Teadus- ja arendustegevuse aruanne 2022

Geoloogia instituut

Geoloogia instituut on maapõue ja mänduse alast kompetentsi koondav instituut Tehnikaülikoolis. Instituudi teadlased tegelevad aluspõhjageoloogia, paleokeskkonna, kliima, meregeoloogia, maavarade, mänduse ning ringmajandusega. Instituut vastutab Maa süsteemide ja maapõueressursside õppekavade eest, pakub laboriteenuseid ja konsultatsioone ning haldab Eesti suurimaid kivimikollektsioone.

Direktor: Professor **Olle Hints,** gi@taltech.ee, +372 620 30 10

2022. a tegutses geoloogia instituudi kooseisus 4 uurimisrühma, mis vastavad neljale osakonnale:

- Aluspõhjageoloogia ja teaduskollektsioonide osakond
- Kvaternaarigeoloogia osakond
- Maavarade ja rakendusgeoloogia osakond
- Mänduse ja maavaratehnoloogia osakond

2022. a avaldasid geoloogia instituudi teadlased kokku 53 kõrgetasemelist teadusartiklit ja hulgaliselt muid publikatsioone ning osalesid enam kui 15 teadus- ja arendusprojektis, sh Eesti Teadusagentuuri grantid, Horizon 2020 ja Horizon Europe, EIT Raw Materials võrgustiku projektid, Keskkonnainvesteeringute Keskuse uurimisteemad jt. Tähelepanuväärseimaks sündmiseks oli 2022. a riigi teaduspreemia määramine geo- ja bioteaduste alal instituudi teadlastele Siim Veskile ja Anneli Poskale tööde tsükli „Mineviku õppetunnid: jääajajärgne keskkond muutuva kliima ja kasvava inimmõju tingimustes" eest.

Department of Geology

The Department of Geology is the centre of expertise on geology, mineral resources, and mining at TalTech. Our researchers focus on bedrock geology, paleoenvironments, mineral resources, mining engineering and circular economy. We are responsible for study programmes on Earth systems and resources, offer lab analyses and expert services, and hold the largest geoscience collections in Estonia.

Director: Associate Professor **Olle Hints**, gi@taltech.ee, +372 620 30 10

In 2022 the Department of Geology hosted four research groups and structural divisions:

- Division of Bedrock Geology and Collections
- Division of Quaternary Geology
- Division of Mineral Resources and Applied Geology
- Division of Mining and Mineral Technology

In 2022, the researchers of the Department of Geology published 53 high-level scientific articles and numerous other publications and participated in more than 15 research and development projects, including Estonian Science Agency grants, Horizon 2020 and Horizon Europe, EIT Raw Materials network projects etc. The most notable event was the awarding of the 2022 state research prize in the field of geo- and biosciences to department's researchers Siim Veski and Anneli Poska for their work cycle "Lessons from the past: the post-ice age environment under the conditions of a changing climate and growing human influence".

Aluspõhjageoloogia uurimisrühm

Juht: Olle Hints, kaasprofessor, +372 620 30 27, olle.hints@taltech.ee

Liikmed (akadeemilisel ametikohal): Ursula Toom, Aivo Lepland

Liikmed (doktorandid): Tatiana Kulashova

Liikmed (mitteakadeemilisel ametikohal): Peep Männik, Jaak Nõlvak, Helje Pärnaste, Tiiu Märss, Erik Tzodsenidze

Võtmesõnad: aluspõhi, Eesti geoloogia, settekivimid, paekivi, paleokeskkond, paleokliima, paleontoloogia, geokeemia, stratigraafia, sedimentoloogia, Paleosoikum, Vanaaegkond, Baltoskandia, Baltika, Ordoviitsium, Silur, elurikkuse areng, väljasuremine, jääaeg, mikrofossiilid, kivistised, kivimikollektsioonid, geoloogilised andmebaasid, e-teenused.

AAK prioriteetsed suunad: Keskkonnaressursside vääristamine, usaldusväärsed IT lahendused.

Frascati Manuali alamvaldkond: 1.5 Maateadused ja nendega seotud keskkonnateadused.

