



Questionnaire

Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Ústav geotechniky Slovenskej akadémie vied, verejná výskumná inštitúcia

Watsonova 45, 040 01 Košice

(English: Institute of Geotechnics, Slovak Academy of Sciences. Acronym: IGTSAS)

1.2. URL of the institute web site

<http://ugt.saske.sk>

1.3. Executive body of the institute and its composition

Directoriat	Name	Year of birth	Years in the position, from - to
Director	Ing. Slavomír Hredzák, PhD.	1967	01/2014 - present
Deputy director	visit. prof. Ing. Vítězoslav Krúpa, DrSc.	1950	01/2014 – 12/2017
Deputy director	Ing. Lucia Ivaničová, PhD.	1977	01/2018 - 04/2019 07/2022 – present
Deputy director	Ing. Jozef Hančulák, PhD.	1966	04/2019 - 06/2022
Scientific secretary	Ing. Miroslava Václavíková, PhD.	1977	01/2014 - 05/2022
Scientific secretary	Ing. Silvia Dolinská, PhD.	1977	05/2022 - present

1.4. Head of the Scientific Board

2016 – July 2018 prof. RNDr. Jaroslav Briančin, CSc.

July 2018 – present Ing. Alena Luptáková, PhD.

1.4.1 Composition of the International Advisory Board

Prof. Dr. Vladimír Čablík (Mineral Processing) Faculty of Mining and Geology, VSB – Technical University of Ostrava, CZ
Prof. Andy Cundy (Geochemistry, Environmental Radioactivity) Ocean and Earth Science National Oceanography Centre Southampton, University of Southampton, UK
Prof. Sergey Mikhalovsky (Physical Chemistry, Chemical Kinetics and Catalysis, Chemistry) Advanced Nanostructured Materials Design and Consultancy Ltd. – ANAMAD Ltd., Brighton, UK
Dr. Stefano Ubaldini (Hydrometallurgy, Bio-Hydrometallurgy, Geology) Institute of Environmental Geology and Geoengineering of the Italian National Research Council (IGAG-CNR), Roma, IT
Dr. Yishan Zheng (Biomaterials) NHS Blood and Transplant, Leeds, UK

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
52.31	37.15	51.00	33.91	46.43	31.60	46.15	31.96	43.72	29.73	44.30	29.76	47.32	32.35

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

n/a

1.6. Basic information on the funding of the institute

Until Dec 31, 2021 IGTSAS has been a scientific institution in the legal form of state contributory organization, not focused on profit formation.

1.6.1. Institutional salary budget, other salary budget¹, non-salary budget²

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget <i>[millions of EUR]</i>	0.743	0.776	0.816	0.905	1.003	0.995	0.873
Other salary budget <i>[millions of EUR]</i>	0.162	0.178	0.065	0.065	0.073	0.104	0.108
Total salary budget <i>[millions of EUR]</i>	0.905	0.954	0.881	0.970	1.076	1.099	0.981
Non-salary budget <i>[millions of EUR]</i>	0.324	0.340	0.269	0.291	0.284	0.298	0.301

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

The Institute of Geotechnics of Slovak Academy of Sciences (IGTSAS) was founded by the Presidium of Slovak Academy of Sciences on November 22, 1954. Until Dec 31, 2021 IGTSAS has been scientific institution in the legal form of state contributory organization, not focused on profit formation. The main objective of the IGTSAS is the basic research in the fields of Earth and environmental sciences, environmental engineering, mining, mineralurgy, metallurgy, mineral and environmental biotechnologies and nanotechnologies.

Subjects of activity:

- basic research of processes in the field of rock cutting, rock mechanics and underground constructions, the transport of energy and mass in the rock disintegration processes; basic research of solid dispersions origin patterns and their properties modifications by physical, mechanical, chemical and biotechnological processes; qualitative and quantitative evaluation of phase interactions at the disperse systems origin and at their spreading in working and living environment,
- application of theoretical knowledge from presented areas for detailing the top technologies principles in the following fields: rock cutting, mineral processing, monitoring of selected components of working and living environment, monitoring of environmental, chemical and

¹ Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.

² Includes Goods and Services and PhD fellowships

geological changes in the waste repositories with the aim of ecological remediation and mineral recovery,

- advisory and expertise services related to main activities,
- scientific education in terms of generally valid legislation,
- publication of the scientific-research activities using the periodic and non-periodic press. The publishing of periodic and non-periodic press follows the regulations of the SAS Presidium.

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

Current research activities of IGTSAS issue from the Institute's tradition related mainly to the mining activities in Slovakia strongly connected to mineral exploitation, and processing and beneficiation of raw materials. The main research scope was focused initially at various aspects of mining activities (exploitation and mineral resources processing) as mining has been an industry with long history and major tradition in Slovakia. However, after the regression in mining industry in 1990s, the IGTSAS has begun its focus transition to the new research activities such as:

- small-diameter rock drilling and tunnel excavation,
- environmental remediation of mining and industrial areas,
- development of materials based on minerals for environmental applications,
- mechanosynthesis and mechanochemical activation of minerals and materials,
- clean-up technologies of industrial waste waters and soils,
- applications of biotechnologies in soil decontamination from organic pollution,
- biotechnologies for mineral processing, separation and remediation processes,
- stabilization of solid wastes,
- environmental monitoring of air quality in industrial zones and urban agglomerations.

The IGTSAS has a solid position on both international and national levels, which is reflected by substantial number of invitations to participate on project proposals, scientific papers and projects proposal reviews, invited lectures, expert studies and reports, etc. The publication activity of the institute as whole is growing with the significant impact of young researchers.

IGTSAS' scientific community has a strong interdisciplinary background. The project teams are usually built across the departments using the complementary skills of researchers.

Researchers at IGTSAS work with various forms of minerals. The mineral represents a research object as a part of rock mass and raw material, but also represents a research tool being a functional material (sorbent, catalyst, medicine, etc.), see more in Chapter 4.

The overview of the most important activities achieved during the assessed period is presented within the 5 individual scientific departments of IGTSAS:

Department of Destructional and Constructional Geotechnics

Department of Physical and Physico-Chemical Mineral Processing Methods

Department of Mechanochemistry

Department of Mineral Biotechnologies

Department of Environment and Hygiene in Mining

Department of Destructional and Constructional Geotechnics (DDCG)

The research team of DDCG offers a wide range of knowledge and experience of processes running in cutting and drilling of rocks and concrete, ranging from small-diameter rotary drilling up to the large-diameter tunnelling using full-face tunnel boring machines (TBM). The experimental research resulted in development of new techniques for the rock mass evaluation as well as for improvement of rock cutting process efficiency using advanced mathematical and statistical methods and deploying the means of artificial intelligence. Unique experimental laboratory horizontal drilling rig was upgraded with new measuring chains. DDCG collaborates intensively

with other departments in the research on biocorrosion of concrete and geological issues of soil treatment from mixed contaminants. The DDCG researchers also support the ICT services of the whole Institute (administration of ICT and website). The main activities of DDCG in the accreditation period covered research projects and expertise services for industry:

DDCG 1. Prediction of drillability of intact rock and rock mass

Mathematical model of drill bit penetration depth was developed as a function of thrust force and drilled length, thus providing the assessment and prediction of rock drillability. The model quantified the decreasing drill bit capability to achieve maximum penetration depending on progressing bit wear. Indirect assessment and drillability prediction applied during control drilling process control shall reduce the energy consumption and costs for exchange of drill bits in underground construction, tunneling, drilling and mining. Combined with the previous mathematical models WORS and IKONA developed by the DDCG team in the past, the model can also be applied for the prediction of underground fault zones and applied to optimize the drilling process and to predict a suitable drilling regime.

DDCG 2. Identification of specific drilling energy based on vibration signal

Methodology for assessment of rock drilling process efficiency was designed and elaborated using the energy quantity identified from the recorded vibration signal for different types of drill bits, rocks and applied regimes. Relationship between the vibration acceleration and the specific energy was defined. Limit intervals defining the optimal drilling regime were determined for the individual orthogonal drilling planes from minimum values of SE and the corresponding inverse mean values of the vibration acceleration. The limit intervals help to assess the rock drilling process as either efficient or non-efficient. This research indicates the possibility of using monitored vibration emissions for optimal control of rock drilling process.

DDCG 3. Effect of the strain rate on strength and deformation rock properties for the research of rock cutting

The main goal of the project is to investigate the influence of the strain rate on the deformation and strength properties of rocks and rock-like materials, especially concrete, to investigate their disintegration by mechanical as well as non-mechanical methods. The rate of deformation significantly affects the resulting values of the monitored strength and deformation parameters of these materials. The results of the measurements and their synthesis shall contribute to the refinement of rock disintegration research. The project is still running.

DDCG 4. Assessment of rock abrasiveness for underground construction of road tunnels

DDCG researchers have wide experience with transfer of scientific knowledge to industry. Our developed monitoring and optimization systems were successfully applied in mining and in excavation of exploratory galleries of the highway tunnels Branisko and Višňové in Slovakia in the past. DDCG lab disposes wide range of facilities for testing the strength and strain properties of rocks, abrasiveness assessment according to different testing approaches CERCHAR, LCPC, ON 441121. During the accreditation period, the team elaborated expert reports on rock properties assessment based on commercial orders from university and construction industry on regular base.

Department of Physical and Physico-Chemical Methods of Mineral Processing (DMMP)

The research activities of the DMMP during the assessed period were devoted to:

1. mineral processing of materials including secondary raw materials utilization,
2. removal of high-priority toxic substances from waters and soils,
3. microwave treatment of raw materials, industrial wastes and biomass.

Since the department has very active in applying and receiving the funding from European Framework Programmes (FP7, H2020, HE), the most significant impact originated from 3 projects FP7-WaSClean, H2020-SASPRO and H2020-NanoMed. Objectives of all three projects lied in the field of environmental applications such as remediation of industrial sites, degradation of persistent organic pollutants by electrochemical oxidation, degradation of polyaromatic hydrocarbons using the combination of biological and chemical approaches, synthesis of advanced material (adsorbents and catalytic materials) for wastewater treatment, etc.

DMMP 1. Water and soil clean-up from mixed contaminants

Project FP7-PEOPLE-2013-IAPP-612250-WaSClean

Electrochemical oxidation method prior the biological treatment has been developed based on the demand of the industrial partner of the project for the highly effective degradation methods of reactive dyes used in textile industry. Patent application process started in 2021.

DMMP 2. Bifunctional silica and magnetite spherical particles with tailored porosity and surface chemistry for complex water treatment

Project SASPRO 1298/03/01 (H2020-MSCA-Cofund scheme)

Resulted from Marie Curie Fellowship of Dr. Inna Melnyk, who has developed new synthetic hybrid adsorbents and composite with catalytic properties. After the fellowship Dr. Melnyk received the position of a Senior Scientist at IGTSAS and continued independently with this research, opening PhD position. She has received the APVV funding within which she opened several post doc positions for young perspective researchers. She also helped to improve awareness about the PhD study at IGTSAS at the international level. She helps the institute in contacting the Ukrainian top universities to promote our PhD programme for the best UA students.

DMMP 3. Nanoporous and nanostructured materials for medical applications

Project H2020-MSCA-RISE-2016- NanoMed-734641

Resulted from the need to reduce severe health effects after the nuclear disasters such as Chernobyl, Fukushima etc. IGTSAS contributes to development and study of entero-adsorbent to rapidly eliminate severe health risks after the acute exposure, which nowadays seems to be real threat due to the war in UA.

DMMP 4. Composite materials for elimination of absorbable organic halogen from environment

The PhD Thesis has been opened on demand of metallurgical leader U.S.Steel s.r.o, who showed the interest to collaborate on this research due to the problem with their waste waters containing absorbable organic halogens (AOX). This research generated substantial data, which were published in high IF journals and showed the importance of this research.

Department of Mechanochemistry (DM)

Research in the DM focuses on the elaboration of mechano-chemical, physico-chemical and chemical methods of synthesis and application of nanocrystalline materials and their composites prepared from precursors based on natural minerals, synthetic substances, as well as selected components of intermediate products and wastes from various industries. Shearing, stretching and grinding are typical methods for the mechanochemical generation of reactive sites. The potential for application of the products rests in their implementation in the electrotechnical industry (semiconductors, photovoltaic cells, batteries, thermoelectrics, and fuel cells based on sulfides, selenides, oxides and silicates), hydrometallurgy (recovery of precious (gold) or on the other hand undesirable metals (antimony, arsenic)), ecology (valorization of waste, CO₂ storage), and medicine (antibacterial agents, drugs based on minerals).

DM 1. Chalcogenide materials as potential sources for future environmentally friendly thermoelectrics

Interesting results were obtained on mechanochemical synthesis and application of environmentally friendly chalcogenides. The results were published in high-ranked journals. The idea to substitute toxic and scarce elements like tellurium and cadmium was strongly stressed. For broader dissemination of results, purchase of a high capacity mill is planned in the future.

DM 2. Biomechanochemical synthesis of antibacterially active Ag nanoparticles

An alternative method toward the traditional green synthesis of silver nanoparticles utilizing plant extracts was developed. The principle is in one-step solid state processing of silver nitrate and plant powder to yield Ag nanoparticles/plant nanocomposites. Some substances present in plants serve the role of both reducing and stabilizing agents. For this purpose, common plants such as lavender or oregano, but also lichens have been used. Possibility to use eggshell waste for this purpose was demonstrated as well.

DM 3. Recovery of precious gold nanoparticles by using mechanochemico-biological activation

Gold nanoparticles from the refractory arsenopyrite concentrate (Pezinok, SK) and refractory sulphide concentrate (Banská Hodruša, SK) were obtained by a non-cyanide environmentally friendly mechanochemico-biological process in the presence of algae with mechanochemical

activation in contrast to this process without using mechanical activation of algae. Obtaining gold nanoparticles through this process would also lead to the elimination of algae from the aquatic environment where they are dangerous.

DM 4. Synthesis and characterization of complex/high entropy oxides as potential candidates for ion batteries and solid oxide fuel cells components

Mechanochemical and/or mechanically induced reactions are performed to obtain nanocrystalline oxides with promising electrochemical properties. Complex oxides are synthesized and investigated, the focus is devoted to the properties to structure correlations.

DM 5. Response to mechanochemistry on a national and international scale

Although mechanochemistry is ranked among unconventional methods of materials preparation, it is established as a branch of chemistry and nowadays it has a growing tendency in worldwide applications. This is evidenced by the special issue published in 2013 by the prestigious journal Chemical Society Reviews dedicated to Mechanochemistry (Chem. Soc. Rev. 2013, vol. 42, issue 18, 24.892-IF2012) and the paper entitled „Hallmarks of mechanochemistry: From nanoparticles to technology“, which was awarded in 2018 by SAS President as a scientific publication with an extremely high number of citations (see Chapter Awards 2.3.12). Several international conferences are also dedicated to mechanochemistry. The first and the oldest one is the so-called INCOME (International Conference on Mechanochemistry and Mechanical Alloying). The first INCOME took place in 1993 in Kosice and has been organized regularly every three years. Recently in 2017, it was organized again in Košice with around 150 participants from all over the world and DM was in charge of the conference organizers. Two professors in our department (P. Baláž and V. Šepelák) belong to the key people in the world mechanochemical community. Moreover, Prof. Šepelák has been the President of the International Mechanochemical Association since 2014. Regarding the success of young scientists, FORBES magazine ranked Dr. M. Baláž among the top 6 Slovak scientists under 30 years of age and he also won the competition Young Researcher within the event Scientist of the Year of Slovakia in 2018. Dr. Fabián was awarded the Young Research Award in the field Solid State Chemistry by the International Visegrad Fund in 2016. (see Chapter Awards 2.3.12).

Department of Mineral Biotechnologies (DMB)

DMB focused on:

DMB 1. Basic and applied research in mineral bioprocessing and bioremediation of mining-impacted environments.

Bioleaching of polymetallic ores and biological upgrade of non-metallic raw materials was studied within the EIT-BioLeach and CORFO projects. Based on the data from laboratory tests, the bioheap leaching and percolation column leaching of tetrahedrite and silica sand were designed, that are now being tested in a pilot scale. The basic research has brought significant original discoveries in the study of elementary processes and mechanisms of biogeochemical reactions in the interaction of microorganisms with the rock environment.

To mitigate the negative impact of mining and metallurgy industry on the environment, the study within the projects VEGA 2/0145/15, VEGA 2/0142/19 and APVV-20-0140 and APVV-20-0140 was devoted to the proposal of new and emerging technologies to recover valuable products from various types of wastes. The resources in mine wastes, including mine waters, if managed effectively, present significant opportunities, including contributing to the circular economy, minimizing environmental impacts and creating additional value from waste. Our research successfully demonstrated that the treatment of mine drainage waters could be tailored by manipulation of precipitation conditions and selection of adsorptive media to target different mine waters and resources of interest.

The research was also focused on the prediction and prevention of bio corrosion of building materials, especially on the impact of biodeterioration and improving the resistance of cement composites, as well as on the study of biohydrometallurgical treatment of spent lithium-ion and zinc-carbon batteries.

As part of this research, five PhD dissertations were completed in assessed period: Štyriaková, 2017; Šuba, 2018; Rudzanová, 2019; Bártová, 2020; Hagarová, 2021.

DMB 2. Biodegradation of mixed contaminants

International cooperation on the Project FP7-PEOPLE-2013-IAPP-612250-WaSClean has launched the research and implementation of advanced electrochemical oxidation processes in water treatment from mixed contaminants. The main topic of the DMB research activities was the identification and biodegradation of halogenated organic compounds and inorganic oxyanions emerging as by-products of electrochemical treatment.

Two PhD dissertations were devoted to the identification of organic pollutants and their degradation products using mass spectrometry: Jáger, 2017; Bodnár, 2021.

DMB 3. Remediation of Vrakuňa landfill

Research within the joint project with Comenius University, funded by Bratislava Self-Governing Region, addressed the issue of environmental burden of great social and national importance. Chemical waste landfill in Bratislava, Vrakuňa district, represents highly contaminated site, polluted by toxic waste from the former chemical plant. The landfill leachate poses an acute threat to groundwater reserves in Quaternary alluvial sediments of the Danube basin which represent the biggest reservoir of fresh groundwater in central Europe. The activities were focused on the identification of wide variety of organic contaminants escaping from the chemical landfill to groundwater and proposal of proper groundwater decontamination methods/technology and site remediation. The study was devoted to new and integrated technology that is now being patented.

The wider societal and environmental benefits of DMB research can be summarized as follows:

1. Reduction in concentration of potentially toxic elements in mine water discharge and industrial effluents, benefiting local ecology and local populations, and improving water quality and water recovery/re-use potential;
2. Development of solutions maximizing sustainability with low energy and low carbon footprint;
3. Recovery of elements of value from waste discharges providing a potential "revenue from wastes" ecosystem, and encouraging site maintenance and investment;
4. Local employment and inward investment opportunities at abandoned or closing mining assets;
5. Assessment of potential pathways for treatment residues re-use and economic valorization, ideally involving local actors and stakeholders, for agricultural and other applications.

Department of Environment and Hygiene in Mining

Research in the department has long been focused on the study of the impact of industrial and other anthropogenic activities on selected factors of living and working environment. The research in the evaluated period was specialised on two specific components of the polluted environment:

DEHM 1. Air quality and pollution research activities were carried out through the study of selected components of atmospheric deposition (AD) and particulate matter (PM) collected in the area of Košice and Krompachy with metallurgical industry. Qualitative and quantitative characteristics of the AD, suspended particles (PM) and the fluxes AD of selected major and trace elements were studied. The chemical and phase composition, shape characteristics, size and distribution and other properties of the particles were investigated mainly using ICP MS, XRD, Coulter Counter, SEM and EDX methods. The main objective of the research is to obtain the missing knowledge about air pollutants in relation to emission sources which is necessary for elimination or minimization of their environmental risks. Fe-deposition as a "marker" of particulate matter was used to quantify the contribution of the steel factory, local sources and long-range transport to their total immissions for individual sampling points in the Košice area. Detailed analysis of atmospheric deposition of heavy metals allowed evaluating the impact of copper smelters on the grade of environmental burden in the area of Krompachy. The research in this field in Slovakia is the only one of its kind and brings valuable knowledge and generally applicable information on air pollution propagation also on an international scale. The results are directly applicable in solving environmental problems of producers of industrial emission sources, local and other administrative authorities.

DEHM 2. Research of contaminated soils and sediments delivered progressive screening methods for quality assessment and identification of their potential environmental risk that have been applied to samples from selected areas burdened by historical and current mining and metallurgical activities. Arable soils, soils of permanent grasslands, bottom sediments of streams, water reservoirs and tailings from the area of Košice, Krompachy and Rudňany were

investigated. Potential contamination of soils from the surroundings of U.S.Steel factory and sediments from the Krompachy copper-plant settling pit was studied by XRF, CHNS, TGA/MS method and eco-toxic test methods. The acute toxicity of contaminated sediments from the Ružín reservoir burdened by centuries of metal-mining activities in the region was assessed using the Phytotoxkit test and SOS-Chromotest. The toxic effects and distribution of mercury in contaminated soils from Košice area and sediments from Rudňany burdened by old polymetallic and Fe-mining activities were evaluated using earthworms *Dendrobaena veneta*. The results obtained provide important information on the environmental risks of the investigated soils and sediments, the possibility of their elimination or use for other applications.

DEHM 3. Assessment, identification and quantification of air pollution sources share on dust deposition

DEHM have developed a complex methodology identification and quantification of air pollution sources meeting the Technology Readiness Level 9, being directly applicable after considering local emission and imission conditions.

DEHM has installed a monitoring network of atmospheric deposition, dust particles and selected contaminants at 3 sites in industry-loaded areas of Krompachy and Central Spiš and 8 sites in the wider urban area of Košice. The network provides a valuable database of knowledge and primary information on the current state, spatial and temporal development of mass flows of monitored pollutants and other parameters in relation to sources of pollution and the origin of dust particles. The measurements are directly usable for elimination of environmental risks due to air pollution by local authorities.

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (in percentage)

Basic/applied research 95/5 (%)

International/regional 90/10 (%)

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.

Note: Average FTE/year = 32.35 => 33 selected papers, TOP3 papers in bold.

The Code Nr. is used in Chapter 2.1.8 for assignment of cited papers

Code Nr.	Scientific output
2.1.2.1 TOP3	<u>JÁGER, Dávid - KUPKA, Daniel - VÁCLAVÍKOVÁ, Miroslava** - IVANIČOVÁ, Lucia - GALLIOS, G.P.</u> Degradation of Reactive Black 5 by electrochemical oxidation. In <i>Chemosphere</i>, 2018, vol. 2, no. 10, p. 405-416. (2017: 4.427 - IF, Q1 - JCR, 1.435 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 0045-6535. https://doi.org/10.1016/j.chemosphere.2017.09.126 Published within the project FP7-PEOPLE-2013-IAPP-612250-WaSClean: Water and Soil Clean-Up from Mixed Contaminants. Mechanism of degradation and transformation of RB5 dye was described on demand of textile industry. Electrochemical and chemical oxidation for RB5 dye effluents treatment were compared and key degradation/transformation products were identified by HPLC-ESI-MS. The identified species are a starting point for textile wastewaters toxicity assessment.

<p>2.1.2.2 TOP3</p>	<p>KOTSYUDA, Sofiya S. - TOMINA, Veronika - ZUB, Yuriy - <u>VÁCLAVÍKOVÁ, Miroslava</u> - FURTAT, Iryna - LEBED, Anastasia P. - <u>MELNYK, Inna</u>. Bifunctional silica nanospheres with 3-aminopropyl and phenyl groups. Synthesis approach and prospects of their applications. In <i>Applied Surface Science</i>, 2017, vol. 420, p. 782-791. (2016: 3.387 - IF, Q1 - JCR, 0.958 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0169-4332. https://doi.org/10.1016/j.apsusc.2017.05.150</p> <p>Published within the project FP7-PEOPLE-2013-COFUND-609427-SASPRO: No.1298/03/01 BISILMAG: Bifunctional silica and magnetite spherical particles with tailored porosity and surface chemistry for complex water treatment. The one-stage synthesis of bifunctional microspheres under different synthetic conditions was demonstrated; the peculiarities of the structure and advantages of such materials in the adsorption of cations, dyes, as well as their antibacterial properties were shown.</p>
<p>2.1.2.3 TOP3</p>	<p><u>BALÁŽ, Peter</u> - <u>ACHIMOVIČOVÁ, Marcela**</u> - <u>BALÁŽ, Matej</u> - CHEN, Kan - DOBROZHAN, Oleksandr - GUILMEAU, Emanuel - HEJTMÁNEK, Jiri - KNÍŽEK, Karel - KUBIČKOVÁ, L. - LEVINSKÝ, P. - PUCHÝ, Viktor - REECE, Michael J. - VARGA, Peter - ZHANG, R. Z. Thermoelectric Cu-S-Based Materials Synthesized via a Scalable Mechanochemical Process. In <i>ACS Sustainable Chemistry & Engineering</i>, 2021, vol. 9, p. 2003-2016. (2020: 8.198 - IF, Q1 - JCR, 1.878 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 2168-0485. https://doi.org/10.1021/acssuschemeng.0c05555</p> <p>Published within the project APVV-18-0357-MULTINANO: Chalcogenides as emerging eco-friendly and low-cost nanomaterials for energy- and medicine- related sectors. Cu-based sulfides thermoelectrics (chalcopyrite CuFeS₂, mohite Cu₂SnS₃, tetrahedrite Cu₁₂Sb₄S₁₃, mawsonite Cu₆Fe₂SnS₈ and kesterite Cu₂ZnSnS₄) were synthesized by industrial milling in an excentric vibratory mill to demonstrate scalability of their synthesis. The obtained results illustrate the possibility of large-scale production of energy-conversion related materials.</p>
<p>2.1.2.4</p>	<p><u>FINDORÁKOVÁ, Lenka</u> - <u>ŠESTINOVÁ, Oľga</u> - <u>KOVÁČOVÁ, Milota</u>. Assessment of potential sediment contamination using screening methods (XRF, TGA/MS) taking into account principles of green chemistry, Eastern Slovakia. In <i>Environmental Earth Sciences</i>, 2017, vol. 76, p. 119. (2016: 1.569 - IF, Q3 - JCR, 0.591 - SJR, Q2 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 1866-6280. https://doi.org/10.1007/s12665-017-6433-z</p>
<p>2.1.2.5</p>	<p><u>ŠESTINOVÁ, Oľga</u> - <u>FINDORÁKOVÁ, Lenka</u>. Assessment of eastern Slovakia sediments genotoxicity and phytotoxicity using screening tests: chromotests and phytotoxkit. In <i>Fresenius Environmental Bulletin</i>, 2017, vol. 26, no. 3, p. 2454-2462. (2016: 0.425 - IF, Q4 - JCR, 0.191 - SJR, Q3 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 1018-4619.</p>
<p>2.1.2.6</p>	<p><u>HANČULÁK, Jozef</u> - <u>KURBEL, Tomáš</u> - <u>FEDOROVÁ, Erika</u> - <u>BRIANČIN, Jaroslav</u> - <u>ŠESTINOVÁ, Oľga</u> - <u>FINDORÁKOVÁ, Lenka</u> - <u>ŠPALDON, Tomislav</u>. Atmospheric Deposition of Solid Particles in the Area of Košice. In <i>Solid State Phenomena</i>, 2016, vol. 244, p. 188-196. (2015: 0.216 - SJR, Q3 - SJR). (2016 - SCOPUS). ISSN 1012-0394. https://doi.org/10.4028/www.scientific.net/SSP.244.188</p>
<p>2.1.2.7</p>	<p><u>HANČULÁK, Jozef</u> - <u>ŠPALDON, Tomislav</u> - <u>ŠESTINOVÁ, Oľga</u>. Selected Characteristics of the Atmospheric Deposition in the Area of Košice. In <i>Inżynieria Mineralna - Journal of the Polish Mineral Engineering Society</i>, 2020, rocznik 45, no.2, p. 45-50. (2019: 0.249 - SJR, Q3 - SJR). ISSN 1640-4920. https://doi.org/10.29227/IIM-2020-01-37</p>
<p>2.1.2.8</p>	<p><u>KRÚPA, Vítazoslav</u> - <u>KRULÁKOVÁ, Mária</u> - <u>LAZAROVÁ, Edita</u> - <u>LABAŠ, Milan</u> - <u>FERIANČÍKOVÁ, Katarína</u> - <u>IVANIČOVÁ, Lucia**</u>. Measurement, modeling and prediction of penetration depth in rotary drilling of rocks. In <i>Measurement</i>, 2018, vol. 117, p. 165-175. (2017: 2.218 - IF, Q2 - JCR, 0.733 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 0263-2241. https://doi.org/10.1016/j.measurement.2017.12.007</p>

