Scientific report for the I. period

PART 2: PROGRAMME PROJECT INFORMATION

2.1. Project No. 4

Title	„Studies of mineral resources- the new products and technologies" (Zeme) [Earth]		
Project leader's name, surname	Valdis Seglins		
Degree	Dr. geol.		
Institution	University of Latvia		
Position	Senior researcher		
Contacts	*Phone number*		29265952
	E-mail		Valdis.Seglins@lu.lv

2.2. Project goal and objectives
(Describe the project goals and objectives so that the achevements reported below could be placed in context and evaluated)
Overall objective for the project the first phase is to perform the studies of mineral resources (mainly clay, dolostone, peat and gyttja) and initiate experimental and analytical part of the project.

Project goal and objectives	Major results
1. Study mineral resources and determine mineral deposits suitable for studies in details for the Second Phase of the project. Initiate experimental and analytical part of the project.	Wide range of local mineral resources was studied in details - besides traditional (sand and gravel, clay and dolostone) with particular attention to technological properties, studies include salt, colored stones, flint, ochre and amber. The lest was finalised ir original per review monographs. For studies in details selected several clay deposits (Kuprava, Nīcgale un Tūja) suitable for development new technologies and products. Strongly developed geophysical research methods (mainly georadar) in peat deposits to reach high resolution geological research applications. Most these studies will be finalised during the 2nd phase of the project.
2. To investigate treatment, preparation and modification possibilities of Latvian clays for development of new technologies and innovative products with high added value for application in cosmetics and improvement of environmental quality (innovative	The most stabile emulsions were obtained by the addition of 10 mass% untreated clay fraction with the highest content of clay minerals. The obtained results show that illite clays from Latvia with fraction under 2 μm can be used in cosmetic product like sunscreen as natural UV filter

sorbents and biodegradable polymers). Particular objectives of project in the 1st period: Investigation of clay properties for application in sunscreens and development of biodegradable composite materials and innovate granular sorbent	and possibly emulsifier. ochre
3. To determine and limit the choice of perspective mineral raw materials to use for development of ceramic products	According to their chemical and phase compositions as well as transformation during thermal treatment, the most promising and usable for the work in the 1st period mineral raw materials was clay from deposits of Laza-Apriki, Nicgale, Prometejs, Kallukalns and Pavari, as well as quartz sand from Bale query and Jekabpils dolomite wastes). They were used to develop: (a)Low temperature (100 – 150 °C) setting 'geopolymer' materials with compressive strength of 15 – 20 MPa, mainly for the use in restoration of buildings and cultural monuments; (b) Porous, cordierite crystalline phase-containing ceramics, using carbonate-containing Nicgale clay and quartz sand from Bale query; cordierite formation temperature of 1200°C (traditionally – 1400 °C); (c) Dense ceramic material with increased strength and varying colour palette by using from clay-separated illite fraction and $Al(OH)_3$ as additive. (d) Mullite-ZrO_2 ceramic with illite clays as sintering aid and strength improver; (e) Alkaline (Na^+ or K^+) solution activated clays (from Kallukalns and Livani deposits) in compositions with fine fraction of Jekabpils waste dolomite. Material development intended as a new porous ceramics for building material applications. Most of results have been summarised in papers and presented at scientific conferences.
4. The project goal was obtaining of highly porous clay and oxide ceramics, determination of sorption properties and possible practical use of these ceramics. Project objectives (1) Investigation of thermal, physical and chemical processes during firing of various clays and oxides;	Described in details project tasks was implemented and results gained in all components and major results are published and reported in the scientific conferences (in details see p. 2.3.). This leads to clear working program for future research activities.

