Geoloogia instituut, 2016. aasta teadus- ja arendustegevuse aruanne

1. Struktuuriüksuse struktuur 2017. a

Geoloogia instituut
Department of Geology
Atko Heinsalu, atko.heinsalu@ttu.ee, +372 5912 3761

The Department of Geology is currently employing 3 professors.
The total number of academic staff is 30.
1 doctoral dissertations were defended in 2016.
The Department of Geology consists of 5 research groups and the Department of Collections.

2. Teadus- ja arendustegevuse ülevaade uurimisrühmade[1] lõikes

2.1 Struktuuriüksusesse kuuluvad uurimisrühmad (research groups).

2.1.1 aluspõhjageoloogia osakond (Division of Bedrock Geology)
Professor Olle Hints

Paleosoikumi töörühma uuringud on seotud eeskätt Ordoviitsiumi ja Siluri ajastu paleontoloogia, paleokliima, keskkonnamuutuste ja integreeritud bio- ja kemostratigraafiaga. Töörühma peamise loodusliku laboratooriumi moodustavad Baltika paleokontinendi kivimid ja geoloogilised läbilõiked, mis on ühed paremini säilinud Paleosoikumi arhiivid maailmas. Neid täiendavad andmed teistelt paleokontinentidelt ja regioonidest (Siber, Põhja-Ameerika, Kesk-Euroopa jt). Töörühma peamised teaduslikud küsimused on seotud orgaanilise maailma evolutsiooni ja elurikkuse arenguga, väljasuremiste ja põhjustega, paleokliima- ja keskkonnamuutustega, paleobiogeograafiaga, fossiilste ökosüsteemide funktsioneerimisega ning aineringe tsüklite arenguga geoloogilises ajas.

The research of the working group is focusing on Early Paleozoic paleobiology, paleoclimate, paleoenvironmental change, and integrated bio- and chemostratigraphy. The Baltoscandian rocks, which constitute one of the best archives of Paleozoic Earth history worldwide, are used as a natural laboratory, complemented by data from other paleocontinents and regions (e.g., Siberia, North America and Central Europe etc). The main scientific questions targeted by the group are related to the evolution and diversification of biosphere, extinction events and their connections with climate change and environmental perturbations, paleobiogeography, functioning of fossil ecosystems, geochemical cycling and its changes through time.

2016

- Pandi alus Siluri ajastu paleokliima kaasaegsele käsitlusele kasutades konodondi-apatiidi hapniku isotooptermomeetrit, mis näitab globaalsete geobiosündmuste otsest seost kliimaga.
- Loodi Baltoskandia kitiinikute biostratigraafia, bentoniitide ja isotoopsündmuste integreeritud kvantitatiiv-stratigraafiline mudel, mis lubab varasemast täpsemalt hinnata elustiku ja keskkonna muutuste ajalist suhet ja selgitada paleo-elurikkuse arengut.
- Ordoviitsiumi ning Siluri läbilõigete baasil valmis süsiniku isotoopkoostise muutuste kõver, mille juures erilise tähelepanu all olid Guttenbergi, Hirnantia ja Irevikeni sündmused.
- Bio- ja kemostratigraafiliste meetodite kombineerimine võimaldas täpsustada geoloogilist ajaskaalat ning dateerida olulisi tasemeid.
- Paleontoloogilistes töödes kirjeldati uusi fossiilide taksoneid ja selgitati organismide biogeograafilist levikut ja biostratigraafilne väärtust, paleobioloogia valdkonnas jätkati uue suunana jäljekivististe uurimisega, mis annavad väärtuslikku teavet mitte-fossiliseeruvate organismide ja nende elukeskkonna kohta.

[1] Oma uurimisvaldkonnas teadusprojekte/-lepinguid teostav teadlaste ja/või õppejõudude kooslus, mis võib hõlmata liikmeid mitmest struktuuriüksusest. Viimasel juhul näidatakse tulemused kõigi uurimisgrupis osalevate struktuuriüksuste aruannetes.

