kaljo, D. (19–22 October; Moscow, Russia)
Kaup, E. (7 June; University of Helsinki Helsinki, Finland)
Kiipli, E. (5–15 July; Garntangen, Norway)
Konsa, M. (30 November–9 December; Riga, Latvia)
Kurik, E. (31 March–16 April; Greifswald, Braunschweig, Germany)
Martma, T. (18–22 March; University of Helsinki Helsinki, Finland)
Martma, T. (17 April–2 May; Norwegian Polar Institute Tromsø and Svalbard, Norway)
Martma, T. (7 June; University of Helsinki Helsinki, Finland)
Molodkov, A. (29 April–9 May; Moscow, Russia)
Männik, P. (20–23 February; St. Petersburg, Russia)
Männik, P. (5 March–29 April; Texas, USA)
Männik, P. (3 July–8 August; Komi Republic, Russia)
Männik, P. (8–15 November; Tomsk, Russia)
Märss, T. (21 May–10 June; The Natural History Museum London, UK)
Nõlvak, J. (21–29 April; Helsinki, Finland)
Poska, A. (1 January–15 June; Uppsala University Uppsala, Sweden)
Raidla, V. (7 June; University of Helsinki Helsinki, Finland)
Raukas, A. (26–31 January; United Nations New York, USA)
Raukas, A. (31 August–1 September; Latvian University Riga, Latvia)
Raukas, A. (5–12 October; Geological Institute of Hungary Budapest, Hungary)
Raukas, A. (16–22 October; Estonian Embassy Moscow, Russia)
Saarse, L. (9–10 May; University of Turku Turku, Finland)
Saarse, L. (27–29 September; Uppsala University Uppsala, Sweden)
Saarse, L. (24–28 October; Stockholm, Sweden)
Shogenova, A. (12–14 September; Technical University of Denmark Lyngby, Denmark)
Vaher, R. (22–25 January; Geological Survey of Finland Espoo, Finland)
Vassiljev, J. (28 April–2 May; St. Petersburg, Russia)
Veski, S. (28 April–2 May; St. Petersburg, Russia)
Veski, S. (2–10 May; University of Turku Turku, Finland)
Veski, S. (24–29 November; Stockholm University Stockholm, Sweden)
Viira, V. (11–30 October; Stockholm, Sweden)

Guest scientists

Antoshkina, A., Institute of Geology, Ural Branch of the Russian Academy of Sciences, Russia; 2–10 September; host: P. Männik

Auer, M., Indiana University, USA; 31 July–4 August; host: A. Raukas

Barrick, J.E., Texas Technical University, USA; 16 May–5 June; host: P. Männik

Beznosova, T., Institute of Geology, Ural Branch of the Russian Academy of Sciences, Russia; 2–10 September; host: P. Männik

Boulton, G., University of Edinburgh, UK; 24–26 May; host: R. Vaikmäe

Clark, J., Oregon University, USA; 1–7 July; host: A. Raukas

Csaba, D.H., Hungarian Geological Institute, Hungary; 6–13 August; host: A. Raukas

Donoghue, P., Birmingham University, UK; 19–24 February; host: E. Kurik

Grahn, Y., University of Rio de Janeiro, Brazil; 11–15 October; host: J. Nõlvak

Harris, M., Wisconsin-Milwaukee University, USA; 21 July–14 August; host: L. Hints

Löfgren, A., Lund University, Sweden; 11–18 June; host: V. Viira

Loydell, D. + 22 students, Portsmouth University, UK; 4–14 June; host: D. Kaljo

Marini, F., Nancy, France; 18–24 July; host: A. Raukas

Miller, C.G., The Natural History Museum, UK; 17–30 September; host: T. Märss

Modlinski, Z., Polish Geological Institute, Poland; 20–23 May; host: J. Nõlvak

Neuman, B.E.E., Bergen University, Norway; 21–29 November; host: D. Kaljo

Nystrand, B.-Å. + students, Uppsala University, Sweden; 14–17 November; host: S. Veski