(2) Determination of pores structure of obtained materials by mercury porosimetry and nitrogen absorption (BET); (3)The possible use of some organic by-products for the increasing of porosity of ceramic materials; (4) Determination of sorption ability of such materials concerning to some organic pollutants in the water; (5) Investigation of various surface activation with task to increase a sorption ability; (6) Determination of filtering and sorption ability of highly porous ceramics	
5. The aim of the sub-project is to study peat and sapropel (organogenic deposits) properties and their application potential. The worktasks of the 1.st year of the project includes sampling of peat and sapropel samples, characterisation of their properties by means of different methods and relations to application options..	During the 1. year of study major attention was addressed to study in details peat and sapropel (organogenic deposits) properties, their relations to diagenetic transformation processes of natural organic matter as well as to study their application potential. This includes sampling of peat and sapropel samples, characterisation of their properties by means of different methods and relations to application options. Supplementary studies was related to environmental remediation possibilities, both in respect to dredging of eutrophic lakes and complex use of peat and sapropel to develop added value products. Major research results was published and study reaches one National patent.
6. To develop an improved biopreparation with *Rhizobium leguminosarum* estimating microbial viability in suspension and on different carriers and to estimate an effect of the ceramic beads after their use in wastewater treatment as an alternative fertilizer	Gained results are published and it can be concluded that the model system constructed in this study has a potential for further development of the wastewater treatment process in the columns cascade. The porous ceramic beads were shown to be a stable supporting material for microbial immobilization.

2.3. Description of gained scientific results

(Describe scientific results achieved during reporting period, give their scientific importance)

The project was organised as integrated study between 6 research groups from several institutions (mainly University of Latvia and Riga Technical University) coordinated in manner from bottom to up-- in particular conditions-- from geological basic studies

to intense microbiological studies. The following will shortly describes major results of particular subprojects.

1. **Mineral resources studies**. Besides traditional high quality Latvia mineral resources (e.g. dolostone, clay, sand and gravel, and peat) during the first year substantial attention was addressed to evaluation of untraditional for Latvia mineral resources like flint, ochre, salt, colored stone, amber) finalised by several published original per reviewed monographs and therefore this area for future studies is finalised for years. Palaeogeographical studies for prognosis of sand and gravel deposits are finalised in doctoral thesis of M. Krievans.

At this phase of the project evaluated clay deposits and selected several most suitable (Kuprava, Nīcgale un Tūja) for studies in details during the second phase, where the most attention will be forwarded to development of new technologies and potential market high value added products.

Evaluated indirect geological research methods (geophysical studies) in particular for applications to peat studies to reach instrumental qualities of data and there is possibilities to develop the method during the second phase of the project to finalise with methodology of this method for applied geological field studies, mostly for road constructions and quality control.

2. **Studies in details clays regarding applications for cosmetics demonstrate** that illite clays from Latvia with fraction under 2 μm mixed with 50% (mass/mass) glycerol/water solution showed the ability to partially absorb UV radiation. The absorption ability was influenced by the mineralogical and chemical composition and the amount of clay fraction added. The highest UV absorption ability showed samples with the highest content of iron oxide in the chemical composition and with the highest concentration (30 mass%) of clay fraction. From the obtained data sun protection factor (SPF) was calculated, giving the highest SPF 2,8. The addition of clay fraction also improved the stability of oil-in-water emulsions. The stability was influenced by the mineralogical composition, chemical treatment of clay samples and added concentration. The most stabile emulsions were obtained by the addition of 10 mass% untreated clay fraction with the highest content of clay minerals. The obtained results show that illite clays from Latvia with fraction under 2 μm can be used in cosmetic product like sunscreen as natural UV filter and possibly emulsifier. Scientific importance of the current work is confirmed with PhD thesis of I. Dušenkova.

Scientific research about application of biodegradable composite materials as alternative daily cover materials in waste landfills and investigation and criteria of clay properties for application in development of biodegradable composite materials was gathered and investigated. Based on the literature data, a sprayable cover material is the most convenient for daily use. The main components used to develop biodegradable composite materials are clay (10% - 90%), fiber (20% - 60%) and a polymer (0,5% - 15%). The particle size of clay material should be within the range of 0,001 – 0,1 mm. Despite the fact that montmorillonite containing clays are mostly used because of their rheological properties (plasticity and viscosity), rheological properties of illite containing clays also can be used in development of biodegradable composite materials for application as waste landfill covers. It is possible to develop a sprayable alternative daily cover material by using polymer materials and fibres and locally available clays, which would allow greater use of the resources available in Latvia. The literature review about criteria of clay properties for application in development of biodegradable composite materials are essential in experimental design and will be used in development of daily cover from Latvian illite clays