In 2016

- Oxygen isotope records from conodont apatite enabled reconstructing Silurian global climate history, showing direct links between major geobioevents and climate change.
- New integrated quantitative stratigraphic model for Baltoscandian chitinozoan biostratigraphy, K-bentonites and carbon isotope signatures allowed evaluating age-relations between biotic and environmental changes and reconstruct paleobiodiversity in highest resolution.
- Based on Ordovician-Silurian succession an updated carbon isotope curve was created for the Baltic region with particular emphasis on Guttenberg, Hirnantian and Ireviken events, allowing new environmental interpretations and chemostratigraphic correlations.
- Combined bio- and chemostratigraphty improved correlation tools and allowed precise dating of key succession and events.
- In paleontological studies new taxa were described and biogeographic and stratigraphic distribution of different fossil groups was analysed globally and within the Baltic region.

Olulisemad artiklid:

- **Hints**, L., Paškevicius, J. **Martma**, T., **Männik**, P., **Nõlvak**, J. 2016. Upper Sandbian-lower Katian bio- and chemostratigraphy in the Pajevonys-13 core section, Lithuania. Estonian Journal of Earth Sciences 65, 85-97.
- **Hints**, O., **Tonarová**, P., Desrochers, A. 2016. Late Ordovician jaw-bearing polychaetes from Anticosti Island, eastern Canada, and their biogeographic significance. Canadian Journal of Earth Sciences 53, 731-738.
- Trotter, J.A., Williams, I.S., Barnes, C.R., **Männik**, P., Simpson, A. 2016. New conodont δ18O records of Silurian climate change: Implications for environmental and biological events. Palaeogeography, Palaeoclimatology, Palaeoecology 443, 34-48.

2.1.2 isotoopgeoloogia osakond (Division of Isotope Geology)

Senior researcher Rein Vaikmäe

Isotoopgeoloogia osakonna peamised uurimissuunad on: (1) põhjavee isotoopkoostis, vanus, päritolu ja numbrilised mudelid; (2) polaaralade isotoop-põhised paleokliima- ja keskkonnamuutused; (3) CO_2 sidumine ja geoloogiline ladustamine.

The studies of the research group are focused on: (1) groundwater isotopic composition, age, origin and numerical models; (2) isotopic signatures of paleoclimatic and environmental change in polar areas; (3) CO_2 capture and geological storage.

2016

- Viimasel jääajal ladestus Norra šelfi meresettesse suurtes kogustes metaani. Mandrijää taandumisel algas metaani lekkimine, mille tulemusel tekkisid merepõhja karbonaatsed koorikud. Uuriti koorikute moodustumise vanust e metaani lekkimise vanust ja arutleti selle mõju globaalsele kliima soojenemisele.
- Tehti kindlaks, et Põhja-Eesti Ordoviitsium-Kambriumi põhjaveekompleksis oleva põhjavee arengut on mõjutanud tänapäevastest sademetest, jääaja mandriliustike sulavetest ja reliktsetest mineraalvetest pärineva vee segunemine. Põhjavete isotoop- ja keemiline koostis näitab, et Pleistotseeni jäätumised on avaldanud varem arvatust laialdasemat mõju põhjavee kujunemisele ja kuna liustike sulavetest pärinev põhjavesi on oma olemuselt taastumatu, siis tuleb sellega arvestada põhjavee tarbimist puudutavates otsustes.
- Tehti kindlaks, et Balti Arteesiabasseini pinnalähedaste põhjaveekihtide vee isotoopkoostis on hapniku ja vesiniku raskemate isotoopide sisalduse poolest oluliselt vaesestunud võrreldes piirkonna sademete aasta keskmise isotoopkoostisega. Püstitati hüpotees, et taimed viivad vegetatsiooniperioodil pinnasest välja ebaproportsionaalselt suure koguse suvistest sademetest, mistõttu infiltreerunud põhjavees domineerivad kevadised sulaveed ja sügisesed sadeveed.