2.1.2.9	<u>LAZAROVÁ, Edita</u> - <u>KRULÁKOVÁ, Mária</u> - <u>LABAŠ, Milan</u> - <u>IVANIČOVÁ, Lucia</u> - <u>FERIANČÍKOVÁ, Katarína</u> . Vibration signal for identification of concrete drilling process and drill bit wear. In <i>Engineering Failure Analysis</i> , 2020, vol. 108, art. no. 104302. (2019: 2.897 - IF, Q1 - JCR, 0.853 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 1350-6307. https://doi.org/10.1016/j.engfailanal.2019.104302
2.1.2.10	<u>FERIANČÍKOVÁ, Katarína**</u> - <u>LAZAROVÁ, Edita</u> - <u>KRULÁKOVÁ, Mária</u> - <u>IVANIČOVÁ, Lucia</u> - <u>LEŠŠO, Igor</u> . Geometry Interpretation of Differentiability of Rock Types in Hilbert's Space. In <i>Inżynieria Mineralna - Journal of the Polish Mineral Engineering Society</i> , 2019, rocznik 44, no. 2, p. 49-54. (2018: 0.222 - SJR, Q3 - SJR). ISSN 1640-4920. https://doi.org/10.29227/IM-2019-02-07
2.1.2.11	<u>MAJZLAN, Juraj**</u> - <u>ŠTEVKO, Martin</u> - <u>CHOVAN, Martin</u> - <u>LUPTÁKOVÁ, Jarmila</u> - <u>MILOVSKÁ, Stanislava</u> - <u>MILOVSKÝ, Rastislav</u> - <u>JELEŇ, Stanislav</u> - <u>SÝKOROVÁ, Martina</u> - <u>POLLOK, Kilian</u> - <u>GÖTTLICHER, Jörg</u> - <u>KUPKA, Daniel</u> . Mineralogy and geochemistry of the copper-dominated neutral mine drainage at the Cu deposit Ľubietová-Podlipa (Slovakia). In <i>Applied Geochemistry</i> , 2018, vol. 92, p. 59-70. (2017: 3.088 - IF, Q2 - JCR, 1.016 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 0883-2927. https://doi.org/10.1016/j.apgeochem.2018.02.012
2.1.2.12	<u>EŠTOKOVÁ, Adriana</u> - <u>KOVALČÍKOVÁ, Martina</u> - <u>LUPTÁKOVÁ, Alena</u> - <u>PRAŠČÁKOVÁ, Mária</u> . Testing Silica Fume-Based Concrete Composites under Chemical and Microbiological Sulfate Attacks. In <i>Materials</i> , 2016, vol. 9, no. 5, p. 1-15. (2015: 2.728 - IF, Q1 - JCR, 0.830 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 1996-1944. https://doi.org/10.3390/ma9050324
2.1.2.13	<u>SEDLÁKOVÁ-KADUKOVÁ, Jana</u> - <u>MARCINČÁKOVÁ, Renáta</u> - <u>LUPTÁKOVÁ, Alena</u> - <u>VOJTKO, Marek</u> - <u>FUJDA, Martin</u> - <u>PRISTAŠ, Peter</u> . Comparison of three different bioleaching systems for Li recovery from lepidolite. In <i>Scientific Reports</i> , 2020, vol. 10, no. 1, art. no. 14594, p. 1-8. (2019: 3.998 - IF, Q1 - JCR, 1.341 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS). ISSN 2045-2322. https://doi.org/10.1038/s41598-020-71596-5
2.1.2.14	<u>PASICHNYK, Maria</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>MELNYK, Inna**</u> . Fabrication of polystyrene-acrylic/ZnO nanocomposite films for effective removal of methylene blue dye from water. In <i>Journal of Polymer Research</i> , 2021, vol. 28, no. 2, p.56. (2020: 3.097 - IF, Q2 - JCR, 0.500 - SJR, Q2 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 1022-9760. https://doi.org/10.1007/s10965-021-02418-z
2.1.2.15	<u>BALÁŽ, Peter</u> - <u>HEGEDUS, Michal**</u> - <u>BALÁŽ, Matej</u> - <u>DANEU, Nina</u> - <u>SIFFALOVIC, P.</u> - <u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - <u>TÓTHOVÁ, Erika</u> - <u>TEŠINSKÝ, Matej</u> - <u>ACHIMOVIČOVÁ, Marcela</u> - <u>BRIANČIN, Jaroslav</u> - <u>DUTKOVÁ, Erika</u> - <u>KANUCHOVÁ, Mária</u> - <u>FABIÁN, Martin</u> - <u>KITAZONO, Satoshi</u> - <u>DOBROZHAN, Oleksandr</u> . Photovoltaic materials: Cu ₂ ZnSnS ₄ (CZTS) nanocrystals synthesized via industrially scalable, green, one-step mechanochemical process. In <i>Progress in Photovoltaics : research and applications</i> , 2019, vol. 27, no. 18, p. 798-811. (2018: 7.776 - IF, Q1 - JCR, 1.942 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 1062-7995. https://doi.org/10.1063/1.5082636
2.1.2.16	<u>BALÁŽ, Matej</u> - <u>GOGA, Michal</u> - <u>HEGEDUS, Michal</u> - <u>DANEU, Nina</u> - <u>KOVÁČOVÁ, Mária</u> - <u>TKÁČIKOVÁ, Ľudmila</u> - <u>BALÁŽOVÁ, Ľudmila</u> - <u>BAČKOR, Martin</u> . Biomechanochemical Solid-State Synthesis of Silver Nanoparticles with Antibacterial Activity Using Lichens. In <i>ACS Sustainable Chemistry & Engineering</i> , 2020, vol. 8, no.37, p. 13945-13955. (2019: 7.632 - IF, Q1 - JCR, 1.766 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 2168-0485. https://doi.org/10.1021/acssuschemeng.0c03211

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2.1.2.18	<u>BALÁŽ, Peter</u> - HEGEDUS, Michal** - <u>ACHIMOVIČOVÁ, Marcela</u> - <u>BALÁŽ, Matej</u> - <u>TEŠINSKÝ, Matej</u> - <u>DUTKOVÁ, Erika</u> - KAŇUCHOVÁ, Mária - <u>BRIANČIN, Jaroslav</u> . Semi-industrial Green Mechanochemical Syntheses of Solar Cell Absorbers Based on Quaternary Sulfides. In <i>ACS SUSTAIN CHEM ENG</i> , 2018, vol. 6, p. 2132-2141. (2017: 6.140 - IF, Q1 - JCR, 1.657 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents). ISSN 2168-0485. https://doi.org/10.1021/acssuschemeng.7b03563
2.1.2.19	<u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka**</u> - KELLO, Martin - KOVÁČ, Jaroslav Jr. - <u>TÓTHOVÁ, Erika</u> - SHPOTYUK, Oleh - <u>BALÁŽ, Peter</u> - MOJŽIŠ, Ján - ANDREJKO, S. Preparation of As ₄ S ₄ /Fe ₃ O ₄ nanosuspensions and in-vitro verification of their anticancer activity. In <i>Materials Science and Engineering C - Biomimetic and Supramolecular Systems</i> , 2020, vol. 110, p.110683. (2019: 5.880 - IF, Q1 - JCR, 1.149 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0928-4931. https://doi.org/10.1016/j.msec.2020.110683
2.1.2.20	<u>BALÁŽ, Matej**</u> - <u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - <u>ACHIMOVIČOVÁ, Marcela</u> - <u>TEŠINSKÝ, Matej</u> - <u>BALÁŽ, Peter</u> . Simultaneous valorization of polyvinyl chloride and eggshell wastes by a semi-industrial mechanochemical approach. In <i>Environmental Research</i> , 2019, vol. 170, p. 332-336. (2018: 5.026 - IF, Q1 - JCR, 1.567 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 0013-9351. https://doi.org/10.1016/j.envres.2018.12.005
2.1.2.21	<u>DUTKOVÁ, Erika**</u> - <u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - SHPOTYUK, Oleh - JAKUBÍKOVÁ, Jana - CHOLUJOVÁ, Dana - ŠIŠKOVÁ, Viera - DANEU, Nina - <u>BALÁŽ, Matej</u> - KOVÁČ, Jaroslav - KOVÁČ, Jaroslav Jr. - <u>BRIANČIN, Jaroslav</u> - DEMCHENKO, Pavlo. SDS-Stabilized CuInSe ₂ /ZnS Multinanostructures Prepared by Mechanochemical Synthesis for Advanced Biomedical Application. In <i>Nanomaterials-Basel</i> , 2021, vol. 11, no. 1, p. 69. (2020: 5.076 - IF, Q1 - JCR, 0.919 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS). ISSN 2079-4991. https://doi.org/10.3390/nano11010069
2.1.2.22	<u>TÓTHOVÁ, Erika</u> - WITTE, Ralf - DA SILVA, Klebson Lucenildo - <u>ZORKOVSKÁ, Anna</u> - SENNA, M. - HAHN, Horst - HEITJANS, Paul - <u>ŠEPELÁK, Vladimír</u> . Combined mechanochemical/thermal synthesis of microcrystalline pyroxene LiFeSi ₂ O ₆ and one-step mechanosynthesis of nanoglassy LiFeSi ₂ O ₆ based composite. In <i>Journal of Alloys and Compounds</i> , 2017, vol. 707, p. 310-314. (2016: 3.133 - IF, Q1 - JCR, 0.954 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0925-8388. https://doi.org/10.1016/j.jallcom.2016.11.172
2.1.2.23	<u>ACHIMOVIČOVÁ, Marcela**</u> - <u>BALÁŽ, Matej</u> - GIRMAN, Vladimír - KURIMSKÝ, Juraj - <u>BRIANČIN, Jaroslav</u> - <u>DUTKOVÁ, Erika</u> - <u>GÁBOROVÁ, Katarína</u> . Comparative Study of Nanostructured CuSe Semiconductor Synthesized in a Planetary and Vibratory Mill. In <i>Nanomaterials-Basel</i> , 2020, vol.10, no. 11, p.2038, 1-13. (2019: 4.324 - IF, Q2 - JCR, 0.858 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS). ISSN 2079-4991. https://doi.org/10.3390/nano10102038
2.1.2.24	<u>FABIÁN, Martin**</u> - ARIAS-SERRANO, Blanca I. - YAREMCHENKO, Aleksey A. - KOLEV, Hristo - KAŇUCHOVÁ, Mária - <u>BRIANČIN, Jaroslav</u> . Ionic and electronic transport in calcium-substituted LaAlO ₃ perovskites prepared via mechanochemical route. In <i>Journal of the European Ceramic Society</i> , 2019, vol. 39, p. 5298-5308. (2018: 4.029 - IF, Q1 - JCR, 1.219 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents). ISSN 0955-2219. https://doi.org/10.1016/j.jeurceramsoc.2019.07.038

2.1.2.25	<u>FICERIOVÁ, Jana**</u> - <u>DUTKOVÁ, Erika</u> - <u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - <u>HARVANOVÁ, Jarmila</u> . Acquirement of gold from concentrate (Pezinok, Slovakia) with utilization of algae in mechanochemical processes. In <i>IOP Conference Series: Earth and Environmental Science</i> , 2020, vol. 609, no. 012040, p. 79. (2019: 0.175 - SJR). ISSN 1755-1307. https://doi.org/10.1088/1755-1315/609/1/012040
2.1.2.26	<u>YANKOVYCH, Halyna</u> - <u>NOVOSELTSEVA, Viktoria</u> - <u>KOVALENKO, Olena</u> - <u>MARCIN BEHUNOVÁ, Dominika</u> - <u>KAŇUCHOVÁ, Mária</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>MELNYK, Inna**</u> . New perception of Zn(II) and Mn(II) removal mechanism on sustainable sunflower biochar from alkaline batteries contaminated water. In <i>Journal of Environmental Management</i> , 2021, vol. 292, art. no. 112757. (2020: 6.789 - IF, Q1 - JCR, 1.441 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 0301-4797. https://doi.org/10.1016/j.jenvman.2021.112757
2.1.2.27	<u>MELNYK, Inna**</u> - <u>TOMINA, Veronika</u> - <u>STOLYARCHUK, Nataliya</u> - <u>SEISENBAEVA, Gulaim</u> - <u>KESSLER, Vadim</u> . Organic dyes (acid red, fluorescein, methylene blue) and copper(II) adsorption on amino silica spherical particles with tailored surface hydrophobicity and porosity. In <i>Journal of Molecular Liquids</i> , 2021, vol. 336, p. 116301. (2020: 6.165 - IF, Q1 - JCR, 0.929 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS). ISSN 0167-7322. https://doi.org/10.1016/j.molliq.2021.116301
2.1.2.28	<u>ZUBRIK, Anton</u> - <u>MATIK, Marek</u> - <u>HREDZÁK, Slavomír</u> - <u>LOVÁS, Michal</u> - <u>DANKOVÁ, Zuzana</u> - <u>KOVÁČOVÁ, Milota</u> - <u>BRIANČIN, Jaroslav</u> . Preparation of chemically activated carbon from waste biomass by single-stage and two-stage pyrolysis. In <i>Journal of cleaner production</i> , 2017, vol. 143, p. 643-653. (2016: 5.715 - IF, Q1 - JCR, 1.659 - SJR, Q1 - SJR, Current Contents - CCC). (2017 - Current Contents). ISSN 0959-6526. https://doi.org/10.1016/j.jclepro.2016.12.061
2.1.2.29	<u>OTERO-GONZÁLEZ, Lila</u> - <u>SAVINA, Irina N.</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>TRENIKHIN, Mikhail V.</u> - <u>CUNDY, Andy</u> - <u>SAVINA, Irina N.**</u> . Novel nanostructured iron oxide cryogels for arsenic (As(III)) removal. In <i>Journal of Hazardous Materials</i> , 2020, vol. 381, p. 120996. (2019: 9.038 - IF, Q1 - JCR, 2.010 - SJR, Q1 - SJR, Current Contents - CCC). (2020 - Current Contents). ISSN 0304-3894. https://doi.org/10.1016/j.jhazmat.2019.120996
2.1.2.30	<u>YANKOVYCH, Halyna</u> - <u>MELNYK, Inna</u> - <u>VÁCLAVÍKOVÁ, Miroslava**</u> . Understanding of mechanisms of organohalogen removal onto mesoporous granular activated carbon with acid-base properties. In <i>Microporous and Mesoporous Materials</i> , 2021, vol. 317, art. no. 110974. (2020: 5.455 - IF, Q1 - JCR, 1.079 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents). ISSN 1387-1811. https://doi.org/10.1016/j.micromeso.2021.110974
2.1.2.31	<u>MARCIN BEHUNOVÁ, Dominika**</u> - <u>GALLIOS, G.P.</u> - <u>GIRMAN, Vladimír</u> - <u>KOLEV, Hristo</u> - <u>KAŇUCHOVÁ, Mária</u> - <u>DOLINSKÁ, Silvia</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> . Electrophoretic Deposition of Graphene Oxide on Stainless Steel Substrate. In <i>Nanomaterials-Basel</i> , 2021, vol. 11, no.7, art.no.1779. (2020: 5.076 - IF, Q1 - JCR, 0.919 - SJR, Q1 - SJR, Current Contents - CCC). (2021 - Current Contents, WOS, SCOPUS). ISSN 2079-4991. https://doi.org/10.3390/nano11071779
2.1.2.32	<u>MELNYK, Inna**</u> - <u>POGORILYI, Roman P.</u> - <u>ZUB, Yuriy</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>GDULA, Karolina</u> - <u>DABROWSKI, Andrzej</u> - <u>SEISENBAEVA, Gulaim</u> - <u>KESSLER, Vadim</u> . Protection of Thiol Groups on the Surface of Magnetic Adsorbents and Their Application for Wastewater Treatment. In <i>Scientific Reports</i> , 2018, vol. 8, no. 1, art. no. 8592. (2017: 4.122 - IF, Q1 - JCR, 1.533 - SJR, Q1 - SJR, Current Contents - CCC). (2018 - Current Contents, WOS, SCOPUS). ISSN 2045-2322. https://doi.org/10.1038/s41598-018-26767-w

2.1.2.33	<u>ZUBRIK, Anton**</u> - <u>MATIK, Marek</u> - <u>LOVÁS, Michal</u> - <u>DANKOVÁ, Zuzana</u> - <u>KAŇUCHOVÁ, Mária</u> - <u>HREDZÁK, Slavomír</u> - <u>BRIANČIN, Jaroslav</u> - <u>ŠEPELÁK, Vladimír</u> . Mechanochemically Synthesised Coal-Based Magnetic Carbon Composites for Removing As(V) and Cd(II) from Aqueous Solutions. In <i>Nanomaterials-Basel</i> , 2019, vol. 9, no. 1, p. 100. (2018: 4.034 - IF, Q1 - JCR, 0.896 - SJR, Q1 - SJR, Current Contents - CCC). (2019 - Current Contents, WOS, SCOPUS). ISSN 2079-4991. Dostupné na: https://doi.org/10.3390/nano9010100
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2.1.3 List of monographs/books published abroad

Code Nr.	Scientific output
AAA	Scientific monographs published abroad
2.1.3.1	<u>BALÁŽ, Matej</u> . <i>Environmental Mechanochemistry: Recycling Waste into Materials Using High-Energy Ball Milling</i> . Switzerland : Springer International Publishing, 2021. 700 p. ISBN 978-3-030-75223-1. https://doi.org/10.1007/978-3-030-75224-8
ABC	Chapters in scientific monographs published abroad
2.1.3.2	<u>BALÁŽ, Matej</u> - <u>BEDLOVIČOVÁ, Zdenka</u> - <u>KOVÁČOVÁ, Mária</u> - <u>SALAYOVÁ, Aneta</u> - <u>BALÁŽOVÁ, Ľudmila</u> . Green and Bio-Mechanochemical Approach to Silver Nanoparticles Synthesis, Characterization and Antibacterial Potential. In <i>Nanostructures for Antimicrobial and Antibiofilm Applications</i> . - Springer Natura Switzerland, 2020, p. 145-183. ISBN 978-3-030-40336-2. https://doi.org/10.1007/978-3-030-40337-9_7
2.1.3.3	<u>DANKOVÁ, Zuzana</u> - <u>MOCKOVČIAKOVÁ, Annamária</u> . Adsorption of Heavy Metals Cations on Bentonite and Bentonite/Iron Oxide Composite. Rec.: Galamboš Michal, Martin Dano. In <i>Environmental Science and Engineering</i> . 11 section. Soil Pollution and Phytoremediation. - Houston, USA : Studium Press LLC, Houston, USA, 2017, p. 290-320. ISBN 9781-62699-088-3.
2.1.3.4	<u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - <u>SHPOTYUK, Oleh</u> - <u>DUTKOVÁ, Erika</u> - <u>TÓTHOVÁ, Erika</u> - <u>KOVÁČ, Jozef</u> - <u>KELLO, Martin</u> - <u>BALÁŽ, Matej</u> - <u>BALÁŽ, Peter</u> . Processing of natural mineral magnetite for medical applications. In <i>Biocompatible Hybrid Oxide Nanoparticles for Human Health</i> . - Eastbourne, UK : Elsevier, 2019, p. 125-147. ISBN 978-0-12-815875-3. https://doi.org/10.1016/B978-0-12-815875-3.00008-4
2.1.3.5	<u>SHPOTYUK, Oleh</u> - <u>LUKÁČOVÁ BUJŇÁKOVÁ, Zdenka</u> - <u>BALÁŽ, Peter</u> - <u>SHPOTYUK, Yaroslav</u> - <u>INGRAM, Adam</u> . Multiparticle composites based on nanostructured arsenic sulfides As ₄ S ₄ in biomedical engineering. In <i>Materials for Biomedical Engineering. Inorganic Micro- and Nanostructures</i> . - Elsevier, 2019, p. 119-151. ISBN 978-0-08-102814-8. https://doi.org/10.1016/B978-0-08-102814-8.00005-6
2.1.3.6	<u>TOMINA, Veronika</u> - <u>FURTAT, Iryna</u> - <u>STOLYARCHUK, Nataliya</u> - <u>ZUB, Yuriy</u> - <u>KAŇUCHOVÁ, Mária</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>MELNYK, Inna</u> . Surface and structure design of aminosilica nanoparticles for multifunctional applications: adsorption and antimicrobial studies. In <i>Biocompatible Hybrid Oxide Nanoparticles for Human Health</i> . - Eastbourne, UK : Elsevier, 2019, p. 15-31. ISBN 978-0-12-815875-3. https://doi.org/10.1016/B978-0-12-815875-3.00002-3

2.1.4. List of monographs/books published in Slovakia

Code Nr.	Scientific output
AAB	Scientific monographs published in Slovak publishing houses
2.1.4.1	<u>EŠTOKOVÁ, Adriana</u> - <u>KOVALČÍKOVÁ, Martina</u> - <u>LUPTÁKOVÁ, Alena</u> . Síranová korózia cementových kompozitov. Rec. Številová, N., Kaňuchová, M., Strigáč, J., Košice : TU Košice, 2017. 143 s. ISBN 978-80-553-2839-3

2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

Code Nr.	Scientific output
2.1.5.1	<u>KUPKA, Daniel</u> - <u>KUBINEC, R.</u> - <u>JÁGER, Dávid</u> - <u>BÁRTOVÁ, Zuzana</u> - <u>JENČÁROVÁ, Jana</u> - <u>MAČINGOVÁ, Eva</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> - <u>BLAŠKO, J.</u> - <u>FILO, Július</u> - <u>GALBAVÁ, Paulína</u> - <u>SZABÓVÁ, Ž.</u> Partial final report on the state of groundwater pollution from the environmental burden Bratislava - Vrakuňa - Vrakunská cesta, landfill CHZJD and surrounding area: Joint project of BSK, SAS and PriF UK for research of possibilities of decontamination of environmental burden Bratislava Vrakuňa - Vrakunská cesta-landfill CHZJD (in Slovak). 103 p. https://bratislavskykraj.sk/wp-content/uploads/2020/05/skladka_chzjd_vrakuna-zaverecna_sprava_vyskumu_uqt_sav_a_prif_uk1-min.pdf
2.1.5.2	<i>Biocompatible Hybrid Oxide Nanoparticles for Human Health</i> . Eds.: Melnyk, I., Václavíková, M., Seisenbaeva, G., Kessler, V.G., Eastbourne, UK : Elsevier, 2019. 288 p. ISBN 978-0-12-815875-3
2.1.5.3	<u>KOTULOVÁ, Júlia</u> - <u>KORČÁK, Martin</u> - <u>PAVLÍK, Viliam</u> - <u>KUPKA, Daniel</u> - <u>FRANKOVSKÁ, J.</u> - <u>KYŠKA-PIPIK, Radovan</u> . High-capacity hydrogen-based energy storage as a solution for the future (In Slovak). Veľkokapacitné úložisko energie na báze vodíka ako riešenie budúcnosti. In <i>Slovgas</i> , 2016, vol. 4, no. 4, p. 8-12. ISSN 1335-3853.
2.1.5.4	<u>IVANIČOVÁ, Lucia**</u> - <u>LAZAROVÁ, Edita</u> - <u>KRULÁKOVÁ, Mária</u> - <u>LABAŠ, Milan</u> - <u>FERIANČÍKOVÁ, Katarína</u> - <u>MARCIN BEHUNOVÁ, Dominika</u> . Indirect prediction of drill bit wear in andesite drilling. In <i>ICCC'2018 : Proceedings of 19th International Carpathian Control Conference, May 28-31, Szilvasvarad, Hungary</i> . 19th. - NEW YORK, NY 10017 USA : IEEE, 345 E 47TH St, 2018, p. 79-84. ISBN 978-1-5386-4761-5. https://doi.org/10.1109/CarpathianCC.2018.8399606
2.1.5.5	<u>ŠESTINOVÁ, Oľga**</u> - <u>HANČULÁK, Jozef</u> - <u>DOLINSKÁ, Silvia</u> - <u>FINDORÁKOVÁ, Lenka</u> - <u>ŠPALDON, Tomislav</u> . Study of mercury behavior and earthworm bioassays in three solid environment components from selected areas of Eastern Slovakia. In <i>Global Nest Journal</i> , 2019, vol. 21, no. 4, p. 484-489. (2018: 0.869 - IF, Q4 - JCR, 0.267 - SJR, Q3 - SJR). ISSN 1790-7632. https://doi.org/10.30955/gni.002641
2.1.5.6	<u>ŠIMONOVÍČOVÁ, Alexandra</u> - <u>KUPKA, Daniel</u> - <u>NOSALJ, Sanja</u> - <u>KRAKOVÁ, Lucia</u> - <u>DRAHOVSKÁ, H.</u> - <u>BÁRTOVÁ, Zuzana</u> - <u>VOJTKOVÁ, Hana</u> - <u>BOTUROVÁ, Kateřina</u> - <u>PANGALLO, Domenico**</u> . Differences in metabolites production using the Biolog FF Microplate™ system with an emphasis on some organic acids of <i>Aspergillus niger</i> wild type strains. In <i>Biologia</i> , 2020, vol. 75, no. 10, p. 1537-1546. (2019: 0.811 - IF, Q4 - JCR, 0.265 - SJR, Q3 - SJR, Current Contents - CCC). (2020 - Current Contents, WOS, SCOPUS). ISSN 0006-3088. https://doi.org/10.2478/s11756-020-00521-y
2.1.5.7	<u>JENČÁROVÁ, Jana**</u> - <u>LUPTÁKOVÁ, Alena</u> - <u>KUPKA, Daniel</u> . Removal of contaminants from water by bacterial activity. In <i>Inżynieria Mineralna - Journal of the Polish Mineral Engineering Society</i> , 2020, rocznik 2, no. 1, p. 63-66. (2019: 0.249 - SJR, Q3 - SJR). ISSN 1640-4920. https://doi.org/10.29227/IM-2020-01-40
2.1.5.8	<u>MELNYK, Inna**</u> - <u>NAZARCHUK, Galyna</u> - <u>ZUB, Yuriy</u> - <u>VÁCLAVÍKOVÁ, Miroslava</u> . IR spectroscopy study of SBA-15 silicas functionalized with the ethylthiocarbamidepropyl groups and their interactions with Ag(I) and Hg(II) ions. In <i>Applied Nanoscience</i> , 2019, vol. 9, no. 5, p. 683-694. (2018: 3.198 - IF, Q2 - JCR, Current Contents - CCC). (2019 - Current Contents). ISSN 2190-5509. https://doi.org/10.1007/s13204-018-0761-5
2.1.5.9	<u>SCHÜTZ, Tomáš</u> - <u>DOLINSKÁ, Silvia</u> - <u>HUDEC, Pavol</u> - <u>MOCKOVČIAKOVÁ, Annamária</u> - <u>ZNAMENÁČKOVÁ, Ingrid</u> . Cadmium Adsorption on Manganese Modified Bentonite and Bentonite-Quartz Sand Blend. In <i>International Journal of Mineral Processing</i> , 2016, vol. 150, p. 32-38. (2015: 1.617 - IF, Q2 - JCR, 0.815 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 0301-7516. https://doi.org/10.1016/j.minpro.2016.03.003

2.1.5.10	<p><u>KRULÁKOVÁ, Mária</u> - <u>LAZAROVÁ, Edita</u> - <u>LABAŠ, Milan</u> - <u>IVANIČOVÁ, Lucia</u> - <u>FERIANČÍKOVÁ, Katarína</u>. Identification of diamond drill bit wear from monitored vibratio signal (in Slovak: Identifikácia opotrebenia diamantovej vrtej korunky z monitorovaného vibračného signálu. In <i>Polní geotechnické metody 2018 : sborník 34. mezinárodní conference, 6.- 7. září 2018 Ústí nad Labem</i>. Eds.: Kurka, J., Štrosová, M., Šimová, V., ; rec. Kurka, J., Turček, P.,. - Ústí nad Labem : AZ Consult, spol s.r.o., 2018, p. 130. ISSN 1213-1237.</p>
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2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad

Efforts were made in patent application issuing from previous and running international and national cooperation:

<p>Method of copper extraction from waste copper slags</p>
<p>NADIROV, Rashid Kazimovich - MUSSAPIROVA, Lyazzat Arkhatovna - <u>BALÁŽ, Matej</u>. National Institute of Intellectual Property, Ministry of Justice of the Republic of Kazakhstan : Al-Farabi Kazakh National University“ Republican State Enterprise on the Right of Economic Management of the Ministry of Education and Science of the Republic of Kazakhstan, 28.04.2020. Patent 4900.</p> <p>Methodology of selectively leaching our copper from copper smelter slag with the assistance of the mechanical activation performed in a wet stirred media mill was described. By applying proper conditions, it was possible to recover more than 80% of copper present int he slag, whereas the majority of zinc and iron remained in the solid.</p>
<p>Method of obtaining needle-like nanocrystals of copper sulfide</p>
<p>BURKITBAYEV, Mukash M. - SHALABAYEV, Zhandos S. - KHAN, Natalya Vladimirovna - <u>BALÁŽ, Matej</u> - URAKAEV, Farit. National Institute of Intellectual Property, Ministry of Justice of the Republic of Kazakhstan : Al-Farabi Kazakh National University Republican State Enterprise on the Right of Economic Management of the Ministry of Education and Science of the Republic of Kazakhstan, 14.08.2020. Patent 5287.</p> <p>The presented patent describes the method of obtaining needle-like copper sulfide nanostructures using mechanochemistry. The key is in the utilization of sodium thiosulphate as an additional source of sulfur which causes the nucleation of the produced nanomaterial.</p>

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia

<p>Monitoring system of the degree of environmental pollution in an industrial environment and construction of measuring sensor</p>
<p>KOLCUNOVÁ, Iraida – KURMISKÝ, Juraj – DOLNÍK, Bystrík – CIMBALA, Roman – <u>BRIANČIN, Jaroslav</u> – PETRÁŠ, Jaroslav – ZBOJOVSKÝ, Ján – <u>FABIÁN, Martin</u> – DŽMURA, Jaroslav. Industrial property Office of the Slovak republic (Úrad priemyselného vlastníctva Slovenskej republiky), Švermova 43, 974 04 Banská Bystrica 4, 16.10.2020, Utility model No. 8919</p> <p>The utility model is focused on the novel method for monitoring of the degree of environmental pollution by sensor containing two electrodes, signal generator, analog-digital interface and detector. Electrodes are prepared by vapour deposition of conductive metal with thickness of several micrometers.</p>
<p>Integrated Technology for Water Clean-up from Mixed Contaminants</p>
<p>Inventor: MVDr. Daniel KUPKA, co-inventors: Ing. Miroslava VÁCLAVÍKOVÁ, PhD., Mgr. Gergo BODNÁR, PhD. The technology resulted from the research project FP7-WaSClean. Patent application process started by submission of Notification of creation of an object of industrial rights to the Technology Transfer Office of Slovak Academy of Sciences on Nov 30, 2021.</p>

Microbiological deferritization – quartz sand purification by heap bioleaching

A patent application was registered at Technology Transfer Office of Slovak Academy of Sciences on Aug 2, 2016 with notification of the creation of an industrial property. The technology resulted from the project “Development of in-situ bioleaching method to clean quartz sands and application through testing prototype pilot plant” on demand from Chilean industrial partner Cristalerías de Chile S.A., a quartz sand producer. The heap bioleaching with the recycling of leachates provides the development of new economic technology suitable for the quality improvement of quartz sand. Principal researcher of the project responsible for IGTSAS (author of intellectual property) left the Institute in 2017 and patent application discontinued.

2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

The overview of the most important research outputs achieved during the assessed period is presented within the five individual departments of IGTSAS. However there were also research topics, where interdisciplinary research was performed, bringing together skills and qualifications from various departments, thus delivering mixed project teams.

Department of Destructional and Constructional Geotechnics (DDCG)

DDCG is focused on the investigation of the rock breaking by mechanical means (cutting, drilling, excavation, tunnelling) covering wide range of aspects. The automated measuring chain of the experimental laboratory horizontal drilling rig has been optimized and upgraded by sensors with higher sampling frequency (up to 18 kHz) allowing more detailed sampling and characterization of the drilling process. There have been two main streams of the DDCG research in the Assessment Period:

DDCG 1. Rock drillability prediction

Mechanical rock drilling is generally considered a technology with large energy consumption resulting in efforts to control this process economic efficiency improvement. A model for prediction of the drill bit penetration depth was developed based on monitored process parameters, quantifying the decreasing drill bit ability to achieve maximum penetration depending on progressing bit wear. Indirect assessment and prediction of drill bit wear in automated process control shall enable reduction of energy consumption and reduce the drill bit wear in underground construction and mining (Krúpa, V. et al., 2018, 2.1.2.8; Ivaničová, L. et al., 2018, 2.1.5.4).

DDCG 2. Vibration emissions in small diameter rotary drilling of rocks and concrete

Vibration emissions as phenomena accompanying the rotary rock drilling have been analyzed in both time and frequency domains. Shewhart control diagrams were used to control the standard deviation of the accompanying vibrations as an indirect feature of process quality assessment. We proved that vibrations increase linearly with drill speed and are related to bit wear and system condition (Kruľáková et al., 2018, 2.1.5.10).

A methodology for evaluating the drilling process efficiency using an energy quantity identified from measured vibration signal for different types of drill bits, of different rock types and for different applied modes was designed and developed. The optimal drilling mode was defined based on the minimum values of specific drilling energy and the corresponding average mean values of the acceleration of the vibration signal (Labaš, 2019).

Advanced mathematical procedures of Hilbert's abstract space were applied to distinct the drilled rock types using the vibration signal. A novel method expressing the differences between the vibrations in drilling of different rock types was developed, which enables to set the differences in abstract space to the planar visualization (Feriančíková et al., 2.1.2.10).

The use of vibration signal as a diagnostic parameter of the drilling process appears to be a potentially successful approach; hence the correlations between the applied regime, specific energy and vibrations were analyzed to identify the drill bit wear. We observed that the vibration acceleration bears the information on the regime change. The vibration acceleration limit values were corresponded to the minimum values of specific energy, preconditioning the use of vibrations in automated online systems of optimal control of rock drilling (Lazarová et al., 2020, 2.1.2.9).