Rinterknecht, V., Oregon University, USA; 1–7 July; host: A. Raukas

Sather, O.M., Geological Survey of Norway, Norway; 26–30 September

Sheehan, P., Milwaukee Public Museum, USA; 21 July–14 August; host: L. Hints

Sorlie, J.E., Norwegian Geotechnical Institute, Norway; 26–30 September

Szymanski, B., Polish Geological Institute, Poland; 20–23 May; host: J. Nõlvak

Vuorinen, A.M., University of Helsinki, Finland; 26–30 September

Co-operation partners

Arctic and Antarctic Research Institute (St. Petersburg, Russia)
Arctic Centre, University of Lapland (Rovaniemi, Finland)
Australian National University (Canberra, Australia)
British Geological Survey (Wallinford, UK)
Centre for Isotopic Research (Grøningen, Netherlands)
CNRS Laboratory of Glaciology and Environmental Geophysics (Grenoble, France)
Ecole Nationale Superieure de Geologie (Nancy, France)
Environmental Department of the Harju County (Tallinn, Estonia)
Estonian Environment Information Centre (Tallinn, Estonia)
Geological Survey of Denmark (Copenhagen, Denmark)
Geological Survey of Estonia (Tallinn, Estonia)
Geological Survey of Finland (Espoo, Finland)
Geological Survey of Lithuania (Vilnius, Lithuania)
Geological Survey of Norway (Trondheim, Norway)
Geological Survey of Sweden (Uppsala, Sweden)
Hungarian Geological Institute (Budapest, Hungary)
Indiana University (Indiana, USA)
Institute of Geology, Ural Branch of the Russian Academy of Sciences (Syktyvkar, Russia)
Institute of History (Tallinn, Estonia)
Institute of Low Temperature Science, Hokkaido University (Sapporo, Japan)
Krakow University of Mining and Metallurgy (Krakow, Poland)
Kunda Nordic Cement Ltd (Kunda, Estonia)
Latvian University (Riga, Latvia)
Laurentian University (Sudbury, Canada)
Lund University (Lund, Sweden)
Milwaukee Public Museum (Milwaukee, USA)
Moscow State University (Moscow, Russia)
National Museum of Wales (Cardiff, UK)
Norwegian Geotechnical Institute (NGI) (Oslo, Norway)
Norwegian Polar Institute (Tromsø, Norway)
Oregon State University (Oregon, USA)
Partek Nordkalk Ltd (Vasalemma, Estonia)
Polish Geological Institute (Warszawa, Poland)
Polytechnical University of Catalonia (Barcelona, Spain)
Risø National Laboratory (Risø, Denmark)
Russian Academy of Sciences, Geological Institute of the Kola Science Centre (Apatity, Russia)
Russian Academy of Sciences, Institute of Earth Physics (Moscow, Russia)
Russian Academy of Sciences, Institute of Limnology (St. Petersburg, Russia)
Russian Academy of Sciences, Institute of Oceanology (Moscow, Russia)
Russian Academy of Sciences, Institute of Palaeontology (PIN) (Moscow, Russia)
Siberian Division of the Russian Academy of Sciences, Institute of Archaeology and Ethnography (Novosibirsk, Russia)
St. Petersburg State University (St. Petersburg, Russia)
Station Marine d'Endoume (Marseille, Prantsusmaa)
Stockholm University (Stockholm, Sweden)
Tallinn Pedagogical University, Institute of Ecology (Tallinn, Estonia)
Tallinn Technical University, Department of Mining (Tallinn, Estonia)
Tartu University Institute of Geology (Tartu, Estonia)
Tartu University, Chair of Archaeology (Tartu, Estonia)
Tartu University, Institute of Experimental Physics (Tartu, Estonia)
Technical University of Denmark (Lyngby, Denmark)
Technische Universität Braunschweig (Braunschweig, Germany)
Texas Technical University (Lubbock, USA)