In 2016

- Large quantities of methane were stored into marine sediments along Norwegian shelf during the glaciations. Authigenic carbonate crusts were formed simultaneously with methane release after deglaciation of Scandinavian Ice Sheet. Timing of crust formation associated with methane seeps across the seabed were analysed. Impact on atmospheric methane concentrations and the possible response to global climate change is discussed.
- It was determined that groundwater in the North Estonian Ordovician-Cambrian aquifer system represents a mixture of waters originating from modern precipitation, glacial meltwater and relict Na-Cl. The isotopic and chemical composition of groundwater indicates that the influence of Pleistocene glaciations on the geochemical evolution of groundwater has been far more extensive than previously thought. These findings should be taken into account in future decisions concerning the management of groundwater resources.
- Groundwater and modern precipitation spatial composition in the Baltic Artesian Basin area revealed that the isotopic composition of shallow groundwater is depleted with respect to weighted mean annual values in local precipitation. Hypothetically, the long vegetation period allow plants to transpire a substantial portion of the summer precipitation input, which causes the groundwater recharge to be strongly biased towards the spring snowmelt and autumn precipitation.

Olulisemad artiklid:

- Crémière, A., Lepland, A., Chand, S., Sahy, D., Condon, D.J., Noble, S.R., **Martma**, T., Thorsnes, T., Sauer, S., Brunstad, H. 2016. Timescales of methane seepage on the Norwegian margin following collapse of the Scandinavian Ice Sheet. Nature Communications 7, 11509.
- **Pärn**, J., **Raidla**, V., **Vaikmäe**, R., **Martma**, T., **Ivask**, J., Mokrik, R., Erg, K. 2016. The recharge of glacial meltwater and its influence on the geochemical evolution of groundwater in the Ordovician-Cambrian aquifer system, northern part of the Baltic Artesian Basin. Applied Geochemistry 72, 125-135.
- **Raidla**, V., Kern, Z., **Pärn**, J., Babre, A., Erg, K., **Ivask**, J., Kalvāns, A., Kohán, B., Lelgus, M., **Martma**, T., Mokrik, R., Popovs, K., **Vaikmäe**, R. 2016. A δ18O isoscape for the shallow groundwater in the Baltic Artesian Basin. Journal of Hydrology 542, 254-267.

2.1.3 kvaternaarigeoloogia osakond (Division of Quaternary Geology)

Professor Siim Veski

Pärastjääaegsetesse järve, soo- ja meresetetesse talletunud bio-, lito- ja kronostratigraafiline teave võimaldab lahti mõtestada viimase 15 000 a jooksul aset leidnud looduslikke kui ka inimtekkelisi keskkonna- ja kliimamuutusi Eestis ja naaberaladel. Setetest kogutud bioloogiliste ning geokeemiliste andmete põhjal taastuletatakse pärastjääaegsed kliimamuutused, Läänemere basseini soolsuse ja rannajoone asendi muutused, maastike ja siseveekogude looduslik areng, bioloogiline mitmekesisus, agraarse maakasutuse tagajärjel tekkinud maastiku ajalis-ruumilised muutused ja selle mõju siseveekogudele. Setete bioloogiliste koosluste põhised mudelid võimaldavad kvantitatiivselt hinnata pärastjääaegse kliima- ja keskkonnamuutuste vahelisi seoseid ja ökosüsteemide mitmekesisuse kujunemist.

The research group aims at reconstruction of post-glacial paleoecology, paleoenvironmental and paleoclimatic change, both natural and man-made, at high temporal resolution in Estonia and neighbouring areas during the last 15,000 yr through a multidisciplinary and multiproxy study of natural archives such as lake, bog and marine sediments. The group are focused on three overlapping research subjects: (1) late-glacial abrupt changes; (2) Holocene natural and man-made related changes and (3) development of the Baltic Sea basin.