containing composite materials. Scientific importance of the literature research about application of biodegradable composite materials as alternative daily cover in waste landfills is confirmed with an articleTechnological method for obtaining granular sorbents (hollow spheres) from polystyrene pellets, binder and clays from Liepa deposit with laboratory scale homemade rotary granulator was developed. Mechanical properties, structure and surface morphology of the obtained hollow spheres were investigated. The process includes these steps in this direct order – inserting polystyrene pellets in the granulator cylinder, addition of clay powder, setting the mixing speed and turning on the motor, praying the binder solution, spraying the clay powder on the wet hollow spheres until they become lighter in color and the clay coverage on the spheres is 0,5-1,5 mm. Then the spheres are calcined in 5 different temperatures - 950, 1000, 1050, 1100 and 1150^{o}C. The results showed that the calcination temperature affect the mechanical strength of the obtained material - mechanical strength increases by increasing the calcination temperature. The surface morphology is not influenced by the calcination temperature – all sample particles have spherical shape with a number of different sized bumps on the surface obtained from uneven deposition of clay particles on the hollow sphere surface. Diameter of these bumps is 20–27% from the sphere diameter. The outcome of the method is ~ 57%, which could be increased by recycling the clays from the granulator cylinder walls. This method provides homogeneity of the obtained hollow sphere properties which is essential in further research about the application possibilities of this material.

4.3. **Ceramics studies demonstrate** the objectives of the 1st period have been reached. In the light of research that has been dedicated to the development of energy saving ceramic materials, the main scientific and practical conclusions are as follows:

- It is possible to “deform” the initial structure of clay mineral illite (it is the main component of local clays), which is a prerequisite for development of ceramic material at lower (in comparison to traditional) firing temperatures. It is also possible to obtain new phases (for example, hydrated sodium alumosilicate) this way, which have a potential use for creation of new binders. The most important changes with illite happen by chemical activating using 4-6 M alkaline solutions and, especially, by dehydration in process of thermal treatment at about 600 °C.

  The influence of KOH on the destruction of illite structure is of greater extent if compared with same concentration NaOH solution. From the practical point of view the temperature of firing of corresponding material has been decreased by about 150 – 200 °C. The resulting materials are intended for the main application in construction industry. The compressive strength of these materials is in the range of 10 – 18 MPa depending on the used clay. The formation of sodium alumohydrosilicate ($Na(AlSiO_4)_6 \cdot H_2O$) is characteristic for clays with high carbonate content (CaO+MgO content of about 9-12 %, loss of ignition 14-15 %) after treatment with NaOH. These materials harden at 100 °C, reaching high enough strength (over 15 MPa).
- Porous cordierite-containing material has been developed using local clays and sand as well as synthetic additives in order to ensure proper stoichiometry. This cordierite ceramic material forms at already 1200 °C (in comparison with traditional 1400 °C) in the presence of liquid phase. Materials with low density (near 1 g/cm^3), high porosity (over 50 %) and compressive strength of about 5 MPa can be obtained. The material is suitable for the use in ceramic filtering systems, for example – hot exhaust gas purification systems.

- It is shown that illite mineral fraction has high stability against 1-6 M alkali solutions – its 2:1 structure only weakens, but does not fall apart. On the other hand, thermal treatment at 600 °C has a higher influence. Therefore thermally treated illite mineral is an active sintering aid and a promising candidate in compositions with synthetic components for obtaining of new high-temperature crystalline phase-containing refractory products.
- Thermally treated illite mineral fraction combined with 20-50 % $Al(OH)_3$ forms new, dense ceramic materials with varying colour palette. Sintered samples can be characterized with density of 2.2 – 2.5 g/cm^3 and high compressive strength (about 170 MPa). Such ceramic products can be used either as high durability floor tiles or as a various construction elements in general, including load-bearing parts. The use of this material as a colouring high-temperature pigment (in form of a powder with particle size in large nanometer scale) should also be considered.

The recycling of Jekabpils waste dolomite fine fraction into new materials is problematic since the procedure temperature should be low. However it is possible to obtain synthetic gypsum ($CaSO_4 \cdot 2H_2O$) by using chemical treatment with concentrated sulphuric acid.