Department of Physical and Physico-Chemical Methods of Mineral Processing (DMMP)

Last decades, the research activities of DMMP were strongly affected by regression in mining industry and thus the department re-drewed the strategy with the emphasis to the environmental applications (remediation of industrial sites, synthesis of advanced material for wastewater treatment, and modernization of classical mineral processing methods). The main research activities of DMMP during the assessed period were devoted to:

DMMP 1. Mineral processing of materials including secondary raw materials utilization

Rare earth elements (REE) have the irreplaceable role in recent technologies such as production of screens, permanent magnets, smartphones, and electric cars; in metallurgy and glass industry, in nuclear power as well as in medical industry. The research was focused on the extraction of lanthanides and strategic minerals from secondary raw materials. The significant attention was given to recycling of hard fly ash after the coal combustion in order to obtain pure lanthanides (Znamenáčková et al., 2019).

Barite is included in last lists of critical raw materials (EU, 2017, 2020). Due to its exceptionally high specific gravity "for a non-metallic mineral" it represents a key drilling chemical in the oil and gas industry, but also as X-ray proof plaster (e.g. in hospitals). Barite and siderite recoveries from flotation tailings after siderite-barite-sulfides ore upgrading were investigated (Markušovce, SK). An application of proposed gravity pre-concentration can cut half the feed for follow-up operations, meaning installation of smaller magnetic separators (half capacity in comparison with direct feeding of settling pit material into magnetic separation without gravity pre-concentration), and also approx. 5-times lower capacity of flotation line, which shall result in lower capital and running costs of tailings processing (Hredzák et al., 2019).

DMMP 2. Removal of high-priority toxic substances from waters and soils

Significant progress has been recorded in the degradation of organic pollutants in waters and soils such as reactive dyes, polyaromatic hydrocarbons etc. DMMP group together with DMB described the degradation mechanism of azo-dyes by electrochemical oxidation, which was examined using a dimensionally stable anode and stainless steel cathodes as electrode materials, with NaCl as supporting electrolyte. The electrochemical treatment was compared to the chemical treatment with hypochlorite generated by electrolysis. Both chemical and electrochemical methods resulted in the transformation/degradation of the large dye molecules into smaller compounds with lower molecular weight. We confirmed that hydroxyl radicals and other reactive species produced during electrolysis are efficient oxidants capable to mineralize particular parts of these refractory molecules (Jáger et al., 2018, 2.1.2.1-TOP3, see Chapter 2.6.1, Case Study WaSClean).

This work also resulted in new ideas to improve and/or develop new electrode materials with improved characteristics. The deposition of the graphene oxide (GO) on stainless steel substrate and its potential environmental application was studied. GO nanomaterials were grown vertically on stainless steel substrate to form a 3D architecture by applying DC current (electrophoretic deposition). This unique material offers unconventional physico-chemical properties that can improve significantly the removal efficiency while at the same time restrict the negative impact to the environment and human health. GO is capable simultaneously remove a broad class of molecules and display a strong affinity for the adsorption of contaminants and convert them to harmless products (Marcin Behunová, et al., 2021, 2.1.2.31).

The removal of adsorbable organic halogens (AOX) is also one of new hot topics studied at DMMP. The PhD thesis (H. Yankovych) was offered in 2018 on demand of the industrial partner U.S.Steel Košice, who presented interest to cooperate on the problem of AOX removal from their wastewaters (See Case Study in Chapter 2.6.1). The AOX and their harmful effect on the environment and living organisms, with a special attention to the adsorptive removal of 4-halogenophenols onto activated carbon were studied (Yankovych et al., 2021, 2.1.2.30). As the alternative materials for AOX elimination, composites with photocatalytic properties based on activated carbon and TiO₂ have been investigated as well. Recently another manuscript of this high-priority topic has been submitted to J Applied Catalysis B – Environmental with IF 21.41.

Adsorption properties of materials in environmental applications were also studied within the SASPRO project, which resulted in a successful APVV project and several H2020 applications, including ERC. The one-stage synthesis of bifunctional microspheres under different synthetic conditions was demonstrated and the peculiarities of the structure and advantages of such materials in the adsorption of cations, dyes, as well as their antibacterial properties were shown (Melyk et al., 2017, 2.1.2.2-TOP3). It was shown necessary to introduce organic groups on the surface of magnetic particles with -SH groups to preserve the groups from interacting

with each other and to maintain 3-mercaptopropyl free groups capable of effective adsorption of a large number of heavy metal Ag(I), Cd(II), Hg(II), and Pb(II) ions from solutions (Melnyk et al. 2018, 2.1.2.32). It was demonstrated that silica microspheres with aminogroups had the high sorption capacity to Cu(II) ions and organic dyes (Acid red 88, Fluorescein, Methylene blue) (Melnyk et al., 2021, 2.1.2.27). Also, polystyrene-acrylic/ZnO nanocomposite films could be used for the efficient removal of Methylene blue (Pasichnyk, et al., 2021, 2.1.2.14). Other adsorption experiments revealed that the SBA-15 silicas functionalized with thiourea groups had high selectivity for silver(I) ions and could concentrate Ag(I) ions from metal ions mixture at pH~2 (Melnyk et al. 2019, 2.1.5.8).

Low cost natural adsorbents (zeolites, clay minerals, agricultural waste biomass) are also studied at the DMMP as effective adsorbents of heavy metals and metalloids in both cationic (Cd, Cu, Pb,) and anionic form (As, Cr) from waters (Otero-Gonzales et al. 2019, 2.1.2.29). The magnetic lignite and magnetic char were prepared by high-energy ball co-milling from either raw Slovak lignite or coal-based char together with a ferrofluid. The magnetic char was an excellent sorbent of As(V) oxyanions whereas the magnetic lignite was less effective. Both magnetic composites are also effective sorbents for removing Cd(II) cations (Zubrik et al., 2019, 2.1.2.33). In the field of waste biomass the sunflower biochar was obtained from the sunflower wastes through pyrolysis and was applied in removal of zinc(II) and manganese(II) ions with for purification of water contaminated with battery waste (Yankovych et al. 2021, 2.1.2.26; Zubrik et al. 2017 2.1.2.28). The bentonite from deposit Stará Kremnička and quartz sand from deposit Šaštín both from Slovakia were modified by manganese oxides in order to increase their sorption properties towards the Cd²⁺ cations from aqueous solutions as an alternative to commercial adsorbents (Schütz et al., 2016, 2.1.5.9).

DMMP 3. Microwave treatment of raw materials, industrial wastes and biomass

Microwave energy has a potential to be used in metal recovery operations, such as heating, drying, leaching, roasting/smelting and waste management. The extraction processes are environmentally and economically attractive as they can provide detoxication of industrial sludge and removal of valuable metals for their further reuse. The application of microwave energy in the pre-treatment of refractory tetrahedrite ore delivered higher Sb-concentration compared to conventional leaching (Znamenáčková et al., 2021). The basic oxygen furnace (BOF) dust samples from the gas-cleaning system generated during the carbon making processes were subjected microwave extraction. The microwave treatment of the BOF dust resulted in a very rapid dis-solution of the zinc phase (Vereš et al., 2017). Asbestos, commonly used in the construction industry, belongs to the group of hazardous materials and shows carcinogenic activity. It is therefore advisable to attempt to dispose of asbestos minerals in asbestos-containing materials and to convert them into a harmless material. We proved microwave thermal decomposition as innovative and rapid destruction method of fibrous structure of silicate minerals in all volume of heated material (Znamenáčková et al., 2016).

Department of Mechanochemistry (DM)

Research in the Department of Mechanochemistry focuses on the elaboration of mechano-chemical, physico-chemical and chemical methods of synthesis and application of nanocrystalline materials and their composites prepared from precursors based on natural minerals, synthetic substances, as well as selected components of intermediate products and wastes from various industries. Mechanochemistry is a branch of chemistry, which is concerned with the chemical and the physicochemical changes of substances of all states of aggregation due to the influence of mechanical energy. According to the mechanochemistry definition, two main processes are applied in the department: i) mechanochemical synthesis, where the new materials are produced, and ii) mechanical activation of substances, where the improvement of their properties is obtained without a chemical change.

DM 1. Material science and preparation of nanomaterials based on minerals

Artificial nanostructured ternary and quaternary sulphide minerals stannite Cu₂FeSnS₄ and kesterite Cu₂ZnSnS₄ (Baláž et al., 2018, 2.1.2.18), chalcopyrite CuFeS₂, mohite Cu₂SnS₃, tetrahedrite Cu₁₂Sb₄S₁₃, mawsonite Cu₆Fe₂SnS₈ and kesterite Cu₂ZnSnS₄ (Baláž et al., 2021, 2.1.2.3-TOP3; Baláž et al., 2019, 2.1.2.15), and copper selenide, klockmanite CuSe (Achimovičová et al., 2020, 2.1.2.23) were synthesized by an eco-friendly ball-milling method in an industrial mill in a batch mode experiments that are 10-50 times higher amounts as the throughout of laboratory

planetary mills. These mechanochemically synthesized compounds present perspective materials in solar cell and photovoltaic technology, and thermoelectrics-energy materials for converting heat to electricity. The application of an eccentric vibratory mill for these syntheses constitutes a big challenge for researchers in their permanent effort in scaling up new materials and processes. Also, lanthanum aluminate-based perovskite ceramics $\text{La}_{1-x}\text{Ca}_x\text{AlO}_{3-\delta}$ ($x = 0.05\text{--}0.20$) were prepared via one-step high-energy mechanochemical processing. These ceramics are mixed conductors under oxidizing conditions and ionic conductors with potential use in fuel cells and LiBs (Fabián et al., 2019, 2.1.2.24).

DM 2. Mineral-based materials for biomedical applications

$\text{As}_4\text{S}_4/\text{Fe}_3\text{O}_4$ composites dispersed in a water solution of Poloxamer 407 were prepared with the in-vitro anticancer activity on breast MCF-7 and tongue SCC-25 cancer cells (Lukáčová Bujňáková et al., 2020, 2.1.2.19), and the sodium dodecyl sulphate capped $\text{CuInSe}_2/\text{ZnS}$ nanocomposites suitable for bioimaging applications with anti-myeloma sensitizing potential (Dutková et al., 2021, 2.1.2.21). The stable suspensions of composites were obtained by wet stirred media milling. Silver nanoparticles as excellent antibacterial agents were prepared by milling AgNO_3 and lichen species (*Xanthoria elegans*, *Cetraria islandica*, *Usnea antarctica* and *Leptogium puberulum*) as reducing agents (M. Baláž et al., 2020, 2.1.2.16).

DM 3. Ecology

Mechanochemical carbonization of zinc oxide using CO_2 was carried out by 10 min of milling with the formation of nanocrystalline hydrozincite ($\text{Zn}_5(\text{CO}_3)_2(\text{OH})_6$, 13 nm), a mineral normally occurring in nature. It is therefore a possible efficient and practical use of greenhouse gas, as it is firmly bound in the structure of hydrozincite, which at the same time does not burden the environment (Tóthová et al., 2016, 2.1.2.22). For valorization of polyvinyl chloride and eggshell waste, a semi-industrial approach for simultaneous treatment of eggshell and industrial PVC waste utilizing the tool of ball milling was tested. On a hundred-gram scale, it is possible to transfer more than 50% of chlorine present in the polyvinyl chloride representing an environmental burden, into a harmless soluble form - calcium chloride (M. Baláž et al., 2019, 2.1.2.20). The published review dealing with the ball milling of eggshell waste provides critical mechanochemical insight into this topic and aims to emphasize the green and sustainable way of utilizing eggshell waste by the environmentally friendly method (M. Baláž, 2018, 2.1.2.17; M. Baláž, 2021, 2.1.3.1).

DM 4. Hydrometallurgy

By using the mechanochemical-biological method the acquirement of gold from concentrate (Pezinok, Slovakia) was studied. It was possible to obtain the gold nanoparticles by mechanochemically activation of the concentrate and siliceous shells of limnetic algae in the thiourea solution as alternatives to cyanides (Ficeriová et al., 2020, 2.1.2.25).

Department of Mineral Biotechnologies (DMB)

The main objective of the DMB is to perform basic & applied research in the field of environmental microbiology and biotechnology with a priority focus on the recovery of critical raw materials and the mitigation of the negative impact of mining industry to the environment. Activities during the assessed period were mainly devoted to 4 areas:

DMB 1. Biohydrometallurgy in metal extraction from minerals and acid mine drainage remediation

The basic research was focused on the study of biodiversity of mining-impacted environments, and the study of microbial growth and mechanisms and kinetics of oxidative and reductive processes taking part in metal mobilization and transformation of mineral structures (Kupka et al., 2019). The oxidative (bio)leaching of polymetallic Ag-Cu-Sb-tetrahedrite-siderite ore from Rožňava, SK in the presence of Fe- and S-oxidizing bacteria revealed selective recovery of Cu, Zn, Ag, approaching > 80 % metal yield, while the Sb concentrations remained low, suggesting formation of precipitates. The high Cu and Sb content and relatively high content of Ag (up to 1%) makes the tetrahedrite mining in this deposit economically attractive (Hagarová et al., 2020). Three different biological systems - acidophilic bacteria, microscopic fungus and yeasts were investigated for lithium extraction from lepidolite. Two-step bioleaching by the application of heterotrophic organisms followed by autotrophic bioleaching could lead to the increase of the process kinetics and efficiency of Li extraction from lepidolite (Sedláková-Kaduková et al., 2020, 2.1.2.13).

Extensive mining activities in Slovakia in the past, have left a legacy of numerous abandoned mines, waste dumps, tailing impoundments and mine impacted waters (MIW), after the mining industry started to decline in the 1990s (Majzlan et al, 2.1.2.11). On the other hand,

due to the nature of mining operations, valuable elements can still be found in the various mine waste streams. The research was focused on the study of processes for selective and efficient removal of targeted constituents, which reduces residual wastes, and gives the potential for valorization of resources to generate new revenue streams and offset remediation costs (Jenčárová et al., 2020, 2.1.5.7). Biologically produced H₂S has been used for selective recovery of metals from various bio-hydrometallurgical process streams (Luptáková et al., 2016).

DMB 2. Biotechnology in the processing of non-metallic raw materials,

The biological treatment of non-metallic raw materials was carried out by heterotrophic bacterial strains that facilitate the removal of iron impurities by reductive dissolution or by the production of various chelating agents (Štyriaková et al., 2016; Šuba et al., 2018).

DMB 3. Prediction and prevention of bio-corrosion of building composite materials

The research focused on the resistance of concrete and cement composites (CC) to biological deterioration effect of the harsh environment. Biogenic sulfuric acid attacked the cement matrix of the concrete and caused a loss of strength, which reduced durability (Luptakova et al., 2019). The resistance improvement of CC to biological damage by partially replacing the cement with suitable materials such as zeolite (Luptáková et al., 2016), silica ash (Eštoková et al., 2016, 2.1.2.12) and blast furnace slag (Eštoková et al., 2017, 2.1.4.1) was investigated.

DMB 4. Application of biological and electrochemical advanced oxidation processes in the removal of persistent organic pollutants

The development and implementation of electrochemical methods is a progressive trend in water and wastewater treatment technology. Electrochemical cleaning is an effective alternative or complementary technology to the conventional mechanical, biological and physico-chemical water treatment methods (Kupka et al., 2016). DMB with DMMP described the degradation mechanism of synthetic dyes by electrochemical oxidation (Jáger et al., 2018, 2.1.2.1-TOP3).

Department of Environment and Hygiene in Mining (DEHM)

The research was focused mainly on two specific environmental components burdened by historical and current mining and metallurgical activities:

DEHM 1. Study of air quality through selected parameters of atmospheric deposition and particulate matter (PM)

Total atmospheric deposition (AD) was sampled in the area of Košice with the steel and ironworks factory. Qualitative and quantitative characteristics and the fluxes of AD of elements (Fe, Al, Mn, Zn, Pb, Cu, Cr, Cd, As) and PM were studied. High occurrence of fine particles under 10 µm was found in the samples. SEM and EDX analysis showed the presence of particles whose origin comes mainly from emission sources of the U.S. Steel factory (annual emissions up to 6 mil tons) (Hančulák et al., 2016, 2.1.2.6). The relationship between the deposition of the observed elements, PM and the distance from the factory was studied. The significant dependence was found in descending order for the Mn, Fe, PM, Cr, Al and partly for Zn. The strong correlation coefficients were proved between the elements where their dominant sources are emissions sources of the factory, namely Mn, Fe and Cr. The portion of emission sources of ironworks on the Fe fluxes at the individual sites in the city was calculated in the range from 24.7 to 54.1% (Hančulák et al., 2020, 2.1.2.7). Significant differences were found between fluxes of AD in terms of spatial and seasonal variations. The impact of emission sources of the U.S. Steel on the fluxes of Fe at the urban sites in winter was more than doubled portion compared to the summer period (Hančulák et al., 2021). The results can be directly used in solving the issue of air protection by the operators of emission sources, and local and administrative authorities.

DEHM 2. Research of contaminated soils and bottom sediments

Potential contamination of sediments from the Kropachy water reservoir in the vicinity of Kovohuty Kropachy (copper producing&processing factory) was studied by rapid screening methods (XRF, CHNS, TGA/MS). In relation to allowable values, it was found that sediments are highly contaminated with Ni, Cu, Pb and this contamination was related to its highest clay and silt proportion. The best correlation was confirmed between weight losses in the temperature range (400–620 C) and the following metal concentrations: As, Cu, Zn, Pb and Hg. The best correlation was confirmed between mass loss in the temperature range (400-620 C) and concentrations of As, Cu, Zn, Pb and Hg, which is also related to the decomposition of minerals such as siderite, barite, and exothermic loss of aromatic carbon (Findoráková et al., 2.1.2.4).

The acute toxicity of contaminated sediments from the Ružín reservoir burdened by mining activities was assessed using the Phytotoxkit test and SOS-Chromotest. In the sediments, the limit

values for the concentrations of the metals Cu, As, Sb and Hg were exceeded. Acute genotoxicity analysis proved a potential genotoxicity for the Hornád river sediment sample, and nontoxicity for Hnilec river sediment. Based on the results of the phytotoxicity testing on *Sinapis alba*, no potential phytotoxic effect of the metals on sediments was observed (Šestinová et al., 2.1.2.5).

Toxic effects and distribution of mercury in contaminated soils and sediments from eastern Slovakia were evaluated using earthworms *Dendrobaena veneta*. The high mercury concentrations were determined in the tailing-sediment from Rudňany (polymetallic mine), in sediment from the Krompachy reservoir and in soils from the vicinity of Rudňany and Krompachy. A significant positive correlation was found between highest concentrations of mercury Rudňany-tailing sediment (Hg = 188.5 mg/kg, $r = 0.87$) with the highest mortality of earthworms after 28 days bioassay (Šestinová et al., 2019, 2.1.5.5). The DEHM research results and activities provide important information about the environmental risks of the studied components of the environment and a suitable background material for their possible use or revitalization.

2.1.9. Table of research outputs

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately.

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad (AAA, ABA)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.034	0.910	1	0.167	0.005	0.170
Scientific monographs and monographic studies in journals and proceedings published in Slovakia (AAB, ABB)	0	0.000	0.000	1	0.029	1.048	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.167	0.005	0.170
Chapters in scientific monographs published abroad (ABC)	0	0.000	0.000	1	0.029	1.048	0	0.000	0.000	3	0.094	3.093	1	0.034	0.929	0	0.000	0.000	5	0.833	0.026	0.850
Chapters in scientific monographs published in Slovakia (ABD)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000
Scientific papers published in journals registered in Current Contents Connect (ADCA, ADCB, ADDA, AADB)	26	0.700	28.729	40	1.180	41.929	37	1.171	41.998	34	1.064	35.052	54	1.816	50.186	40	1.344	36.397	231	38.500	1.190	39.252
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above (ADMA, ADMB, ADNA, ADNB)	19	0.511	20.994	16	0.472	16.771	14	0.443	15.891	22	0.688	22.680	7	0.235	6.506	6	0.202	5.460	84	14.000	0.433	14.274
Scientific papers published in other foreign journals (not listed above) (ADEA, ADEB)	4	0.108	4.420	2	0.059	2.096	0	0.000	0.000	4	0.125	4.124	2	0.067	1.859	1	0.034	0.910	13	2.167	0.067	2.209
Scientific papers published in other domestic journals (not listed above) (ADFA, ADFB)	2	0.054	2.210	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	2	0.333	0.010	0.340
Scientific papers published in foreign peer-reviewed proceedings (AECA)	0	0.000	0.000	1	0.029	1.048	0	0.000	0.000	1	0.031	1.031	0	0.000	0.000	0	0.000	0.000	2	0.333	0.010	0.340
Scientific papers published in domestic peer-reviewed proceedings (AEDA)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000
Published papers (full text) from foreign scientific conferences (AFA, AFC)	10	0.269	11.050	3	0.088	3.145	7	0.222	7.946	3	0.094	3.093	2	0.067	1.859	3	0.101	2.730	28	4.667	0.144	4.758
Published papers (full text) from domestic scientific conferences (AFB, AFD)	22	0.592	24.309	24	0.708	25.157	34	1.076	38.593	24	0.751	24.742	17	0.572	15.799	23	0.773	20.928	144	24.000	0.742	24.469

2.2. Measures of research outputs (citations, etc.)

Compared to the previous Assessment Period, young researchers boosted their publication activity and moreover became recognized in their fields of research.

2.2.1. Table with citations per annum (without self-citations)

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) are listed separately

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	576	15.50	634	18.70	690	21.84	770	24.09	1 006	33.84	1 094	36.76	4 770	795.00	24.57
Citations in SCOPUS (1.2, 2.2) if not listed above	117	3.15	74	2.18	50	1.58	79	2.47	113	3.80	116	3.90	549	91.50	2.83
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	1	0.03	1	0.03	2	0.06	1	0.03	0	0.00	5	0.17	10	1.67	0.05
Other citations (not listed above) (3.1, 4.1)	53	1.43	60	1.77	44	1.39	37	1.16	48	1.61	26	0.87	268	44.67	1.38
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0.00

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

Nr.	Cited	Publication
1	429	BALÁŽ, Peter - ACHIMOVIČOVÁ, Marcela - BALÁŽ, Matej - BILLIK, Peter - CHERKEZOVA-ZHELEVA, Zara - CRAIDO, José Manuel - DELOGU, Francesco - DUTKOVÁ, Erika - GAFFET, Eric - GOTOR, Francisco José - KUMAR, Rakesh - MITOV, Ivan - ROJAC, Tadej - SENNA, M. - STRELETSKII, Andrey - WIECZOREK-CIUROWA, Krystyna. Hallmarks of mechanochemistry: From nanoparticles to technology. In <i>Chemical Society Reviews</i> , 2013, vol. 42, p. 7571-7637. (2012: 24.892 - IF, Q1 - JCR, 15.022 - SJR, Q1 - SJR, karentované - CCC). (2013 - Current Contents). ISSN 0306-0012. https://doi.org/10.1039/c3cs35468g
2	351	BALÁŽ, Peter. <i>Mechanochemistry in Nanoscience and Minerals Engineering</i> . Berlin : Springer-Verlag Berlin Heidelberg, 2008. 413 p. ISBN 978-3-540-74854-0. https://doi.org/10.1007/978-3-540-74855-7 .
3	112	BALÁŽ, Matej. Eggshell membrane biomaterial as a platform for applications in materials science. In <i>Acta biomaterialia</i> , 2014, vol. 10., no. 9, p. 3827-3843. (2013: 5.684 - IF, Q1 - JCR, 1.963 - SJR, Q1 - SJR). ISSN 1742-7061. https://doi.org/10.1016/j.actbio.2014.03.020
4	93	SALAZAR-ALVAREZ, G. - QIN, J. - ŠEPELÁK, Vladimír - BERGMANN, Ingo - VASILAKAKI, M. - TROHIDOU, K.N. - ARDISSON, J.D. - NOGUÉS, J. Cubic versus spherical magnetic nanoparticles: The role of surface anisotropy. In <i>Journal of the American Chemical Society</i> , 2008, vol. 130, no. 40, p. 13234-13239. (2007: 7.885 - IF, Q1 - JCR, 5.202 - SJR, Q1 - SJR). ISSN 0002-7863. https://doi.org/10.1021/ja0768744
5	88	VÁCLAVÍKOVÁ, Miroslava - GALLIOS, G.P. - HREDZÁK, Slavomír - JAKABSKÝ, Štefan. Removal of arsenic from water streams: An overview of available techniques. In <i>Clean Technologies and Environmental Policy</i> , 2008, vol. 10, no. 1, p. 89-95. (2007: 0.341 - SJR, Q2 - SJR). ISSN 1618-954X. https://doi.org/10.1007/s10098-007-0098-3
6	77	VEREŠ, Ján - LOVÁS, Michal - JAKABSKÝ, Štefan - ŠEPELÁK, Vladimír - HREDZÁK, Slavomír. Characterization of blast furnace sludge and removal of zinc by microwave assisted extraction. In <i>Hydrometallurgy</i> , 2012, vol. 2012, no. 129-130, p. 67-73. (2011: 2.027 - IF, Q1 - JCR, 1.515 - SJR, Q1 - SJR, karentované - CCC). (2012 - Current Contents). ISSN 0304-386X. https://doi.org/10.1016/j.hydromet.2012.09.008
7	73	ZUBRIK, Anton - MATIK, Marek - HREDZÁK, Slavomír - LOVÁS, Michal - DANKOVÁ, Zuzana - KOVÁČOVÁ, Milota - BRIANČIN, Jaroslav. Preparation of chemically activated carbon from waste biomass by single-stage and two-stage pyrolysis. In <i>Journal of cleaner production</i> , 2017, vol. 143, p. 643-653. (2016: 5.715 - IF, Q1 - JCR, 1.659 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 0959-6526. https://doi.org/10.1016/j.jclepro.2016.12.061
8	71	BALÁŽ, Peter. Mechanical activation in hydrometallurgy. In <i>International Journal of Mineral Processing</i> , 2003, vol. 72, no. 1-4, p. 341-354. ISSN 0301-7516. https://doi.org/10.1016/S0301-7516(03)00109-1
9	62	BALÁŽ, Peter. <i>Extractive metallurgy of activated minerals</i> . Amsterdam : Elsevier Science B.V., 2000. 278 p. Process Metallurgy, 10. ISBN 978-0-444-50206-3
10	59	VASEASHTA, A. - VÁCLAVÍKOVÁ, Miroslava - VASEASHTA, S. - GALLIOS, G.P. - ROY, P. - PUMMAKARNCHANA, O. Nanostructures in Environmental pollution detection, monitoring, and remediation. In <i>Science and technology of advanced materials</i> , 2007, vol. 8, no. 1-2, p. 47-59. (2006: 1.124 - IF, Q2 - JCR, 0.702 - SJR, Q1 - SJR). ISSN 1468-6996. https://doi.org/10.1016/j.stam.2006.11.003

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

Nr	Cited	Publication
1	485	BALÁŽ, Peter. <i>Mechanochemistry in Nanoscience and Minerals Engineering</i> . Berlín : Springer-Verlag Berlín Heidelberg, 2008. 413 p. https://doi.org/10.1007/978-3-540-74855-7 . ISBN 978-3-540-74854-0
2	457	BALÁŽ, Peter - ACHIMOVIČOVÁ, Marcela - BALÁŽ, Matej - BILLIK, Peter - CHERKEZOVA-ZHELEVA, Zara - CRAIDO, José Manuel - DELOGU, Francesco - DUTKOVÁ, Erika - GAFFET, Eric - GOTOR, Francisco José - KUMAR, Rakesh - MITOV, Ivan - ROJAC, Tadej - SENNA, M. - STRELETSKII, Andrey - WIECZOREK-CIUROWA, Krystyna. Hallmarks of mechanochemistry: From nanoparticles to technology. In <i>Chemical Society Reviews</i> , 2013, vol. 42, p. 7571-7637. (2012: 24.892 - IF, Q1 - JCR, 15.022 - SJR, Q1 - SJR, karentované - CCC). (2013 - Current Contents). ISSN 0306-0012. https://doi.org/10.1039/c3cs35468g
3	198	TKÁČOVÁ, Klára. <i>Mechanical activation of minerals</i> . Tkáčová Klára. 170s. Elsevier, Amsterdam, 1989
4	187	VÁCLAVÍKOVÁ, Miroslava - GALLIOS, G.P. - HREDZÁK, Slavomír - JAKABSKÝ, Štefan. Removal of arsenic from water streams: An overview of available techniques. In <i>Clean Technologies and Environmental Policy</i> , 2008, vol. 10, no. 1, p. 89-95. (2007: 0.341 - SJR, Q2 - SJR). ISSN 1618-954X. https://doi.org/10.1007/s10098-007-0098-3
5	183	BALÁŽ, Peter. <i>Extractive metallurgy of activated minerals</i> . Amsterdam : Elsevier Science B.V., 2000. 278 p. Process Metallurgy, 10. ISBN 978-0-444-50206-3
6	160	SALAZAR-ALVAREZ, G. - QIN, J. - ŠEPELÁK, Vladimír - BERGMANN, Ingo - VASILAKAKI, M. - TROHIDOU, K.N. - ARDISSON, J.D. - NOGUÉS, J. Cubic versus spherical magnetic nanoparticles: The role of surface anisotropy. In <i>Journal of the American Chemical Society</i> , 2008, vol. 130, no. 40, p. 13234-13239. (2007: 7.885 - IF, Q1 - JCR, 5.202 - SJR, Q1 - SJR). ISSN 0002-7863.: https://doi.org/10.1021/ja0768744
7	129	BALÁŽ, Peter. Mechanical activation in hydrometallurgy. In <i>International Journal of Mineral Processing</i> , 2003, vol. 72, no. 1-4, p. 341-354. ISSN 0301-7516. https://doi.org/10.1016/S0301-7516(03)00109-1
8	114	BALÁŽ, Matej. Eggshell membrane biomaterial as a platform for applications in materials science. In <i>Acta biomaterialia</i> , 2014, vol. 10., no. 9, p. 3827-3843. (2013: 5.684 - IF, Q1 - JCR, 1.963 - SJR, Q1 - SJR). ISSN 1742-7061. https://doi.org/10.1016/j.actbio.2014.03.020
9	105	VASEASHTA, A. - VÁCLAVÍKOVÁ, Miroslava - VASEASHTA, S. - GALLIOS, G.P. - ROY, P. - PUMMAKARNCHANA, O. Nanostructures in Environmental pollution detection, monitoring, and remediation. In <i>Science and technology of advanced materials</i> , 2007, vol. 8, no. 1-2, p. 47-59. (2006: 1.124 - IF, Q2 - JCR, 0.702 - SJR, Q1 - SJR). ISSN 1468-6996. https://doi.org/10.1016/j.stam.2006.11.003
10	104	DRUSKA, P. - STEINKE, U. - ŠEPELÁK, Vladimír. Surface structure of mechanically activated and of mechanosynthesized zinc ferrite. In <i>Journal of Solid State Chemistry</i> , 1999, vol. 146, p. 13-21. ISSN 0022-4596.