CERCSi teaduserialad: P420 Petroloogia, mineroloogia, geokeemia; P450 Stratigraafia; B330 Paleozooloogia, fülogenees.

Uurimisrühma tutvustus:

Aluspõhjageoloogia ka teaduskollektsioonide osakonna põhikompetentside hulka kuulub Eesti geoloogilise ehituse, erinevate kivimite, kivististe ja geoloogilise arenguloo põhjalik tundmine. Sellised baasteadmised on vajalikud rakendusuuringutes, kuid uurimisrühma põhiliseks tegevusvaldkonnaks on alusuuringud, enamasti tihedas rahvusvahelises koostöös. Rühma peamisteks uurimissuundadeks on:

- paleokeskkonna ja paleokliima modelleerimine kasutades geokeemilisi ja sedimentoloogilisi indikaatoreid, sh süsiniku ja hapniku isotoopkoostist;
- paleoelurikkuse dünaamika modelleerimine ja selle seosed kliima ja keskkonnamuutustega;
- erinevate organismirühmade evolutsioon ja paleobiogeograafilise leviku analüüs;
- mikropaleontoloogia ja kõrglahutusega biostratigraafia.

Oluline osa uurimisrühma tegevusest baseerub instituudi geoloogilistel teaduskollektsioonidel, mis on unikaalseks arhiiviks planeedi kauge mineviku uurimisel. Selle arhiivi haldamist, arendust ja teadlastele avamist korraldab uurimisrühm riikliku teadustaristu programmi ning rahvusvaheliste koostööprojektide raames.

Olulisemad tulemused:

2022. a olulisemate tulemuste hulka kuulub paleo-elurikkuse mustrite tuvastamine ning suhete organismirühmade vaheliste seoste selgitamine Paleosoikumi merelistes ökosüsteemides Baltika kontinendil. Tähelepanuväärne on mitmete teadusele uute liikide kirjeldamine, mis aitavad paremini mõista elu arengulugu ning on ühtlasi aluseks kivimite senisest täpsemal biostratigraafilisel dateerimisel. Sekundaarioonide massispektromeetria võimaldas tuvastada hapniku isotoopkoostise muutusi mikroskoopilistes konodontides, viidates kliima ja keskkonnatingimuste sujuvale muutusele ning Balti paleobasseini diferentseerumisele Ordoviitsiumi ajastul. Kokku ilmus uurimisrühma liikmetel 19 kõrgetasemelist publikatsiooni.

Olulisemad partnerid Eestis: Tartu Ülikooli geoloogia osakond, Eesti geoloogiateenistus

Olulisemad partnerid välismaal: Hiina TA Nanjingi Geoloogia ja Paleontoloogia Instituut, Potsdam

Veebileht: https://taltech.ee/geoloogia-instituut/uurimisruhmad#p31321

Bedrock Geology Research Group

Group leader: Olle Hints, Associate Professor, olle.hints@taltech.ee

Members: Ursula Toom, Merlin Liiv, Peep Männik, Jaak Nõlvak, Aivo Lepland, Linda Hints, Tiiu Märss

Doctoral students: Tatiana Kulashova

Keywords: bedrock, geology of Estonia, sedimentary rocks, limestone, paleoenvironment, paleoclimate, paleontology, geochemistry, stratigraphy, sedimentology, Paleozoic, Baltoscandia, Baltica, Ordovician, Silurian, paleobiodiversity, mass extinction, ice age, microfossils, fossils, geological collections, geological databases and e-services.

Overview:

Bedrock geology has been among the key study fields in the Department of Geology since 1950s. At present, the research group of bedrock geology holds competences on regional geology, sedimentary rocks, stratigraphy and paleontology of Estonia and beyond. Such expertise is needed in applied geosciences, but the main work of the group is aiming at better understanding of the interactions between geo- and biosphere processes in deep time. The group holds leading palaeontological competence in Estonia, and for some fossil groups, leading expertise worldwide (notably for conodonts, chitinozoans and scolecodonts). The group's main research directions are:

- Paleoenvironment and paleoclimate reconstructions using multiple proxy indicators such as carbon and oxygen isotopes, sedimentology etc.
- Paleobiodiversity dynamics including mass extinction and their links with climate and environmental changes.
- Paleobiology and evolution of various groups of organisms during the Paleozoic.
- High-resolution bio- and chemostratigaphy that provides regional spatio-temporal framework and global time correlations.