4. Highly porous ceramics with activated surface. The major results can be summarised as: (1) There were determined diverse processes in Devonian and Quaternary clays by obtaining ceramic pellets during sintering at various temperatures; (2) It was determined a dependence of pore size, pore volume, and specific surface area on the initial composition, grain size distribution in the investigated clays and sintering temperature; (3) An addition of glycerine (by-product by refinement of rape oil) improves the pore structure and sorption ability of ceramic granules; (4) Depending on clay type and sintering conditions pellets can reduce the level of organic pollution; (5) The sorption ability of ceramic pellets slightly increases after irradiation with accelerated electrons; (6) The sorption ability concerning to various pollutants is selective and depends on the type of clays (Devonian or Quaternary clays); (7) Nanodisperse additives improves mechanical properties and changes thermal conductivity of highly porous oxide ceramics.

5. The peat, gyttja, clay properties and possible modification studies. Within the first year of the project extensive field sampling of peat and sapropel were done to reflect environmental variability and impacts of differing development conditions on the composition of sedimentary and peat material. For characterisation of full sample profiles besides to their dating, biological composition, pollen analysis, also multiproxy physical and chemical analysis were done including for example elemental analysis (C, H, N, O, S, metal concentration (18 metals), spectroscopic analysis (UV-Vis, FTIR, Fluorescence spectra, fluorescence 3D EEM, ^{13}C NMR, ^{1}H NMR etc). Contribution of environmental impacts of climate change and land use change *versus* human impacts were studied and critical impacts were identified and described. Multiproxy approach on analysis of peat and lake sediments to characterise humification conditions has been applied for first time and obtained results support further studies on application potential of sedimentary material.

4.6. Microbiological studies. Nitrogen-fixing bacteria are widely used in agriculture as a biofertilizer to stimulate the plant growth. The aim of these experiments was to develop biopreparations of *Rhizobium leguminosarum* with an enhanced activity/viability by immobilizing bacteria on an appropriate carrier/substrate. Five sterile materials were compared for immobilizing, i.e., peat, clay powder, two types of

oval ceramic aggregates and cylindrical ceramic beads fabricated by different technologies. Viability of *R. leguminosarum* during storage was influenced by both, type of carrier and temperature. The best results were obtained for biopreparation of *R. leguminosarum* immobilized on peat and stored either at -18 °C or +4 °C. These samples contained at least 10^7 CFU/g substrate, and therefore could be considered as an appropriate biofertilizer. During the pot experiment, formation of root nodules on the roots of beans and faba beans in the presence of two strains of *R. leguminosarum* was shown to be plant species-specific. Further study is necessary to test the developed biopreparations under field conditions.

The suitability of ceramic beads for immobilization of N- and P-utilizing microorganisms in the wastewater treatment process, as well as the further use of ceramic beads as alternative fertilizer was tested in the experiments with synthetic wastewaters. After 42 days experiment in the columns cascade, formation of crystals on the beads surface was detected. Concentration of N/P/K achieved up to 1.4/0.6/0.5 g/kg beads, respectively. Comparison of rye and cress response to the presence of the used ceramic beads in loamy sand soil showed the plant species specific effect after a 21-day vegetation experiment. An increase of dry mass of aboveground biomass for rye and cress was 11.2% and 20.0%, respectively, as compared to control without beads. It can be concluded that the model system constructed in this study has a potential for further development of the wastewater treatment process in the columns cascade. The porous ceramic beads were shown to be a stable supporting material for microbial immobilization. The scheme of further experiments can be modified by shortening the retention time of wastewater in the columns as well as optimizing the "beads : liquid phase" ratio.

2.4. Further research and practical exploitation of the results

(Describe further research activities that are planned, describe possibilities to practically exploit results)

Future research activities are described in work program is underway and as scientific report of the 2nd phase will be presented by March 2016. This will finalize initiated experimental studies in specific regarding clay and peat modifications.

In respect to geological studies major attention will be concentrated on Quaternary geological deposits forming regularities (deglaciation models developed) to reach suitable clay and sand deposits as raw material for new technologies and products. Therefore corresponding field and sampling activities for test material collection will be performed for studies in the 3 other research groups of this project. As important task is to develop geophysical methods (georadar) suitable for instrumental accuracy regarding depth of peat deposits and applications to road construction geotechnical studies in details.