2016

- Uuringud keskendusid õietolmupõhisete ajalis-ruumiliste kliimamuutuste ja taimkatte rekonstrueerimise mudelite arendamisele, testimisele ja rakendamisele.
- Tuginedes Baltimaade hilisjääaja paleobioloogilisele andmestikule (vetikatest imetajateni) võrreldi ajavahemikul 14000-11000 at aset leidnud kliimamuutusi ja bioloogiliste koosluste muutuste kiiruseid. Leiti, et Holotseeni alguses toimunud kliima järsu soojenemisega kaasnes kiireim liikide väljasuremine, mis on suurusjärgus võrreldav tänapäeval aset leidvate muutustega.
- Täpsustati mandrijää taandumise kronoloogiat ja hilisjääaja taimkatte muutusi Põhja-Eestis.
- Uuriti mineviku kliimamuutuste, metsa tulekahjude ja inimtegevuse vahelisi seoseid boreaalsete metsade liigilisele koostisele Holotseenis.
- Avastati Islandi Askja vulkaani 1875 a purske jäljed Lätis.
- Tehti kindlaks ristisõdade võimalik mõju Läänemeremaade looduskeskkonnale.

In 2016

- Research focused on the development, testing and application of pollen inferred spacio-temporal climate and vegetation models.
- Based on the Baltic late Weichselian (14,000 to 11,000 BP) paleobiological dataset (from algae to mammals) the climate change and biological turnover rate speeds were compared with the modern period. We found that at the beginning of the Holocene climatic warming was accompanied by the fastest species extinction, which is comparable in magnitude to the changes observed today.
- The Late-Glacial glacier retreat chronology and associated vegetation change in North Estonia was clarified.
- Links between the boreal forest species composition, past climate change, forest fires and human activities were examined throughout the Holocene period.
- Traces of the 1875 AD Iceland Askja volcanic eruption were discovered in bog sediments of Latvia which allows independent dating and anchoring of paleoecological events.
- The impact of the crusade wars on the landscape and environment of northern Latvia between the 13th–16th centuries (medieval Livonia) was evaluated.

Olulisemad artiklid:

- Ilvonen, L., Holmström, L., Seppä, H., **Veski**, S. 2016. A Bayesian multinomial regression model for palaeoclimate reconstruction with time uncertainty. Environmetrics 27, 409-422.
- **Stivrins**, N., Soininen, J., **Amon**, L., Fontana, S.L., Gryguc, G., Heikkilä, M., Heiri, O., Kisielienė, D., **Reitalu**, T., Stančikaitė, M., **Veski**, S., Seppä, H. 2016. Biotic turnover rates during the Pleistocene-Holocene transition. Quaternary Science Reviews 151, 100-110.
- **Stivrins**, N., Wulf, S., Wastegård, S., **Alliksaar**, T., Gałka, M., Andersen, T., **Heinsalu**, A., Aakala, T., Seppä, H., **Veski**, S. 2016. Detection of the Askja AD 1875 cryptotephra in Latvia, Eastern Europe. Journal of Quaternary Science 31, 437-441.

2.1.4 Maavarade- ja rakendusgeoloogia osakond (Division of Mineral Resources and Applied Geology)
Juht pole nimetatud

Uus töörühm.
The new research group.

2.1.5 Mäendusosakond (Division of Mining)
Vanemteadur Veiko Karu

TTÜ struktuurireformi raames liitus energeetikateaduskonna mäeinstituut geoloogia instituudiga 01.09.2016 ning selle struktuuriüksuse T&A tulemused ei kajastu käesolevas aruandes.

Department of Mining joined with Department of Geology in September 2016

2.1.6 Teaduskogude osakond (Division of Collections)
Peavarahoidja Ursula Toom

Geoloogia instituudile kuuluvad Eesti suurimad geokogud (kivimproovid, kivistised, puursüdamikud jne, arhiiv ja elektroonne andmebaas). Geokogud moodustavad lahutamatu osa instituudi teadusprogrammidest, samuti külastavad kollektsioone erialateadlased üle terve maailma. Kollektsioone paiknevad spetsiaalses hoidlas ülikoolilinnakus ja Särghaua Maateaduste Õppekeskuse uutes puursüdamike hoidlates, kus on hoiul 5000 kasti puursüdamikke (4-6 m igas kastis) ja 1000 kasti kivimiproove. Geokogud on osa Eesti teaduse taristu teekaardist „Loodusteaduslikud arhiivid ja infovõrgustik (NATARC)“, mille eesmärgiks on arendada loodusteaduslike kollektsioonide hoiustamistingimusi ja infosüsteeme.