The Natural History Museum (London, UK)
Timan-Petchora Science Centre (Ukhta, Russia)
Ukhta National Technical University (Ukhta, Russia)
Universität Greifswald (Greifswald, Germany)
University of Alabama (Tuscaloosa, USA)
University of Alberta (Alberta, Canada)
University of Arhus (Arhus, Denmark)
University of Avignon (Avignon, France)
University of Bern, Department of Climate and Environmental Physics (Bern, Swizerland)
University of Copenhagen (Copenhagen, Denmark)
University of Edinburgh (Edinburgh, UK)
University of Gent (Gent, Belgium)
University of Helsinki (Helsinki, Finland)
University of Liverpool (Liverpool, UK)
University of Oulu, Institute of Geology (Oulu, Finland)
University of Portsmouth (Portsmouth, UK)
University of Rennes (Rennes, France)
University of Rio de Janeiro (Rio de Janeiro, Brazil)
University of St. Andrews (St. Andrews, UK)
University of Turku (Turku, Finland)
University of Vilnius (Vilnius, Lithuania)
Uppsala University (Uppsala, Sweden)
VSEGEI (St. Petersburg, Russia)
Wisconsin-Milwaukee University (Milwaukee, USA)

Membership

Academie Europaea: R. Vaikmäe (member);
Academy Nord, Research Centre Free Europe: A. Raukas (member of the council);
Academy of Sciences of New York: A. Raukas (acting member);
American Geochemical Society: A. Lepland (member);
American Geographical Society: A. Raukas, L. Saarse (member);
American Geophysical Society: A. Lepland (member);
American Geophysical Union: R. Vaikmäe (member);
Archimedes Foundation: R. Vaikmäe (member of the board);
Association Eesti Elujõud (the Vitals of Estonia): A. Raukas (member);
Association Eluterve Eesti (Sound Estonia): A. Raukas (member);
Australian National Antarctic Research Expeditions (ANARE) Club: E. Kaup (member);
Baltic Sea Science Congress 2001: S. Veski (member of the organizing committee);
Baltic Stratigraphical Association: D. Kaljo (deputy chairman); E. Kurik, T. Märss, H. Nestor, A. Raukas (members);
Biographic Lexicon of Estonian Science: H. Nestor (member of the editorial board);
Board of the Estonian Encyclopedia Publishers: A. Raukas (chairman);
CIMP Subcommission on Chitinozoa: V. Nestor, J. Nõlvak (members);
Circumpolar Arctic Palaeoenvironment, CAPE: R. Vaikmäe (member of the steering committee);
Commission of Estonian Mineral Resources: D. Kaljo (chairman); A. Teedumäe (member of expert team);
Commission on Estonian Stratigraphy: D. Kaljo (chairman); L. Hints (member); P. Männik (secretary); E. Kurik (chairman of Devonian Working Group); J. Nõlvak (chairman of Ordovician Working Group); A. Raukas (member, chairman of Quaternary Working Group); H. Nestor (chairman of Silurian Working Group); K. Mens (chairman of Vendian-Cambrian Working Group);
Council of Estonian Academic Library: D. Kaljo (chairman); R. Vaikmäe (member);
Council of Europe, Committee on Higher Education and Research: R. Vaikmäe (member of the bureau);
Council of Institute of Geology at TTU: A. Raukas (chairman); D. Kaljo (deputy chairman); L. Hints, P. Männik, T. Märss, A. Miidel, L. Saarse, R. Vaikmäe, S. Veski (members);
Council of Kalev Sports Society: A. Raukas (member);
Council of Tallinn Technical University: A. Raukas (member);
Curatorium of Tallinn Pedagogical University: A. Raukas (chairman);
EC 5th Framework Programme Subprogramme INCO-2: R. Vaikmäe (delegate of the programme committee);
Encyclopaedia of Estonia: A. Raukas (scientific chief editor);
Encyclopaedia of Tallinn: A. Raukas (member of the editorial board);
Estonian Academy of Sciences: A. Raukas (member); D. Kaljo (member, board member, foreign secretary);
Estonian Academy of Sciences, Commission of Meteoritics: A. Raukas (chairman); Ü. Kestlane (member); R. Tiirmaa (secretary);
Estonian Academy of Sciences, Commission for Nature Conservation: A. Miidel (member);
Estonian Academy of Sciences, Commission on Target Financing of Monographic Research: A. Raukas (member);
Estonian Academy of Sciences, Council of Energetics: A. Raukas (member);
Estonian Academy of Sciences, Division of Biology, Geology and Chemistry: D. Kaljo (deputy chairman);
Estonian Academy of Sciences, Publishing Board: A. Raukas (member);
Estonian Agricultural University, Council on Defence of Doctor's Degree in Natural Sciences: A. Raukas (member);
Estonian Association of Owners by Title: A.