In respect to clay studies in details further research will be aimed to obtain clay fraction under 2 μm using spray drying and more detailed research about the influence of illite clay addition and various parameters on the stability of oil-in-water emulsions. The achieved results will be used to develop ecological cosmetics containing illite clays. To evaluate the application possibility of Latvian illite clays in development of biodegradable cover materials, influence of different clays and their concentration on the formation properties of the cover material layer will be investigated. Further research about the granular sorbents (hollow spheres) will include investigation of porosity and sorption properties of the material, obtained with

different parameters, in order to develop products for application in agronomy and ecology.
Regarding development of ceramics studies is concluded, that future development of the study will concentrate on (a) enlargement of the basis of illite clays suitable for 'geopolymer' synthesis to obtain materials with relative low temperatures and higher possible compressive strength; (b) using of mixes from different clays and fly ashes to reduce the global warming potential and impact of by-products (fly ashes) on environment; (c) functionalizing of different substrates (e.g., cellulose fibers) by clay or clay mineral – illite nanoparticle deposition to improve, e.g., its resistance to temperature; (d) use of organic templates (e.g. wood) to reproduce its unique morphology to obtain new ceramic materials, for example, for medicine.
Number of specific in details studies are underway regarding studies of clay high porous ceramics technology development and target oriented properties of product development.
The study continuation will include modification options, studies of humic substances isolated from peat and sapropel, their structure, as well as their application possibilities.
Regarding development of microbiological studies the scheme of further experiments can be modified by shortening the retention time of wastewater in the columns as well as optimizing the "beads : liquid phase" ratio. In respect to f nitrogen-fixing bacteria used in agriculture as a biofertilizer to stimulate the plant growth urther study is necessary to test the developed biopreparations under field conditions.

2.5. Dissemination and outreach activities
(Describe activities that were performed during reporting period to disseminate project results)

Project development and particular activities and recent results are reflected in the project homepage (in Latvian) - see www/lu.lv/vpp/. There are number activities performed including presentations at National Radio, participation in science popularisation events Scientists Night ("Zinātnieku nakts"). To wide range of users are addressed most of scientific monographs, but still by content are in a range of scientific books. Research within the project about the application of Latvian clays in cosmetics was disseminated to the public with a popular-science publication "RTU researcher Inga Dušenkova is looking for wider application of Latvian clays" in newspaper Latvijas Avīze on the 1st April 2015 and with an interview "Application of Latvian clays in cosmetics" in Latvian Radio 1 on the 23rd April 2015. Most of outreach activities are coming out from peat, gyttja and microbiological studies and are well known by publications in National newspapers and popular scientific magazine "Ilustrēta Zinātne".
Specifically should be mentioned traditional dr. R. Svinka cooperation and scientific expertise in development and evaluation of pupils (Secondary School grade) scientific works usually related with mineral resources, chemical and technological processes.

Most of scientific results are published, including 4 articles (*SCOPUS*, SNIP > 1) and 3 articles included in *SCOPUS* (SNIP<1), EBSCO, VINITI, Chemical Abstracts databases. Results are presented in 5 original scientific monographs, and most of the program 1st stage research results are concentrated in 3 protected doctoral thesis.
As particular high rate should be recognised in respect to participation in International scientific conferences (5 conferences and abstracts are published), and there are

number of participations National scale Scientific conferences (11 presentations performed with published abstracts) with participation of project social partners from industry. For this cooperation during the University of Latvia Annual Scientific Conference particular section with number of presentation was organised to spread out project scientific results (in details see- http://www.geo.lu.lv/petnieciba/lukonferences/petniecibalukonferences/lietiska/).

Besides developed new research methods and methodology and one National patent is registered.

