TTÜ GEOLOOGIA INSTITUUT
TEADUS- JA ARENDUSTEGEVUSE AASTAARUANNE 2014

1. Struktuur

TTÜ Geoloogia Instituut, Institute of Geology at Tallinn University of Technology, direktor Atko **Heinsalu**

- Administratsioon, Administration, Atko **Heinsalu**
- Füüsikalise geoloogia õppetool, Chair of Physical Geology, Alvar **Soesoo**
- Isotoop-paleoklimatoloogia osakond, Department of Isotope-paleoclimatology, Rein **Vaikmäe**
- Litosfääriuuringute osakond, Department of Lithosphere Studies, Alvar **Soesoo**
- Paleontoloogia ja stratigraafia osakond, Department of Paleontology and Stratigraphy, Olle **Hints**
- Pärastjääaja geoloogia osakond, Department of Postglacial Geology, Siim **Veski**
- Teaduskogude osakond, Department of Collections, Ursula **Toom**

2. Teadus- ja arendustegevuse (edaspidi T&A) iseloomustus

2.1 struktuuriüksuse koosseisu kuuluvate uurimisgruppide teadustöö kirjeldus ja aruandeaastal saadud tähtsamad uurimistulemused *(inglise keeles*), uurimisgrupi kuni 5 olulisemat publikatsiooni aruandeaastal.

Füüsikalise geoloogia õppetool, Chair of Physical Geology, **Alvar Soesoo**

The Chair is providing teaching and practicals in geological subjects at BSc, MSc and PhD levels. Two PhD dissertations (Toivo Kallaste, Sigrid Hade) and seven MSc thesis (Kati Elmi *cum laude*, Vladimir Karpin *cum laude*, Joonas Pärn *cum laude*, Mikk Hüüdma, Marianne Kangur, Raili Kukk, Elise Perle) were defended in 2014. So far independent BSc and MSc degree programs Earth Sciences and Geotechnology were linked into a joint curriculum of "Earth Sciences and Geotehnology".

Isotoop-paleoklimatoloogia osakond, Department of Isotope-Paleoclimatology, **Rein Vaikmäe**

The main research applies isotopic and geochemical indicators of climate and environmental changes on three integrated directions: (1) groundwater flow history, global palaeoclimate signals and antropogenic influence in the Baltic Artesian Basin (BAB): a synthesis of numerical models and hydrogeochemical data (IUT 19-22; ETF8948 and LEPGI 350 (IAEA); (2) study of new polar ice core records in order to link climate records from different polar areas (LEP GI343 (KESTA); (3) estimation of capacity and safety of Baltic sedimentary basin for CO_2 geological storage (IUT 19-22).

The main scientific results include:

(1) the first ^{81}Kr and ^{85}Kr measurements in groundwater from seven exploitation wells in the BAB confirmed that glaciations and deglaciations in the BAB area during last million years did not impact on groundwater flow strongly enough as to replace of deep saline Na-Ca-Cl basinal brines with fresh and isotopically depleted glacial meltwater over all the BAB area

(related publications will be submitted in onset of 2015). Joonas Pärn compleated his MSci project and successfully (*cum laude*) defended the Master Thesis "Origin of groundwater in the Ordovician-Cambrian aquifer system in Estonia". On the basis of the variations in groundwater isotope and chemical composition in the Ordovician-Cambrian aquifer system three types of groundwater were observed: groundwater originating from modern precipitation located in the northern and north-eastern part of the aquifer system; groundwater of glacial origin located in the north-western part of the aquifer system, and groundwater originating from brine waters located in the southern part of the aquifer system.