Raukas (chairman and head of the board);

Estonian Astronomical Society: J. Ivask (member);

Estonian Cromatographic Society: J. Ivask (member of council);

Estonian Geographical Society: A. Raukas (deputy chairman); E. Kaup, R. Vaikmäe (member);

Estonian Geological Society: A. Marandi, R. Vaikmäe (members); D. Kaljo, A. Raukas (members of the council);

Estonian Malacological Society: E. Tavast (member);

Estonian Maritime Academy, Board of Councils: A. Raukas (member);

Estonian Maritime Academy, Council of Marine Department: A. Raukas (member);

Estonian Mining Society: K. Erg (member);

Estonian Ministry of Education, Board of Scientific Competence: R. Vaikmäe (member);

Estonian Ministry of Environment, Board: A. Raukas (member);

Estonian Ministry of Environment, Coastal Monitoring Program: A. Raukas (leader);

Estonian National Committee of Geologists: D. Kaljo (chairman); A. Raukas (deputy chairman);

Estonian Naturalists Society: H. Nestor (chairman of divison of palaeontology); R. Einasto, L. Hints, D. Kaljo, H. Kink, A. Kleesment, M. Konsa, E. Kurik, P. Männik, K. Mens, A. Miidel, H. Nestor, V. Nestor, J. Nõlvak, E. Pirrus, A. Raukas, L. Saarse, L. Sarv, E. Tavast, R. Tiirmaa, R. Vaher, V. Viira (members);

Estonian Ornithological Society: O. Hints (member);

Estonian Polar Club: E. Kaup (chairman); T. Martma, R. Vaikmäe (members);

Estonian Polar Foundation: E. Kaup (member of board);

Estonian Rome Club: A. Raukas (member);

Estonian Society for Research of Native Place: A. Raukas (member);

Estonian Technological Agency, Advisory Board: R. Vaikmäe (member);

Estonian Technological Agency, Financial Board: R. Vaikmäe (member);

Estonian Union of History and Philosophy of Science: H. Nestor (member of council, chairman of Tallinn division);

Estonian Union of Scientists: A. Raukas (co-chairman); R. Einasto, D. Kaljo, R. Karukäpp, H. Kink, H. Nestor, E. Tavast, R. Vaher (members); R. Vaikmäe (member of the board); A. Kleesment (member of the council);

Estonian Working Group of the Joint Commission on Monitoring and Scientific Research of Water Basins on the Estonian-Russian Border: A. Raukas (member);

European Pollen Monitoring Program: A. Poska (member);

European Society for Isotopic Research: T. Martma (member); R. Vaikmäe (president);

Finnish Society of Earth Physics: A. Raukas (member);

Geological Society of Finland: A. Raukas (corresponding member);

Geological Society of London: D. Kaljo (honorary member);

International Association for the Study of Fossil Cnidaria and Porifera: H. Nestor (member of the council);

International Association of Geomorphologists: A. Raukas (Estonian national representative);

International Association of Hydrogeologists (IAH): A. Marandi, R. Vaikmäe (members);

International Association of Hydrological Sciences (IAHS): K. Erg (member);

International Association of Theoretical and Applied Limnology (SIL): E. Kaup (member);

International ESR Society: A. Molodkov (member);

International Federation of Scientists: A. Raukas (member);

International Geological Correlation Program (IGCP), Project 415: R. Vaikmäe (co-leader);

International Geomorphological Association, Estonian National Committee: A. Raukas (chairman); R. Karukäpp (secretary);

International Glaciological Society, IGS: R. Vaikmäe (member);

International Palaeontological Association, Graptolite Working Group: D. Kaljo (member);

International Permafrost Association, IPA: R. Vaikmäe (individual member);

International Society of Vertebrate Morphology: T. Märss (member);

International Union for Quaternary Research (INQUA): A. Raukas (honorary member);