Appendix

Scientific results

Scientific publications

Original scientific papers (*SCOPUS*) (SNIP > 1)

1. Berzins A., Petrina Z., Nikolajeva V., Svinka R., Svinka V., Strikauska S., Muter O. 2015. Characteristics of a Ceramic Carrier after Wastewater Treatment Process in the Model Column Cascade with Ethanol Addition. The Open Biotechnology Journal 9, 76-84. Available at: http://benthamopen.com/contents/pdf/TOBIOTJ/TOBIOTJ-9-76.pdf

2. Dabare, L., R.Svinka. Characterization of porous ceramic pellets from Latvian Clays. Chemija. 2014. vol. 25. No. 2. p. 82–88. ISSN:0235-7216 Available at: http://www.scijournal.org/impact-factor-of-CHEMIJA.shtml (SCOPUS)

3. Stankevica, K., L.Kalnina, M.Klavins, A.Cerina, E.Kaup (2015) Reconstruction of the Holocene palaeoenvironmental conditions accordingly to the multiproxy sedimentary records from Lake Pilvelis, Latvia, *Quaternary International*, 72, 1-14. Available at: http://www.sciencedirect.com/science/article/pii/S1040618215001226

4. Zake-Tiluga, I., R.Svinka, V.Svinka. Highly Porous Corundum – Mullite Ceramics – Structure and Properties. *Ceramics International*, 2014, vol. 40, iss. 2, pp. 3071.-3077. ISSN 0272-8842. Pieejams: doi:10.1016/j.ceramint.2013.09.139 (SCOPUS). Available at: http://www.sciencedirect.com/science/article/pii/S0272884213012443

Original scientific papers *ERIH* (A and B) database included

Original scientific papers in other datav bases (EBSCO, VINITI, Chemical Abstracts):

1. Medne, O., R. Serzane, L. Berzina-Cimdina. Composition for alternative daily cover materials with a perspective of usage of Latvian local resources. *Material Science and Applied Chemistry*, 2015, No. 32, 45-48.
Available at: https://ortus.rtu.lv/science/lv/publications/20943

2. Rundans,M., G.Sedmale, I.Sperberga, I.Pundiene. Development of cordierite ceramics from natural raw materials. Advances in Science and Technology, Vol. 89, 2014, pp. 94-99.
Available at: http://dx.doi:10.4028/www.scientific.net/AST.89.94

3. Sedmale, G., I.Sperberga, M.Rundans, L.Grase. Different treatment application of illite clay for low temperature ceramics. Advances in Science and Tehnology, Vol.92, 2014, pp. 62-67.
Available at: http://dx.doi:10.4028/www.scientific.net/AST.92.62

Original per reviewed scientific monographs

1. Segliņš, V. 2015 Aiz dzintara spīduma. Daugavpils Universitāte, akadēmiskais apgāds "Saule", 170 lpp.

2. Segliņš, V. 2015. Sāls druska. Daugavpils Universitāte, akadēmiskais apgāds "Saule", 150 lpp.

3. Segliņš, V. 2015 Dārgakmeņi un rotakmeņi. Daugavpils Universitāte, akadēmiskais apgāds "Saule", 144 lpp.

4. Segliņš, V. 2015 Raibas pēdas akmenī un mums visapkārt. Daugavpils Universitāte, akadēmiskais apgāds "Saule", 88 lpp.

5. Krievāns, M. 2015. Hidrogrāfiskā tīkla veidošanās Lejas Gaujas senioielejā pēdējā apledojuma beigu posmā. Rīga, Latvijas Universitātes akadēmiskais apgāds, 132 lpp.

Developed new methods and methodologies

1. Šiškins, A. "Technology for obtaining granular sorbents (hollow spheres) using Latvian clays" (in Latvian), 2015

Protecteds doctoral Thesis

1. Dušenkova, I. "Development of preparation technology and investigation of properties of Latvian clays for application in cosmetic products" (in Latvian), defended in 2015. Available on the Internet: https://ortus.rtu.lv/science/en/publications/19817-Development+of+preparation+technology+and+investigation+of+properties+of+Latvian+clays+for+application+in+cosmetic...