2.2.4. List of 10 most-cited publications published during the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

Nr.	Cited	Publication
1	98	ZUBRIK, Anton - MATIK, Marek - HREDZÁK, Slavomír - LOVÁS, Michal - DANKOVÁ, Zuzana - KOVÁČOVÁ, Milota - BRIANČIN, Jaroslav. Preparation of chemically activated carbon from waste biomass by single-stage and two-stage pyrolysis. In <i>Journal of cleaner production</i> , 2017, vol. 143, p. 643-653. (2016: 5.715 - IF, Q1 - JCR, 1.659 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 0959-6526. https://doi.org/10.1016/j.jclepro.2016.12.061
2	77	BORETTI, Albert** - AL-ZUBAIDY, Sarim - VÁCLAVÍKOVÁ, Miroslava - AL-ABRI, Mohammed - CASTELLETTO, Stefania - MIKHALOVSKY, Sergey*. Outlook for graphene-based desalination membranes. In <i>npj Clean Water</i> , 2018, vol. 1, no. 5, p. 1-11. ISSN 2059-7037. https://doi.org/10.1038/s41545-018-0004-z

3	54	SHAMS, Mohammad H. - ROZATIAN, Amir, S.h. - YOUSEFI, Mohammad H. - VALÍČEK, J. - ŠEPELÁK, Vladimír. Effect of Mg ²⁺ and Ti ⁴⁺ dopants on the structural, magnetic and high-frequency ferromagnetic properties of barium hexaferrite. In <i>Journal of Magnetism and Magnetic Materials</i> , 2016, vol. 399, p. 10-18. (2015: 2.357 - IF, Q2 - JCR, 0.730 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents, WOS, SCOPUS). ISSN 0304-8853. https://doi.org/10.1016/j.jmmm.2015.08.099
4	53	BALÁŽ, Matej**. Ball milling of eggshell waste as a green and sustainable approach: A review. In <i>Advances in colloid and interface science</i> , 2018, vol. 256, p. 256-275. (2017: 7.346 - IF, Q1 - JCR, 1.977 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents). ISSN 0001-8686. https://doi.org/10.1016/j.cis.2018.04.001
5	51	VIGLAŠOVÁ, Eva** - GALAMBOŠ, Michal - DANKOVÁ, Zuzana - KRIVOSUDSKÝ, Lukáš - LENGAUER, Christian L. - HOOD-NOWOTNY, Rebecca - SOJA, Gerhard - ROMPEL, Annette - MATIK, Marek - BRIANČIN, Jaroslav. Production, characterization and adsorption studies of bamboo-based biochar/montmorillonite composite for nitrate removal. In <i>Waste Management</i> , 2018, vol. 79, p. 385-394. (2017: 4.723 - IF, Q1 - JCR, 1.456 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents). ISSN 0956-053X. https://doi.org/10.1016/j.wasman.2018.08.005
6	50	JÁGER, Dávid - KUPKA, Daniel - VÁCLAVÍKOVÁ, Miroslava** - IVANIČOVÁ, Lucia - GALLIOS, G.P. Degradation of Reactive Black 5 by electrochemical oxidation. In <i>Chemosphere</i> , 2018, vol. 2, no. 10, p. 405-416. (2017: 4.427 - IF, Q1 - JCR, 1.435 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents). ISSN 0045-6535. https://doi.org/10.1016/j.chemosphere.2017.09.126
7	38	STREČKOVÁ, Magdaléna - MÚDRA, Erika - ORIŇAKOVÁ, Renáta - MARKUŠOVÁ BUČKOVÁ, Lucia - ŠEBEK, Martin - KOVALČÍKOVÁ, Alexandra - SOPČÁK, Tibor - GIRMAN, Vladimír - DANKOVÁ, Zuzana - MIČUŠÍK, Matej - DUSZA, Ján. Nickel and nickel phosphide nanoparticles embedded in electrospun carbon fibers as favourable electrocatalysts for hydrogen evolution. In <i>Chemical Engineering Journal</i> , 2016, vol. 303, p. 167-181. (2015: 5.310 - IF, Q1 - JCR, 1.676 - SJR, Q1 - SJR, karentované - CCC). (2016 - Current Contents). ISSN 1385-8947. https://doi.org/10.1016/j.cej.2016.05.147
8	37	BALÁŽ, Matej - DANEU, Nina - BALÁŽOVÁ, Ľudmila - DUTKOVÁ, Erika - TKÁČIKOVÁ, Ľudmila - BRIANČIN, Jaroslav - VARGOVÁ, Mária M. - BALÁŽOVÁ, Miriama - ZORKOVSKÁ, Anna - BALÁŽ, Peter. Bio-mechanochemical synthesis of silver nanoparticles with antibacterial activity. In <i>Advanced Powder Technology</i> , 2017, vol. 28, p. 3307-3312. (2016: 2.659 - IF, Q2 - JCR, 0.705 - SJR, Q1 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 0921-8831. https://doi.org/10.1016/j.appt.2017.09.028
9	37	VUKOJEVIČ, Vesana** - DJURDJIČ, Sladjana - OGNJANOVIČ, Miloš - SAMPHAO, Anchalee - FABIÁN, Martin - KALCHER, Kurt - STANKOVIČ, Dalibor M.*. Enzymatic glucose biosensor based on manganese dioxide nanoparticles decorated on graphene nanoribbons. In <i>Journal of Electroanalytical Chemistry</i> , 2018, vol. 823, p. 610-616. (2017: 3.235 - IF, Q1 - JCR, 0.765 - SJR, Q1 - SJR, karentované - CCC). (2018 - Current Contents). ISSN 0022-0728. https://doi.org/10.1016/j.jelechem.2018.07.013
10	34	GALLIOS, G.P. - TOLKOU, Athanasia K. - KATSOYIANNIS, Ioannis A. - ŠTEFUŠOVÁ, Katarína - VÁCLAVÍKOVÁ, Miroslava - DELIYANNI, Eleni A. Adsorption of Arsenate by Nano Scaled Activated Carbon Modified by Iron and Manganese Oxides. In <i>Sustainability</i> , 2017, vol. 9, no. 10, p. 1684. (2016: 1.789 - IF, Q2 - JCR, 0.548 - SJR, Q2 - SJR, karentované - CCC). (2017 - Current Contents). ISSN 2071-1050. https://doi.org/10.3390/su9101684

2.2.5. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015–2020). The cited papers must bear the address of the institute

Author name	Cited
Baláž Peter	2052
Baláž Matej	1009
Dutková Erika	876

Note: other frequently cited authors: Šepelák 871, Achimovičová 709, Václavíková 486, Danková 448, Hredzák 372, Fabián 338, Tkáčová 167.

2.2.6. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute

Author name	Cited
Baláž Peter	3650
Šepelák Vladimír	1999
Dutková Erika	1244

Note: other frequently cited authors: Achimovičová 1079, Baláž M 1052, Václavíková 789, Hredzák 691, Tkáčová 598, Danková 584, Fabián 456.

2.2.7. List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute

Author name	Cited
Baláž Matej	494
Václavíková Miroslava	338
Baláž Peter	311

Note: other frequently cited authors: Dutková 307, Danková 273, Dolinská 121, Zubrik 121, Hredzák 117, Achimovičová 111, Melnyk 62.

2.3. Research status of the institute in international and national context

- International/European position of the institute**

2.3.1. List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on

IGTSAS has cooperated with number of universities, scientific institutes and companies abroad. Cooperation usually runs in multi-lateral and bilateral projects, in joint organizing of scientific conferences, joint preparation and processing of mineral and material samples, in analyses and determination of samples properties, joint experiments and publications. The research activities of the IGTSAS were implemented via research projects, out of which 10 crucial ones are listed below:

Key international projects of IGTSAS
<p>Water and Soil Clean-up from Mixed Contaminants (10/2013 – 09/2017) Project FP7-PEOPLE-2013-IAPP-WaSClean-612250 coordinated by IGTSAS Partners: United Kingdom, Greece, Kazakhstan Responsible person in the organisation: Consortium coordinator / Ing. M. Václavíková, PhD.</p> <p>WaSClean project aimed to develop novel materials and technologies for remediation of contaminated soils, wastewater and groundwater from xenobiotics (man-made) contaminants, via a Marie Curie Industry-Academia Partnership&Pathways programme of knowledge exchange and scientific work actions between 8 partner organisations (6 from three EU countries and 2 from an ICPC country). The project was coordinated by IGTSAS. Chemical and biological approaches were combined to develop novel technologies for removal of toxic metals/metalloids and recalcitrant organic contaminants from contaminated soil and groundwater. A range of methods, based on iron chemistry and biogeochemistry, bioremediation and electrochemical oxidation were employed at laboratory and pilot/field scale, to produce integrated clean-up solutions for problem contaminated sites and contaminants. The project brought together an multidisciplinary consortium of specialists from different areas of contaminated land</p>

management, environmental (geo)chemistry, nanotechnology, (geo)microbiology and physical, analytical, synthetic, polymer and surface chemistry, working with a common aim of developing new and efficient methods of contaminant removal from soil and groundwater. Total 86 secondments within the project consortium were delivered, with IGTSAS serving both as hosting (for 8 secondments) and sending (25) institution. Patent application for Integrated technology of water clean-up from mixed contaminants started in November 2021 (See Chapters 2.1.7 and 2.6.1 for further information).

Bifunctional Silica and Magnetite Spherical Particles with Tailored Porosity and Surface Chemistry for Complex Water Treatment

(03/2016 – 12/2018)

Project SASPRO 1298/03/01

Responsible person in the organisation: C/ Ing. Miroslava Václavíková, PhD.,

SASPRO Fellow: Dr. Inna Melnyk

The purpose of the SASPRO project was to develop bi(or multi)functional silica and magnetically removable adsorbents for water purification and remediation securing the removal of chemical pollutants in both organic and inorganic nature. SASPRO has united the efforts of the scientists and their expertise in two adjacent fields - synthesis and functionalization of mesoporous silica and silica-based adsorbents from Ukraine and advanced experience in physicochemical characterization of surface binding with valuable experience of their implementation in water purification from the Slovak side. This international cooperation also attracted new PhD students from Ukraine to IGTSAS and induced further international project proposals.

Nanoporous and Nanostructured Materials for Medical Applications

(01/2017 – 06/2022)

Project H2020-MSCA-RISE-2016- NanoMed-734641

Partners: Spain, France, United Kingdom, Moldova, Greece, Hungary, Portugal, Kazakhstan, Ukraine

Responsible person in the organisation: W / Ing. Miroslava Václavíková, PhD.

This project aims to stimulate intersectoral and international collaboration within Europe and with an ICPC country, Kazakhstan, in the area of novel nanoporous and nanostructured adsorbents for the treatment of very serious health conditions associated with acute and chronic exposure to external radiation and uptake of heavy metals and radiation as a consequence of accidental, occupational or deliberate activities and events. This can dramatically lower the quality of life of the people affected and at present the treatment available is costly and inefficient. Radioactive contamination is a particularly serious problem in two of the countries participating in this project on large territories of the Chernobyl zone (UA) and around Semipalatinsk nuclear test site (KZ), respectively. The expected impact of the project is development of efficient and cost-effective methods of protection of first responders, population and cancer patients treated with radiotherapy from elevated doses of external and incorporated radiation and for occupational health protection of personnel working and the population living in areas contaminated with heavy metals.

Technical Advances to Detect and Remove Contaminants from Water for Safety and Security

(11/2012 – 04/2016)

Project NATO Science for Peace and Security Programme 984403

Partners: USA, Armenia, Moldova, Greece

Responsible person in the organisation: W / Ing. Miroslava Václavíková, PhD.

The project was focused to use advanced (nano) technology to detect and mitigate inadvertent and intentional (CBRN) water source contamination, develop a stand-alone prototype to supply clean water, and develop a GPS/GIS based Contamination Identification and Level Monitoring Electronic Display Systems (CILM-EDS) prototype to spatially monitor contaminants and water levels, in event of natural catastrophe. Objectives of the research and project were aligned with NATO priorities. The research was focused three areas: 1. Sensing and detection of metals, pathogenic agents, organic compounds, pharmaceuticals, pesticide run-off, and compounds with large shelf-life in water; 2. Contamination remediation strategies of metal, inorganic and organic contaminants, TIC, TIMs, and compounds with long shelf life and pharmaceuticals; 3. GIS/GPS

based contamination identification and level monitoring electronic display systems (CILM-EDS) prototype to spatially monitor contaminants and water levels.

Structure-Function Relationship of Advanced Nanooxides for Energy Storage Devices

(10/2015 – 09/2018)

Project V4-Japan Joint Research Program on Advanced Materials - AdOX

Partners: Czech Republic, Japan, Poland

Responsible person in the organization: W / prof. RNDr. V. Šepelák, DrSc.

The main objective of the project was focused on the development of novel and sophisticated chemical routes towards energy harvesting materials within multidisciplinary oriented approach in the field of solid state chemistry. Basic concept included (i) to obtain well-defined complex oxide materials by starting from well-designed precursors, (ii) utilization of phenomena at the solid interfaces, particularly those between inorganic – organic solids, (iii) utilization of unique features of non-conventional processes, i.e. mechanical activation and microwave technology, and (iv) characterization of the products under well-defined and reproducible conditions, without restriction to the properties of the end use, e.g. the capacity fade of the complete Li-ion and Na-ion batteries.

Industrial synthesis of metal sulphides via mechanochemical activation in vibration mills

(11/2015 – 10/2017)

Project BMBF INHEMES FKZ 01DS15022

Partners: Germany

Responsible person in the organization: W / prof. RNDr. Peter Baláž, DrSc.

The aim of the project INHEMES was to produce copper sulphides by means of a simple and one-step process through the solid-state reactions between metal and sulfur in an eccentric vibratory mill. Based on cooperation between the German and Slovak partners, the fundamentals of the kinetics of copper sulphide mechanochemical synthesis have been studied on the micro-scale and verified in the industrial mill.

Development of in-situ bioleaching method to clean quartz sands and application through testing prototype pilot plant

(01/2014 – 12/2017)

Project PROJEKTO CORFO I + D Cod. 13IDL2 – 23505

Partners: Cristalerias de Chile S.A.

Responsible person in the organization: C / Ing. Iveta Štyriaková, PhD.

Collaborative project of applied research for development of innovation technologies was funded by the Chilean Economic Development Agency CORFO between the IGTSAS and company Cristalerias de Chile S.A. The cooperation has been induced on demand of Chilean side as the result of responses to the previous publications of the Department of Mineral Biotechnologies IGTSAS. Cristalerias de Chile SA is a company engaged in the production of glass containers and uses raw silica sand, which does not fulfil the purity necessary for creating quality glass. The company asked IGTSAS for a cooperation in development of a pilot plant technology for biotransformation of silicate minerals by heterotrophic bacteria serving for development of bioleaching for purification of quartz sands in Chile. The extent of iron coatings removal from Chile's quartz sands depended on way and conditions of bioleaching. The heap bioleaching with the recycling of leachates provided the development of new economic technology suitable for the quality improvement of quartz sand. A pre-patent application was registered in the system for the management of intellectual property SAS (KTT SAV) with notification of the creation of an industrial property (See Chapter 2.1.7 for further information).

Solutions for Critical Raw Materials Under Extreme Conditions – CRM-EXTREME

(03/2016 – 03/2020)

Project COST CA15102

Partners: AT, BE, BG, CR, CZ, DK, EE, FI, FR, DE, GR, IE, IL, IT, LV, LU, NL, MK, NO, PL, PT, RO, RS, SK, SI, ES, SW, CH, TR, UK

Responsible person in the organization: W / prof. RNDr. Peter Baláž, DrSc.

The efficient scientific cooperation between the partners is witnessed by the number of resulting publication outputs (47 joint papers, plus the FAD-Final Action Dissemination), by the number of induced submitted European project applications and the high success rate (7 funded projects

from 15 proposals). Attention to the industry's needs and involvement of industrial stakeholders was continuously promoted through participation in industrially oriented meetings (Burgos, Milan, Brussels, Athens).

Mechanochemistry for Sustainable Industry

(05/2019 – 04/2023)

Project COST CA18112

Partners: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Greece,, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom

Responsible person in the organization: W / RNDr. Matej Baláž, PhD.

This COST Action aims at establishing a multi-disciplinary network of European scientists, engineers, technologists, entrepreneurs, industrialists and investors addressing the exploitation of mechanical activation in the production of chemicals through sustainable and economically convenient practices on the medium and large scales. Specifically, this Action addresses the objective of harmonizing fundamental and applied research with technological innovation and industrial needs, representing the necessary step for enhancing the impact of mechanical processing onto organic synthesis and transferring specific knowledge into the industrial value chains. The project has hosted a set of management committee meetings, organized more training schools and many short-term scientific missions took place. The project is still ongoing.

BioLeach: Innovative Bio-treatment of Raw Materials

(07/2020 – 03/2022)

Project EIT RIS Raw Materials KIC (Knowledge and Innovation Community) project No.18259 under Horizon Europe partnership

Cooperating partners: Hungary, Spain, Germany, Poland, Ireland, Portugal, Italy

IGTSAS is a RIS Task Partner of The Faculty of Mining, Ecology, Process Control and Geotechnologies of the Technical University of Košice (TUKE as KIC Centre Hub), Slovakia.

Responsible person in the organisation: W / Dr. Daniel Kupka

High economic investments into the import of raw materials significant for further industrial utilization increase the importance of local sources. However, their lower quality and lack of technologies improving their industrial value prefer serious financial investments into the import of higher quality materials. These materials include metallic raw materials (mRMs), extremely important sources of CRM, REE and metals, but also non-metallic raw materials (nRMs) widely used in several industrial sections such as paper, ceramic, glass, chemical industry and agriculture. Currently used technologies are expensive and environmentally not acceptable, so low cost and ecological method of bioleaching are suggested. Bioleaching is an alternative way of improving deposits via the activity of bacteria, which induce changes of chemical and structural features of rocks and minerals. The challenge of the project is to configure and improve this effective, economical and innovative method for specific local sources. The second aim is related to greater utilisation of local sources. Effective bacteria can be used industrially for treatment of mRMs to extract CRM, REE and metals, but also for treatment of nRMs, whose commercial value is decreased by impurities limiting the area of their application. Therefore the further aim of this project is to test and evaluate local minerals as new potential sources, whose increased industrial value was obtained by bioleaching. IGTSAS acts as a major RIS Task Partner of Coordinator TU Košice.

2.3.2. List of international conferences (co)organised by the institute

Institute of Geotechnics SAS organized 17 international conferences (5 conferences as main organizer, 12 as co-organizer) in the Assessment Period:

Nr.	International conference/workshop/symposium
1	MECC 2016: 8 th Mid-European Clay Conference 04.-08.07.2016, Košice, Slovakia, 174 participants
2	Geotechnics 2016: 15th International Conference on Progress, Methods and Traditions in Geotechnics, Vysoké Tatry, Slovakia, 21.-23.09.2016, 115 participants
3	3 rd Workshop on Water and Soil Clean-up from Mixed Contaminants Košice, Slovakia 21.-23.09.2016, 43 participants
4	Present and Future of the Mining and Geology, 26 th International conference Demänovská dolina, Slovakia, 06.-07.10.2016, 52 participants
5	4 th International Scientific Conference on Biotechnology and Metals Košice, Slovakia, 10.-11.11.2016, 72 participants
6	12 th International Conference on Preparation of Ceramic Materials Košice-Jahodná, 13.-15.06.2017, 62 participants
7	INESS 2017 and 4 th Workshop on Water and Soil Clean-Up from Mixed Contaminants Nazarbayev University, Astana, Kazakhstan, 09.-11.08.2017, 127 participants
8	INCOME 2017 – 9 th Intl. Conference on Mechanochemistry and Mechanical Alloying Košice, Slovakia, 03.-07.09.2017, 150 participants
9	Present and Future of the Mining and Geology 2017 Demänovská Dolina, Slovakia, 05.-06.10.2017, 56 participants
10	20 th International conference on Waste Recycling Košice, Slovakia, 07.12.2017, 39 participants
11	Present and Future of the Mining and Geology 2018 Demänovská Dolina, Slovakia, 04.-05.10.2018, 65 participants
12	5 th International scientific conference on Biotechnology and Metals Košice, Slovakia, 11.-12.10.2018, 56 participants
13	21 st International conference on Waste Recycling University of Miskolc, Hungary, 22.-23.11.2018, 70 participants
14	12 th International Conference on Preparation of Ceramic Materials Košice-Jahodná, Slovakia, 25.-27.06.2019, 65 participants
15	Present and Future of the Mining and Geology 2019 - 30 th International conference Demänovská Dolina, Slovakia, 03.-04.10.2019, 55 participants
16	Surface Chemistry of Hybrid Materials, Molecules 2021 Webinar 24.09.2021, 17 participants
17	Present and Future of the Mining and Geology 2021 – 31 st International conference Demänovská Dolina, Slovakia, 03.-04.10.2021, 43 participants

2.3.3. List of edited proceedings from international scientific conferences

2016
<i>Biotechnology & Metals 2016 : e-Proceedings of the 4th International Scientific Conference, Košice, November 10-11, 2016, Košice, Slovensko</i> [elektronický zdroj]. Eds. Jana Jenčárová, Alena Luptáková, Jana Kaduková, ; rec. Luptáková, A., Kaduková, J., Jenčárová, J., Mačingová, E., Rudzanová, D., Šestinová, O.,. Košice : Slovak Mining Society at the Institute of Geotechnics SAS & Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016. 153p. ISBN 978-80-89883-01-1
<i>Biotechnology & Metals 2016 : Book of abstracts of the 4th International Scientific Conference, Košice, November 10-11, 2016.</i> Eds. Jana Jenčárová, Alena Luptáková, Jana Kaduková ; rec. Luptáková, A., Kaduková, J., Jenčárová, J., Mačingová, E., Rudzanová, D., Šestinová, O.,.

Košice : Slovak Mining Society at the Institute of Geotechnics SAS & Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016. 102p. ISBN 978-80-89883-02-8
2017
<i>Waste Recycling 20 : Proceedings of 20th International Conference on Waste Recycling</i> , December 7, 2017, Kosice, Slovakia. Eds. Behunová, D., Ivaničová, L., ; rec. Bálintová, M., Hredzák, S., Čablik, V.
2018
<i>Biotechnology & Metals 2018 : e-Proceedings of the 5th International Scientific Conference, Košice, Oktober 10-11, 2018 Košice, Slovensko</i> . Eds.: Kisková, J., Sedláková-Kaduková, J., Luptáková, A., ; rec.: Sedláková, J., Pristaš, P., Kisková, J., Maliničová, L., Luptáková, A., Košice : Faculty of Science, Pavol Jozef Šafárik University in Košice, Institute of Geotechnics of Slovak Academy of Sciences, Slovak Mining Society at the Institute of Geotechnics SAS, 2018. 128 s. ISBN 978-80-89883-07-3
<i>Biotechnology & Metals 2018 : Book of Abstracts the 5th International Scientific Conference, Košice, Oktober 10-11, 2018 Košice</i> ,. Eds.: Kiskova, J., Sedláková-Kaduková, J., Luptáková, A.,; rec.: Sedláková, J., Pristáš, P., Kisková, J., Maliničová, L., Luptáková, A.,. Košice : Faculty of Science, Pavol Jozef Šafárik University in Košice, Institute of Geotechnics of Slovak Academy of Sciences, Slovak Mining Society at the Institute of Geotechnics SAS, 2018. 106 p. ISBN 978-80-89883-06-6

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

<p>Inna V. Melnyk, PhD Open Acces journal: <i>Molecules</i> Publisher: MDPI, Basel, Switzerland Guest editor of Special Issue (2020-2022): Surface Chemistry of Hybrid Materials High Visibility: indexed by the Science Citation Index Expanded (Web of Science), Scopus, Chemical Abstracts, Inspec and Polymer Library. Citations available in PubMed, full-text archived in PubMed Central. CiteScore (2020 Scopus data): 4.7, which equals rank 9/33 (Q2) in 'Chemistry (miscellaneous)' and rank 51/166 (Q2) in 'Pharmaceutical Science'.</p>
<p>RNDr. Marcela Achimovičová, PhD. Open Acces journal: <i>Nanomaterials</i> Publisher: MDPI, Basel, Switzerland Guest editor of Special Issue (2020-2021): Mechanochemistry and Nanotechnology High Visibility: indexed by the Science Citation Index Expanded (Web of Science), Scopus, Chemical Abstracts, Inspec and Polymer Library. Citations available in PubMed, full-text archived in PubMed Central. CiteScore (2018 Scopus data): 4.21, which equals rank 66/439 (Q1) in 'General Materials Science' and rank 29/272 (Q1) in 'General Chemical Engineering'.</p>
<p>RNDr. Matej Baláž, PhD. Open Acces journal: <i>Molecules</i> Publisher: MDPI, Basel, Switzerland Guest editor of Special Issue (2018-2019): Recent Development of Mechanochemical Synthesis High Visibility: indexed by the Science Citation Index Expanded (Web of Science), Scopus, Chemical Abstracts, Inspec and Polymer Library. Citations available in PubMed, full-text archived in PubMed Central. CiteScore (2018 Scopus data): 3.28, which equals rank 4/25 (Q1) in 'Chemistry (miscellaneous)' and rank 26/174 (Q1) in 'Pharmaceutical Science'.</p>

- **National position of the institute**

IGTSAS has a dominant position in Slovakia within the basic and applied research in the area of rock cutting, mineral processing, mechanochemistry, mineral biotechnologies and environmental protection. The institute cooperates with Slovak universities via joint projects and laboratories, providing PhD education and teaching university courses. IGTSAS has been asked for joint industrial research and expertise services on regular base. Research infrastructure acquired in the previous accreditation period (2012-15) helped the institute to increase its publishing activities and boost the national cooperation with universities, institutes and industrial partners due to new laboratories and equipment purchased during the implementation of the projects. Nevertheless, the main support for direct research costs was covered by 6 national projects of Slovak Research and Development Agency APVV.

2.3.5. List of selected activities of national importance

<p>Decontamination of environmental load Bratislava - Vrakuňa, CHZJD Landfill Project of Office of Bratislava Self-Governing Region, IGTSAS & Faculty of Natural Sciences, Comenius University (2017) Responsible person in the organisation: Coordinator / MVDr. Daniel Kupka, PhD Chemical waste landfill in Bratislava, Vrakuňa district, represents an area polluted by toxic organic waste from the former chemical plant CHZJD producing the explosives, herbicides, pesticides, insecticides and rubber chemicals. The subject of the project was laboratory research and verification of the possibilities of remediation of the environmental burden of Vrakuňa. Attention was focused mainly on the elimination of organic pollution through biological and physico-chemical degradation processes. Accompanying contaminants of inorganic nature such as heavy metals and semi-metals (e.g. arsenic, lead, copper, chromium, cadmium) are also taken into account. The outputs: 1. Analysis of the pollution itself according to the parameters required in the standard, examination of the effects affecting the accuracy of the analysis and comparison with analyzes performed so far at other workplaces. 2. Comprehensive identification of unknown chemical substances found in groundwater under the landfill and evaluation of their possible impact on human health. 3. Laboratory tests of contaminated water treatment and proposal of further steps for groundwater decontamination methods under the landfill and the surrounding area.</p>
<p>Remediation of the environmental load Bratislava Vrakuňa, CHZJD landfill Project of Ministry of Environment: Remediation SK/EZ/B2/136 (2020-2021) Partner organisations: GEO-test, a.s. Brno, CZ; ProMinent Slovensko s.r.o., Bratislava; Environcentrum s.r.o., Košice. Pilot project for verification of groundwater remediation technology in the area encapsulated by an underground barrier. The waste-free technology for the remediation of groundwater under the chemical landfill body was successfully tested. Contaminated groundwater was pumped from the IG-624V hydrogeological well (former Darex company site) was treated in three steps: 1. Water pretreatment and softening by the degassing method. 2. Pressure membrane filtration. 3. Electrolysis. The three-stage water treatment reduced the contamination to the level of the target values for groundwater, which were set in the risk analysis for the given contaminated site. The cleaning technology was implemented using advanced physical processes without the use of any chemical additives. Pilot testing was covered by resources of Environcentrum, s.r.o., GEOTEST, a.s. and IGTSAS). The remediation project was stopped by Ministry of Environment.</p>
<p>Complex research on wastewater treatment at U.S.Steel Košice Joint project with U.S.Steel Košice, (2018-2022) MVDr. Daniel Kupka, PhD. U.S.Steel Košice, steel producing factory asked IGTSAS for cooperation in improvement of their water treatment processes. Three main areas were investigated: design and testing of surfactants removal from wastewaters, water softening, and removal of adsorbable organic halogens from wastewaters. The joint research delivered significant direct impacts on surface water quality and cost-efficiency of production processes.</p>

Mechanochemistry of Semiconductor Nanocrystals: from Minerals to Materials and Drugs

Project APVV-14-0103, (07/2015 – 06/2019)

prof. RNDr. Peter Baláž, DrSc.

The project was focused on the elaboration of the specific mechanochemical routes to synthesize the advanced materials with a high level of utilization in nanotechnology. Methods of mechanochemistry have been applied where procedures of synthesis, reduction, mechanical activation and nanomilling were used. These procedures were used for the preparation of various advanced materials in materials engineering, extractive metallurgy and medicine.

Development of a System for Continuous Monitoring of Pollution Impact on the High-Voltage Insulation

Project APVV-15-0438, (07/2016 – 06/2020)

RNDr. Martin Fabián, PhD.

The dynamics of air pollution are affected by ongoing climate change and industrial fumes. One of the problems facing distribution companies and the transmission system is the environmental pollution of electrical insulation, which is a potential danger to the trouble-free operation of the electricity system. External pollution modifies the electrical breakdown strength of this insulation. The project was focused on the development of modern equipment, enabling real-time monitoring of insulator surface pollution both in autonomous mode and as part of the existing network IT infrastructure.

Chalcogenides as emerging eco-friendly and low-cost nanomaterials for energy- and medicine- related sectors

Project APVV-18-0357, (07/2019 – 06/2023)

Dr.h. c. prof. RNDr. Peter Baláž, DrSc.

The project is aimed at the synthesis, characterization and utilization of advanced chalcogenide materials for application in the energy and medicine sector. Binary, ternary and quaternary compounds of copper with a variable composition are treated. Efficiency for thermoelectric materials is tested. Bio-imaging, as well as antibacterial activities, are currently studied. Mechanochemical methodology with the ability for scaling synthesis of materials is applied.

Relationships between structure and unusual physical properties in highly nonequilibrium oxides prepared by unconventional mechanochemical synthesis

Project APVV-19-0526, (07/2020 – 06/2024)

RNDr. Martin Fabián, PhD.

Nonconventional mechanochemical methods are used to prepare the far-from-equilibrium novel nanooxides. The studies of the early stages of the mechanically induced nucleation and growth of nonequilibrium phases provide access to the elucidation of the microscopic mechanism of the nonconventional mechanochemical preparation route. This point represents one of the fundamental but till now the unsolved scientific issues in the field of mechanochemistry/solid state chemistry. Mechanical, magnetic and electric responses of the far-from-equilibrium nanophases are studied experimentally with the aim to establish the interplay between their local structure and the functional behavior.

Hybrid Composites for Complex Treatment of Industrial Waters

Project APVV-19-0302, (07/2020 – 06/2024)

Dr. Inna Melnyk, PhD.

The core subject of the project proposal lays in the research priorities defined by Strategy of research and innovations for the intelligent specialization of Slovak republic – RIS 3 as well as Strategy Europe 2020. The main objective of the project is the preparation of composite micro and nano adsorbents bases on silica and metal oxides for the removal of inorganic and organic pollutants from waters.

Possibilities of critical raw materials recovery by advanced methods of mining wastes processing

Project APVV-20-0140, (07/2021 – 06/2025)

Ing. Alena Luptáková, PhD.

Interdisciplinary project focused on research and development of progressive methods for waste treatment from the mining and processing industry of ore raw materials in order to obtain critical raw materials with regard to environmental protection. Solution concept results from the intensification of natural processes combined with advanced physico-chemical and especially biological-chemical processes.

Microwave energy application for intensification of extraction and pyrolytic processes of coal and wastes

Project VEGA 2/0114/13, (01/2013 – 12/2016) with excellent final ranking

RNDr. Silvia Dolinská, PhD.