International Union for Quaternary Research (INQUA), Estonian National Committee: R. Vaikmäe (chairman); A. Raukas, L. Saarse (members);

International Union for Quaternary Research (INQUA), Comission on Continental Palaeohydrology: L. Saarse (corresponding member);

International Union of Geological Sciences, Commission on Geological Sciences and Environmental Planning: A. Raukas (Estonian national representative);

International Union of Geological Sciences, Subcommission on Devonian Stratigraphy: E. Kurik (corresponding member);

International Union of Geological Sciences, Subcommission on Ordovician Stratigraphy: L. Hints, D. Kaljo, J. Nõlvak (corresponding member);

International Union of Geological Sciences, Subcommission on Silurian Stratigraphy: T. Märss, H. Nestor (corresponding members); D. Kaljo (member);

IPA Task Force for Isotope Geochemistry of Permafrost: R. Vaikmäe (chairman);

Journal: Baltica: A. Raukas (member of the editorial board);

Journal: Boreas: R. Vaikmäe (member of the editorial board);

Journal: Bulletin of the Geological Survey of Estonia: A. Miidel (member of the editorial board);

Journal: Oceanological Studies: A. Raukas (member of the editorial board);

Journal: Oil Shale: A. Raukas (member of the editorial board);

Journal: Paleontologicheskij Zhurnal: D. Kaljo (member of the editorial board);

Journal: Proceedings of the Estonian Academy of Sciences. Geology: A. Raukas (chairman of the editorial board); D. Kaljo (deputy chairman of the editorial board); A. Miidel (secretary); R. Vaikmäe (member of the editorial board);

Journal: Quaternary International: R. Vaikmäe (member of the editorial board);

Journal: Stratigrafiya. Geologicheskaya korrelyaciy: D. Kaljo (member of the editorial board);

Non-profit Society Museum of Konstantin Päts: A. Raukas (member);

Non-profit Society Pakri Nature Centre: H. Kink, A. Raukas (members of the board);

Nordic Association for Hydrology: R. Vaikmäe (member);

Palaeontological Association: O. Hints, D. Kaljo (members);

Pander Society: P. Männik, V. Viira (members);

Past Global Changes (PAGES): L. Saarse, S. Veski (corresponding members);

Peribaltic Group of the INQUA, Comission on Glaciations: R. Karukäpp, A. Raukas (members);

Royal Geographical Society: A. Raukas (honorary member);

Scientific Society of Gdansk: A. Raukas (foreign member);

Tallinn Association of Estonian Real Estate Holders: A. Raukas (member of the board);

Tallinn College of Engineering, Board of Councils: A. Raukas (member);

Tallinn Pedagogical University, Council on the Defence of Doctor's Degree in Ecology: A. Raukas (member);

Tallinn Pedagogical University, Advisory Board: A. Raukas (chairman); R. Vaikmäe (member);

Tallinn Technical University, Commission on Development: A. Raukas (member);

UNESCO International Hydrological Programme, Estonian National Committee: R. Vaikmäe (member);

Other events

Awards

Dimitri Kaljo (leader of the working group), **Linda Hints**, **Tõnu Martma** and **Jaak Nõlvak**, were awarded the *Estonian State Prize* in geo- and biosciences for a series of papers in isotope geology, especially in Ordovician and Silurian stratigraphy, climatology and oceanology (see Kaljo, 2001 and Kaljo et al. 2001 for full details).

Anto Raukas was elected *Honorary Member of the Estonian Geographical Society.*

Conferences and workshops organized

Ecogeochemistry in the Baltic region: results and prospects, 15.–17. Feb 2001, Tallinn, Estonia.

Groundwater Inflow from Coastal Aquifers to the Baltic Sea, 04.–05. May 2001, Tallinn, Estonia.

Planning of interdisciplinary projects in the field of archaeo-geo-biology, 13.–15. Oct 2001, Pärnu, Estonia.

Publications 2001

Papers in SCI and CC listed journals

Bitinas, A., Damušyte, A., Hütt, G., Jaek, I., Kabailiene, M. 2001. Application of the OSL dating for stratigraphic correlation of Late Weichselian and Holocene sediments in the Lithuanian Maritime Region. *Quaternary Science Reviews* **20**, 767–772.