The Department of Geology holds the largest georepository in Estonia (fossils, rock samples, drill cores, etc., archive and the electronic information system). They form an integral part of the institute's research programme and are regularly used by geologists all over the world. The collections have been funded by the state. The fossil collections have been deposited in special storage rooms in campus. Drill cores (5000 boxes, 4-6 m cores in each box) are stored in the newly built Särghaua Earth Science Centre drill core repositories. Division of Collections is a partner in the national research infrastructure roadmap object “Natural history archives and information network (NATARC)“, which develops services related to hosting and computing of scientific repositories and data archives.

2.2 Loetelu uurimisrühma töötajate olulisematest sise- ja välisriiklikest T&A-ga seotud tunnustustest (töötaja nimi, allüksus ning tunnustus).

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2.3 Loetelu uurimisgrupi liikmetest, kes on riiklike T&A-ga seotud otsustuskogude liikmed (töötaja nimi, ametikoht ning otsustuskogu nimetus ja positsioon otsustuskogus).

Atko Heinsalu - Eesti Teadusagentuuri loodusteaduste ja tehnika ekspertkomisjoni liige;

Olle Hints - HTM teaduskollektsioonide ekspertnõukogu, aseesimees;

Olle Hints - Eesti Teadusagentuuri avatud teaduse ekspertkomisjon, esimees;

Olle Hints - Eesti teaduse infrastruktuuri teekaardi "Loodusteaduslikud arhiivid ja andmevõrgustik (NATARC)", nõukogu liige;

Siim Veski - Eesti Teadusagentuuri bio- ja keskkonnateaduste ekspertkomisjoni liige;

2.4 Loetelu uurimisgrupi liikmetest, kes on välisriikide akadeemiate ja/või muude oluliste T&A-ga seotud välisorganisatsioonide liikmed (töötaja nimi, allüksus ning välisakadeemia või muu olulise T&A-ga seotud välisorganistatsiooni nimetus).

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2.5 Uurimisgrupis osalenud järeldoktorite ning TTÜ-st järeldoktorantuuri suundunud uurimisgrupi töötajate loetelu (nii ETIS-e kaudu esitatud taotluste kui muude meetmete alusel näidates ära järeldoktori nime, päritolumaa ja asutuse, järeldoktorantuuri perioodi ning meetme, mille alusel järeldoktorit rahastatakse).

Valle Raidla, Saksamaa, Heidelbergi Ülikool, 1.06.2015-31.05.2017, Personaalse uurimistoetuse järeldoktori toetus

Normunds Stivrins, Soome, Helsinki Ülikool, 1.01.2015-31.08.2017, Helsingi Ülikooli järeldoktori toetus

Geoloogia instituudi 2016 a teadusartiklid:

1.1

1) **Amon**, L., **Saarse**, L., **Vassiljev**, J., **Heinsalu**, A., **Veski**, S. 2016. Timing of the deglaciation and the late-glacial vegetation development on the Pandivere Upland, North Estonia. *Bulletin of the Geological Society of Finland* **88**, 69-83. https://doi.org/10.17741/bgsf/88.2.002

2) Babre, A., Kalvāns, A., Popovs, K., Retiķe, I., Dēliņa, A., **Vaikmäe**, R., **Martma**, T. 2016. Pleistocene age paleo-groundwater inferred from water stable isotope values in the central part of the Baltic Artesian Basin. *Isotopes in Environmental and Health Studies* **52**, 706-725. Published online: 04. May 2016. DOI:10.1080/10256016.2016.1168411

3) Barlow, E., van Kranendonk, M.J., Yamaguchi, K.E., Ikehara, M., **Lepland**, A. 2016. Lithostratigraphic analysis of a new stromatolite–thrombolite reef from across the rise of atmospheric oxygen in the Paleoproterozoic Turee Creek Group, Western Australia. *Geobiology* **14**, 317-343. Published online: 29. February 2016. DOI:10.1111/gbi.12175