The project was focused on the application of microwave energy for the intensification of processes of extraction and pyrolysis of coal and wastes. The presence of fatty acids (palmitic, linoleic, oleic, stearic, eicosanoic, docosanoic, and tetracosanoic), stigmaterol and triglycerides was determined by application of microwave energy at extraction of rape residue. Also, the project objective deal with the preparation of magnetic carbon materials based on the biomass wastes. The new as-prepared carbon materials, so called biochars are very good adsorbents for remediation of industrially polluted environment, for example for adsorption of inorganic and organic pollutants.

Mechanosynthesis of lithium nanosilicates with attractive electrochemical and magnetic properties

Project VEGA 2/0064/14 (01/2014 – 12/2016) with excellent final ranking

RNDr. Erika Tóthová, PhD.

Microcrystalline $\text{LiFeSi}_2\text{O}_6$ pyroxene and nanoglassy $\text{LiFeSi}_2\text{O}_6/\text{Li}_2\text{FeSi}_2\text{O}_6$ composite were prepared by combined mechanochemical/thermal processing and one-step mechanosynthesis, respectively, starting from $\text{Fe}_2\text{O}_3+\text{Li}_2\text{SiO}_3+2\text{SiO}_2$ mixture. The solely thermal treatment of the non-activated educts mixture does not result in the formation of pyroxene. These materials have the potential for use in LiBs and as multiferroic materials.

Bacterial transformation of sulphur compounds in processes of materials synthesis and degradation

Project VEGA 2/0145/15, (01/2015 – 12/2018) with excellent final ranking

Ing. Alena Luptáková, PhD.

The project was focused on the study of bio-oxidative and bio-reductive properties of selected species of sulphur bacteria in removing of inorganic and organic pollutants from contaminated industrial waste waters and at in the origin, course and inhibition of the corrosive effects of natural and synthetic materials with special emphasis on building materials.

Identification of specific drilling energy based on vibration signal

Project VEGA 2/0080/16, (01/2016 – 12/2019) with excellent final ranking

Ing. Edita Lazarová, PhD.

The research was focused on the investigation of vibration signals generated during rock drilling and the possibility of their use for efficient drilling process control. The observed correlation between the specific energy and the behaviour of the reciprocal average effective values of vibration acceleration in the drilling axis direction and the revolutions creates a precondition for the use of the vibration signal for optimising the control of this technological process in terms of the maximum service life of a drilling tool, i.e., the minimum wear intensity.

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

n/a

- Position of individual researchers in the international context**

2.3.7. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

Nr.	Invited/keynote presentation at international conference
1	BALÁŽ, P.: Materials Science & Technology 2016: Symposium „Mechanochemical Synthesis and Reactions in Materials Science“, Salt Lake City, USA
2	MELNYK, I.: Plenary lecture - Fourth International Conference of CIS Countries „Sol-gel 2016“, September 19-23, 2016, Yerevan, Armenia
3	ŠEPELÁK, V.: Materials Science & Technology 2016: Symposium „Mechanochemical Reactions and synthesis of oxides“, Salt Lake City, USA
4	ŠEPELÁK, V.: Solid State Chemistry Conference: „Mechanically induced chemistry of oxides: present state“, Prague, Czech Republic
5	ŠEPELÁK, V.: 2nd Mediterranean Conference on the Application of the Mössbauer Effect: „Structural disorder phenomena in nanostructured oxides“, Cavtat, Croatia
6	Baláž, M.: Ball milling of eggshell waste: A review, Materials Science & Technology 17, Pittsburgh, USA, October 8-12, 2017
7	Baláž, P.: Mechanochemistry of Solids: From Minerals to Nanomaterials and Drugs, XVII Balkan Mineral processing Congress, Antalya, Turkey, November 1-3, 2017
8	Hredzák, S.: Composition of low-grade nickel ore leaching residuum in Slovakia, XII International symposium on Recycling Technologies and Sustainable Development, September 13-15, 2017, Hotel Jezero, Bor Lake, Serbia
9	Hredzák, S.: Topical research trends in the Institute of Geotechnic SAS in Košice - Aktuálne trendy výskumu na Ústave geotechniky SAV v Košice. The Present and Future of the Mining and Geology October 5-6 2017, Hotel Repiská, Demänovská Dolina, Slovakia.
10	Labaš, M.: Some results of rock disintegration on the laboratory drilling stand - Vybrané výsledky rozpojovania hornín na laboratórnom vrtnom stende. The Present and Future of the Mining and Geology October 5-6 2017, Hotel Repiská, Demänovská Dolina, Slovakia.
11	Melnyk, I.: Membrane composites based on inorganic substrates and functionalized polysiloxanes as potential water treatment agents. Nanomaterials and Application, Bled, Slovenia, June 14-18, 2017.
12	Hredzák, S. Study on upgrading of flotation sand from the Markušovce settling pit. International Conference Present and Future of Mining and Geology, Oct 4-5, 2018, Demänovská Dolina
13	Labaš, M. Induced vibration signals in volume disintegration of rocks. International Conference Present and Future of Mining and Geology, Oct 4-5, 2018, Demänovská Dolina
14	Šepelák, V.: Magnetic Behavior of Nanostructured Oxides Prepared by Mechanochemical Synthesis, Materials Science & Technology 17, Pittsburgh, USA, October 8-12, 2017
15	Kupka, D. "Bacterial Oxidation of Ferrous Iron - From Natural Weathering Processes to Industrial Biomining", October 11–12, 2018, 5th International Conference Biotechnology & Metals 2018, Košice, Slovakia.

16	Melnyk, I. "Target silica spheres for water purification. International Conference on Nanomaterials and Nanotechnology", October 29–30, 2018, London, UK.
17	Šepelák, V. "Mechanochemical Reactions of Oxides Followed by Multi-Nuclear Magnetic Resonance Spectroscopy", Materials Science & Technology 2018, October 14–18, 2018, Columbus, USA.
18	Baláž, P.: Energy-related materials: Mechanochemical synthesis via industrial milling, European Symposium for Comminution and Classification, Leeds, Great Britain, 2-4 September 2019.
19	Melnyk, I. One-pot synthesis of advanced aminosilicas for environmental remediation. 4th International Conference NANOAPP 2019 – Nanomaterials and Applications, June 3-6, 2019, Ljubljana, Slovenia.
20	Melnyk, I. Sol-gel technique to design hybrid materials and their application in water purification. Nanoscience and Nanotechnology in Security and Protection Against CBRN Threats, September 12-20, 2019, Sozopol, Bulgaria
21	Baláž, M. Mechanochemistry: Multidisciplinary Tool Applicable in Different Sectors of Science and Technology, SCHOLA 2021 Factory of Engineering Pedagogy. December 7, 2021, (online)
22	Fabián, M. Mechanothesized Complex Oxides. Local Structure and Functional Properties, Keynote lecture, VIII-th Crystallographic Symposium (NCS-2021), 1.9.-4.9. 2021, Varna, Bulgaria
<i>Note: List of invited lectures at foreign institutions, additional information</i>	
1	Baláž, M.: Mechanochemistry: Green and effective tool for the synthesis of materials and broadening of their application potential. Department for nanostructured materials, K7, Jožef Štefan Institute, Ljubljana, Slovenia, 13.10.2016
2	Baláž, P.: Hallmarks of mechanochemistry: on extra-ordinary job for very small particles. Scientific Research Company Electron-Carat, Lviv, Ukraine, 1.3.2016
3	Baláž, P.: Mechanochemistry of inorganic compounds: New prospects for materials science. Solvay Research Centre, Paris, France, 2.5.2016
4	Luptáková, A.: History of Mining, Metallurgy and Biohydrometallurgy in Slovakia, Institute of Environmental Geology and Geoengineering of the Italian National Research Council (IGAG-CNR), Roma, Italy, 22. 09. 2016
5	Vereš, J.: Microwave Technology. Key Laboratory of Resource Clean Conversion in Ethnic Regions, Yunnan Minzu University 18.10.2016, Kunming, China
6	Vereš, J.: Microwave Technology in Metallurgical Waste Treatment. Key Laboratory of Unconventional Metallurgy, Kunming University of Science and Technology, 19.10.2016, Kunming, China
7	Mačingová E.: Study of Manganese Removal in the Process of Mine Water Remediation. Institute of Environmental Geology and Geoengineering of the Italian National Research Council (IGAG-CNR),, Rome, Italy, 26.9.2017.
8	Rudzanová D.: Industrial Waste Waters Treatment by Sulphate-reducing bacteria. Institute of Environmental Geology and Geoengineering of the Italian National Research Council (IGAG-CNR), Rome, Italy, 26.9.2017.
9	Baláž, M.: Mechanochemistry: Environmentally friendly approach for the synthesis of materials and broadening of their application potential. Department of General and Inorganic Chemistry, Al-Farabi Kazakh National University, Almaty, Kazakhstan, June 12, 2018.
10	Lukáčová Bujňáková, Z.: Mechanochemistry, an effective technique for preparation of advanced materials. Institute Jožef Stefan, Ljubljana, Slovenia, May 5, 2018
11	Luptáková, A.: Department of Mineral Biotechnology of Institute of Geotechnics Slovak Academy of Sciences – research and experiences. Institute of Environmental Geology and Geoengineering of the Italian National Research Council (IGAG-CNR),, Roma, Italy, 24. 09. 2019.

2.3.8. List of researchers who served as members of the organising and/or programme committees

2016			
Researcher	Conference Title	Member of committee	
		org.	prog. or scien.
Hredzák Slavomír	15 th International conference – Geotechnics 2016 - Advanced methods and traditions in geotechnics, Horný Smokovec, High Tatras, Slovakia, 21.-22.09.2016	-	yes
Krúpa Vítazoslav		-	yes
Hredzák Slavomír	20 th International Conference on Environment and Mineral Processing and Workshop “Critical Raw Materials and their recycling for circular economy of the EU”, Ostrava-Poruba, Czech republic, 2.-4.06.2016	-	yes
Hredzák Slavomír	48 th International October Conference on Mining and Metallurgy, Hotel Albo, Bor, Serbia, 28.09.-1.10.2016	-	yes
Hredzák Slavomír	International Conference “The Present and Future of the Mining and Geology”, 2016, Hotel Repiská - Demänovská dolina, Slovakia, 6.-7.10.2016	-	yes
Hredzák Slavomír	XI International Symposium on Recycling Technologies and Sustainable Development - RT&SD 2016, Hotel “ALBO”, Bor, Serbia, 2.-4.11.2016	-	yes
Hredzák Slavomír	XXIV International Conference “Ecological Truth” Eco-Ist’16, Hotel “Breza” Vrnjacka Banja, Serbia, 12.-15.06.2016	-	yes
Bendek František	3 rd Workshop on Water & Soil Clean-up from Mixed Contaminants, Košice, Slovakia, 22.-23.09.2016	yes	-
Ivaničová Lucia		yes	yes
Hredzák Slavomír			yes
Jáger Dávid		yes	-
Kupka Daniel		yes	yes
Marcin Behúnová Dominika			-
Stuchlá Katarína		yes	yes
Tomčová Jana		yes	-
Václavíková Miroslava		yes	yes
Žáková Janette		yes	-
Hredzák Slavomír		4 th International Scientific Conference on Biotechnology and Metals, Košice, Slovakia, 10.-11.11.2016	yes
Jenčárová Jana	yes		-
Kupka Daniel	-		yes
Leľáková Beáta	yes		-
Luptáková Alena	yes		yes
Mačingová Eva	yes		-
Rudzanová Dominika	yes		-
Stuchlá Katarína	yes		-
Šestinová Oľga	yes		-
Krúpa Vítazoslav	2 nd International Conference on Engineering Sciences and Technologies (ESaT 2016), Tatranské Matliare, Slovakia, 29.06.-1.7.2016		-
Štyriaková Iveta	MECC 2016, 8 th Mid-European Clay Conference, Hotel Yasmín, Košice, Slovakia, 29.06.-1.7.2016	yes	-
Bekényiová Alexandra		yes	-
Danková Zuzana		yes	-
Fedorová Erika		yes	-
Štyriaková Darina		yes	-
Šuba Jaroslav		yes	-

2017			
Baláž Matej	9 th International Conference on Mechanochemistry and Mechanical Alloying (INCOME 2017), Košice, Slovakia, September 3-7, 2017	yes	-
Baláž Peter		yes	yes
Bekényiová Alexandra		yes	-
Danková Zuzana		yes	-
Fabián Martin		yes	-
Lukáčová Bujňáková Zdenka		yes	-
Stuchlá Katarína		yes	
Šepelák Vladimír		yes	yes
Tešínský Matej		yes	-
Tóthová Erika		yes	-
Žáková Janette		yes	-
Briančin Jaroslav		Preparation of Ceramic Materials, Jahodná, Slovakia, 13.-15.06.2017	yes
Bodnár Gergő	20 th International Conference on Waste Recycling, Košice, Slovakia, 7.12.2017	yes	-
Dolinská Silvia		yes	-
Hredzák Slavomír		-	yes
Ivaničová Lucia		yes	yes
Jáger Dávid		yes	-
Krúpa Vítazoslav		-	yes
Luptáková Alena		yes	-
Marcin Behúnová Dominika		yes	-
Melyk Inna		yes	-
Rudzanová Dominika		yes	-
Stuchlá Katarína		yes	-
Václavíková Miroslava		yes	yes
Znamenáčková Ingrid	yes	-	
Zubrik Anton	yes	-	
Žáková Janette	yes	-	
Hredzák Slavomír	21 st International Conference on Environment and Mineral Processing and workshop "Critical Raw Materials for the 21st Century", Ostrava-Poruba, Czech republic, 1.-3.06.2017	-	yes
Hredzák Slavomír	49 th International October Conference on Mining and Metallurgy, Hotel Jezero, Bor Lake, Serbia, 18.-21.10.2017	-	yes
Hredzák Slavomír	International Conference "The Present and Future of the Mining and Geology", 2017, Hotel Repiská - Demänovská dolina, Slovakia, 5.-6.10.2017	-	yes
Hredzák Slavomír	XII International Symposium and 6th Student Symposium "Recycling Technologies and Sustainable Development" RT&SD2017, Hotel Jezero, Bor Lake, Serbia, 13.-15.09.2017	-	yes
Hredzák Slavomír	XXV International Conference "Ecological Truth" Eco-Ist'17, Hotel "BREZA" Vrnjicka Banja, Serbia, 12.-15.06.2017	-	yes
Václavíková Miroslava	4 th Workshop on Water and Soil Clean-Up from Mixed Contaminants & INESS 2017 - 5th International Conference on Nanomaterials and Advanced Energy Storage Systems, Astana, Kazakhstan, 9.-11.08.2017	-	yes
2018			
Hredzák Slavomír	22 nd International Conference on Environment and Mineral Processing, Ostrava-Poruba, Czech republic, 31.05.-2.6.2018	yes	yes
Hredzák Slavomír	26 th International Conference Ecological Truth and Environmental Research - EcoTER 2018, Hotel Jezero, Bor Lake, Serbia, 12.-15.06.2018	-	yes

Hredzák Slavomír	50 th International October Conference on Mining and Metallurgy - IOC 2018, Hotel Jezero, Bor Lake, Serbia, 30.09.-3.10.2018	-	yes
Hredzák Slavomír	International Conference "The Present and Future of the Mining and Geology", 2018, Hotel Repiská - Demänovská dolina, Slovakia, 4.-5.10.2018	-	yes
Hredzák Slavomír	21 st International Conference on Waste Recycling 21, Miskolc, Hungary, 22.-23.11.2018	-	yes
Ivaničová Lucia		-	yes
Václavíková Miroslava		yes	yes
Hredzák Slavomír		yes	-
Jenčárová Jana		yes	-
Kupka Daniel		-	yes
Luptáková Alena		yes	yes
Mačingová Eva		yes	-
Marcin Behúnová Dominika		yes	-
Rudzanová Dominika	yes	-	
Stuchlá Katarína	yes	-	
2019			
Hredzák Slavomír	23 rd International Conference on Environment and Mineral Processing and Workshop Waste – Secondary Raw Materials, Ostrava-Poruba, Czech republic, 30.5.-1.06.2019	yes	yes
Hredzák Slavomír	International Conference "The Present and Future of the Mining and Geology", 2019, Hotel Repiská - Demänovská dolina, Slovakia, 3.-4.10.2019	-	yes
Hredzák Slavomír	51 st International October Conference on Mining and Metallurgy, Hotel Jezero, Bor Lake, Serbia, 16.-19.10.2019	yes	yes
Hredzák Slavomír	International Mineral Processing and Recycling Conference, Belgrade, 8.-10.05.2019	yes	yes
2021			
Hredzák Slavomír	XIV International Mineral Processing and Recycling Conference, Belgrade, Serbia, 12.-14.05.2021	-	yes
Hredzák Slavomír	International Conference "The Present and Future of the Mining and Geology", 2021, Hotel Repiská - Demänovská dolina, Slovakia, 7.-8.10.2021	-	yes
Melnyk Inna	Surface Chemistry of Hybrid Materials (online), Košice, Slovakia, 24.09.2021	yes	yes

2.3.9. List of researchers who received an international scientific award

Researcher	Award
Kováčová Mária	Poster Award: Mária Kováčová, Matej Baláž, Erika Dutková, Ľudmila Tkáčiková: Biomechanochemical synthesis of silver nanoparticles using Thymus vulgaris L. plant, 13-16 May, 2019, VSB Technical University of Ostrava, Czech Republic
Šepelák Vladimír	Expert of Alexander von Humboldt Foundation, Awarded by Alexander von Humboldt Foundation
Yankovych Halyna	Poster Award - 2 nd place: H. Yankovych, M. Václavíková "Elimination of p-halogenophenols from Wastewater by Granulated Activated Carbon". NATO ASI on Nanoscience and Nanotechnology in Security and Protection Against CBRN Threats, 12-20 September 2019, Sozopol, Bulgaria
Baláž Peter	Doctor Honoris Causa Awarded by University of Miskolc, Hungary for long-term cooperation in mechanochemistry, 30.6.2017
Tóthová Erika	Poster Award: 19 th International Symposium on the Reactivity of Solids (ISRS-19), (SRS-19), Bayreuth, Germany, July 15-18 2018 for contribution: Vladimír Šepelák, Erika Tóthová, Mamoru Senna, Horst Hahn, Paul Heitjans "Mechanosynthesis of Pyroxene-Based Nanocomposites"

Melnyk Inna	Diploma for the best oral presentation at the Ukrainian conference with international participation "Chemistry, Physics and Technology of Surface", 21-22 October 2020 Kyiv, Ukraine
Melnyk Inna	Poster Award – 3 rd place: 4 th EastWest Chemistry Conference 2021, National Chemistry Conference, 7-9 October 2021, Turkish Chemical Society
Yankovych Halyna	The best oral presentation at XXII International Conference for Students, PhD Students and Young Scientists MODERN CHEMISTRY PROBLEMS, 26-27 May 2021, Kyiv, Ukraine
Fabián Martin	International Visegrad Fund Young Research Award 2016 in the field of Solid State Chemistry, Budapest, 2016, Hungary

- **Position of individual researchers in the national context**

2.3.10. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

Nr.	Invited/keynote presentation at international conference
1	Baláž, M. Mechanochemistry: A multidisciplinary tool usable in various branches of science and technology, Forum of Engineers and Technicians of Slovakia (FITS) 2021. Sep 29, 2021, Košice

2.3.11. List of researchers who served as members of organising and programme committees of national conferences

IGTSAS organizes regular annual national conference series "Scientific Symposium with International Participation: Situation in Ecologically Loaded Regions of Slovakia and Central Europe" Scientific Symposium held in Hrádok pri Jelšave, Slovakia. The Symposia were focused on three main areas: 1. Effects of emissions and immissions to air, soil, water, plants, animals, forestry, food chain and human population in the regions of Slovakia and Central Europe. 2. Theoretical and practical aspects of research of individual compounds of environment. 3. Technologies and materials for environmental protection and ecology-friendly procedures of production in the environmentally loaded regions. Symposia bring together scientists and representatives of the regional and national authorities, policy makers, and remediation companies discussing the transfer of knowledge in the above mentioned areas.

Researcher	Conference Title	Member of committee	
		org.	prog. or scien.
2016			
Briančin Jaroslav	The XXV. Scientific Symposium with International Participation: "Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovakia, 20.-21.10.2016	yes	yes
Hančulák Jozef		yes	-
Hredzák Slavomír		yes	-
Krúpa Vítazoslav		-	yes
Stuchlá Katarína		yes	-
Šestinová Oľga		yes	-
Zubrik Anton		yes	-
2017			
Hančulák Jozef	The XXVI. Scientific Symposium with International Participation: "Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovakia, 19.-20.10.2017	yes	yes
Hredzák Slavomír		yes	-
Stuchlá Katarína		yes	-
Šestinová Oľga		yes	-
Zubrik Anton		yes	-
2018			
Briančin Jaroslav	The XXVII. Scientific Symposium with International Participation:	yes	yes
Hančulák Jozef		yes	yes

Hredzák Slavomír	"Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovakia, 8.-9.11.2018	yes	-
Ivaničová Lucia		-	yes
Stuchlá Katarína		yes	-
Šestinová Oľga		yes	-
Václavíková Miroslava		yes	yes
Zubrik Anton		yes	-
2019			
Briančin Jaroslav	The XXVIII. Scientific Symposium with International Participation: "Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovakia, 24.-25.10.2019	yes	yes
Hančuľák Jozef		yes	yes
Hredzák Slavomír		yes	-
Stuchlá Katarína		yes	-
Šestinová Oľga		yes	-
Václavíková Miroslava		yes	yes
Žáková Janette		yes	-
2020			
Briančin Jaroslav	The XXIX. Scientific Symposium with International Participation: "Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovak republic, 5.-6.11.2020	yes	yes
Hančuľák Jozef		yes	yes
Hredzák Slavomír		yes	-
Matik Marek		yes	-
Šestinová Oľga		yes	-
Václavíková Miroslava		yes	yes
Zubrik Anton		yes	-
2021			
Briančin Jaroslav	The XXX. Scientific Symposium with International Participation: "Situation in Ecologically Loaded Regions of Slovakia and Central Europe", Hotel Hrádok, Hrádok pri Jelšave, Slovak republic, 21.-22.10.2021	yes	yes
Hančuľák Jozef		yes	yes
Hredzák Slavomír		yes	--
Matik Marek		yes	-
Šestinová Oľga		yes	-
Václavíková Miroslava		yes	yes
Zubrik Anton		yes	-
Žáková Janette		yes	-

2.3.12. List of researchers who received a national scientific award

2016	
Baláž Matej	SAS Award for the 1 st place in the Competition of young scientists of the SAS under 35, 1 st Department of Sciences. Presentation of the topic "Utilization of mechanochemistry for expanding the application potential of bio-waste based on eggshell and its membrane".
Baláž Matej	Forbes Slovakia: FORBES 30 Under 30. Ranked among the Top 30 under 30 Slovaks
Hredzák Slavomír	ZSVTS Association of Slovak Scientific and Technical Societies: Silver medal for merits in the development of science and technology
Kušnierová Mária	SAS Award for lifelong contribution in the field of mineral biotechnology research
Luptáková Alena	Rector's Award of the Technical University of Košice Award for publishing activity in the category Scientific paper published in 2016: EŠTOKOVÁ, Adriana - KOVALČÍKOVÁ, Martina - LUPTÁKOVÁ, Alena - PRAŠČÁKOVÁ, Mária. Testing Silica Fume-Based Concrete Composites under Chemical and Microbiological Sulfate Attacks. In <i>Materials</i> , 2016, vol. 9, no. 5, p. 1-15. (2015: 2.728 - IF, Q1 - JCR, 0.830 - SJR, Q1 - SJR, Current Contents - CCC). (2016 - Current Contents). ISSN 1996-1944.
Šepelák Vladimír	Literary Fund Award for exceptional scientific response to one work V. Šepelák, D. Baabe, D. Mienert, D. Schultze, F. Krumeich, F. J. Litterst, K. D. Becker, Evolution of structure and magnetic properties with annealing temperature in nanoscale high-energy-milled nickel ferrite. <i>Journal of Magnetism and Magnetic</i>

	<i>Materials 257 (2003) 377.</i>
2017	
Baláž Peter	SAS Award of the personalities of the SAS, on the occasion of their anniversaries for their lifelong contribution in the field of chemistry, Bratislava, 5.10.2017
2018	
Baláž Peter Achimovičová Marcela Baláž Matej Dutková Erika	Award of the SAS Presidency for a scientific publication with an extremely high number of citations. BALÁŽ, Peter - ACHIMOVIČOVÁ, Marcela - BALÁŽ, Matej - BILLIK, Peter - CHERKEZOVÁZHELEVA, Zara - CRAIDO, José Manuel - DELOGU, Francesco - DUTKOVÁ, Erika - GAFFET, Eric - GOTOR, Francisco José - KUMAR, Rakesh - MITOV, Ivan - ROJAC, Tadej - SENNA, M. - STRELETSKII, Andrey - WIECZOREK-CIUROWA, Krystyna. Hallmarks of mechanochemistry: From nanoparticles to technology. <i>Chemical Society Reviews</i> , Vol. 42, No. 18, pp. 7571-7637, 2013. Bratislava, July 2018
Baláž Matej	Award Scientist of the Year Slovakia 2018 in the category Young Researcher
2019	
Mockovčiaková Annamária	RNDr. Annamária Mockovčiaková, Ph.D. was awarded by SAS Presidium for research activities focused on the use of mathematical methods in solving problems in the field of mineralurgy and environmental technologies. She applied fractal geometry to the evaluation of rock and mineral surfaces in the processes of physical and physico-chemical treatment.
2020	
Baláž Matej	3 rd place in the competition Falling Walls Lab Slovakia 2020, Comenius University Bratislava
Baláž Matej	ESET Science Award Top 5 finalist in the category Outstanding Young Scientist under 35

2.4. Research grants and other funding resources

(List type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator “C”, work package leader “W”, investigator “I”. Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**

2.4.1. List of major projects of Framework Programmes of the EU (which pillar), NATO, COST, etc.

Note: All of the presented projects are interdisciplinary.

<p>Water and Soil Clean-up from Mixed Contaminants (10/2013 – 09/2017) Project: FP7-PEOPLE-2013-IAPP-WaSClean-612250 Cooperating partners: Great Britain, Greece, Kazakhstan Total funding: 1,968,656 € / Funding for the Institute: 570,993 € Responsible person in the organization: Consortium coordinator / Ing. M. Václavíková, PhD.</p>
<p>Nanoporous and Nanostructured Materials for Medical Applications (01/2017 – 06/2022) Project: H2020-MSCA-RISE-2016-NanoMed-734641 Cooperating partners: Spain, France, Great Britain, Greece, Hungary, Kazakhstan, Moldova, Portugal, Ukraine Total funding: 972,000 € / Funding for the Institute: 48,900 € Responsible person in the organisation: W / Ing. Miroslava Václavíková, PhD.</p>

<p>Technical Advances to Detect and Remove Contaminants from Water for Safety and Security (11/2012 – 04/2016) Project: NATO: Science for Peace and Security Programme EAP.SFPP.984403 Cooperating partners: Armenia, Greece, Moldova, USA Total funding: 80,000 € / Funding for the Institute: 25,000 € Responsible person in the organisation: W / Ing. Miroslava Václavíková, PhD.</p>
<p>Solutions for Critical Raw Materials Under Extreme Conditions (03/2016 – 03/2020) Project COST CA15102 CRM-EXTREME Partners: AT, BE, BG, CR, CZ, DK, EE, FI, FR, DE, GR, IE, IL, IT, LV, LU, NL, MK, NO, PL, PT, RO, RS, SK, SI, ES, SW, CH, TR, UK Total funding: n/a € / Funding for the Institute: 15,204 € Responsible person in the organisation: W / prof. RNDr. Peter Baláž, DrSc.</p>
<p>Mechanochemistry for Sustainable Industry (05/2019 – 04/2023) Project: COST, CA18112 Cooperating partners: Albania, Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Latvia, Lithuania, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom Total funding: 4,663,934 € / Funding for the Institute: 2,000 € Responsible person in the organisation: W / RNDr. Matej Baláž, PhD.</p>
<p>Structure-Function Relationship of Advanced Nanooxides for Energy Storage Devices (10/2015 – 09/2018) Project: V4-Japan Joint Research Program on Advanced Materials - AdOX Cooperating partners: Czech Republic, Japan, Poland Total funding: 510,800 € / Funding for the Institute: 120,000 € Responsible person in the organisation: W / prof. RNDr. V. Šepelák, DrSc.</p>
<p>Industrial synthesis of metal sulphides via mechanochemical activation in vibration mills (11/2015 – 10/2017) Project: IB-COMSTRUC-010 Cooperating partner: Germany Total funding: 100,737 € / Funding for the Institute: 25,300 € Responsible person in the organisation: W / prof. RNDr. Peter Baláž, DrSc.</p>
<p>Development of in-situ bioleaching method to clean quartz sands and application through testing prototype pilot plant (01/2014 – 12/2017) Project: PROJEKTO CORFO I + D Cod. 13IDL2 – 23505 Cooperating partner: Cristalerias de Chile S.A. Total funding: 73,000 € / Funding for IGT: 73,000 € Responsible person in the organisation: W / Ing. Iveta Štyriaková, PhD.</p>
<p>BioLeach: Innovative Bio-treatment of Raw Materials (07/2020 – 03/2022) International Cooperation: EIT Raw Materials KIC (Knowledge and Innovation Community) project No. 18259 under Horizon Europe partnership Cooperating partners: Hungary, Spain, Germany, Poland, Ireland, Portugal, Italy IGTSAS as major Task Partner of Coordinator Technical University of Košice, Slovakia (TU Košice as RIS Hub) Total funding: 1,119,029 € / Funding for the Institute: 30,000 € (2020-2021) Responsible person in the organisation: W / Dr. Daniel Kupka</p>

Add information on your activities in international networks

IGTSAS has spread its networking activities not only by implementation of funded joint projects (see Lists in Chapter 2.4), but also by formation of new project consortia by inviting partners or being invited or via joining the international project calls. It is important to emphasize that huge amount of work of all researchers related to the preparation and writing of project proposals involves tremendous administration and financial management load. Nowadays, due to a lack of personnel in administration as well as significant lack of budgets, researchers had to become also project managers, accountants, HR managers and often even lawyers, which consumes lots of their time and energy, which in long term may result in loss of interest and drop of scientific outputs. Efforts of these researchers are highly appreciated as well.

Many of submitted projects were successful and granted; however still many of them received high rank (90-95%) and even they easily passed threshold, they did not receive funding. Additional information on the networking activities in international competition is described below in the list of submitted, however not funded international projects.