(2) seasonal variability of bromine and iodine in polar snow and ice was investigated to evaluate their emission, transport and deposition in Antarctica and the Arctic and better understand potential links to sea ice. (Spolaor et al 2014). Stable isotope ratios and surface mass balance (SMB) data from eight shallow firn cores retrieved at Fimbul Ice Shelf, East Antarctica, have been investigated. Isotope ratios and SMB from the stacked record of all cores were also related to instrumental temperature data from Neumayer Station on Ekström Ice Shelf. Since the second half of the twentieth century the SMB shows a statistically significant negative trend, whereas the $\delta^{18}O$ of the cores shows a significant positive trend. (Schlosser et al 2014). Samples from two ice cores drilled at Lomonosovfonna, Svalbard, covering the period 1957–2009, and 1650–1995, respectively, were analysed for NO_3^- concentrations, and NO_3^- stable isotopes ($\delta^{15}N$ and $\delta^{18}O$). We suggest that the $\delta^{15}N$ recorded at Lomonosovfonna is influenced mainly by fossil fuel combustion, soil emissions, and forest fires; the first and second being responsible for the marked decrease in $\delta^{15}N$ observed in the post-1950s record with soil emissions being associated to the decreasing trend in $\delta^{15}N$ observed up to present time, and the third being responsible for the sharp increase of $\delta^{15}N$ around 2000.

(3) petrophysical, geophysical and geological structure-scale modelling was finalised and prepared publications and collecting data for the basin-scale modelling of CO_2 storage in the Baltic Cambrian Basin. New classification of reservoir quality of rocks for CO_2 geological storage in terms of gas permeability and porosity was proposed for Middle Cambrian sandstones of Deimena Formation in the Baltic Region and applied to interpret petrophysical changes of the reservoir rocks caused by CO_2 injection-like alteration experiment. Results of EU CCS Directive implementation showed that the main challenges include high investment costs and lack of public and consequently political support for onshore storage in Europe (Shogenova et al 2014).

11 WoS cited journals papers (ETIS 1.1) were published in 2014.

1. **Raidla**, V., Kirsimäe, K., **Ivask**, J., **Kaup**, E., Knöller, K., Marandi, A., **Martma**, T., **Vaikmäe**, R. 2014. Sulphur isotope composition of dissolved sulphate in the Cambrian-Vendian aquifer system in the northern part of the Baltic Artesian Basin. *Chemical Geology* **383**, 147-154. DOI:10.1016/j.chemgeo.2014.06.011

2. Spolaor, A., Vallelonga, P., Gabrieli, J., **Martma**, T., Björkman, M.P., Isaksson, E., Cozzi, G., Turetta, C., Kjær, H.A., Curran, M.A.J., Moy, A.D., Schönhardt, A., Blechschmidt, A.-M., Burrows, J.P., Plane, J.M.C., Barbante, C. 2014. Seasonality of halogen deposition in polar snow and ice. *Atmospheric Chemistry and Physics* **14**, 9613-9622. doi:10.5194/acp-14-9613-2014

3. Schlosser, E., Anschütz, H., Divine, D., **Martma**, T., Sinisalo, A., Altnau, S., Isaksson, E. 2014. Recent climate tendencies on an East Antarctic ice shelf inferred from a shallow firn core network. *Journal of Geophysical Research, Atmospheres* **119**, 6549-6562. DOI: 10.1002/2013JD020818

4. **Shogenova**, A., Piessens, K., Holloway, S., Bentham, M., Martínez, R., Flornes, K.M., Poulsen, N.E., Wójcicki, A., Sliaupa, S., Kucharič, L., Dudu, A., Persoglia, S., Hladik, V., Saftic, B., Kvassnes, A., **Shogenov**, K., **Ivask**, J., Suárez, I., Sava, C., Chikkatur, A. 2014. Implementation of the EU CCS Directive in Europe: results and development in 2013. *Energy Procedia* **63**, 6662-6670. doi:10.1016/j.egypro.2014.11.700

5. Wendl, I.A., Eichler, A., Isaksson, E., **Martma**, T., Schwikowski, M. 2014. 800 year ice-core record of nitrogen deposition in Svalbard linked to ocean productivity and biogenic emissions, *Atmospheric Chemistry and Physics* **14**, 24667-24700, doi:10.5194/acpd-14-24667-2014