Björck, S., Muscheler, R., Kromer, B., Heinemeier, J., Johnsen, S.J., Andersen, C.S., Conley, D., Koc, N., Spurk, M., Veski, S. 2001. High-resolution analyses of an early Holocene climate event may imply decreased solar forcing as an important climate trigger. *Geology* **29**(12), 1107–1110.

Hints, O. 2001. Ordovician eunicid polychaetes of Estonia and surrounding areas: a review of their distribution and diversification. *Review of Palaeobotany and Palynology* **113**(1-3), 41–55.

Hütt, G., Göksu, H.Y., Jaek, I., Hiekkanen, M. 2001. Luminiscence dating of Somero sacristy SW Finland using the 210°C TL peak of quartz. *Quaternary Science Reviews* **20**, 773-777.

Hütt, G, Jaek, I., Vasilchenko, V. 2001. Photoionization of radiation-induced traps in quartz and alkali feldspars. *Applied Radiation and Isotopes* **54**, 175–182.

Isaksson, E., Pohjola, V., Jauhiainen, T., Moore, J., Pinglot, J-F., Vaikmäe, R., van de Wal, R.S.W., Hagen, J-O., Ivask, J., Karlöf, L., Martma, T., Meijer, H.A.J., Mulvaney, R., Thomassen, M.P.A., Van den Broeke, M. 2001. A new ice core record from Lomonosovfonna, Svalbard: viewing the data between 1920–1997 in relation to present climate and environmental conditions. *Journal of Glaciology* **47**(157), 335–345.

Kaljo, D., Hints, L., Martma, T., Nõlvak, J. 2001. Carbon isotope stratigraphy in the latest Ordovician of Estonia. *Chemical Geology* **175**, 49–59.

Kawamura, T., Shirasawa, K., Ishikawa, N., Lindfors, A., Rasmus, K., Granskog, M.A., Ehn, J., Lepparänta, M., Martma, T., Vaikmäe, R. 2001. Time series observations of the structure and properties of brackish ice in the Gulf of Finland, the Baltic Sea. *Annals of Glaciology* **33**, 1–4.

Kiipli, T., Männik, P., Batchelor, R.A., Kiipli, E., Kallaste, T., Perens, H. 2001. Correlation of Telychian (Silurian) altered volcanic ash beds in Estonia, Sweden and Norway. *Norsk Geologisk Tidskrift* **81**(3), 179–193.

Laigna, K., Raukas, A. 2001. The effect of subsurface mining on the land surface and preliminary calculation of pillars. *Oil Shale* **18**(3), 203–213.

Märss, T., Gagnier, P.-Y. 2001. A new chondrichthyan from the Wenlock, Lower Silurian, of Baillie-Hamilton Island, the Canadian Arctic. *Journal of Vertebrate Paleontology* **21**(4), 687–695.

Miidel, A., Noormets, R., Hang, T., Flodén, T., Bjerkéus, M. 2001. Bedrock geology and topography of the Lake Peipsi depression, eastern Estonia. *GFF* **123**(1), 15–22.

Olsson, I.U., Kaup, E. 2001. The varying radiocarbon activity of some recent submerged Estonian plants grown in the early 1990's. *Radiocarbon* **43**(3),

Puura, V., Kärki, A., Konsa, M., Floden, T., Pihlaja, P., Suuroja, K. 2001. Estolites – magnetic metalliferous particles from suevites from craters of Estonia, Fennoscandia, and Africa. *Meteoritics & Planetary Science Supplement* **36**(9), A169–170.

Raukas, A., Tiirmaa, R., Kaup, E., Kimmel, K. 2001. The age of the Ilumetsa meteorite craters in South-East Estonia. *Meteoritics & Planetary Science* **36**(11), 1507–1514.

Soehn, K.L., Märss, T., Caldwell, M.W., Wilson, M.V.H. 2001. New and biostratigraphically useful thelodonts from

the Silurian of the Mackenzie Mountains, Northwest Territories, Canada. *Journal of Vertebrate Paleontology* **21**(4), 651–659.