4) Crémière, A., **Lepland**, A., Chand, S., Sahy, D., Condon, D.J., Noble, S.R., **Martma**, T., Thorsnes, T., Sauer, S., Brunstad, H. 2016. Timescales of methane seepage on the Norwegian margin following collapse of the Scandinavian Ice Sheet. *Nature Communications* **7**, 11509. Published online: 11. May 2016. DOI:10.1038/NCOMMS11509

5) Crémière, A., **Lepland**, A., Chand, S., Sahy, D., Kirsimäe, K., Bau, M., Whitehouse, M.J., Noble, S.R., **Martma**, T., Thorsnes, T., Brunstad, H. 2016. Fluid source and methane-related diagenetic processes recorded in cold seep carbonates from the Alvhein channel, central North Sea. *Chemical Geology* **432**, 16-33. Published online: 22. March 2016. doi:10.1016/j.chemgeo.2016.03.019

6) Druzhinina, O., **Molodkov**, A., Bitinas, A., Bregman, E. 2016. The oldest evidence for human habitation in the Baltic region: a preliminary report on the chronology and archaeological context of the Riadino-5 archaeological site. *Geoarchaeology* **31**, 156-164. Published online: 23. February 2016. DOI:10.1002/gea.21553

7) Eriksson, M.E., Lindskog, A., Servais, T., **Hints**, O., **Tonarová**, P. 2016. Darriwilian (Middle Ordovician) worms of southern Sweden. *GFF* **138**, 502-509. Published online: 27. June 2016. DOI:10.1080/11035897.2016.1181102

8) Glinskiy V., **Mark-Kurik**, E. 2016. Revision of *Psammosteus livonicus* Obruchev (Agnatha, Heterostraci) from the Devonian Amata Regional Stage of the NW of the East European Platform. *Estonian Journal of Earth Sciences* **65**, 1-18. doi:10.3176/earth.2016.02

9) Gusev, E.A., **Molodkov**, A.N., Streletskaya, I.D., Vasiliev, A.A., Anikina, N.Y., Bondarenko, S.A., Derevyanko, L.G., Kupriyanova, N.V., Maksimov, F.E., Polyakova, E.I., Pushina, Z.V., Stepanova, G.V., Oblogov, G.E. 2016. Deposits of the Kazantsevo Transgression (MIS 5) in the Northern Yenisei Region. *Russian Geology and Geophysics* **4**, 586-596. Published online: 23. April 2016. doi:10.1016/j.rgg.2015.05.013

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11) Harper, D.A.T., **Hints**, L. 2016. Hirnantian (Late Ordovician) brachiopod faunas across Baltoscandia: A global and regional context. *Palaeogeography, Palaeoclimatology, Palaeoecology* **444**, 71-83. Published online: 7. December 2015. doi:10.1016/j.palaeo.2015.11.044

12) **Hints**, L., Paškevicius, J. **Martma**, T., **Männik**, P., **Nõlvak**, J. 2016. Upper Sandbian-Lower Katian bio- and chemostratgraphy in the Pajevonys-13 core section, Lithuania. *Estonian Journal of Earth Sciences* **64**, 85-97. doi:10.3176/earth.2016.08

13) **Hints**, O., **Tonarová**, P., Desrochers, A. 2016. Late Ordovician jaw-bearing polychaetes from Anticosti Island, eastern Canada, and their biogeographic significance. *Canadian Journal of Earth Sciences* **53**, 731-738. Published online: 18. February 2016. doi:10.1139/cjes-2015-0222

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15) Ilvonen, L., Holmström, L., Seppä, H., **Veski**, S. 2016. Rejoinder. *Environmetrics* **27**, 434-438. Published online: 4. October 2016. DOI:10.1002/env.2409

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19) Krūmiņš, J., Kļaviņš, M., Kalniņa, L., Segliņš, V., **Kaup**, E. 2016. Impact of the physico-chemical properties of fen peat on the metal accumulation patterns in mires of Latvia. *Baltica* **29**, 19-32. Published online 14 June 2016. doi:10.5200/baltica.2016.29.03

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