Litosfääriuuringute osakond, Department of Lithosphere Studies, **Alvar Soesoo**

The research is focused on correlation based on bentonites of Ordovician and Silurian, palaeo-volcanism, palaeo-environmental studies, palaeotectonics, genesis of layered intrusions and metal-rich shales. Geochemical similarity of Katian (Ordovician) bentonites of the eastern Baltic with bentonites in Scandinavia and Scotland was discovered and the same volcanic source for all was proposed. The use of high-resolution geochemical methods on Silurian bentonites allowed correlation from Lithuania to Estonia. In Precambrian sediments anomalous sulphur isotope compositions were discovered and interpreted as a result of impact generated dust in the palaeo-atmosphere. Study of Precambrian rocks of Karelia emphasize the importance of distinguishing primary versus secondary isotopic compositions in studies of carbonate rocks used for reconstruction of global environmental change. Grain size studies of the Upper Ordovician rocks of Latvia showed significant fluctuations and increase in size due to the glaciations and sea level fall already in Katian, before widely known Hirnantian glaciation. Our crustal evolution observations support the model that the crust develops a self-organized critical state during magma generation. In this state, magma batches accumulate in a non-continuous, step- wise manner to form ever-larger accumulations. There is no characteristic length or time scale in the partial melting process or its products. A joint comparative study of the central and southern parts of the Palaeo-Proterozoic Svecofennian orogen in the Baltic/Fennoscandian Shield and the platform area to the east and south of the Baltic Sea indicates that at least these parts of the orogen are built up of several NW-SE trending, 100–300 km wide tectonic megadomains separated from each other and complicated by major zones of mostly dextral shearing. The generation of these zones occurred successively between 1.86 and 1.75 Ga, concomitantly with continuing crustal accretion getting younger towards the southwest. Even considering the distorting presence of a number of microcontinents, this indicates the one-time existence and repeated episodic activity of a master subduction zone stepwise falling back to the present south-southwest. The multi-proxy study of Tremadocian black shales from the eastern Baltic Palaeobasin (Türisalu Fm.) reveals that primary muds of those complexes likely deposited mainly as the result of intermittent event deposition. Redox-sensitive element distribution, widely used as palaeo-redox proxy, shows significant cm-scale vertical variation in the Türisalu Fm. and could have been more strongly linked with micro-environmental changes at sediment water interface rather than with oscillations of redox potential of marine water. Altogether **18** WoS cited journals papers (ETIS 1.1) were published in 2014.

1. Bons, P.D., Baur, A., Elburg, M.A., Lindhuber, M.J., Marks, M.A.W., **Soesoo**, A., van Milligen, B.P., Walte, N.P. 2014. Layered intrusions and traffic jams. *Geology* **xx**, xx-xx. (published online 4. December 2014). doi: 10.1130/G36276.1

2. **Hints**, R., **Hade**, S., **Soesoo**, A., **Voolma**, M. 2014. Depositional framework of the East Baltic Tremadocian black shale revisited. *GFF* **136**, 464-482. DOI:10.1080/11035897.2013.866978

3. **Kiipli**, T., **Soesoo**, A., **Kallaste**, T. 2014. Geochemical evolution of Caledonian volcanism recorded in the sedimentary rocks of the eastern Baltic region. *Geological Society, London, Special Publications* **390**, 177-192. doi:10.1144/SP390.5

4. van Zuilen, M.A., Philippot, P., Whitehouse, M.J., **Lepland**, A. 2014. Sulfur isotope mass-independent fractionation in impact deposits of the 3.2 billion-year-old Mapepe Formation, Barberton Greenstone Belt, South Africa. *Geochimica et Cosmochimica Acta* **142**, 429-441. DOI:10.1016/j.gca.2014.07.018

5. Bogdanova, S., Gorbatschev, R., Skridlaite, G., **Soesoo**, A., Taran, L., Kurlovich, D. 2014. Trans-Baltic Palaeoproterozoic correlations towards the reconstruction of supercontinent Columbia/Nuna. *Precambrian Research* **xx**, xx-xx. (published online 11. June 2014). DOI:10.1016/j.precamres.2014.11.023

Paleontoloogia ja stratigraafia osakond, Department of Paleontology and Stratigraphy, **Olle Hints**

The research within the department focused on Early Paleozoic paleobiology and paleobiodiversity, paleoenvironments, paleoclimate and integrated bio- and chemostratigraphy. Highlights of the research in 2014 include the following:

Discovery of copulatory organs of Devonian placoderm fish provided evidence on the primitive origin of internal fertilization of all crown jawed vertebrates. This study, published in Nature and largely based on fossils found in South Estonia, implies that external fertilization and spawning, characteristic of most extant aquatic gnathostomes, must be derived from internal fertilization, even though this transformation has been thought implausible. Other paleontological studies provided new ideas on the phylogeny of Silurian jawless vertebrates and Ordovician brachiopods, showed paleogeographical dispersal and environmental tolerance of polychaete worms, and helped to understand evolution and diversification of chitinozoans, trilobites and coral faunas. In addition, several new enigmatic fossils were first described and discussed in 2014.