Veski, S., Heinsalu, A., Kirsimäe, K., Poska, A., Saarse, L. 2001. Ecological catastrophe in connection with the impact of the Kaali Meteorite about 800–400 BC on the island of Saaremaa, Estonia. *Meteoritics & Planetary Science* **36**(10), 1367–1375.

Viira, V., Löfgren, A., Mägi, S., Wickström, J. 2001. An Early to Middle Ordovician succession of conodont faunas at Mäekalda, northern Estonia. *Geological Magazine* **138**, 699–718.

Vimeux, F., Masson, V., Jouzel, J., Petit, J.R., Steig, E.J., Stievenard, M., Vaikmäe, R., White, J.W.C. 2001. Holocene hydrological cycle changes in the Southern Hemisphere documented in East Antarctic deuterium excess records. *Climate Dynamics* **17**(7), 503–513.

Papers in other peer-reviewed journals and books

Edmunds, W. M., Hinsby, K., Marlin, C., Condesso de Melo, M.T., Manzano, M., Vaikmäe, R., Travi, Y. 2001. Evolution of groundwater systems at the European coastline. In: Palaeowaters in Coastal Europe: evolution of groundwater since the late Pleistocene. The Geological Society of London, London. *Geological Society Special Publication* **189**, 289–311.

Erg, K., Kann, J., Raukas, A. 2001. Rational use and environmental impacts of oil shale mining in Estonia. In: Ünal, E., Ünver, B., Tercan, E. (eds). Proceedings of the Seventeenth International Mining Congress and Exhibition of Turkey, Ankara 19–22 June 2001. The Chamber of Mining Engineers of Turky, Ankara. 467–472.

Hang, T., Miidel, A. Kalm, V., Kimmel, K. 2001. New data on the distribution and stratigraphy of the bottom deposits of Lake Peipsi, eastern Estonia. *Proceedings of the Estonian Academy of Sciences. Geology* **50**(4), 233–253.

Harper, D.A.T., Hints, L. 2001. Distribution and diversity of Ordovician articulated brachiopods in the East Baltic. In: Brunton, C.H.C., Cocks, L.R.M., Long, S.L. (eds), Brachiopods. Past and present. Chapter 1. Taylor & Francis, London, New York. *The Systematics Association Special Volume Series* **63**, 315–326.

Hütt, G., Jaek, I. 2001. Advances in the luminescence dating: the optically stimulated luminescence based procedures and their physical background. *Proceedings of the Estonian Academy of Sciences. Geology* **50**(4), 214–232.

Ivask, J., Pentchuk, J., Vaikmäe, R. 2001. Ion chromatographic determination of major anions and cations in Antarctic ice. *Proceedings of the Estonian Academy of Sciences. Chemistry* **50**(1), 46–51.

Jaek, I., Hütt, G., Rammo, I., Vassilchenko, V. 2001. Search for the dose-sensitive optically stimulated luminescence response in natural carbonates. *Proceedings of the Estonian Academy of Sciences. Geology* **50**(3), 139–148.

Jensen, S., Mens, K. 2001. Trace fossils *Didymaulichus* cf. *tirasensis* and *Monomorphichnus* sp. from Lower Cambrian of Estonia. *Proceedings of the Estonian Academy of Sciences. Geology* **50**(2), 75–85.

Kaup, E., Ellis-Evans, J.C., Burgess, J.S. 2001. Increased phosphorus levels in the surface waters of Broknes, Larsemann Hills, Antarctica. *Verhandlungen Internationale Vereingung der Limnologie* **27**(5), 3137–3140.

Märss, T. 2001. *Andreolepis* (Actinopterygii) in the Upper Silurian of northern Eurasia. *Proceedings of the Estonian Academy of Sciences. Geology* **50**(3), 190–206.

Mõtus, M.-A. 2001. Environment related morphological variation in Early Silurian tabulate corals from the Baltic area. *Bulletin of the Tohoku University Museum* **1**, 62–69.

Nemliher, J. 2001. The shell structure and mineralogy of *Mickwitzia* (Lingulata: brachio-

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