2. Krievāns, M. 2015 „Hidrogrāfiskā tīkla veidošanās Lejas Gaujas senielejai pieguļošajā teritorijā Vēlā Vislas apledojuma deglaciācijas laikā"
Full text is available at: https://dspace.lu.lv/dspace/bitstream/handle/7/28297/298-46546-Maris_Krievans_2015.pdf?sequence=1&isAllowed=y

3. Mahņicka-Goremikina, L.. Sintēzes apstākļu un leģējošo piedevu ietekme uz porainas augsttemperatūras keramikas īpašībām un struktūru. Rīga, 2015, 136 lpp.
Full text is available at: https://ortus.rtu.lv/science/lv/publications/20334

Information for public

Organized scientific and public conferences

University of Latvia Annual scientific conference - Programm oriented section: LU 73. konferences Lietišķās ģeoloģijas sekcija- organizēta tieši VPP rezultātu apspriešanai. Results and presentations are available (18 oral presentations and 6 posters): http://www.geo.lu.lv/petnieciba/lukonferences/petniecibalukonferences/lietiska/

Abstracts of Conference available at: Konferences tēzes pieejamas elektroniski: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf

International scientific conferences - participation, abstracts published

1. Dudare, D., M.Klavins (2014) The interaction between humic substances and metals, depending on structure and properties of humic substances. In: Book of Abstracts of the 17th Meeting of IHSSIonannina, Greece, 2014, pp. 11-12

2. Klavins, M., O.Purmalis Diagenesis of structure and properties of humic substances. . In: Book of Abstracts of the 17th Meeting of IHSSIonannina, Greece2014, pp.,1-2

3. Klavins, M., O.Purmalis Variability of humic acid properties depending on their precursor material: a study of peat profiles Geophysical Research, 2015, Abstracts, 17, EGU2015-8994.

4.. Sperberga, I., M.Rundans, A.Cimmers,L.Krage, I.Sidraba Mechanical properties of materials obtained via alkaline activation of illite-based clays of Latvia. 1st International Conference on Rheology and Modeling of Materials", published by Journal of Physics : Conference Series vol. 602 (2015; doi: 10.1088/1742-6596/6021/012007.
Available at: http://iopscience.iop.org/article/10.1088/1742-6596/602/1/012007

5. Sperberga, I., G.Sedmale, M.Rundans, A.Cimmers, V.Seglins. Quaternary clays of Latvia for chemical and thermal activation. In: Scientific Research Abstracts of Internat. Conf. on Applied Mineralogy & Advanced Materials, June 7-12, 2015, Castellaneta Marina, Italy, *Vol. 4, 2015,pp. 20-21.*

Local Latvia scale scientific conferences- participation and published abstracts

1. Dabare, L., R.Svinka, V.Svinka. Ammonia removal from water solution by adsorption on porous caly ceramic pellets, 55th International Scientific Conference of the Riga Technical University, Riga, 14-17 October 2014. p.45.

2. Damberga, M., I.Pudže, L.Dabare,R.Švinka. Atšķirīgu kvartāra mālu keramikas sorbcijas īpašības. Ģeogrāfija, Ģeoloģija. Vides zinātne. LU 73. Zinātniskā konferences referātu tēzes, Latvijas Universitāte, 2015,267-269. (ISBN 978-9984-45-958-5); Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf;

3. Krūmiņš,J., M.Kļaviņš, V.Segliņš (2015) Zemā tipa kūdras sadalīšanās procesu raksturošana izmantojot 3D fluorescences metodi. LU 73 zinātniskā konference, lpp. 355 – 356. Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf

4. Leščinskis, O., R.Švinka, V.Švinka. Keramikas granulu absorbcijas spējas izmaiņa. Ģeogrāfija, Ģeoloģija. Vides zinātne. LU 73. Zinātniskā konferences referātu tēzes, Latvijas Universitāte, 2015,297-299. (ISBN 978-9984-45-958-5); Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf;

5. Randers, M., Sedmale. Diferencēti apstrādātu mālu struktūra un īpašības Ģeogrāfija, Ģeoloģija. Vides zinātne. LU 73. Zinātniskā konferences referātu tēzes, Latvijas Universitāte, 2015, 309-310.lpp. (ISBN 978-9984-45-958-5;). Available at: : http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf

6. Rundāns, M., Šperberga, G.Sedmale. Poraina kordierīta keramika ar Latvijas kvartāra mālu," Ģeogrāfija, Ģeoloģija. Vides zinātne. LU 73. Zinātniskā konferences referātu tēzes, Latvijas Universitāte, 2015, 310-311.lpp. (ISBN 978-9984-45-958-5). Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf;

7. Svinka, R., O.Lescinskis, V.Svinka. Ativation of ceramic surface with accelerated electrons. 55th International Scientific Conference of the Riga Technical University, Riga, 14-17 October 2014 p.46.