2016
Smart Exploitation of Rare Indigenous EU Deposits for the Production of High Purity Quartz HORIZON 2020 - SC5-13-2016 HIDALGO 730271 (2016-2020) Principal investigator at IGTSAS: W / Ing. Miroslava Václavíková, PhD.
Innovative Technologies for Metal By-Products Recovery from Feldspar and Uranium Yellow Cake Production HORIZON 2020 - SC5-13-2016 InMets (2016-2020) Principal investigator at IGTSAS: W / Ing. Slavomír Hredzák, PhD.
Application of Microwave Energy in Metallurgical Waste Treatment H2020-MSCA-IF-2016 Ametist (2016-2020) Principal investigator at IGTSAS: W / RNDr. Michal Lovás PhD.
Innovative solutions for sustainable production of raw materials and for enhanced recovery of by-products from phosphate rocks HORIZON 2020 - SC5-13-2016-2017 InPhoRock (2016-2020), IT, FR, GR, RO, FI, UA, NO, Morocco, Senegal Principal investigator at IGTSAS: W / Ing. Alena Luptáková, PhD.
Mechanochemistry and Catalysis for New Added-value Chemicals COST OC-2016-1-20913 Mech@Chem Principal investigator at IGTSAS: W / RNDr. Matej Baláž, PhD
Extractive metallurgy and industrial processes of activated minerals Applied research coordinator: Leon Carlos Arturo Villachica, Smallvill s.a.c., Lima, Peru Principal investigator at IGTSAS: W / Prof. RNDr. Peter Baláž, DrSc.
2017
Target Silica Materials For Pollution Control, Water Purification and Bioencapsulation HORIZON 2020, ERC Advanced Grant (ERC-2017-ADG), SIWABIO, Project No. 789293 Principal investigator at IGTSAS: C / Dr. Inna Melnyk
Application of Microwave Energy in Metallurgical Waste Treatment HORIZON 2020, Marie Skłodowska Curie Actions, MSCA-IF-EF-ST-AMETIST Principal investigator at IGTSAS: W / RNDr. Michal Lovás, PhD.
Elaboration of selective adsorbents from hybrid silica-based precursors HORIZON 2020, Marie Skłodowska Curie Actions, MSCA-IF-EF-RI-SUPERADSORBENTS Principal investigator at IGTSAS: W / Ing. Miroslava Václavíková, PhD.
Interface of sciences at abiotic and biotic mineral-solution interfaces towards tomorrow's technologies HORIZON 2020, Marie Skłodowska Curie Actions, MSCA-ITN-ETN-INTERFACES C: Norwegian University of Science and Technology (NTNU), Prof. Hanumantha Rao Kota Principal investigator at IGTSAS: W / MVDr. Daniel Kupka, PhD.
Boundary engineering for next generation energy storage devices EIG Concert Japan (04/2018-03/2021) C: Shizuoka University, Japan. Partners: J. Heyrovsky Institute of Physical Chemistry, Prague, Czech Republic, IGTSAS Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.
Eco-friendly and low-cost copper-based materials for solar and thermoelectric applications DAAD-PPP (2018-2019) C: Technische Universität Clausthal, Germany Principal investigator at IGTSAS: W / prof. RNDr. Peter Baláž, DrSc.

<p>Development of new approaches for the synthesis of poly(lactide-co-glycolide)-coated magnetic nanoparticles as efficient carriers for nanomedicine National Scholarship Programme of the Slovak Republic (2017) Principal investigator at IGTSAS: W / Inna Melnyk, PhD. Fellow / Liudmyla Storozhuk, PhD.</p>
<p>2018</p>
<p>Innovative solutions for sustainable production of raw materials and for enhanced recovery of by-products and critical materials from phosphate rocks with a zero waste approach HORIZON 2020 – RIA, CE-SC5-06-2018 – PHOSPHOWASTE C: Centro Interuniversitario Di Ricerca Per Lo Sviluppo Sostenibile, Valmontone, Roma, Italy. Partners: IT, FR, NO, GR, Tunisia Principal investigator at IGTSAS: W / Ing. Alena Luptáková, PhD.</p>
<p>Cost-efficient, Low-energy and Effective Application of Bioremediation for CRM Recovery HORIZON 2020 – RIA, CE-BIOTEC-04-2018 - New biotechnologies for environmental remediation C: Technical University of Košice Partners: Bangor University, UK; Stichting IHE Delft Institute for Water Education, NL; Trinity College Dublin, IRL; University of Bologna, IT; Magyar Bányászati és Földtani Szolgálat, HU; Zoltan Bay Nonprofit Ltd, HU; University of Oulu, FI; Gómez Pardo Foundation, ES Principal investigator at IGTSAS: W / Ing. Alexandra Bekényiová, PhD.</p>
<p>Bio-mechanochemical synthesis of silver nanoparticles: In situ approach and antibacterial activity HORIZON 2020 MSCA Individual Fellowship 2018, Proposal ID 842650 Fellow: RNDr. Matej Baláž, PhD. Supervisor: Dr. Franziska Emmerling, The German Federal Institute for Materials Research and Testing (BAM), Germany</p>
<p>Mechanochemical synthesis of complex sulphides and their integration into micro-TEGs HORIZON 2020 - M-ERA.NET Call 2018 Partners: Jozef Stefan Institute Ljubljana, SI; Technical University Wroclaw, PL; CNRS CRISMAT Caen, FR Principal investigator at IGTSAS: W / prof. RNDr. Peter Baláž, DrSc.</p>
<p>Mechanochemical synthesis and investigation of novel nanostructured selenospinel for energy conversion and storage applications HORIZON 2020 MSCA-IF-EF-ST Proposal ID 842324 Partners: Institute of Experimental Physics SAS, FNS UPJS Kosice, Slovakia C: Dr.h.c. prof. RNDr. Peter Baláž, W / Mgr. Marcela Achimovičová, PhD. (reintegration)</p>
<p>Synthesis, structure-properties, electrochemical-properties, and oxygen transportation investigation on novel cathodes for solid oxide fuel cells SAS-MOST Taiwan Partner: Department of Materials Science and Engineering, National Dong Hwa University, Taiwan Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>An Opportunity for Industrial Minerals Talc and Pyrophyllite – the Basis for Development of New Advanced Ecological Materials APVV Bilateral Call SK-SRB-18-0064 (01/2019 – 12/2021) Principal investigator at IGTSAS: Ing. Slavomír Hredzák, PhD.</p>
<p>Study of critical elements recovery and other useful components from coal fly ashes after coal combustion APVV Bilateral Call SK-PL-18-0050 (01/2019 – 12/2021) Principal investigator at IGTSAS: Ing. Ingrid Znamenáčková, PhD.</p>
<p>Multiparticulate mechanochemically synthesized nanocomposites with guided fluorescent-magnetic-anticancer functionality APVV Bilateral Call SK-PL-18-0066 (01/2019 – 12/2021) Principal investigator: Mgr. Zdenka Bujňáková, PhD.</p>
<p>2019</p>
<p>Mercury and Arsenic Pollution: Biogeochemistry and Advanced Remediation Techniques Horizon 2020 - MSCA-RISE-2019 C: Prof. K. László, Budapest University of Technology and Economics, HU Principal investigator at IGTSAS: W / Ing. Miroslava Václavíková, PhD.</p>
<p>3-D printed Graphene Based Electrode Materials for Efficient Sodium Ion Energy Storage Devices HORIZON 2020 - M-ERA.NET Call 2019 C: Université Paris Sud, FR Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>New ion batteries based on advanced oxides. Unconventional synthesis and effect of structure on electrochemical properties SAS-TUBITAK (2020-2023), TR Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>

<p>Synthesis of new types of cathodes for solid oxide fuel cells: A look at the relationships between structure, electrochemical properties and ion transport SAS-MOST Taiwan (2020-2023) Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>Hybrid Adsorbents and Catalysts for Water Remediation from Pharmaceutically Active Compounds APVV Bilateral Call SK-BY-RD-19-0013 (08/2019-07/2022) Principal investigator at IGTSAS: W / Dr. Inna Melnyk, PhD.</p>
<p>2020</p>
<p>High-entropy oxides for electrochemical energy applications prepared via mechanosynthesis Alexander von Humboldt Fellowship for Experienced Researchers Call (2021-2023) Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>Decontamination of the pharmaceutically active compounds in local water sources by novel designed SiO₂ based adsorbent-catalyst nanomaterials 7th Joint Call for JRP SAS – TUBITAK Nr. 546061 (09/2020-08/2023), TR Principal investigator at IGTSAS: W / Dr. Inna Melnyk, PhD.</p>
<p>Membrane and advanced electrochemical systems for industrial wastewater treatment and assessment of 3R 7th Joint Call for JRP SAS – TUBITAK Nr. 546640 (2021-2023), TR Principal investigator at IGTSAS: W / MVDr. Daniel Kupka, PhD.</p>
<p>Bioglass 60S/Ga(or Ge)/pharmaceutical composite materials for creation of implant materials with prolonged chemotherapeutic action National Scholarship Programme of the Slovak Republic (2020/2021) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow / Dr. Andrii Kussyak, PhD.</p>
<p>Polymer nanocomposite coatings on the surface of textile materials: production and perspectives in water filtration and photocatalysis National Scholarship Programme of the Slovak Republic (2020/2021) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow/As.Prof. Mariia Pasichnyk, PhD.</p>
<p>Preparation and characterization of Bioglass 60S/Ga (or Ge)/medicine composites as implant materials with prolonged chemotherapeutic action National Scholarship Programme of the Slovak Republic (2020/2021) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow/Dr. Andrii Kussyak, PhD.</p>
<p>Porous silica-based composites containing stable organic radicals: synthesis, characterization and application National Scholarship Programme of the Slovak Republic (2020/2021) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow/As.Prof. Oleg Tkachenko, PhD.</p>
<p>Adsorption and desorption behavior of protein-based substances with magnetic nanocomposites National Scholarship Programme of the Slovak Republic (2020/2021) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow/As.Prof. Nataliia Kusayk, PhD.</p>
<p>2021</p>
<p>Removal of persistent and mobile organic contaminants through a novel approach combining cold plasma, adsorption and photocatalytic technology H2020-LC-GD-2020; RIA Call: Building a low-carbon, climate resilient future: Research and innovation in support of the European Green Deal; Acronym: ROMAN. Principal investigator at IGTSAS: W / Ing. Miroslava Václavíková, PhD.</p>
<p>Circular strategy for supply of secondary raw materials from mining residues by advanced techniques and sustainable processes HORIZON 2020 - M-ERA.NET Call 2021 STRETCH - ID: 148 (04/2022 - 03/2025) C: Dr. Ubaldini, Institute of Environmental Geology and Geoengineering CNR, IT, ES, BE Principal investigator at IGTSAS: W / Ing. Alena Luptáková, PhD.</p>
<p>Advanced recovery of critical elements from secondary sources IVF V4-Japan Joint Research Program (10/2021 - 09/2024) C: Assoc. prof. Gjergj Dodbiba, PhD., University of Tokyo, Graduate School of Engineering, Department of Systems Innovation, Japan, CZ, HU, PL Principal investigator at IGTSAS: W / Ing. Alena Luptáková, PhD.</p>
<p>Development and testing of "green" technologies for obtaining new multifunctional materials based on coal and biodegradable waste to ensure safe life National Center of Science and Technology Evaluation, KZ, BR10965242 (2022-2024) Cooperating partner: Al-Farabi Kazakh National University, Almaty, Kazakhstan Principal investigator at IGTSAS: W / RNDr. Matej Baláž, PhD.</p>

<p>Synthesis, processing and investigation of multicomponent oxides and fluorides for thin and thick film all-solid rechargeable batteries IVF V4-Japan Joint Research Program (10/2021 – 09/2024) C: Assoc. prof. Akichika Kumatani, Advanced Institute for Materials Research (AIMR), Tohoku University, Japan Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>Spinel-based high-entropy oxides prepared via one-step mechanosynthesis and their properties DAAD Fellowship, Karlsruher Institut für Technologie, Institut für Nanotechnologie KIT, Germany (01/2022 – 04/2022) Principal investigator at IGTSAS: C / Mgr. Olena Porodko</p>
<p>Development of new functional nanostructured materials with reducing and catalytic effect for the treatment of water contaminated with halogenated organic pollutants ERA.NET Call 2021 C: University of Pardubice, Czech Republic Principal investigator at IGTSAS: W / Mgr. Marcela Achimovičová, PhD.</p>
<p>Design and Additive Manufacturing of customized implants for use in cranioplasty with comparable properties to endogenous bone tissue ERA.NET Call 2021 C: Institute of Technology and Business, České Budějovice, Czech Republic Principal investigator at IGTSAS: W / RNDr. Martin Fabián, PhD.</p>
<p>Mechanically Activated NanoArsenoSelenides: New Group of Glass Nanohybrides with Molecular Net and Controlled Multifunctionality Bilateral Call APVV SK-UA (01/2022 - 12/2023) Principal investigator at IGT SAS: C/RNDr. Matej Baláž, PhD.</p>
<p>Mechanochemical Treatment of Eggshell Waste for Production of New Materials Bilateral Call APVV SK-RU (01/2022 - 12/2024) Principal investigator at IGTSAS: C / RNDr. Matej Baláž, PhD.</p>
<p>Visible-Light Photocatalysts Immobilized on Granular Activated Carbon for Adsorption/Decomposition of Organic Halogens National Scholarship Programme of the Slovak Republic (2021/22), France Fellow: Mgr. Halyna Yankovych</p>
<p>Functional Mesoporous Silica Materials Modified with Transition Metals as Epoxidation Catalysts National Scholarship Programme of the Slovak Republic (2021/22) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow: Oksana Makota, DrSc., Lviv Polytechnic National University, UA</p>
<p>The modification of magnetic nanoparticles by newly synthesized bifunctional organic molecules for potential use in environmental issue-treatment and target drug deliver National Scholarship Programme of the Slovak Republic (2021/22) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow: Maksym Fershal, PhD., Uzhhorod National University, UA</p>
<p>Magnetic nanoparticles modified with novel bifunctional oxine derivatives: synthesis, characterization and potential use National Scholarship Programme of the Slovak Republic (2021/22) Principal investigator at IGTSAS: W / Inna Melnyk, PhD., Fellow: Maksym Fershal, PhD., Uzhhorod National University, UA</p>
<p>Adsorption and desorption behaviors of protein-based substances with magnetic nanocomposites National Scholarship Programme of the Slovak Republic (2021/22) Principal investigator at IGTSAS: W / Ing. Miroslava Václavíková, PhD., Fellow: Nataliia Kusyak, PhD., Zhytomyr State University of Ivan Franko, UA</p>

- **National projects, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

IGTSAS submitted six project proposals within the open calls of ERA-NET/ERA-MIN3 and succeeded in the latest one:

Successful project
ERA-MIN3 Joint Call 2021 with start from 2022: POTASSIAL-27 Zero-waste valorisation of feldspathic ores: Green application and sustainable sourcing of strategic raw materials. Coordinator: Prof. Murat Erdemoglu, İnönü University (Turkey), 04/2022-05/2025. Partner countries: Principal investigator from IGTSAS: Mgr. Marcela Achimovičová, PhD.
<i>Note: Other submitted proposals within ERA-NET calls (not funded):</i>
M-ERA.NET Call 2018: Mechanochemical synthesis of complex sulphides and their integration into micro-TEGs. Co-investigating organizations: Jozef Stefan Institute Ljubljana, Slovenia; Technical University Wroclaw, Poland; CNRS CRISMAT Caen, France. Principal investigator from IGTSAS: Dr.h.c. prof. RNDr. Peter Baláž, DrSc.
M-ERA.NET Call 2019: 3-D printed Graphene Based Electrode Materials for Efficient Natrium Ion Energy Storage Devices. Co-investigating organization: Universite Paris Sud, France. Principal investigator from IGTSAS: RNDr. Martin Fabián, PhD.
M-ERA.NET Call 2019: Development of new functional nanostructured materials with reducing and catalytic effect for the treatment of water contaminated with halogenated organic pollutants. University Pardubice (Czech Republic), Principal investigator from IGTSAS: Mgr. Marcela Achimovičová, PhD.
M-ERA.NET Call 2021: Design and Additive Manufacturing of customized implants for use in cranioplasty with comparable properties to endogenous bone tissue. Institute of Technology and Business, České Budějovice (Czech Republic). Principal investigator from IGTSAS: RNDr. Martin Fabián, PhD.
ERA-MIN3 Joint Call 2021: Circular strategy for supply of secondary raw materials from mining residues by advanced techniques and sustainable processes. (STRETCH - ID: 148). Coordinator: Dr. Stefano Ubaldini, Institute of Environmental Geology and Geoengineering CNR, Rome, Italy. Principal investigator from IGTSAS: Ing. Alena Luptáková, PhD.

2.4.3. List of projects of the Slovak Research and Development Agency, APVV

The Slovak Research and Development Agency established in 2005 is the only national grant agency established in order to support research and development in Slovakia by granting financial means from the State Budget to implement the projects of research and development in particular science and technology fields (General Calls, max. funding 250,000 Eur/project), and bilateral or multilateral contracts on scientific and technological cooperation (Bilateral calls).

APVV General Calls	
1	Mechanochemistry of Semiconductor Nanocrystals: from Minerals to Materials and Drugs (07/2015 – 06/2019) Project APVV-14-0103 Total funding: 250,000 € / Funding for the Institute: 250,000 € Responsible person in the organisation: C / prof. RNDr. Peter Baláž, DrSc.
2	Development of a system for continuous monitoring of pollution impact on the high-voltage insulation (07/2016 – 06/2020) Project APVV-15-0438 Total funding: 175,500 € / Funding for the Institute: 43,475 € Partners: C / Technical University of Košice Responsible person in the organisation: W / RNDr. Martin Fabián, PhD.

3	Chalcogenides as emerging eco-friendly and low-cost nanomaterials for energy- and medicine- related sectors (07/2019 – 06/2023) Project APVV-18-0357 Total funding: 250,000 € / Funding for the Institute: 250,000 € Responsible person in the organisation: C / Dr.h. c. prof. RNDr. Peter Baláž, DrSc.
4	Relationships between structure and unusual physical properties in highly nonequilibrium oxides prepared by unconventional mechanochemical synthesis (07/2020 – 06/2024) Project APVV-19-0526 Total funding: 249,990 € / Funding for the Institute: 173,065 € Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.
5	Hybrid Composites for Complex Treatment of Industrial Waters (07/2020 – 06/2024) Project APVV-19-0302 Total funding: 250,000 € / Funding for the Institute: 250,000 € Responsible person in the organisation: C / Inna Melnyk, PhD.
6	Possibilities of critical raw materials recovery by advanced methods of mining wastes processing (07/2021 – 06/2025) Project APVV-20-0140 Total funding: 222,176 € / Funding for the Institute: 136,576 € Responsible person in the organisation: C / Ing. Alena Luptáková, PhD.
APVV Bilateral call projects	
1	Mechanochemically-Nanostructured Arsenicals with Guided Anticancer Functionality: from Ab-initio Quantum Chemical Modelling to Experimental Verification (09/2015 – 12/2016) Bilateral cooperation project APVV-SK-UA-2013-0003 Cooperating partner: Ukraine Total funding: 2,374 € / Funding for the Institute: 2,374 € Responsible person in the organisation: C / prof. RNDr. Peter Baláž, DrSc.
2	Photocatalytic purification of contaminated water and air using nanostructured materials (07/2016 – 12/2017) Bilateral cooperation project APVV-SK-BG-2013-0011 Cooperating partner: Bulgaria Total funding: 7000 € / Funding for the Institute: 4000 € Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.
3	Nanoparticle Activated Synthetic Zeolite from Coal Fly Ash for Water Remediation (05/2016 – 12/2017) Bilateral cooperation project APVV-SK-BG-2013-0025 Cooperating partner: Bulgaria Total funding: n/a € / Funding for the Institute: 0 € Responsible person in the organisation: C / Ing. Miroslava Václavíková, PhD.
4	Complex oxide electrolytes for energy conversion technologies: Mechanochemical synthesis and electrochemical characterization (01/2019 – 12/2021) Bilateral cooperation project APVV-SK-PT-18-0039 Cooperating partner: Portugal Total funding: 10,000 € / Funding for the Institute: 5000 € Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

VEGA projects represent smaller, lower budgeted research projects funded directly by SAS, which are however very helpful for covering the research material, consumables and conference, and also for starting up the research career for young scientists.

VEGA funding in particular year (in EUR)					
2016	2017	2018	2019	2020	2021
98,205	89,049	79,350	89,469	89,796	75,737

VEGA projects	
1	<p>Microwave energy application for intensification of extraction and pyrolytic processes of coal and wastes (01/2013 – 12/2016) Project number: VEGA 2/0114/13 Responsible person in the organisation: C / RNDr. Silvia Dolinská, PhD.</p>
2	<p>Hydrometallurgical extraction of gold from White Hill (Detva) deposit and wastes with the application of electrolysis, mechanical activation and sorption (01/2014 – 12/2016) Project number: VEGA 2/0051/14 Responsible person in the organisation: C / Ing. Jana Ficeriová, PhD.</p>
3	<p>Mechanosynthesis of lithium nanosilicates with attractive electrochemical and magnetic properties (01/2014 – 12/2016) Project number: VEGA 2/0064/14 Responsible person in the organisation: C / RNDr. Erika Turianicová, PhD.</p>
4	<p>Mechanochemistry of solids for utilization in nanotechnologies (01/2014 – 12/2017) Project number: VEGA 2/0027/14 Responsible person in the organisation: C / prof. RNDr. Peter Baláž, DrSc.</p>
5	<p>Magnetic behavior of nonequilibrium nanooxides prepared by mechanochemical routes (01/2014 – 12/2017) Project number: VEGA 2/0097/14 Responsible person in the organisation: C / prof. RNDr. V. Šepelák, DrSc.</p>
6	<p>The study of atmospheric deposition, particulate matters and contamination of selected environment components in industrial and urban area of Košice and middle Spiš (01/2015 – 12/2018) Project number: VEGA 2/0194/15 Responsible person in the organisation: C / Ing. Jozef Hančulák, PhD.</p>
7	<p>Prediction of drillability of intact rock and rock mass (01/2015 – 12/2018) Project number: VEGA 2/0160/15 Responsible person in the organisation: C / Ing. Lucia Ivaničová, PhD.</p>
8	<p>Bacterial transformation of sulphur compounds in processes of materials synthesis and degradation (01/2015 – 12/2018) Project number: VEGA 2/0145/15 Responsible person in the organisation: C / Ing. Alena Luptáková, PhD.</p>

9	<p>The development of bioremediation technology of metals removing from soil and sediment (01/2015 – 12/2018) Project number: VEGA 2/0049/15 Responsible person in the organisation: C / Ing. Iveta Štyriaková, PhD. / from Sep 1, 2017: Ing. Zuzana Danková, PhD.</p>
10	<p>Microwave-assisted synthesis of polycomponent materials for mineral processing and environmental technologies (01/2015 – 12/2018) Project number: VEGA 2/0158/15 Responsible person in the organisation: C / RNDr. Anton Zubrik, PhD.</p>
11	<p>Use of screening methods for the quality assessment of selected environment components (01/2016 – 12/2017) Project number: VEGA 2/0079/16 Responsible person in the organisation: C / RNDr. Lenka Findoráková, PhD.</p>
12	<p>Synthesis and applications of oxides for production of ecologically clean energy (01/2016 – 12/2018) Project number: VEGA 2/0128/16 Coordinating partner: Faculty of Mining, Ecology, Process Control and Geotechnologies, Technical University of Košice Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.</p>
13	<p>Identification of specific drilling energy based on vibration signal (01/2016 – 12/2019) Project number: VEGA 2/0080/16 Responsible person in the organisation: C / Ing. Edita Lazarová, PhD.</p>
14	<p>Mechanism of anti-tumor activity of realgar nanoparticles and its synergism with anti-myeloma agents (01/2017 – 12/2019) Project number: VEGA 2/0100/17 Responsible person in the organisation: C / RNDr. Zdenka Lukáčová Bujňáková, PhD.</p>
15	<p>Study of physico-chemical properties of nanooxides prepared by combined mechanochemical-thermal synthesis (01/2017 – 12/2019) Project number: VEGA 2/0175/17 Responsible person in the organisation: C / RNDr. Erika Tóthová, PhD.</p>
16	<p>Recovery of selected critical minerals from environmental loads after mining, metallurgy and coal-fired power industry (01/2017 – 12/2020) Project number: VEGA 2/0055/17 Responsible person in the organisation: C / RNDr. Silvia Dolinská, PhD.</p>
17	<p>Preparation and functionalization of chalcogenide minerals and their nanocomposites by high-energy milling (01/2018 – 12/2020) Project number: VEGA 2/0065/18 Responsible person in the organisation: C / RNDr. Erika Dutková, PhD.</p>
18	<p>High-energy milling for the synthesis of nanomaterials using bioapproach and selected environmental applications (01/2018 – 12/2021) Project number: VEGA 2/0044/18 Responsible person in the organisation: C / RNDr. Matej Baláž, PhD.</p>
19	<p>The assessment of environmental load of the environment in former mining area using traditional and alternative bioindication methods (01/2018 – 12/2021) Project number: VEGA 2/0326/18</p>

	Coordinating partner: Faculty of Humanities and Natural Sciences, University of Prešov Responsible person in the organisation: W / Ing. Alena Luptáková, PhD.
20	Multicomponent filters in process of leachates cleaning from the toxic elements after the bioremediation of soils contaminated by metallurgical industry (01/2019 – 12/2020) Project number: VEGA 2/0029/19 Responsible person in the organisation: C / Ing. Alexandra Bekényiová, PhD. (from 1.7.2020 Ing. Ingrid Znamenáčková, PhD.)
21	Mechanosynthesis of complex oxides as suitable components to the devices producing green energy (01/2019 – 12/2022) Project number: VEGA 2/0055/19 Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.
22	The study of particulate matters in ambient air and selected environment components using the screening methods (01/2019 – 12/2022) Project number: VEGA 2/0165/19 Responsible person in the organisation: C / Ing. Jozef Hančulák, PhD.
23	The effect of the strain rate on the strength and deformation rock properties for the research of the rock disintegration (01/2019 – 12/2022) Project number: VEGA 2/0133/19 Responsible person in the organisation: C / Ing. Milan Labaš, PhD.
24	Study of the bio-oxidising and bio-reducing processes of sulphur and its compounds in environment and industry (01/2019 – 12/2022) Project number: VEGA 2/0142/19 Responsible person in the organisation: C / Ing. Alena Luptáková, PhD.
25	Preparation of Materials for the Remediation of Old Mining Sites (01/2019 – 12/2022) Project number: VEGA 2/0156/19 Responsible person in the organisation: C / Ing. Miroslava Václavíková, PhD.
26	A green approach to the direct synthesis of selected oxide and selenide mineral phases by high-energy milling (01/2020 – 12/2022) Project number: VEGA 2/0103/20 Responsible person in the organisation: C / Mgr. Marcela Achimovičová, PhD.
27	Gold recovery from refractory sulphide concentrates by mechanochemico-biological activation (01/2020 – 12/2022) Project number: VEGA 2/0112/20 Responsible person in the organisation: C / Ing. Jana Ficeriová, PhD.
28	Intensification of Selected Metals Recovery from Refractory Polymetallic Ores and Mining Wastes in Microwave Field (01/2021 – 12/2024) Project number: VEGA 2/0167/21 Responsible person in the organisation: C / Ing. Ingrid Znamenáčková, PhD.

2.4.5. List of projects supported by EU Structural Funds

In the previous Accreditation Period 2012-2015, seven granted ERDF projects were extremely beneficial for IGTSAS and helped the institute to increase its publishing activities and boost the international collaboration due to new laboratories and high-tech equipment purchased during the implementation of the projects. The new infrastructure formed a baseline for success in EU projects in the following period 2016-2021.

Note: However, in the current Accreditation Period 2016-2021, due to political decisions, the ERDF Calls were either not even published, or they were cancelled during the evaluation of the proposed projects. This extremely unhealthy situation diminished our efforts in acquiring the new infrastructure using the ERDF funds.

IGTSAS applied with 6 project proposals within 2 ERDF Calls as listed below:

<p>Call code OPVaIVA/DP/2016/1.2.1-02 Call for support of industrial R&D centers in RIS3 SK 2014-2020 specialization (PVVC)</p>
<p>Industrial R&D centre of advanced methods for elimination of persistent organic pollutants from environment (2016-2023), ITMS code: NFP313010C048 Principal investigator: Environcentrum s.r.o., Košice Cooperating organizations: Institute of Geotechnics SAS, Košice Responsible investigator for IGTSAS: Dr. Daniel Kupka.</p>
<p>Industrial R&D centre of raw materials – Research & Application of Innovative Methods at Prospecting and Complex Utilize of Deposits and Wastes Containing Critical Raw Materials (GeoINTElIgence) (2017-2021) Principal investigator: GREEN VIEW, Ltd. (geology), Bratislava Cooperating organizations: Slovenská banská, spol. s r.o. (limited company, Au-Ag-Cu-Pb-Zn mining) Hodruša-Hámre, Faculty of Natural Sciences of the Comenius University, Bratislava, The Earth Science Institute SAS, Bratislava, Institute of Geotechnics SAS, Košice, Technical university in Košice. Responsible investigator for IGTSAS: Dr. Slavomír Hredzák</p>
<p>Call code OPVa-VA/DP/2016/1.2.1-03 Call for R&D proposals</p>
<p>Progressive materials for applications in energy industry in extreme conditions (2017-2021) Principal investigator: Institute of Material Research SAS, Košice Responsible investigator for IGTSAS: Dr. Slavomír Hredzák Progressive materials for application in energy industry and in extreme conditions (EXTREMAT) Academic Partners: Institute of Experimental Physics SAS, Košice, Institute of Geotechnics SAS, Košice, Institute of materials and machine mechanics SAS, Pavol Jozef Šafárik University in Kosice, Technical university of Košice Partners from industry: U. S. Steel Košice, s.r.o., EVPÚ a.s. - Electrotechnical research and projecting company, Nová Dubnica, ZTS VVÚ, a.s - Heavy Engineering Works - Research and Development Institute, Košice, SPINEA Technologies s.r.o., Prešov, MASAM, s.r.o. Vrábľa, EDIS vvd - Electronic Digital Systems Research and Development Cooperative, Košice, SPP – distribúcia, a.s. (Slovak gas industry – distribution), Bratislava, ZEOCEM, a.s. Bystré.</p>
<p>Call code OPVaIVA/DP/2018/1.2.1-05 Research-developmental project plan for support of long-term strategic research “Industry for 21st Century” (DSV)</p>
<p>Research on high capacity energy storage in the form of hydrogen in geological structures Principal investigator: The Earth Science Institute SAS, Bratislava. Cooperating organizations: Institute of Geotechnics SAS, Košice, Institute of Inorganic Chemistry SAS, Bratislava, Faculty of Civil Engineering of the Slovak University of Technology, Bratislava, Faculty of Natural Sciences of the Comenius University, Bratislava, Faculty of Science of the Pavol Jozef Šafárik University in Kosice, NAFTA, a.s. (joint stock company) Bratislava. Responsible investigator for IGTSAS: Dr. Daniel Kupka.</p>
<p>Research of effective utilization of plasma pulse for construction of non-rotating horizontal tunnel boring machine in crystalline rocks Principal investigator: VUNAR a.s. (joint stock company), Nové Zámky. Cooperating organizations: PREFA ALFA, a.s. (joint stock company), Žilina, Faculty of mechanical engineering of the Slovak University of Technology, Bratislava, Building Testing and Research Institute, n.o. (non-profit organization) Bratislava, Institute of Inorganic Chemistry SAS, Bratislava, Institute of Geotechnics SAS, Košice, ZTS INMART a.s. (joint stock company), Nové Zámky. Responsible investigator for IGTSAS: Dr. Milan Labaš.</p>

Materials for effective production, conversion, transport, storage and safety utilization of energy (M4E)

Principal investigator: Faculty of Science of the Pavol Jozef Šafárik University in Košice. Cooperating organizations: Institute of Materials Research SAS, Košice, Technical university in Košice, **Institute of Geotechnics SAS, Košice**, Institute of Experimental Physics SAS, Košice, Institute of Inorganic Chemistry SAS, Bratislava, J. Selye University, Komárno, ZEOCEM, a.s. (joint stock company) Bystré, SPINEA Technologies s.r.o. (limited company), Prešov.
Responsible investigator for IGTSAS: Dr. Slavomír Hredzák

Note: The Ministry of Education (ME) has allocated a total of 600 million euros to science and research within 2 major ERDF calls: one for Industrial Research and Development Centers (PVVC) and the other for Long-Term Strategic Research (DSV) for 288 million euros.