The group is using the large geological collections at the department that constitute a globally unique archive of deep time Earth environments, climate and biodiversity. The group is responsible for the development and opening up this archive for researchers worldwide as part of national and pan-European research infrastructure.

Main results:

The most important results in 2022 include the reconstruction of paleo-biodiversity patterns and deciphering interactions between different groups of organisms in Early-Paleozoic marine ecosystems on the Baltica palaeocontinent. A number of species unknown to science were first described by the research group, and these data serve for a better understanding of deep-time biological evolution and a more precise biostratigraphic dating technique of sedimentary rocks. Secondary-ion mass spectrometry (SIMS) analysis enabled studying oxygen isotopes from microscopic individual conodont elements and reconstructing climatic and paleoenvironmental conditions within the Baltic palaeobasin. Altogether 19 high-ranking research papers were published by the group in 2022.

Kvaternaarigeoloogia uurimisrühm

Juht: Siim Veski, professor, siim.veski@taltech.ee

Liikmed: Tiiu Alliksaar, Atko Heinsalu, Anneli Poska, Triin Reitalu, Jüri Vassiljev, Leeli Amon, Normunds Stivrinš, Merlin Liiv, Ansis Blaus

Doktorandid: Vladimir Karpin, Anna Lanka, Varvara Bakumenko, Ivan Krivokorin, Eliise Kara

Järeldoktorid: Olga Lisitsyna

Võtmesõnad: geoökoloogia, keskkonna ja kliima areng, paleomitmekesisus, Läänemeri, kronoloogia

AAK prioriteetsed suunad: Keskkonnaressursside vääristamine,

AAK prioriteetsed suunad: Keskkonnaressursside vääristamine, Nutikas merendussektor ja jätkusuutlik merekeskkond.

Frascati Manuali alamvaldkond: 1.5 Maateadused ja nendega seotud keskkonnateadused.

CERCSi teaduserialad: P450 Stratigraafia; T270 Keskkonnatehnoloogia, reostuskontroll; T510 Kronoloogia, vanusemääramise tehnoloogia; P460 Sedimentoloogia; B260 Hüdrobioloogia, mere-bioloogia, veeökoloogia, limnoloogia.

Uurimisrühma tutvustus:

Kvaternaarigeoloogia ja sellega liituvad erialad on olnud geoloogia instituudi üheks oluliseks uurimisvaldkonnaks alates instituudi loomisest. 2022. a on osakonnaga seotud üheksa teadustöötajat, järeldoktor ja viis doktoranti, teadustegevus toimub peamiselt Eesti Teadusagentuuri uurimistoetuste toel. Töögrupi teadustulemused on pälvinud rahvusvahelise tunnustuse ja on võimaldanud viljakat ühistööd mitmete oma ala maailma juhtivate teaduskollektiividega, pakkudes uudseid lahendusi pärastjääaegse taimestiku, kliima, inimtegevuse ja keskkonnamuutuste vaheliste seoste väljaselgitamisel. Töögrupi arendustöö on avardanud võimalusi koostööks teiste teadusharudega nagu klimatoloogia, ökoloogia ja arheoloogia. Osakonna teadurid publitseerivad oma teaduseriala tippajakirjades nagu *Nature Ecology & Evolution*, *Biogeosciences*, *Quaternary Science Reviews*, *Journal of Ecology* jt.

Osakonna peamiste uurimissuundade hulka kuuluvad:

- Pärastjääaegse kliima rekonstrueerimine eri analüüsimeetoditega;
- Maakatte ja taimestiku rekonstrueerimine, kiired muutused;
- Õietolmuandmete-põhised ökoloogilised seosed ja paleo-elurikkus;
- Mineviku maakasutus ning ökosüsteemide kohanemine sellega;
- Jäätaande kronoloogia ja paleogeograafia;
- Läänemere areng ning keskkonnaseisundi muutused, merelised maavard.