8. Vecstaudža D., Štelmahere S., Strikauska S., Grantiņa-Ieviņa L., Muter O. Dažāda izmēra koksnes bioogles frakciju iuetekme uz mikroorganismu aktivlitāti un *Secale cereale* L. augšanu. LU 73. zinātniskās konferences Lietišķās ģeoloģijas sekcijas sēde, 2015.g.06.februārī. Ģeogrāfija. Ģeoloģija. Vides zinātne. Referātu tēzes. Rīga: Latvijas Universitāte, 2015, lpp. 319-320. Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf

9. Zake-Tiluga, I., R.Svinka, V.Svinka, T.Fey Thermal conductivity of porous Al_2O_3 – mullite ceramic. 55th International Scientific Conference of the Riga Technical University, Riga, 14-17 October 2014, Abstarcts, p.44.

10. Zembaks, A., V.Švinka, R.Švinka. Augsti poraina Tūjas mālu keramika. Ģeogrāfija, Ģeoloģija. Vides zinātne. LU 73. Zinātniskā konferences referātu tēzes, Latvijas Universitāte, 2015,332-333. (ISBN 978-9984-45-958-5); Available at: http://www.geo.lu.lv/fileadmin/user_upload/lu_portal/projekti/gzzf/Konferences/Tezu_krajumi/A5_kopa_gala_versija_2015.pdf

11. Žvagiņa S., Petriņa Z., Nikolajeva V., Lielpētere A. Immobilization of root nodule bacterium *Rhizobium leguminosarum* biovar *viciae*. Abstract of the 73rd Scientific Conference of the University of Latvia. Environmental and Experimental Biology, 2015, 13, 49. Available at: http://eeb.lu.lv/EEB/201503/EEB_XII_1_abstracts.pdf

Popular scientific publications

1. Kuzmina, I. "RTU researcher Inga Dušenkova is looking for wider application of Latvian clays" (in Latvian). Latvijas Avīze, April 1, 2015.
Available on the Internet: http://www.la.lv/ja-strada-zinatne-vari-mainit-pasauli/

2. „Ilustrētā zinātne" raksts „Notekūdeņi palīdzēs pabarot Kultūraugus", 2014.g.augusts (8/2014)

Radio interviews

1. Interview with Inga Dušenkova in Latvian Radio 1 - "Application of Latvian clays in cosmetics" (in Latvian), April 23, 2015.
Available on the Internet: http://lr1.lsm.lv/lv/raksts/zinamais-nezinamaja/latvijas-malu-pielietojums-kosmetika.a51027/

2. Raidījums „Zināmais nezināmajā", LR1, red. Olga Rimšāne, 2014.g. 3.novembrī 10.30.-11.00. Piedalījās: A.Bērziņš, V.Nikolajeva, R.Švinka
Available at: http://lr1.lsm.lv/lv/raksts/zinamais-nezinamaja/par-notekudenju-attiiriishanu-un-parstradi.a44525/

Public events for science popularisation

1. Zinātnieku nakts, 2014.g.26.septembrī. “Kristālu veidošanās notekūdeņos”, prezentēja A.Bērziņš (pasākuma programma: http://www.lu.lv/fileadmin/user_upload/lu_portal/zinas/Zinatnieku_nakts_2014.pdf)

Economic indicators

2. Patents:

Latvija National patents

1. M.Kļaviņš, J.Krūmiņš, S.Bunere (2015) Augsnes substrāts izmantošanai bioloģiskajā lauksaimniecībā un tā iegūšanas paņēmiens, LV15013 no 05.03.2015
Available at: http://www.lrpv.gov.lv/sites/default/files/20150620.pdf

Other activities:

Consultations of students of 2nd Riga State gymnasium “The possible purification of polluted with phenol groundwater by use of clay and household filters” - acknowledgement paper.