The first call for PVVC was completed and the ME had already contracted the most successful applicants and published their names. They could get from one to seven million euros. The media and political opposition found out that there were mostly shell companies among the beneficiaries, with no sales or only recently established ones. Police started investigation of assumed corruption.

At DSV call, the successful applicants could draw up to 40 million euros, and although they were already selected as the winning projects, they did not have time to sign the contracts. After the case investigation started, the government politicians announced that they would prefer to cancel the call. The European Commission informed Slovakia that it was suspending payments in four ERDF calls of the Operational Program Science and Research, including this one. No public universities had received any grants within the two calls (!).

2.4.6. List of other projects funded from national resources**SASPRO project**

Project SASPRO 2 (Slovak Academic and Scientific Programme) is a Horizon 2020 mobility programme for experienced researchers based at three top research and training organisations of the Slovak Republic - Slovak Academy of Sciences, Comenius University in Bratislava (partner organisation) and Slovak University of Technology in Bratislava.

Funded by a SAS project of Horizon 2020 MSCA Cofund scheme, where foreign researchers compete to apply for a long-term research projects visits at SAS institutes. IGTSAS as beneficiary was funded directly from SAS Office. SASPRO project leaders at IGTSAS delivered a number of publications, attracted foreign PhD students and induced new international cooperation projects. Dr. Melnyk stayed at the institute even after finish of the project and created a new research group attracting top students from Ukraine to PhD study at our institute.

Bifunctional Silica and Magnetite Spherical Particles with Tailored Porosity and Surface Chemistry for Complex Water Treatment

(03/2016 –12/2018)

Project: SASPRO 1298/03/01

Total funding: 222,981 € / Funding for the Institute: 222,981 €

Responsible person in the organisation: C / Ing. Miroslava Václavíková, PhD.

Fellow: Dr. Inna Melnyk

Regional government project

Note: Joint research project on demand from regional government of Bratislava Self-governing Region (BSK), funded by BSK

Decontamination of Environmental Load Bratislava - Vrakuňa - Vrakunská cesta, CHZJD Landfill: Project of Office of Bratislava Self-Governing Region, IGTSAS & Faculty of Natural Sciences, Comenius University

(07/2017 – 10/2017)

Project number:

Total funding: 125,000 € / Funding for the Institute: 75,000 €

Responsible person in the organisation: C / MVDr. Daniel Kupka, PhD.

MAD/Mobility projects
<i>Note: Bilateral projects funded by national resources involve collaboration projects based on agreements between SAS and foreign academies. MAD projects until 2020, renamed to Mobility projects since 2021 provide inter-academic mobility of researchers and cover reimbursement of travel costs of hosted researchers (MAD scheme), or provide a flat-rate budget for travelling costs for seconded researchers and research consumables (Mobility scheme).</i>
<p>Development of Innovative Processes for the Valorization of Spent Batteries (01/2016 – 12/2017) Bilateral cooperation: SAS-SK/CNR-IT Total funding: n/a / Funding for the Institute: 449 € Responsible person in the organisation: C / Ing. Alena Luptáková, PhD.</p>
<p>Mechanochemical Activation and Synthesis – an Ecological Friendly Process in the Production of Materials for Photocatalytic Air and Water Purification (01/2015 – 12/2018) Bilateral cooperation: SAS-SK/BAS-BG Total funding: 5,740 € / Funding for the Institute: 2,920 € Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.</p>
<p>Development of Magnetic Composites with Adjustable Hydrophobic and Hydrophilic Surface (04/2017 – 12/2019) Bilateral cooperation: SAS-SK/NASU-UA Total funding: 2000 € / Funding for the Institute: 0 € Responsible person in the organisation: C / Ing. Miroslava Václavíková, PhD.</p>
<p>Inorganically Modified Smectites as Multifunctional Sorbents for Target Applications in the Aqueous Environment Remediation (01/2021 – 12/2022) Bilateral cooperation: SAS-SK/CAS-CZ (Nr. Mobility SAV-AVČR-21-08) Total funding: 1500 € / Funding for the Institute: 1500 € Responsible person in the organisation: C / RNDr. Silvia Dolinská, PhD.</p>
<p>Recovery of critical raw materials from industrial wastes by advanced methods (01/2021 – 12/2022) Bilateral cooperation: SAS-SK/CNR-IT (Nr. Mobility CNR-SAV-20-02) Total funding: 3000 € / Funding for the Institute: 3000 € Responsible person in the organisation: C / Ing. Alena Luptáková, PhD.</p>
<p>Insight to Local Structure of Doped/Nanocrystalline Complex Oxides by Sophisticated Physico-Chemical Methods. Educational Approach. (01/2021 – 12/2023) Bilateral cooperation: SAS-SK/BAS-BG (Nr. Mobility Mobility BAS-SAS 21-07) Total funding: 4000 € / Funding for the Institute: 4000 € Responsible person in the organisation: C / RNDr. Martin Fabián, PhD.</p>
National Scholarship Programme of Slovak Republic, SAIA Agency
<i>Research stays funded by SAIA, funding either hosting other researchers at IGTSAS or secondments from IGTSAS to foreign universities/institutes.</i>
<i>Note: NSP projects that were submitted, however not funded are listed in Chapter 2.4.1 Additional info section.</i>
NSP hosted researchers at IGTSAS
<p>Smart solid-state synthesis of nanostructured complex oxides via combined mechanochemical - thermal routes for energy related application National Scholarship Programme of the Slovak Republic (08/2018-10/2018) Principal investigator at IGTSAS: W/ prof. RNDr. Peter Baláž, DrSc. Fellow: prof. Mamoru Senna, Keio University, Tokyo, Japan</p>

<p>Quaternary chalcogenide Cu₂ZnSnS₄ thin films based on the nanoink produced via a mechanochemical synthesis</p> <p>National Scholarship Programme of the Slovak Republic (09/2018-12/2018) Principal investigator at IGTSAS: W/ prof. RNDr. Peter Baláž, DrSc. Fellow: Dr. Oleksander Dobrozhan, Sumy State University, Sumy, UA</p>
<p>Kinetic potentiometric determination of boron in soils after its extraction with α-hydroxy acids</p> <p>National Scholarship Programme of the Slovak Republic (07/2018-09/2018) Principal investigator at IGTSAS: W/ MVDr. Daniel Kupka, PhD. Fellow: Maksym Fershal, PhD., Uzhhorod National University, UA</p>
<p>Magnetic hysteresis behavior on BiFeO₃ Perovskite System Prepared by One-Step Synthesis</p> <p>National Scholarship Programme of the Slovak Republic (12/2018-03/2019) Principal investigator at IGTSAS: W/ RNDr. Martin Fabián, PhD. Fellow: Dr. Klebson Lucenildo da Silva, UEM, Paraná, Brazil</p>
<p>Mechanochemically activated luminescence in Ga₂O₃-based ceramics</p> <p>National Scholarship Programme of the Slovak Republic, 05/2019-08/2019 Principal investigator at IGTSAS: Mgr. Zdenka Lukáčová Bujňáková, PhD., Fellow: prof. Józef Cebulski, Center of Microelectronics and Nanotechnology, University of Rzeszow, PL</p>
<p>High-energy mechanical milling-driven amorphization in multiparticulate arsenical nanocomposites with anticancer activity</p> <p>National Scholarship Programme of the Slovak Republic (02/2019-11/2019) Principal investigator at IGTSAS: W/ Mgr. Zdenka Lukáčová Bujňáková, PhD. Fellow: prof. Oleh Shpotyuk, Lviv Scientific and Research Institute of Materials of Scientific and Research Company "ELECTRON-CARAT", Lviv, UA</p>
<p>Mechanochemically activated luminescence in Ga₂O₃-based ceramics</p> <p>National Scholarship Programme of the Slovak Republic (09/2020-12/2020) Principal investigator at IGTSAS: W/ prof. RNDr. Peter Baláž, DrSc., Fellow: prof. Józef Cebulski, Center of Microelectronics and Nanotechnology, University of Rzeszow, Poland</p>
<p>New doped Bioglass 60S composites for bone tissue engineering applications</p> <p>National Scholarship Programme of the Slovak Republic (09/2021-12/2021) Principal investigator at IGTSAS: W/ Inna Melnyk, PhD. Fellow: Andrii Kussyak, PhD., Zhytomyr State University of Ivan Franko, UA</p>
<p>Novel Effective Nanoscale Cloud Seeding Materials for Weather Modification</p> <p>National Scholarship Programme of the Slovak Republic (09/2021-12/2021) Principal investigator at IGTSAS: W/ Inna Melnyk, PhD. Fellow: Liudmyla Nosach, PhD., Chuiko Institute of Surface Chemistry NASU, UA</p>
<p>Creation of New Catalysts for Epoxidation Based on Mesoporous Silica Matrix Modified with Transition Metals</p> <p>National Scholarship Programme of the Slovak Republic (2021/22) Principal investigator at IGTSAS: W/ Inna Melnyk, PhD., Fellow: prof. Oksana Makota, DrSc., Lviv Polytechnic National University, UA</p>
<p>NSP seconded researchers from IGTSAS</p>
<p>Identification of acidophilic microorganisms from natural matrices burdened by mining and metallurgical activities in selected localities in the Slovak Republic</p> <p>The National Scholarship Programme of the Slovak Republic (09/2019) Masaryk University, Brno, Czech republic Fellow: Mgr. Lenka Hagarová</p>
<p>Synthesis of nanomaterials based on graphene oxide for environmental applications</p> <p>National Scholarship Programme of Slovak republic (03/2019) Aristotle University of Thessaloniki, School of Chemistry, Greece Fellow: Ing. Dominika Behunová</p>

Fellowship projects from different funds
<p>Composite materials based on TiO₂ and activated carbon for elimination and photodegradation of adsorbable organic halogens (03/2020 – 05/2020), Austria Project number: ICM-2019-16133, SAIA, Aktion Austria - Slovakia: Ernst Mach Grant of the Action for doctoral/PhD students Total funding: 3150 € Fellow: Mgr. Halyna Yankovych</p>
<p>Li-ion dynamics in complex oxides prepared by mechanochemical route (09/2020 – 02/2021), Austria Project number: ERASMUS+ SMP-3/2020/21 Total funding: 2147€ Fellow: Mgr. Olha Skurikhina</p>
<p>Li+/Na+ pyroxenes as potential materials for energy storage industry (07/2021– 11/2021), Austria Project number: Project OeAD, 79642 Total funding: 5250 € Fellow: Mgr. Olha Skurikhina</p>
<p>Hybrid composites for the removal of heavy metals from industrial water (11/2021– 12/2021), Turkey Project number: PROM 2019 Total funding: 1566 € Fellow: Mgr. Viktoriia Kyshkarova</p>

2.4.7. List of projects funded from private funds

<p>Complex research on wastewater treatment at U.S.Steel Košice (2018-2019) Funding partner: U.S.Steel Košice, s.r.o. Total funding: 4307 € / Funding for the Institute: 4307 € Responsible person in the organisation: C / MVDr. Daniel Kupka, PhD. <i>Note: See Chapter 2.6.1 Case Study: U.S.Steel.</i></p>
<p>Research project of biodegradation rates of organic pollution in real samples of subsoil (2017) Project number : Contract Nr. 1/0522/2017 Funding partner: Penta Investments SKYPARK, s.r.o., Bratislava Total funding: 4,695 € / Funding for the Institute: 4,695 € Responsible person in the organisation: C / MVDr. Daniel Kupka, PhD. <i>Note: Contractor invited IGTSAS to investigate and perform biodegradation tests of organic pollution in the subsoil of former Apollo Refinery, where the construction of a multifunctional buildings complex was planned. The samples were taken from an area where pollutants leaked into the rock environment and subsequently into groundwaters.</i></p>
<p>Remediation of Environmental Load Bratislava - Vrakuňa - Vrakunská cesta, CHZJD Landfill (2020-2021) Total funding: 30,000,000 € (expected from Ministry of Environment (ME) for whole remediation project). Pilot testing was covered by resources of Environcentrum, s.r.o., GEOTEST, a.s. and IGTSAS). The remediation project was stopped by Ministry of Environment.</p>

2.4.8. List of projects funded from other competitive funds

International Visegrad Fund
<i>Note: The International Visegrad Fund supports regional cooperation between civil society organizations to advance their relations, exchange and share ideas and promote mutual understanding since 2005. The Fund's annual budget is 10 million € provided by equal contributions of the V4 governments (SK, CZ, PL, HU). On ad hoc basis, the Fund also administers financial contributions from third countries dedicated to Visegrad+ projects.</i>
Environmentally Friendly Synthesis of Nanocomposites Based on Eggshell Waste and Silver Nanoparticles with Biological Activity Using Ball Milling (09/2020 – 06/2021) Project number : IVF 52010810 Cooperating partner: Poland Total funding: 5,000 € / Funding for the Institute: 5,000 € Responsible person in the organisation: C / RNDr. Matej Baláž, PhD.
Creation and Characterization of Multifunctional Polymer Nanocomposite Coatings on the Surface of Textile Materials for the Water Filtration Process (03/2021 – 07/2021) Project number : IVF 52010756 Cooperating partner: Ukraine Total funding: 4000 € / Funding for the Institute: 1500 € Responsible person in the organisation: C / Inna Melnyk, PhD.
Structure-Function Relationship of Advanced Nanooxides for Energy Storage Devices (10/2015 – 09/2018) Project: V4-Japan Joint Research Program on Advanced Materials - AdOX Cooperating partners: Czech Republic, Japan, Poland Total funding: 510,800 € / Funding for the Institute: 120,000 € Responsible person in the organisation: W / prof. RNDr. V. Šepelák, DrSc.
Kazakh Fund for Bilateral Projects
<i>Note: Competitive fund of Kazakh Ministry of Education funded by National Center of Science and Technology Evaluation, Kazakhstan</i>
Mechanochemical synthesis of binary nanosulfides with various shapes for remediation of wastewater (01/2021-12/2021) National Center of Science and Technology Evaluation, Kazakhstan, Pr.Nr. AP09563428 Cooperating partners: Al-Farabi Kazakh National University, Almaty, Kazakhstan Total funding: 15,488 € / Funding for the Institute: 1,375 € Responsible person in the organisation: C / RNDr. Matej Baláž, PhD.

2.5. PhD studies and educational activities

IGTSAS offers joint PhD programme with the Faculty of Materials, Metallurgy and Recycling of the Technical University in Košice, which recorded significant changes in 2019 due to the changes in legislation. Until 31.08.2019, the IGTSAS offered the doctoral study in the accredited programme **Metallurgy (code 5.2.39)**. Since September 2019, the new legislation came into force and the study programme Metallurgy has been included within the study field **Extraction and Processing of Earth Resources (code 2118)**. The doctoral program covers the wide range of topics related to mineral processing, separation technologies, mineral biotechnology, development of new materials including nanomaterials and composite adsorbents, catalytic materials and semiconductors, environmental remediation of industrial sites, water and soil treatment, air, water and soil pollution assessment, etc.

IGTSAS belongs to top level research institutions and disposes with a mass of advanced elementary laboratory facilities as well as software, mathematical, programming, processing

and analysing tools, which are essential for successful implementation of experimentally based research theses. IGTSAS offers the high quality complementary training in experimental and analytical techniques, processing of research data, publishing, presentation, communication and language skills.

Please note: PhD rules and limits given by SAS and educational system in Slovakia

Graduates of master degree in engineering or natural science apply for PhD study. The PhD study usually takes 4 years in full-time form (internal with scholarship) or 5 years in external form (no scholarship). Limits for PhD admissions restricted by SAS rules: Maximum 2 new admitted PhD students per year, maximum total 10 PhD students annually (limit valid for 23 potential supervisors at IGTSAS). In case of lack of new PhD applicants within whole academy of sciences, it is possible for us to apply for exception at SAS to acquire 1 additional PhD position (giving max. 3 new admitted PhD students annually).

2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

During the assessed period the IGTSAS provided the accredited joint doctoral study program in cooperation with the Faculty of Materials, Metallurgy and Recycling of the Technical University of Košice:

Accredited programme of PhD study	Period of validity	Funding source
study programme Metallurgy within the study field 5.2.39 Metallurgy	Until Aug 31, 2019	SAS budget
study programme Metallurgy within the study field 2118 Extraction and Processing of Earth Resources	From Sep 1, 2019	SAS budget

2.5.2. Summary table on doctoral studies (number of internal/external PhD students at the end of the year; number of foreign PhD students, number of students who successfully completed their theses during the year, number of PhD students who quit the programme during the year)

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors																		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	10	0	0	9	2	0	10	2	0	9	4	0	9	1	0	8	2	0
from which foreign citizens	0	0	0	0	0	0	2	0	0	3	0	0	4	0	0	4	0	0
External	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other supervised by the research employees of the institute	3	1	0	2	0	0	2	1	0	3	2	0	3	0	0	5	0	0

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

Nr.	PhD students from accreditation period
1	<p>Determination of Industrial Persistent Pollutants by Mass Spectrometry (09/2013 – 08/2017) Mgr. Dávid Jáger, supervisor: MVDr. Daniel Kupka, PhD. Research fellow at DMB since finishing PhD study. Focused on HPLC-MS, participated in FP7-WaSClean and Vrakuňa projects, co-authored one of Top-3 scientific outputs of IGTSAS (see 2.1.1).</p>
2	<p>Bioremediation of Environmental Contamination by Autochthonous Bacteria (09/2013 – 08/2017) Ing. Štyriaková Darina, supervisor: MVDr. Daniel Kupka, PhD. After quitting IGTSAS she continued working at Ekolive, s.r.o., a start-up bioremediation company. Since 2020 she works also as a research associate at Slovenian National Building and Civil Engineering Institute, Ljubljana.</p>
3	<p>The Use of Magnesite in Water Purification (09/2013 – 06/2018) Mgr. František Bendek, supervisor: Ing. Miroslava Václavíková, PhD. Works in Public Service since finishing his PhD study.</p>
4	<p>Removal of Xenobiotics from Industrially Contaminated Soils and Waters (03/2014 – 08/2019) MVDr. Jana Tomčová, supervisor: Ing. Miroslava Václavíková, PhD. After PhD. study she continued her research efforts at the Department of Epizootiology, Parasitology and Protection of One Health, University of Veterinary Medicine and Pharmacy in Košice. She deals with molecular genetic analysis of selected pathogens (bacteria and viruses – coronaviruses, flaviviruses, hantaviruses, lyssaviruses); isolation of nuclear RNAs (DNA, RNA) from clinical samples and their spectrophotometric analysis, including the synthesis of gels and their subsequent identification.</p>
5	<p>Diversity of Culturable and Non-Culturable Bacteria in Matrices Contaminated with Metals and Organic Pollutants (09/2014 – 03/2021) Mgr. Lenka Hagarová, supervisor: MVDr. Daniel Kupka, PhD. Research fellow at the DMB since April 2021 after PhD study. Her focus involves microbiological analyses of soils, waters and sediments using cultivation techniques as well as molecular biology methods such as DNA isolation, DNA quality control, PCR and sequencing.</p>
6	<p>Use of Iron Cycle in Bioleaching and Bioremediation Processes (09/2014 – 08/2018) Ing. Jaroslav Šuba, supervisor: Ing. Iveta Štyriaková, PhD. / Ing. Zuzana Danková, PhD. After PhD study he continued working in Ekolive, s.r.o., an innovative bio-remediation start-up company</p>
7	<p>Synthetic Nanoparticles in Water and Soil Clean-up and Their Interaction with Environment (09/2015 – 08/2019) Ing. Dominika Marcin Behunová, supervisor: Ing. Miroslava Václavíková, PhD. Research fellow at DMMP after PhD, participated in FP7-WaSClean, H2020-NanoMed, focusing on synthetic carbon nanomaterials (graphene oxide) and the degradation of pollutants by electrochemical oxidation technique. She was trained and became a specialist in SEM/EDX analyses.</p>
8	<p>Removal of Organic Pollutants from Industrial Waste Water by Selected Species of Sulfur Bacteria (09/2015 – 08/2019) Ing. Dominika Rudzanová, supervisor: Ing. Alena Luptáková, PhD. Since graduating from PhD, she has been working at T-Systems Slovakia in Košice in network engineering.</p>

9	<p>Mechanochemical Processing of Natural and Synthetic Copper Minerals (09/2015 – 08/2019) Ing. Matej Tešínský, supervisor: Dr.h.c. prof. RNDr. Peter Baláž, DrSc. Works in a private company since PhD finish.</p>
10	<p>Identification of Microbial Communities in Environmental Matrices by Non-cultivation Methods (09/2016 – 08/2020) Mgr. Zuzana Bárťová, supervisor: MVDr. Daniel Kupka, PhD. Research fellow at DMB after PhD study. Her research is focused on removal of environmental burdens and optimization of bioleaching processes in-vitro and in-vivo/in-situ.</p>
11	<p>Analysis of Industrial Pollutants and Their Degradation Products Using Mass Spectrometry (09/2017 – 12/2021) Mgr. Gergő Bodnár, supervisor: MVDr. Daniel Kupka, PhD. After PhD study he worked as a research fellow at DMB focusing on HPLC-MS and mineral biotechnologies for remediation of environmental pollution. Recently in 2022 decided to leave to work as research and development scientist and HPLC-MS specialist for ThermoFisher Scientific.</p>
On-going PhD studies	
12	<p>Composite Materials for Elimination of Industrial Contaminants from Environment (09/2018 – 08/2022) Halyna Yankovych, supervisor: Ing. Miroslava Václavíková, PhD.</p>
13	<p>Use of Selected Plants for Mechanochemical Synthesis of Silver Nanoparticles and Adsorption of Heavy Metal Ions (09/2018 – 08/2022) Mgr. Mária Kováčová, supervisor: RNDr. Matej Baláž, PhD.</p>
14	<p>Novel Preparation, Characterization and Physico-Chemical Properties of Li-, Na- Pyroxenes (10/2018 – 09/2022) Mgr. Olha Skurikhina, supervisor: Mgr. Marcela Achimovičová, PhD.</p>
15	<p>Hydrometallurgy and Mechanochemical Synthesis of Selected Metal Selenides (09/2019 – 08/2023) Mgr. Katarína Gáborová, supervisor: Mgr. Marcela Achimovičová, PhD.</p>
16	<p>Polymer Hybrid Composites for Removal of Heavy Metals from Industrial Waste Water (09/2019 – 08/2023) Viktoriia Kyshkarova, supervisor: Inna Melnyk, PhD.</p>
17	<p>Study of Interactions of Nanomaterials with Biological Systems (09/2019 – 08/2023) Mgr. Martin Stahorský, supervisor: RNDr. Matej Baláž, PhD.</p>
18	<p>Preparation and Study of New Types of Materials for Their Potential Use in Production and Storage of Green Energy (09/2020 – 08/2024) Mgr. Olena Porodko, supervisor: RNDr. Martin Fabián, PhD.</p>
19	<p>Heavy Metals and Organic Pollutants in Solid Phase Aerosols and Atmospheric Deposition (09/2021 – 08/2025) Mgr. Petra Červeňáková, supervisor: Ing. Jozef Hančulák, PhD.</p>

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)*	48	26	14	24	29	33
Practicum courses (hours/year)*	26	0	0	13	13	13
Supervised diploma and bachelor thesis (in total)	8	5	7	2	1	2
Members in PhD committees (in total)	20	28	17	32	11	14
Members in DrSc. committees (in total)	0	0	0	0	0	0
Members in university/faculty councils (in total)	2	2	2	3	2	2
Members in habilitation/inauguration committees (in total)	5	1	2	2	3	2

2.5.5. List of published university textbooks

2.5.6. Number of published academic course books

2.5.7. List of joint research laboratories/facilities with universities

PROMATECH – Research Centre of Progressive Materials and Technologies for Current and Future Applications
<p>The Institute is a member of national research consortium PROMATECH funded by ERDF funds PROMATECH provides the unique platform to share knowledge within the consortium with the aim of development of new technologies and knowledge transfer to industries. PROMATECH project connected several academic institutions, such as Institute of Geotechnics SAS, Institute of Material Research SAS, Institute of Experimental Physics SAS, Institute of Materials and Machine Mechanics SAS and the universities located in Košice: University of P. J. Šafárik and Technical University in Košice In the recently constructed PROMATECH building in the SAS Campus in Košice, IGTSAS has established 4 laboratories:</p> <p>Mechanochemical Laboratory is dedicated to developing new attractive nanomaterials based on minerals and inorganic substances.</p> <p>Laboratory of Solid State Aerosols and Sediments is focused on the research of solid phase aerosols and contaminants in nature and work environments, atmospheric deposition and bottom sediments in rivers and reservoirs.</p> <p>Laboratory of Mineral Biotechnology is dedicated to the study of biotic components activities in geochemical processes in the top of Earth's geosphere.</p> <p>Physico-Chemical Laboratory focuses on research in the field of sorption technologies, for synthesis and testing of mineral sorbents.</p>
VIB Lab - Laboratory for Research and Innovations of Batteries
<p>Agreement on establishment of new laboratory for research and innovation of batteries was settled in August 2021 as cooperation between the Faculty of Materials, Metallurgy and Recycling at Technical University of Košice, IGTSAS and Institute of Materials SAS. The laboratory opened its door in April 2022 serving for characterization of electrochemical properties of synthesized materials (electrodes and electrolytes) for ion batteries, research of battery safety, electrode material life prediction, synthesis of anode materials based on oxides, mainly with a spinel structure (LTO, high-anthropic oxides) and the study of the influence of composition and morphology on electrochemical properties.</p>

Joint laboratory of Transmission Electron Microscopy (TEM)
TEM lab and laboratory for samples preparation are located in the Institute of Physics in the Faculty of Science UPJŠ, in collaboration with Institute of Experimental Physics SAS, Institute of Material Research SAS and Technical University of Košice. Currently, the study of relation between the structure and physical properties of amorphous metallic glasses and nanocrystalline metals prepared by primary crystallization of amorphous metals is crucial. Knowledge of the details of the structure of prepared materials is therefore a prerequisite for using electron microscopy for fulfilling of realised research. The expansion of research on other unconventional materials (e.g. a thin films or powder materials) is planned in the near future, which will have a great potential for practical application. Sophisticated transmission electron microscope JEOL JEM-2100F UHR is designed for ultra-high resolution with excellent analytical capabilities.
Development and Realisation Workplace of Raw Materials Extracting and Treatment (VRP)
IGTSAS is establishing partner of VRP and a partner of National Platform for Research, Development and Innovations of Raw Materials, established by Technical University of Košice (member of The European Technology Platform on Sustainable Mineral Resources), which strongly supports the collaboration with industry. The laboratories of IGTSAS are open for universities (Technical University of Košice, Department of Geology of Mineral Deposits, Faculty of Natural Sciences, Comenius University Bratislava) and industrial members of VRP for consulting and joint research activities.
Joint R&D Lab for Raw Materials Processing
Established in 2020 within the implementation of the EIT-BioLeach project in cooperation with Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice. The laboratory is placed in the semipilot-testing hall of the Institute of Earth Resources TUKE, equipped with mineral processing devices (crushing, milling), separation (magnetic, gravitation separation, flotation, etc.) of minerals, wastes and secondary raw materials. (See Chapter 2.6.1 Case Study BioLeach).
Joint Laboratory of Scanning Electron Microscopy (SEM)
The Laboratory was established by agreement signed between IGTSAS and Institute of Experimental Physics SAS on Oct 30, 2011. The contribution of IGTSAS to lab is Scanning Electron Microscope with field emission cathode TESCAN MIRA 3 FE (TESCAN, Czech Republic). IEP SAS purchased energy dispersive and wavelength dispersive X-ray microanalysis system (EDX, WDX, EBSD – Oxford Instruments, UK) – analysis range ${}^4\text{B}$ – ${}_{92}\text{U}$.
GeoBioLab – Laboratory for geology and biotechnologies in environment
GeoBioLab was established in January 2017 in cooperation with Environcentrum, s.r.o., a company dealing with geological and hydrogeological exploration of environment, remediation of the geological environment, oil decontamination and bioremediation, etc. The laboratory has been active within many research projects cooperating with industrial partners, e.g. FP7-WaSClean, BSK-Vrakuňa, Penta Investments SkyPark, U.S.Steel, etc. (See Chapter 2.6.1 Case Study Vrakuňa, WaSClean).

2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

In 2018, Ministry of Education changed the system of PhD studies in non-higher education institutions. On September 1, 2019, a new system of study fields was introduced and the former study field **5.2.39 Metallurgy** was replaced by a new study field **2118 Extraction and Processing of Earth Resources**.

In accordance with the Internal Quality Assurance System for PhD Study in SAS Organizations, valid since November 2019, the management of the IGTSAS and the Scientific Board developed the **Internal Quality Assessment System for PhD Study**. Dr. Miroslava Vaclavikova acts as a guarantor of the doctoral study at the institute.

The priority of IGTSAS is to ensure a high level of PhD study based on the selection of quality supervisors and applicants and quality control and outputs of individual students, which takes place continuously, as well as in the Annual PhD seminars in English. PhD students are assessed annually and participate at regular student scientific conferences Metallurgy Junior, organized by the Faculty of Materials, Metallurgy and Recycling TU Košice. Since successful implementation of the SASPRO Bisilmag project, 4 top students from Ukraine were attracted to PhD study at IGTSAS bringing new experience to the institute.

DoktoGrant

Since 2019, Slovak Academy of Sciences has introduced a **DoktoGrant**, a competitive scheme for additional funding of daily form PhD students active in SAS. The grant is awarded to cover partially or fully the financial costs of a scientific project forming an integral part of the PhD student's research topic. Grants are awarded for 1 calendar year with possible repeated funding. Within one calendar year, approximately 30 grants are awarded at a maximum of 2,000 Eur per grant. IGTSAS' PhD students have been active since very beginning - applied for 7 grants (6 awarded).

Nr.	SAS Grants for PhD Students
1.	Study the growth kinetics of the bacterial isolate Acidithiobacillus ferrivorans SS3 at suboptimal temperatures simulating the real conditions of acid mine drainage (01/2020 – 02/2021) Project number: DoktoGrant APP0026 Responsible person: Mgr. Lenka Hagarová
2.	Study of possibilities of mechanochemical synthesis of selenide silver - a semiconductor for energy storage (01/2021 – 12/2021) Project number: DoktoGrant APP0180 Responsible person: Mgr. Katarína Gáborová
3.	SiO₂/polymer hybrid composites for complex purification of industrial water (01/2021 – 12/2021) Project number: DoktoGrant APP0141 Responsible person: Mgr. Viktoriia Kyshkarova
4.	Study of the interaction of mechanochemically prepared copper nanosulfides with biological systems (01/2021 – 12/2021) Project number: DoktoGrant APP0233 Responsible person: Mgr. Martin Stahorský
5.	Granular activated carbon enriched with photocatalyst for halogenophenol adsorption /decomposition (01/2021 – 12/2021) Project number: DoktoGrant APP0142 Responsible person: Mgr. Halina Yankovych
6.	Mechanochemical preparation of stable CuS nanosuspension nanoparticles in casein solution using the Taguchi method (01/2022 – 12/2022) Project number: DoktoGrant APP0330 Responsible person: Mgr. Martin Stahorský <i>Note: (applied & awarded in 2021)</i>
7.	Mechanochemical process applied for synthesis and amorphization of Li/Na-based pyroxenes (01/2020 – 12/2020) Project number: DoktoGrant APP0034 Responsible person: Mgr. Olha Skurikhina <i>Note: applied in 2019, not awarded</i>

PhD secondments

PhD students are encouraged to expand their research interests by secondments within implemented projects or by applications in competitive funding of various fellowships/scholarships. Foreign PhD students are welcome at IGTSAS and its laboratories offering full access to research infrastructure.