Töögrupp viib ellu projekti PRG323, mis ühildab interdistsiplinaarse lähenemisviisi kaudu tänapäevastel paleoökoloogistel andmetel põhinevad mineviku taimestiku- ja kliimamuutuste rekonstruktsioonid ja taimestiku modelleerimise, et selgitada bioloogiliste protsesside (ränne ja konkurents) ja abiootiliste tegurite (kliima, toiteainete ja häiringute hulk, inimtegevus) mõju taimestiku dünaamikale hilis- ja pärastjääajal Põhja-Euroopas.

Olulisemad tulemused:

Holotseeni taimestiku kohaliku muutuse määrad, mis ulatuvad sajandist mitme aastatuhandeni, on suurema varieeruvuse ja lühema kestusega kui piirkondlikud. Liikide taksonite muutusi mõjutavad 1500

(Bond) ja 2200 (Bray) aastased kliimatsüklid ja õietolmupõhised Ellenbergi indikaatori väärtused peegeldavad hästi Holotseeni looduslikke keskkonnatingimusi. Uudsena kasutati vaevakase lehe mikrofenoloogilisi mõõtmisi arvutamaks hilisjääaja sesoonseid muutusi, vegetatsioonitemperatuuride summat ja kevade algust. Anneli Poskale ja Siim Veskile omistati riigi teaduspreemia.

Olulisemad partnerid Eestis: Tartu Ülikool, Maaülikool, Eesti Geoloogiateenistus

Olulisemad partnerid välismaal: Läti Ülikool, Helsingi Ülikool, Uppsala maaülikool (Swedish University of Agricultural Sciences)

Veebileht: https://taltech.ee/geoloogia-instituut/uurimisruhmad#p31323

Quaternary Geology Research Group

Leader: Siim Veski, professor, siim.veski@taltech.ee

Members: Tiiu Alliksaar, Atko Heinsalu, Anneli Poska, Triin Reitalu, Jüri Vassiljev, Leeli Amon, Normunds Stivrinš, Merlin Liiv, Ansis Blaus

Doctoral students: Ansis Blaus, Vladimir Karpin, Anna Lanka, Varvara Bakumenko, Ivan Krivokorin

Postdoctoral researchers: Olga Lisitsyna

Keywords: geoecology, paleoclimate and environment, paleodiversity, Baltic Sea, chronology

Overview:

Quaternary geology, paleoecology and related research disciplines explaining the current paradigm of actualism in geology, have been one of the principal targets of research at the Department of Geology since the 1950s. At present, the research group comprises of nine researchers, one postdoc and five PhD students, who work in close collaboration as a targeted team, as well as with other groups in the department. We have fruitful collaboration worldwide, notably in US, Russia, Sweden, Finland, Canada, Germany, UK, Netherlands, Switzerland, Latvia, Lithuania and Belarus.

The main research aim of the Quaternary group is reconstruction of past ecosystems, vegetation history, climate and environmental change, both natural and manmade, at high temporal resolution during the last 15,000 years through multidisciplinary and multiproxy studies of natural archives such as lake, bog and marine sediments. The Quaternary is known for rapid climate change, glacial advances and retreats, constant drift of biota between glacial and warm refugia, sea level fall and rise with each period of freezing and thawing. It's also known as the period of the rise of mankind and its progressively increasing impact upon the environment. The group focusses on better understanding the interactions between Quaternary geo- and biosphere processes, in particular, addressing the following:

- Paleoclimate variation using multi-proxy analyses (such as pollen and chironomid based inference models);
- Paleo-biodiversity (terrestrial and aquatic), functional and phylogenetic diversity dynamics and relationships with climate and environmental changes;
- Past human impact upon landscapes, waterbodies, vegetation structure and land-cover;
- Postglacial retreat of the ice sheet;
- Shoreline displacement of the Baltic Sea.

The group holds leading position in Quaternary and palaeoecological studies in the Baltic realm. The main strengths of the group's work are related to the high-resolution paleo-datasets of geographically and climatically constrained area. Results of the studies conducted at the department have been published in leading research journals including Nature Ecology & Evolution, Biogeosciences, QSR, Journal of Ecology ect.

The group hosts several labs of biostratigraphy, dating, geochemistry, granulometry, and makes use of the department's mass spectrometry lab for stable isotope geochemistry.