Reference successions in Estonia, Sweden and the Ukraine thoroughly studied for biostratigraphy and isotope geochemistry allowed increasing temporal resolution and created basis for more reliable correlations and environmental interpretations for the Baltica paleocontinent. It was revealed that the global Ordovician-Silurian boundary most likely falls into the Juuru Regional Stage in Baltoscandia, hitherto considered as of Silurian age. New radiometric dates for an Ordovician bentonite and Ediacaran and Cambrian detrital zircons further contributed to improvement of the geological time scale and helped to better understand large-scale developments of Baltoscandian sedimentary basins. Specific attention was paid to the development of the reefs in Estonia and Sweden, where integrated sedimentological-paleontological approach allowed evaluation of climatic and environmental conditions. Pioneering studies were started on Ordovician-Silurian biomarker records in collaboration with international partners, and first results of sulphur isotope records in East Baltic Ordovician were published, showing close coupling with carbon cycling and global forcing.

In June 2014 the staff of the department co-organized an IGCP 591 Annual Conference and associated geological excursions that were attended by nearly 100 researchers of Early Paleozoic geology from 31 countries around the world.

31 WoS cited journals papers (ETIS 1.1) were published in 2014.

1. Long, J.A., **Mark-Kurik**, E., Johanson, Z., Lee, M.S.Y., Young, G.C., Min, Z. Ahlberg, P.E., Newman, M., Jones, R., den Blaauwen, J., Choo, B., Trinajstic, K. 2014. Copulation in antiarch placoderms and the origin of gnathostome internal fertilization. *Nature* **xx**, xx-xx. (published online 19. October 2014). doi:10.1038/nature13825

2. **Hints**, O., **Martma**, T., **Männik**, P., **Nõlvak**, J., Põldvere, A., Shen, Y., **Viira**, V. 2014. New data on Ordovician stable isotope record and conodont biostratigraphy from the Viki reference drill core, Saaremaa Island, western Estonia. *GFF* **136**, 100-104. **DOI:**10.1080/11035897.2013.873989
3. **Kaljo**, D., Grytsenko, V., **Kallaste**, T., **Kiipli**, T., **Martma**, T. 2014. Upper Silurian stratigraphy of Podolia revisited: carbon isotopes, bentonites and biostratigraphy. *GFF* **136**, 136-141. DOI:10.1080/11035897.2013.862850
4. **Männik**, P., Põldvere, A., **Nestor**, V., **Kallaste**, T., **Kiipli**, T., **Martma**, T. 2014. The Llandovery–Wenlock boundary interval in the west-central continental Estonia: an example from the Suigu (S-3) core section. *Estonian Journal of Earth Sciences* **63**, 1-17. doi:10.3176/earth.2014.01
5. **Pärnaste**, H., Bergström, J. 2014. Lower to middle Ordovician trilobite faunas along the Ural border of Baltica. *Bulletin of Geosciences* **89**, 431-450. DOI:10.3140/bull.geosci.1448

Pärastjääaja geoloogia osakond, Department of Postglacial Geology, **Siim Veski**

The institutional research funding (IUT1-8; 2013–2018) "Postglacial paleoecology and paleoclimate in the Baltic area" aims at reconstruction of ecosystems, climate and environment change, both natural and man-made, at high temporal resolution in the Baltic area. Quantitative paleoclimatic, biodiversity, aquatic, and land-use reconstructions reveal connections between past environments, climates and man. The main results in 2014 include the following:

Present-day functional and phylogenetic plant diversity was shown to be dependent on past landscape structure, management history (Vandewalle et al 2014) and on the post-glacial migration history (Reitalu et al 2014a). Studies that combine knowledge from contemporary ecology and past vegetation development clearly show that there is plenty of untapped potential for closer cooperation between ecology and palaeoecology (Reitalu et al 2014b).