Running projects:

- PRG323 "Tracking the time-lags of species response to environmental change using palaeo-proxy data and modelling (TrackLag) (1.01.2019–31.12.2023)
- RESTA23 "Quality and properties of Estonian shelly phosphorite as a potential source for phosphorus and rare earth elements and its complex processing technologies" (01.09.2020–31.03.2023)

- RITA1/02-60-04 Innovative approaches to monitoring and assessing marine environment and nature values in Estonian sea area (01.01.2019–31.03.2022)

Main results:

Succession of biomes in Holocene was recorded with compositional turnover rates of vegetation ranging from century to several millennian timescales. Local community changes have higher variation and shorter duration than regional and taxa occurrence is affected by 1500 (Bond) and 2200 (Bray) year climate cycles. Pollen-based Ellenberg Indicator Values reflect well natural environmental conditions. Novel application of micro-phenological Betula nana fossil leaf proxy to the Late Glacial temperature record reveals early season and spring temperature dynamics rather than traditionally inferred winter or summer temperatures. Anneli Poska and Siim Veski received National Research Award in the field of geosciences and life sciences. In total **11** WoS journal papers were published in 2022.

Maavarade ja rakendusgeoloogia uurimisrühm

Juht: Rutt Hints, vanemteadur, telefon 6203036, rutt.hints@taltech.ee

Akadeemilisel ametikohal töötavad uurimisrühma liikmed: prof Alvar Soesoo, Tarmo Kiipli, Heidi Soosalu, Alla Šogenova, Kazbulat Šogenov;

Doktorandid: Siim Pajusaar, Sophie Jane Marie-Pascale Huguette Graul, Mawo Ndiaye, Juan David Solano Acosta;

Mitteakadeemilisel ametikohal töötavad liikmed: Toivo Kallaste, Kristjan Urtson, Nata-Ly Pantšenko, Andre Gregor.

Võtmesõnad: maavarad, geokeemia, mineraloogia, mustad kildad, fosforiidid, maagistumine, geofüüsika, CO_2 ja vesiniku geoloogiline ladustamine, ringmajandus.

AAK prioriteetsed suunad: Keskkonnaressursside vääristamine (mineraalsed toormed, sh tulevikumaavarad ja kriitilised toormed)

Frascati Manuali alamvaldkond: 1.5 Maateadused ja nendega seotud keskkonnateadused.

CERCSi teaduserialad: P430 Maavarad, majandusgeoloogia, P420 Petroloogia, mineroloogia, geokeemia.

Uurimisrühma tutvustus:

Uurimisrühma teadustegevuse fookuses on perspektiivsete Euroopa Liidu kriitilisi toormeid sisaldavate maapõueressursside geneesi, leviku ja väärindamise potentsiaali selgitamine. Rühma tuumikkompetentsid on seotud setteliste maavarade, sealhulgas metallirikaste mustade kiltade, karbonaatkivimite ning põlevkivide, geokeemia ja mineraloogiaga. Lisaks on viimastel aastatel ellu viidud rida T&A uuringuid aluskorra maagileiukohtade erinevate geoloogiliste aspektide analüüsiks. Iseseisvaks uurimissuunaks on CO_2 sidumise ning CO_2 ja vesiniku ladustamise alased uuringud. Interdistsiplinaarse koostöö valdkondades nagu ressursside väärindamine ja kavandusjäätmete taaskasutamise, toetub uurimisrühma pikaajalisele teadustööle röntgenstruktuuranalüüsi ja elementanalüüsi vallas.

Uurimisrühm haldab geokeemia ja mineraloogia laborit, mis on varustatud ICP-MS, XRF ja XRD analüsaatoritega, ning võimaldab läbi viia kompleksseid geokeemilisi, mineraloogilisi ja petroloogilisi uuringuid. Analüütilise kvaliteedi tagamiseks osaletakse Rahvusvahelise Geoanalüütikute Assotsiatsiooni tasemekatsete programmis. Uurimisrühma Eesti-siseste ja rahvusvaheliste koostööpartnerite seas on olulisemad uurimisrühmad Tallinna Tehnikaülikooli materjali- ja keskkonnatehnoloogia instituudist, Tartu Ülikooli geoloogia osakonnast, Eesti Geoloogiateenistusest, Oulu Ülikoolist ja GFZ Geoteaduste uurimiskeskusest.

Jooksvad projektid:

- RESTA18 "Vanaadiumi levik ja esinemisvormid graptoliitargilliidis ning eraldamise tehnoloogiad" (1.07.2020–28.02.2023);
- RESTA20 "Potentsiaalselt kasulikud komponendid ja maagistumise genees Eelkambriumi kivimite polümetalse maagistumise ilmingutes" (1.04.2020–30.11.2022);
- RESTA23 "Eesti karbifosforiidi kvaliteet ja omadused potentsiaalse fosfori ning haruldaste muldmetallide toormena ja selle komplekssed ümbertöötlemistehnoloogiad" (1.09.2020–31.03.2023).
- VHE22029 „Zero Emission Network to facilitate CCUS uptake in Industry" (01.09.2022–28.02.2025)
- VERT20047 „Strateegiline partnerlus ringmajanduse lähenemisviisi edendamiseks kaevandustööstusega seotud õppeprogrammides" (01.09.2020–31.08.2023)

- VFP20055 „Vesiniku ladustamine Euroopa maa-aluses" (01.01.2021–30.06.2023)
- VFP17114NG „Kaltsiumitsükli kasutamine CO2-vaba tsemendiklinkri tootmiseks" (01.10.2017–31.03.2023)

Olulisemad tulemused:

2022. a olulisemate teadustulemuste hulka kuulub Eesti maakoore süvaehituse selgitamine kombineeritud magnetomeetria ja gravimeetria mudelite põhjal. Saadus tulemusi on võimalik rakendada nii võimalike maagistumisalade otsinguks kui ka ka piirkonna geotermaalse potentsiaali mõistmiseks.

Kliimaneutraalse energeetika kasutuselevõtu aspektist on oluline rahvusvaheline teadusuuringute ja innovatsioon koostöö Horisont 2022 raames, milles selgitati, kus ja kuidas oleks võimalik vesinikku ladustada Euroopa maapõue.

Rakenduslikud väljundid:

Lisaks teadustegevusele panustasid töörühma liikmed 2022. a aktiivselt maapõueressursside valdkonna laiemale tutvustamisele osaledes Eesti-sisestel ning rahvusvahelistel avalikel esinemistel ja võttes sõna meedias (1, 2, 3 ja mitmed teised). Ettevõtluskoostöö osas konsulteeriti Trisector OÜ-d põlevkivi aherainest kaltsiumkarbonaadi väärindamise uuringute läbiviimisel.

Olulisemad partnerid Eestis: Tartu Ülikooli geoloogia osakond, Eesti Geoloogiateenistus, Trisector OÜ

Olulisemad partnerid välismaal: GFZ-Potsdam, Oulu Mining School

Veebileht: https://taltech.ee/geoloogia-instituut/uurimisruhmad#p31323

Mineral Resources and Applied Geology Research Group

Research group leader: Rutt Hints, Senior Researcher, phone 6203036, rutt.hints@taltech.ee.

Members: prof. Alvar Soesoo, Tarmo Kiipli, Heidi Soosalu, Alla Šogenova, Kazbulat Šogenov;

Doctoral students: Siim Pajusaar, Sophie Jane Marie-Pascale Huguette Graul, Mawo Ndiaye, Juan David Solano Acosta;

Non-academic members: Toivo Kallaste, Kristjan Urtson, Nata-Ly Pantšenko, Andre Gregor.

Keywords: mineral resources, geochemistry, mineralogy, black shales, phosphorites, ore genesis, geophysics, CCUS, hydrogen storage, circular economy.

Overview:

The main study area of the research group is the perspective mineral resources of Estonia containing raw materials listed as critical by the EU. The research targets issues related to their genesis, distribution, and valorisation. The group's core competencies are related to geochemistry and mineralogy of sedimentary mineral resources, including phosphorites, metalliferous black shales and other carbonaceous rocks. Besides that, several R&D projects focused on various aspects of the geology of Proterozoic ore deposits have been conducted during the last few years. The discrete research area is devoted to carbon capture and CO_2 and hydrogen storage technologies. The interdisciplinary research in areas such as valorization of mineral resources and the recycling of mine wastes is based on the group's extensive research experience in areas such as X-ray powder diffraction.