Sedimentation cyclicity in small lakes was attributed to climate variability and its influence on the lake hydrological regime and sediment influx was cleared. Sediment composition during the Little Ice Age and Medieval period differs clearly, which is an additional indicator studying landscape openness (Saarse 2014). Biostratigphy and shoreline changes during the Limnea Sea stage in the surroundings of Tallinn were elucidated and the isolation history of Lake Harku adjusted to the general shoreline displacement scheme (Grudzinsla et al 2014).

Pollen data and historical evidence (Poska et al 2014; Väli et al 2014) suggest that the forest structure changed from fairly open wooded meadow type grazed forests during early periods to closed boreal forest communities typical of the area today. Maximum landscape openness was reached in the 1700s and 1800s, when almost all of the available land was cultivated or used for cattle rearing. Reconstruction of the long-term development and lateral expansion of a south Swedish peat bog was performed using a multi-proxy approach, including dendrochronology, peat stratigraphy and macrofossil and pollen analyses to gain information on peatland responses to climate change at the end of the 'Holocene Thermal Maximum' (5000–4000 cal yr BP) (Edvardsson et al 2014).

Pollen-based reconstructions of the spatio-temporal dynamics of northern European regional vegetation abundance through the Holocene demonstrate that RV-based estimates of diversity indices, timing of shifts, and rates of change in reconstructed vegetation provide new insights into the timing and magnitude of major human disturbance on Holocene regional vegetation, features that are critical in the assessment of human impact on vegetation, land-cover, biodiversity, and climate in the past (Marquer et al 2014). The regional vegetation cover in central and northern Europe, for five time windows in the Holocene [around 6k, 3k, 0.5k, 0.2k, and 0.05k calendar years before present (bp)] at a 1°×1° spatial scale was quantitatively reconstructed (Trondman et al 2014). A set of statistical models that create spatially continuous maps of past land cover by combining pollen-based point estimates and spatially

continuous estimates of past land cover, obtained by combining simulated potential vegetation with an anthropogenic land-cover change scenario was proposed and its performance tested against modern observations (Pirzamanbein et al 2014). The direct effects of anthropogenic deforestation on simulated climate at two contrasting periods in the Holocene, ~6 and ~0.2 k BP in Europe where estimated to be from −1 °C in south-western Europe to +1 °C in eastern Europe (Strandber et al 2014).

New pollen based reconstructions of summer (May-to-August) and winter (December-to-February) temperatures between 15 and 8 ka BP along a S–N transect in the Baltic–Belarus area (Veski et al 2014) display trends in temporal and spatial changes (Feurdean et al 2014) in climate variability complemented by chironomid-based July mean temperature reconstructions (Heiri et al 2014). The magnitude of change compared with modern temperatures was more prominent in the northern part of Baltic–Belarus area. The Younger Dryas cooling in the area was 5 C° colder than present, as inferred by all proxies. Analyses shows an early Holocene divergence in winter temperature trends with modern values reaching 1 ka earlier (10 ka BP) in southern Baltic–Belarus compared to the northern part of the region (9 ka BP). Latitudinal and longitudinal patterns of inferred temperature change are in excellent agreement with simulations by the ECHAM-4 model, implying that atmospheric general circulation models can successfully predict regionally diverging temperature trends in Europe, even in non-analogue situations.

N. Stivrinds presented his doctoral thesis to the defence committee in December 2014. K. Elmi and E. Perle defended their MSc dissertation. **26** WoS cited journals papers (ETIS 1.1) were published in 2014.