The research group manages the lab of geochemistry and mineralogy equipped with ICP-MS, XRF, and XRD, allowing the complex set of geochemical, mineralogical, and petrological studies to be carried out. The quality of laboratory analyses is assured through participation in the proficiency testing program of the International Association of Geoanalysts. The workgroup's active collaboration partners come from numerous organizations from Estonia and abroad, including the Geological Survey of Estonia, University of Oulu and the GFZ German Research Centre for Geosciences.

Projects in progress:

- RESTA23 "Quality and properties of Estonian shelly phosphorite as a potential source for phosphorus and rare earth elements and its complex processing technologies" (1.09.2020–31.03.2023);

- RESTA20 "Genesis and economically valuable metals in polymetal sulphide mineralizations in Precambrian of Estonia (1.04.2020–30.11.2022)";

- RESTA18 "Vanadium distribution and compounds in Tremadocian black shale and potential extraction technologies" (1.07.2020–28.02.2023)

- VHE22029 "Zero Emission Network to facilitate CCUS uptake in industry" (1.09.2022–28.02.2025);

- VERT20047 "Strategic partnership for fostering circular economy approach in extractive industry related study programmes" (1.09.2020–31.08.2023);

- VFP20055 "Hydrogen Storage In European Subsurface" (1.01.2021–30.06.2023);

- VFP17114NG "CLEAN clinKER production by Calcium looping process" (1.10.2017–31.03.2023).

Main results:

The most relevant research results of 2022 include a novel interpretation of the deep crustal structures of Estonia based on combined gravimetric and magnetometric data sets. The new models could be further used to delineate potential metallogenic areas and to understand the geothermal potential of the region.

Clarifying conditions and requirements for efficient underground hydrogen storage in Europe, as part of research and innovation collaboration under Horizon 2020, bolsters European goals for fast-paced transitions to renewable technologies.

Mäenduse ja maavaratehnoloogia uurimisrühm

Juht: Veiko Karu, EIT vanemprojektijuht, +372 6203850, veiko.karu@taltech.ee

Akadeemilised liikmed: Michael Hitch, professor; Erik Väli, vanemlektor; Sander Kanter, lektor; Tõnu Tomberg, lektor; Peeter Talviste, praktik-professor

Doktorandid: Andrus Paat, Nthati Monei, Vesta Kaljuste

Teised liikmed: Aleks Strazdin; Karin Robam; Tony Hand

Võtmesõnad: mäendus, maavarade kaevandamine; ringmajandus; toormed; fosforiit; ESG; ettevõtlikkus

AAK prioriteetsed suunad: Keskkonnaressursside vääristamine (mineraalsed toormed, sh tulevikumaavarad ja kriitilised toormed)

Frascati Manuali alamvaldkond: 1.5 Maateadused ja nendega seotud keskkonnateadused, 2.1 Ehitusteadused, 5.2 Majandusteadus ja ärindus

CERCSi teaduserialad: T340 Kaevandamine/mäendus; P430 Maavarad, majandusgeoloogia; P470 Hüdrogeoloogia, geoplaneering ja ehitusgeoloogia; T181 Kaugseire

Uurimisrühma tutvustus:

TalTech geoloogia instituudi Mäenduse ja maavaratehnoloogia osakonnale pandi alus 1938. a, kui ülikoolis loodi mäeinseneride koolitamiseks mäeosakond. Ülikooli viimase struktuurireformi käigus liideti 2016. a septembris senine energeetikateaduskonna mäeinstituut geoloogia instituudiga omaette osakonnana. Mäenduse ja maavaratehnoloogia osakonna õppejõud annavad panuse mäeinseneride ettevalmistusse vastava kutsestandardi järgi. Osakonna teadustöö toimub nii läbi riiklike kui ka ettevõtete rahastatud rakendusuuringute projektide. Mäeosakonna kompetentsi kuulub:
- kaevanduste ja maavarade töötlemise tehnoloogiate projekteerimine;
- ressursitõhususe meetmete ja tehniliste lahenduste leidmine ning hindamine;
- ringmajandusega seotud ettevõtlussuundade arendamine.