1. Heiri, O., Brooks, S.J., Renssen, H., Bedford, A., Hazekamp, M., Ilyashuk, B., Jeffers, E.S., Lang, B., Kirilova, E., Kuiper, S., Millet, L., Samartin, S., Toth, M., Verbruggen, F., Watson, J.E., van Asch, N., Lammertsma, E., **Amon**, L., Birks, H.H., Birks, H.J.B., Mortensen, M.F., Hoek, W.Z., Magyari, E., Sobrino, C.M., Seppä, H., Tinner, W., Tonkov, S., **Veski**, S., Lotter, A.F. 2014. Validation of climate model-inferred regional temperature change for late-glacial Europe. *Nature Communications* **5,** 4914. doi:10.1038/ncomms5914
2. **Amon**, L., **Veski**, S., **Vassiljev**, J. 2014. Tree taxa immigration to the eastern Baltic region, southeastern sector of Scandinavian glaciation during the Late-glacial period (14,500–11,700 cal. B.P.). *Vegetation History and Archaeobotany* **23**, 207-216. DOI:10.1007/s00334-014-0442-6
3. **Reitalu**, T., Kuneš, P., Giesecke, T. 2014. Closing the gap between plant ecology and Quaternary palaeoecology. *Journal of Vegetation Science* **25**, 1188-1194. DOI:10.1111/jvs.12187
4. Feurdean, A., Perşoiu, A., Tanţău, I., Stevens, T., Magyari, E.K., Onac, B.P., Marković, S., Andrič, M., Connor, S., Fărcaş, S., Gałka, M., Gaudeny, T., Hoek, W., Kolaczek, P., Kuneš, P., Lamentowicz, M., Marinova, E., Michczyńska, D.J., Perşoiu, I., Płóciennik, M., Słowiński, M., Stancikaite, M., Sumegi, P., Svensson, A., Tămaş, T., Timar, A., Tonkov, S., Toth, M., **Veski**, S., Willis, K.J., Zernitskaya, V. 2014. Climate variability and associated vegetation response throughout Central and Eastern Europe (CEE) between 60 and 8 ka. *Quaternary Science Reviews* **106**, 206-224. DOI:10.1016/j.quascirev.2014.06.003
5. **Poska**, A., **Saarse**, L., Koppel, K., Nielsen, A.B., Avel, E., **Vassiljev**, J., Väli, V. 2014. The Verijärv area, South Estonia over the last millennium: A high resolution quantitative land-cover reconstruction based on pollen and historical data. . *Review of Palaeobotany and Palynology* **207**, 5-17. DOI:10.1016/j.revpalbo.2014.04.001

Teaduskogude osakond, Department of Collections, **Ursula Toom**

Geological collections are an essential part of geosciences and the Institute of Geology holds the largest geocollections in Estonia, being part of the Estonian Research Infrastructure Roadmap project Natural History Archives and Information Network (NATARC). The Department of Collections ensures the preservation and accesibility of physical collections (fossils, rock samples, drillcores etc), and provides the archives and the electronic information system. Many researchers from the host institute are regularly using the collections for their

studies. Altogether 50 researchers from 25 different institutions, representing 12 countries, visited the Institute's collections in 2014. In addition, 22 loans containing more than to 1500 specimens and samples were dispatched to researchers in 15 countries. 35 high-ranking publications were based partly or entirely on the collections, including a paper in *Nature* by Long et al. The latter described the emergence of internal copulation among early vertebrates. In addition to this and other paleontological studies, the collections supported research on late Proterozoic and Cambrian biodiversity and geochemistry, Ordovician-Silurian biomarker records, isotopic composition of paleo-seawater, climate change, geological time scale etc during 2014.

The department has been leading the development of multi-institutional database software for geocollections and geoscience data. Used by three universities and two museums in Estonia, this system makes most of its content freely available online (at Estonian geocollections portal http://geocollections.info and associated resources). At the institute, ca 20000 new specimens and samples were electronically catalogued and ca 5800 digital images added to the database in 2014. Notably the information system joined the international DataCite consortium and started issuing global digital object identifiers (DOIs) for geoscience data sets, making various research data resources better accessible as well as universally citable.