Rahvusvahelised projektid:
- SUMEX, Sustainable Management in the Extractive Industries
- RE-SOURCING, Global Stakeholder Platform for Responsible Sourcing
- AGEMERA, Agile Exploration and Geo-modelling for European Critical Raw materials
- EIT Raw Materials projects, 4 in 2022

Osalemine TA&I-ga seotud välisorganisatsioonide töös:
- Society of Mining Professors: Michael Hitch; Veiko Karu
- EIT Raw Materials: Veiko Karu; Tony Hand
- Green Deal Academia: Veiko Karu; Karin Käär

Olulisemad tulemused:

Uurimisrühma teadusvaldkond on mitmekesine ja katab erinevaid maapõue inseneeria valdkonna teemasid nagu tehnoloogia optimeerimine, kaevandamise keskkonnamõjude vähendamine, tootlikkuse tõstmine jpm. Silmapaistvateks tulemusteks 2022 aastal olid CO_2 sidumisega seotud teemad vähendamaks mäetööstuse CO_2 jalajälge, samuti ka metallide kättesaadavus fütoakumulatsiooni kaudu. Maavarade kaevandamine mõjutab maakasutust, seega sai avaldatud olulised tulemused maapinna stabiilsuse arvutamisel ning modelleerimisel.

Olulisemad partnerid Eestis: Viru Keemia Grupp, Energiasalv OÜ, Trisector OÜ

Olulisemad partnerid välismaal: EIT Raw Materials Network, University of Loraine, Oulu Mining School (University of Oulu).

Veebileht: https://taltech.ee/geoloogia-instituut/uurimisruhmad#p31325

Mining and Mineral Technology Research Group

Research group leader: Veiko Karu, Senior Project Manager, 6203850, veiko.karu@taltech.ee

Academic members: Michael Hitch, professor; Erik Väli, Senior Lecturer; Sander Kanter, Lecturer; Tõnu Tomberg, Lecturer; Peeter Talviste, Professor of Practice

Doctoral students: Andrus Paat, Nthati Monei, Vesta Kaljuste

Other members: Tony Hand, Aleks Strazdin, Karin Robam

Keywords: Mining Science, CO2 Mineral Carbonation, Circular Economy, Phosphorite, Phytoremediation, Entrepreneurship, ESG

Introduction:
The Mining and Mineral Technology Research Group has a long history in Estonia. The original discipline of Mining Engineering was established in 1938. More recently, in autumn of 2016, the previously independent Department of Mining merged with the Department of Geology. Today research and education staff of Mining carry out programming that contributes to the occupational qualifications system of mining engineering as guided by the Estonian Qualifications Authority. The mission of the Mining and Mineral Technology Group is to help young engineers and scientists develop the necessary skills to promote the sustainable and safe development, extraction and closure of Estonia's mineral resources.
The technical competencies of the members of the Mining Research group include mining engineering and design, mineral economics, mining environmental impact and remediation, mine waste management, circular economic and social sustainability, quantitative resource evaluation, ESG management and mining geochemistry. The infrastructure available to the Mining Research group includes a Mining Conditions laboratory, specialized orebody/geological modelling softwares, and physical and virtual simulation tools (e.g., AR Sandbox, VR Headsets etc.).
Running international projects:
- SUMEX, Sustainable Management in the Extractive Industries
- RE-SOURCING, Global Stakeholder Platform for Responsible Sourcing
- AGEMERA, Agile Exploration and Geo-modelling for European Critical Raw materials
- EIT Raw Materials projects, 4 in 2022

Main results:
The research field of the research group is diverse, starting with the usual mining engineering related challenges such as optimizing mining technology, reducing environmental impacts, increasing productivity, etc. Outstanding results in 2022 were related with CO2 sequestration to reduce the CO2 footprint of the mining industry, as well as the availability of metals through phytoaccumulation. The extraction of mineral resources affects land use and land planning, important results were published in the calculation and modelling of ground stability of undermined areas in the Estonian oil shale deposit and Piusa sand caves.

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