4 WoS cited journals papers (ETIS 1.1) were published by department in 2014.

1. Vinn, O., **Toom**, U. 2014. First record of the trace fossil *Oikobesalon* from the Ordovician (Darriwilian) of Baltica. *Estonian Journal of Earth Sciences* **63**, 118-121. doi: 10.3176/earth.2014.11
2. Vinn, O., Wilson, M. A., **Mõtus**, M.-A. **Toom**, U. 2014. The earliest bryozoan parasite: Middle Ordovician (Darriwilian) of Osmussaar Island, Estonia. *Palaeogeography, Palaeoclimatology, Palaeoecology* **414**, 129-132. DOI:10.1016/j.palaeo.2014.08.021
3. Vinn, O., Wilson, M.A., **Toom**, U. 2014. Earliest rhynchonelliform brachiopod parasite from the Late Ordovician of northern Estonia (Baltica). *Palaeogeography, Palaeoclimatology, Palaeoecology* **411**, 42-45. DOI:10.1016/j.palaeo.2014.06.028
4. Vinn, O., Wilson, M.A., Zatoń, M., **Toom**, U. 2014. The trace fossil *Arachnostega* in the Ordovician of Estonia (Baltica). *Palaeontologia Electronica* **17.3.40A**, 1-9.

2.3 Loetelu struktuuriüksuse töötajatest, kes on välisakadeemiate või muude oluliste T&A- ga seotud välisorganisatsioonide liikmed.

Anto Raukas; Euroopa Loodusteaduste Akadeemia tegevliige
Alvar Soesoo; Euroopa Loodusteaduste Akadeemia tegevliige
Rein Vaikmäe; Academia Europaea, valitud liige

WoS cited journals (1.1) papers published 2014

1) Afanassieva, O. B., **Märss**, T. 2014. Новые данные о наружном скелете остеостраков рода *Aestiaspis* (Agnatha) из Силура о. Сааремаа (Эстония) и архипелага Северная Земля (Россия). *Paleontologicheskii Zhurnal* **1**, 75-79. DOI:10.7868/S0031031X14010024

2) Afanassieva, O. B., **Märss**, T. 2014. New data on the exoskeleton of osteostracan genus *Aestiaspis* (Agnatha) from the Silurian of Saaremaa Island (Estonia) and the Severnaya Zemlya Archipelago (Russia). *Paleontological Journal* **48**, 74-78. DOI:10.1134/S003103011401002X

3) Agasild, H., Zingel, P., Tuvikene, L., Tuvikene, A., Timm, H., Feldmann, T., **Salujõe**, J., Toming, K., Jones, R.I., Nõges, T. 2014. Biogenic methane contributes to the food web of a large, shallow lake. *Freshwater Biology* **59**, 272-285. DOI:10.1111/fwb.12263

4) **Amon**, L., **Veski**, S., **Vassiljev**, J. 2014. Tree taxa immigration to the eastern Baltic region, southeastern sector of Scandinavian glaciation during the Late-glacial period (14,500–11,700 cal. B.P.). *Vegetation History and Archaeobotany* **23**, 207-216. DOI:10.1007/s00334-014-0442-6

5) **Bauert**, G., **Nõlvak**, J., **Bauert**, H. 2014. Chitinozoan biostratigraphy in the Haljala Regional Stage, Upper Ordovician: a high-resolution approach from NE Estonia. *GFF* **136**, 26-29. **DOI:**10.1080/11035897.2013.857715

6) **Bauert**, H., Ainsaar, L., Põldsaar, K., Sepp, S. 2014. $\delta^{13}C$ chemostratigraphy of the Middle and Upper Ordovician succession in the Tartu-453 drillcore, southern Estonia and the significance of HICE. *Estonian Journal of Earth Sciences* **63**, 195-200. doi:10.3176/earth.2014.18

7) **Bauert**, H., Isozaki, Y., Holmer, L.E., Aoki, K., Sakata, S., Hirata, T. 2014. New U–Pb zircon ages of the Sandbian (Upper Ordovician) "Big K-bentonite" in Baltoscandia (Estonia and Sweden) by LA-ICPMS. *GFF* **136**, 30-33. **DOI:**10.1080/11035897.2013.862854

8) Bogdanova, S., Gorbatschev, R., Skridlaite, G., **Soesoo**, A., Taran, L., Kurlovich, D. 2014. Trans-Baltic Palaeoproterozoic correlations towards the reconstruction of supercontinent Columbia/Nuna. *Precambrian Research* **xx**, xx-xx. (published online 11. June 2014). **DOI:**10.1016/j.precamres.2014.11.023

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