List of PhD fellows seconded from IGTSAS				
PhD student	Hosting institution	Year	Days count	Project involved
Dominika Behunová	HERMES S.A., Thessaloniki, GR	2016	61	FP7-WaSClean
Matej Tešínský	Institute for Mineral and Waste Processing, Clausthal University of Technology, DE	2016	30	IB-COMSTRUC-010
Dominika Behunová	HERMES S.A., Thessaloniki, GR	2017	61	FP7-WaSClean
Matej Tešínský	Institute for Mineral and Waste Processing, Clausthal University of Technology, DE	2017	60	IB-COMSTRUC-010
Dominika Rudzanová	Institute of Environmental Geology and Geoingeneering, CNR, Rome, IT	2017	10	MAD
Lenka Hagarová	Masaryk University, Brno, CZ	2019	30	National Scholarship Programme of the Slovak Republic, SAIA
Dominika Behunová	Ecosorbent, Chisinau, Moldova	2018	30	H2020-MSCA-RISE-2016, No. 734641-NanoMed
Dominika Behunová	Ecosorbent, Chisinau, Moldova	2019	30	H2020-MSCA-RISE-2016, No. 734641-NanoMed
Zuzana Bártová	Masaryk University, Brno, CZ	2020	6	VEGA 2/0142/19
Lenka Hagarová	Masaryk University, Brno, CZ	2020	6	VEGA 2/0142/19
Olha Skurikhina	Graz University of Technology, Graz, AT	2020	90	Erasmus+ SMP-3/2020/21 Student Mobility for Traineeship
Halyna Yankovych	Salzburg, AT	2020	92	Ernst Mach Grant for the Action for PhD students (ICM-2019-16133)
Katarína Gáborová	Institute of Physics CAS, Prague, CZ	2021	5	APVV / MULTINANO 18-0357
Viktoriiia Kyshkarova	Cracow University of Technology, PL	2021	10	PROM-2019 Polish Mobility Programme
Olha Skurikhina	Graz University of Technology, Graz, AT	2021	188	Erasmus+ SK KOSICE03 Student Mobility for Traineeship
Olha Skurikhina	Graz University of Technology, Graz, AT	2021	5	OeAF 79642 Austrian Agency for Intl.Mobility
Halyna Yankovych	Technology Ltd, Kiev, UA	2021	30	H2020-MSCA-RISE-2016, No. 734641-NanoMed

List of PhD fellows hosted at IGTSAS				
PhD student	Sending institution	Year	Days count	Project involved
Ing. David Längauer	Faculty of Mining and Geology, VŠB – TU Ostrava, CZ	2018	122	Erasmus
Mgr. Zhandos Shalabayev	Al-Farabi Kazakh National University, Almaty, KZ	2018	61	Scholarship provided By Al-Farabi Kazakh National University
Mgr. Zhandos Shalabayev	Al-Farabi Kazakh National University, Almaty, KZ	2019	22	Scholarship provided By Al-Farabi Kazakh National University
Mgr. Lyazzat Mussapirova	Al-Farabi Kazakh National University, Almaty, KZ	2019	41	Scholarship provided By Al-Farabi Kazakh National University
Ing. David Längauer	Faculty of Mining and Geology, VŠB – TU Ostrava, CZ	2019	31	Erasmus
Ing. Věra Vrlíková	Faculty of Mining and Geology, VŠB – TU Ostrava, CZ	2019	12	Student Grant Project SV5119971 Waste from mining activities - raw material resources
Ing. Filip Kovár	Faculty of Materials Science and Technology, VŠBTU Ostrava, CZ	2021	6	Erasmus
Mgr. Victoriya Novoseltseva	Odessa National Academy of Food Technologies, UA	2019	61	National Scholarship Programme of the Slovak Republic, SAIA

PhD conference Metalurgia Junior

PhD students actively participated in the **PhD conference** 2017, 2018 and 2019. The conference was organized by the Faculty of Materials, Metallurgy and Recycling, Technical University of Košice:

2017
Mgr. Zuzana Bártoová: Cultivation of <i>Acidithiobacillus ferrivorans</i> from acid mine waters from the Smolník locality Ing. Dominika Rudzanová: Potential use of sulfate-reducing bacteria in the removal of organic pollutants Ing. Matej Tešínský: Influence of mechanical activation on chalcopyrite leaching in hydrochloric acid
2018
Mgr. Zuzana Bártoová: Autotrophic growth and CO ₂ fixation of iron oxidizing bacteria Ing. Dominika Behunová: Synthesis and Characterization of Graphene Oxide Material and their Application in Environment Mgr. Gergő Bodnár: Electrochemical Oxidation of Atrazine Mgr. Lenka Hagarová: Molecular Identification and Data Processing in Phylogenetic Study of Extreme Acidophiles from Metal-rich Environments Ing. Dominika Rudzanová: Possibilities of Biodegradation of Phenol by Sulphate-Reducing Bacteria from Model Solutions Ing. Matej Tešínský: Mechanochemical Reduction of Natural and Synthetic Sulphidic Copper-bearing Minerals in an Industrial Scale MVDr. Jana Tomčová: Determination of the PAH in Soil Contaminated with Coal Tar
2019
Mgr. Zuzana Bártoová: Study of bacterial culture growth kinetics (<i>Acidithiobacillus ferrivorans</i> SS3 and iron oxidation (Fe ²⁺) in mineral medium Mgr. Gergő Bodnár: Groundwater pollution under the Bratislava-Vrakuňa landfill and possibilities for their remediation

Mgr. Lenka Hagarová: Batch cultivation of *Acidithiobacillus ferrivorans* SS3 and production hydroxysulphate minerals
 Mgr. Mária Kováčová: Bio-mechanochemical synthesis of silver nanoparticles using *Thymus vulgaris* L.
 Mgr. Olha Skurikhina: Nanooxides for Energy
 Mgr. Halyna Yankovych: Adsorption of Organic Halides by Granular Active coal

University education

IGTSAS scientists actively participate in the education process of the following universities:

- Technical University of Košice - Faculty of Materials, Metallurgy and Recycling; Faculty of Mining, Ecology, Management and Geotechnology; Faculty of Civil Engineering,
- University of P.J.Šafárik in Košice,
- Al-Farabi Kazakh National University, Almaty, Kazakhstan,
- VSB – Technical University of Ostrava, Czech republic.

Lectures of study courses: Impact of industrial activities on the environment, Physical engineering, Solid state chemistry, Geophysics in geotechnics, Magnetism of substances, Environmental studies, Laboratory methods of geological research, Electron microscopy, Transport constructions and geotechnics, Mechanochemistry.

Scientists and PhD students also participate in the education at primary and secondary schools, giving scientific-popularization lectures and practical demonstrations of selected experiments (See Chapter 2.7 Popularization activities).

Senior researchers of IGTSAS regularly supervise the bachelor, diploma/master of PhD theses at the universities, offering their experience, skills and research infrastructure to students:

Supervised/consulted bachelor theses

MVDr. Daniel Kupka, PhD.

- Daniela Záhoráková: Analytical methods for the purity control of drugs and food supplements in pharmaceutical production. Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016
- Radka Fogarašová: Analysis of toxic substances in natural and synthetic drugs. Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016
- Imrich Czére: Application of bacteria in electronic waste recycling. Faculty of Materials Science and Technology in Trnava. The Slovak University of Technology in Bratislava, 2018
- Martina Dzurová: Organic and inorganic pollutants in natural surface waters. Faculty of Science, Pavol Jozef Šafárik University in Košice, 2021
- Laura Jágerová: Identification and quantification of PAH's by HPLC-MS in environmental matrices. Metropolitan University College, Copenhagen, Denmark, 2018. Metropolitan University College, Copenhagen, Denmark, 2018

Supervised/consulted diploma (master) theses

RNDr. Matej Baláž, PhD

- Barbora Selepová: Nanopharmacy, University of Veterinary Medicine and Pharmacy in Košice, 2016
- Miriama Balážová: Biosynthesis of nanoparticles using plant extracts, University of Veterinary Medicine and Pharmacy in Košice, 2016-2017
- Mária Vargová: Synthesis of nanoparticles using selected plant extracts and their antimicrobial activity, University of Veterinary Medicine and Pharmacy in Košice, 2016-2018
- Bc. Michal Hegedüs: Mechanochemical synthesis of chalcogenide nanocrystals for photovoltaic applications, Pavol Jozef Šafárik University in Košice, 2016-2018
- Gorazd Brosch: Green synthesis of golden nanoparticles, University of Veterinary Medicine and Pharmacy in Košice, 2017-2019
- Veronika Vernusová: Comparison of selected extraction methods, University of Veterinary Medicine and Pharmacy in Košice, 2017-2019
- Patrik Siksa: Biomechanochemical synthesis of silver nanoparticles, University of Veterinary Medicine and Pharmacy in Košice, 2018-2020

<p>MVDr. Daniel Kupka, PhD.</p> <ul style="list-style-type: none"> • Bc. Nikola Víteková: Element analysis in the field of agricultural and food production. Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016 • Bc. Renáta Bodnárová: Spectral analysis of selected elements in the field of natural medicine. Faculty of Science, Pavol Jozef Šafárik University in Košice, 2016
<p>Ing. Alena Luptáková, PhD.</p> <ul style="list-style-type: none"> • Bc. Adriana Čikotová: Mining waters and the environment. Faculty of Materials, Metallurgy and Recycling at Technical University of Košice, 2021
<p>Supervised/consulted PhD theses outside IGTSAS</p>
<p>Ing. Alena Luptáková, PhD.</p> <ul style="list-style-type: none"> • Ing. Michaela Smoláková: Study of the resistance of cement composites to selected aggressive environments. Faculty of Civil Engineering of the Technical University of Košice, 2016 – 2019, defended 2019 • Ing. Martina Kovalčíková: Study of sulphate corrosion of cement composites. Faculty of Civil Engineering of the Technical University of Košice, defended 2016 • Ing. Petra Pavliková: Removal of sulphates from the aquatic environment. Faculty of Civil Engineering of the Technical University of Košice, 2016 – 2018, defended 2018 • Ing. Miriama Hološová: Study of biocorrosion of cement composites. Faculty of Civil Engineering of the Technical University of Košice, 2020 – 2023 • Mgr. Miroslava Lachka: Influence of variable magnetic field on metabolism and induction of genetic changes of selected organisms with possible application in industry. Faculty of Natural Sciences, University of Saints Cyril and Methodius in Trnava, 2021 - 2024
<p>RNDr. Matej Baláž, PhD.</p> <ul style="list-style-type: none"> • Mgr. Zhandos Shalabayev: Solid-phase and liquid-phase preparation of sulfur nanoparticles and their composites: properties study and application fields, Al-Farabi Kazakh National University, Almaty, Kazakhstan, defended 2019 • Mgr. Lyazzat Mussapyrova: Technology of hydrometallurgical processing of copper smelter slag, Al-Farabi Kazakh National University, Almaty, Kazakhstan, 2019-2022 • Mgr. Natalya Khan: Development of the synthesis technology of nanocomposites S/AgX/Ag (AgX= Cl, Br, I), Al-Farabi Kazakh National University, Almaty, Kazakhstan, 2020-2022 • Mgr. Gairat Burashev: Mechanochemical preparation and properties of nanocomposites based on zinc and cadmium sulphides, 2021-2023

Appointed members of state examination boards for bachelor's and master's examination		
Name	Stuffy field / program	Faculty / university
Matej Baláž	Pharmacy	University of Veterinary Medicine and Pharmacy in Košice
	Materials	Faculty of Materials, Metallurgy and Recycling, TU Košice
Zuzana Bártová	Biology / Genetics and molecular cytology	Institute of Biology and Ecology Faculty of Sciences, P.J. Šafárik University in Košice
Jaroslav Briančin	Materials	Faculty of Materials, Metallurgy and Recycling, TU Košice
Zuzana Danková	Inorganic chemistry	Faculty of Natural Sciences, Comenius University, Bratislava
Silvia Dolinská	Waste processing and disposal	Department of Environmental Engineering, Faculty of Mining and Geology, VŠB – TU Ostrava, CZ
Slavomír Hredzák	Mineral processing and recycling	Department of Mining Engineering and Safety, Faculty of Mining and Geology, VŠB – TU Ostrava, CZ

Slavomír Hredzák	Waste processing and disposal	Department of Environmental Engineering, Faculty of Mining and Geology, VŠB – TU Ostrava, CZ
Vítězoslav Krúpa	Mining / Technologies of mining and tunnelling	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
	Mining / Rescue, fire and safety techniques	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Daniel Kupka	Mineralurgy	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Edita Lazarová	Mining geology and geological prospecting / Technologies in oil and gas industry	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Alena Luptáková	Environmental engineering / Waste processing and recycling	Faculty of Materials, Metallurgy and Recycling, TU Košice
	Ecological and environmental sciences / Waste processing and recycling	Faculty of Materials, Metallurgy and Recycling, TU Košice
Alena Luptáková	Biology / Genetics and molecular cytology	Institute of Biology and Ecology Faculty of Sciences, P.J.Šafárik University in Košice
Olga Šestinová	Mineral biotechnology	Department of Environmental Engineering, Faculty of Mining and Geology, VŠB – TU Ostrava, CZ
	Environmental engineering	Faculty of Civil Engineering TU Košice

Appointed members of Joint Committees for PhD study at universities		
Name	Study Field	Faculty , University
Peter Baláž	Inorganic Chemistry	Faculty of Science University of P.J.Šafárik, Košice
	Minerallurgy (until 2018)	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
	Metallurgy (until 2018)	Faculty of Materials, Metallurgy and Recycling, TU Košice
Slavomír Hredzák	Mineral Processing	Faculty of Mining and Geology, VŠB-TU Ostrava
Vítězoslav Krúpa	Engineering and Transport Constructions	Faculty of Civil Engineering, TU Košice
	Mining	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Daniel Kupka	Minerallurgy	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Miroslava Václavíková	Minerallurgy (until 2017)	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice

Edita Lazarová	Mining Mechanization, Transport and Deep Drilling	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
	Engineering and Transport Constructions	Faculty of Civil Engineering, TU Košice
	Extraction and Processing of Earth Resources (since 2021)	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
Alena Luptáková	Environmental Engineering until 2021	Faculty of Civil Engineering, TU Košice
	Environmental Engineering (until 2021)	Faculty of Materials, Metallurgy and Recycling, TU Košice
	Ecological and Environmental Sciences (since 2021)	Faculty of Civil Engineering, TU Košice
	Ecological and Environmental Sciences (since 2021)	Faculty of Materials, Metallurgy and Recycling, TU Košice
Jaroslav Briančin	Metallurgy (2017-2019)	Faculty of Materials, Metallurgy and Recycling, TU Košice
	Extraction and Processing of Earth Resources (since 2019)	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice

Activities of Scientific Board

Scientific Board of IGTSAS organizes annual seminars of PhD students, where students present their work progress each year. SB also organizes training presentations of PhD students just before their defence in order to get prepared. It also provides the lectures of senior scientists for knowledge exchange between the researchers, and lectures of hosted fellows during their visits to the institute:


2016
Annual PhD seminar / 8 lectures of internal PhD students: Mgr. Zuzana Bártová, Ing. Dominika Behunová, Mgr. František Bendek, Mgr. Dávid Jáger, Ing. Dominika Rudzanová, Ing. Štyriaková Darina, Ing. Jaroslav Šuba, Ing. Matej Tešínský
Lecture of Dr. Inny Melnyk / results of SASPRO project 1298/03/01. Title: Bifunctional silica and magnetite spherical particles with tailored porosity and surface chemistry for complex water treatment
Lecture of hosted fellow prof. Dr. Ing. Eberhard Gock / Clausthal University of Technology, Germany. Title: Mechanochemical synthesis of copper sulphide on a technical scale.
2017
Annual PhD seminar / 6 lectures of internal PhD students: Mgr. Zuzana Bártová, Ing. Dominika Behunová, Mgr. Gergő Bodnár, Ing. Dominika Rudzanová, Ing. Jaroslav Šuba, Ing. Matej Tešínský
Lecture of Ing. Darina Štyriaková / internal PhD student / lecture before the PhD defence Title: Bioremediation of Environmental Contamination by Autochthonous Bacteria
Lecture of Mgr. Dávid Jáger / internal PhD student / lecture before the PhD defence Title: Determination of Industrial Persistent Pollutants by Mass Spectrometry
Lecture of hosted fellow Dr. Veronika Tomina / Chuiko Institute of Surface Chemistry NASU, Kyiv, Ukraine. Title: Composite sorbents based on ceramic substrate and functional polysiloxane layers and their affinity to adsorb heavy metal ions
Lecture of RNDr. Matej Baláž, PhD., & Ing. Zuzana Danková, PhD. / Analysis of surface properties of powder substances
Lecture of Ing. Lucia Ivaničová, PhD. / Experimental laboratory drilling stand: monitoring, optimization, identification and modeling of rock drilling processes.

Lecture of Ing. Miroslava Vaclavíková, PhD. / Project preparation: from call selection through budgeting to management
2018
Annual PhD seminar / 9 lectures of internal PhD students: Mgr. Zuzana Bártová, Ing. Dominika Behunová, Mgr. Gergő Bodnár, Mgr. Mária Kováčová, Ing. Dominika Rudzanová, Ing. Matej Tešínský, MVDr. Jana Tomčová, Mgr. Olha Skurikhina, Mgr. Halyna Yankovych
Lecture of Mgr. František Bendek / internal PhD student / lecture before the PhD defence Title: The Use of Magnesite in Water Purification
Lecture of Ing. Jaroslav Šuba / internal PhD student / lecture before the PhD defence Title: Use of Iron Cycle in Bioleaching and Bioremediation Processes
2019
Annual PhD seminar / 9 lectures of internal PhD students: Mgr. Zuzana Bártová, Mgr. Gergő Bodnár, Mgr. Lenka Hagarová, Mgr. Mária Kováčová, Mgr. Martin Stahorský, Mgr. Katarína Gáborová, Mgr. Olha Skurikhina, Mgr. Halyna Yankovych, Mgr. Viktoriia Kyshkarova
Lecture of MVDr. Jana Tomčová / internal PhD student / lecture before the PhD defence Title: Removal of Xenobiotics from Industrially Contaminated Soils and Waters
Lecture of Ing. Dominika Marcin Behunová / internal PhD student / lecture before the PhD defence Title: Synthetic Nanoparticles in Water and Soil Clean-up and Their Interaction with Environment
Lecture of Ing. Dominika Rudzanová / internal PhD student / lecture before the PhD defence Title: Removal of Organic Pollutants from Industrial Waste Water by Selected Species of Sulfur Bacteria
Lecture of Ing. Matej Tešínský / internal PhD student / lecture before the PhD defence Title: Mechanochemical Processing of Natural and Synthetic Copper Minerals
2020
Annual PhD seminar / 9 lectures of internal PhD students: Mgr. Gergő Bodnár, Mgr. Katarína Gáborová, Mgr. Lenka Hagarová, Mgr. Mária Kováčová, Mgr. Martin Stahorský, Mgr. Olha Skurikhina, Mgr. Halyna Yankovych, Mgr. Viktoriia Kyshkarova, Mgr. Olena Porodko
Lecture of Mgr. Zuzana Bártová / internal PhD student / lecture before the PhD defence Title: Identification of Microbial Communities in Environmental Matrices by Non-cultivation Methods
2021
Annual PhD seminar / 8 lectures of internal PhD students: Mgr. Petra Červeňáková, Mgr. Katarína Gáborová, Mgr. Mária Kováčová, Mgr. Martin Stahorský, Mgr. Olha Skurikhina, Mgr. Halyna Yankovych, Mgr. Viktoriia Kyshkarova, Mgr. Olena Porodko
Lecture of Mgr. Lenka Hagarová / internal PhD student / lecture before the PhD defence Title: Diversity of Culturable and Non-Culturable Bacteria in Matrices Contaminated with Metals and Organic Pollutants
Lecture of Mgr. Gergő Bodnár / internal PhD student / lecture before the PhD defence Title: Analysis of Industrial Pollutants and Their Degradation Products Using Mass Spectrometry

2.6. Societal impact

2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study

Research running at IGTSAS is focused on current global challenges, such as climate change, sustainability of groundwater, soil and air quality, environmental risk management, biotechnologies, protection of biodiversity and population health. Our institute pays special attention to the issues of complex processes of managing the environmental burdens as significant society problems.

Case Study: Remediation of organic groundwater contamination in Vrakuňa	
Summary	
<p>Chemical waste landfill in Bratislava, Vrakuňa district, represents an area polluted by toxic waste from the former chemical plant CHZJD producing the wide scale of persistent organic pollutants, with direct threat to rich groundwater sources. Our attention was focused mainly on the elimination of organic pollution through biological and physico-chemical degradation processes. We described the detailed composition of the toxic chemicals in groundwaters and proposed, designed and tested the feasible decontamination technology of the landfill.</p>	
Underpinning research	
<p>This case study exemplifies an extreme case of industrial contamination near sources of drinking water in urban area. Persistent organic pollutants (POPs) continuously leach from the industrial landfill deposited by Dynamit Nobel Company (later renamed to Chemical Plant of J.Dimitrov – CHZJD, now Istrochem) which started to operate in the 19th century. The CHZJD landfill (~46,500 m²) is located in urban area in the southern part of the capital Bratislava, city districts Vrakuňa and Ružinov. Until 1979 approx. 120,000 m³ of toxic chemical waste (<i>explosives, fertilisers, pesticides, insecticides, fungicides, herbicides, rubber chemicals, solvents, sulphuric acid, etc.</i>) were buried under the surface of a dry side arm of the Danube river with gravel-sand bed without any bottom-isolating barrier, only covered by inert material. The landfill has not been remediated neither isolated ever since.</p> <p>Natural groundwater represents the most important source of drinking water supplies in Slovakia. Groundwater reserves in quarternary sediments of the Danube basin represent a unique structure, so called Rye Island (1200 km²), the biggest reservoir of fresh groundwater in central Europe (Negm et al., 2018), declared as protected water management area since 1978.</p> <p>In 1992, Gabčíkovo–Nagymaros Waterworks were built to eliminate regular flooding of Danube river and to provide a clean electricity source. However, this caused immediate rise of groundwater level. Since 1996, harmful POP substances dumped in the landfill started to leach downstream by the natural groundwater flow, threatening the Rye Island's water sources.</p> <p>The Slovak Geological Survey and Slovak Hydrometeorological Institute have built the network of hydrogeological monitoring wells (Širáňová et al., 1991). The first detailed survey of Vrakuňa landfill was performed by DEKONTA Slovensko, s.r.o. in 2014/15 (Urban et al., 2015). It proved that the quality of groundwater in the districts of Vrakuňa, Ružinov and Podunajské Biskupice has adversely changed and the contamination cloud 'slowly' moves downstream towards the Rye Island (300-500 m/year). Moreover, contaminants such as PAH, phenolic compounds, pesticides rubber residuals based on benzothiazole, etc. were found also in private wells of gardening lofts nearby. Most of these contaminants are not controlled by any directive. Without efficient remediation and isolation of the landfill body, the leakage of toxic substances will degrade the largest drinking water reservoir in Central Europe.</p>	
<p>References to underpinning research</p> <p>Negm A., Zeleňáková M. (eds). 2018. <i>Water Resources in Slovakia: Part I. The Handbook of Environmental Chemistry</i>, vol 69. Springer, Cham.</p> <p>Širáňová V., Tölgyessy P., Surová E., Pospiechová O., 1991: <i>Observation of changes in groundwater quality in area of waste landfills Devínska Nová Ves, Vrakuňa, Smolenice, Boleráz, Budmerice, 1989 – 1990, Final report: Research of geofactors in environment, Slovak Geological Institute (in Slovak)</i></p> <p>Urban, O. et al., 2015. <i>Geological survey of the environmental burden Vrakuňská cesta – landfill CHZJD - SK/EZ/B2/136. Final report from the geological survey of the environment with the risk analysis of the polluted area. DEKONTA Slovakia, Bratislava (in Slovak).</i></p>	 <p>Vrakuňa landfill: downstream groundwater contamination cloud</p>

Details of the impact

IGTSAS was invited by the regional government of Bratislava Self-Governing Region to coordinate a project with Comenius University, Faculty of Natural Sciences based on our deep knowledge of POP remediation technologies and high-tech infrastructure for detailed analysis of organic/inorganic substances. IGTSAS was assigned with three main tasks with following impacts:

Impact 1: Complex pollution analysis according to the parameters required by the STN technical norms. We examined the factors affecting the analysis accuracy and compared our measurements with previous available surveys.

Impact 2: Comprehensive identification of unknown chemicals found in groundwater under the landfill and assessment of their potential impact on human health. By combination of various separation and identification techniques we determined the presence of 965 different substances. We identified 282 organic substances, which is 3-times more than the previous surveys did.

Impact 3: Proposal of comprehensive groundwater decontamination and remediation technology

We focused mainly on methods of separation of organic contaminants from groundwater by sorption on selective adsorbents, and methods of POP decomposition using advanced oxidation processes and biodegradation. Following the physico-chemical treatment methods, the biological processes were applied, both to assess the toxicity of water after chemical treatment and to destroy and eliminate residual pollutants. Pilot project of the technology for decontamination of groundwater closed in underground waterproof retaining wall was designed and validated in cooperation of IGTSAS, GEO-test, a.s. Brno, CZ; ProMinent Slovensko s.r.o., Bratislava, and Environcentrum s.r.o., Košice.

Further research will be performed for future remediation, focusing on preparation of multifunctional sorbents for groundwater clean-up from mixed contaminants leaching from the landfill. Electrochemical degradation shall be combined with membrane filtration, delivering possible integrated technology for design of prototype facilities cleaning the contaminated groundwater from wells up to its possible use as irrigation water, which has been strictly forbidden in Vrakuňa since 2002.

Sources to corroborate the impact

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Case Study: U.S.STEEL wastewaters: from environmental problems to ecological solutions
Summary
U.S.Steel Košice, steel producing factory asked IGTSAS for cooperation in improvement of their water treatment processes. Three main areas were investigated: design and testing of surfactants removal from wastewaters, water softening, and removal of adsorbable organic halogens from wastewaters. The joint research delivered significant direct impacts on surface water quality and cost-efficiency of production processes.
Underpinning research
East Slovakian Steelworks (VSŽ), now known as U.S.Steel Košice has started its full production in 1965. It is the largest steel producer in Central Europe, producing hot and cold rolled steel sheets, galvanized steel, organic coated steel products, etc. The company has its own wastewater treatment plant, where the strict surface water quality limits are applied for final discharged water. Only about 1/6 of treated water is returned back to the production process due to unfavourable water salination. The company had to improve its water treatment processes and take measures to achieve the required limits due to legislation exception in Slovak Water Plan. The designed solution had to involve either currently available, economically and environmentally affordable methods, or the new sophisticated technologies. In June 2018, U.S.Steel Košice presented interest to cooperate with SAS institutes on their (after)production issues and agreed with IGTSAS on 3 main topics:
Details of impact
Impact 1. Design and testing of surfactants removal from waste waters of U.S.Steel IGTSAS designed and tested a technology for treatment of industrial waste waters from surface cleaning of rolled steel sheets. The designed technology uses only physical processes without addition of any chemicals. Physical separation of organic phase from solutions was combined with advanced electrochemical oxidation of residual organic compounds. The phase separation allowed the reuse of more than 90% of treated water back in the process and shortened the time for reaching the pollution limits for wastewater discharge. The main impacts of designed technology involve simplified treatment chain, lower costs and environmentally-friendly procedure.
Impact 2. Improvement of water softening within the water treatment technology in U.S.Steel Steel production processes in U.S.Steel factory require a soft water. The company takes surface water from the Hornád river. Raw water is continuously processed in pre-treatment plant by flocculation and lime softening, followed by sedimentation and filtration. The water is further softened or fully demineralized by the ion exchange resins. These have to be regenerated, which produces waste brine effluents. Such a constant discharge of waste brines with high salts content adversely affects the quality of feed into the wastewater treatment plant. Our proposal was to introduce the advanced electrochemical processes: 1. electrochemical water softening system instead of flocculation should also lower the amount of by-produced flocculation sludge; 2. electrodialysis for demineralization and water polishing, to replace the ion exchangers and to reduce the production of waste brines. This shall also significantly decrease the salt load in water balance of U.S.Steel.
Impact 3. Removal of adsorbable organic halogens from U.S.Steel waste waters IGTSAS focused also on issues of halogenated organic compounds - adsorbable organic halogens (AOX) removal from waste waters, which represents a major environmental issue. PhD position on this topic was opened in cooperation with U.S.Steel in Sep 2019 (H. Yankovych, UA). The 4-year PhD study focused on the research of the AOX and their harmful effect on the environment and living organisms, with a special attention to the adsorptive removal of 4-halogenophenols onto activated carbon, which possess the high specific surface area and surface basicity. This research clearly showed that commercial granular activated carbon possesses a high removal efficiency of halogen-containing organic compounds. PhD thesis (defense in Aug 2022) proved successful feasible AOX elimination approach, which is a major benefit to U.S.Steel directly, and may be beneficial to other industrial partners as well.
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<p>Case Study: WaSClean: Water and Soil Clean-Up from Mixed Contaminants</p>
<p>Summary</p>
<p>FP7 project WaSClean project coordinated by IGTSAS aimed to develop novel materials and technologies for remediation of contaminated soils, wastewater and groundwater from xenobiotics (man-made) contaminants. The Marie Curie Industry-Academia Partnership&Pathways programme was based on knowledge exchange and joint scientific activities between 4 industrial partners (geological and remediation company Environcentrum s.r.o., Košice, SK; nanomaterials producing company MAST Carbon International, Basingstoke, UK; textile dyeing factory HERMES S.A., Thessaloniki, GR; construction company Ekodor LLC, Temirtau, KZ) and 4 academic partners (Aristotle University of Thessaloniki, GR; University of Brighton, UK; Nazarbayev University, Astana, KZ; and IGTSAS as consortium coordinator). The project stimulated the intersectoral collaboration to develop and scale-up comprehensive technology for the remediation of contaminated land and waters from representative heavy metals (e.g. Pb, As, Cr, Cd, Hg), persistent organic pollutants (lindane, atrazine, obsolete pesticides), and synthetic dyes (reactive blue, red, black from textile industry). Chemical and biological approaches were combined to develop novel technologies for removal of toxic metals/metalloids and recalcitrant organic contaminants from contaminated soil and groundwater.</p>
<p>Details of impact</p>
<p>WaSClean outputs have been developed as platform technologies, so that different prototypes can be designed to meet the needs of different target groups. The various composite devices developed under WaSClean employ different surface chemistries tailor-made for different contaminant types and offer a range of configurations suited to specific industry requirements.</p>
<p>Impact 1. Transfer of knowledge The project brought together a multidisciplinary consortium of specialists from different areas of contaminated land management, environmental (geo)chemistry, nanotechnology, (geo)microbiology and physical, analytical, synthetic, polymer and surface chemistry, working with a common aim of developing new and efficient methods of contaminant removal from soil and groundwater. Total 86 secondments (at least 2-months stays) were delivered within the project consortium. The implementation of secondments during the project delivered significant knowledge. Fellows were able to test and optimize the lab methods at a larger scale with real wastewater obtained from the participating SMEs. Strategic long-term partnerships have been established among the partners with complementary skills. A high quality in-house training has been provided to young as well as experienced researchers. Marie Curie Fellows acquired new and complementary skills through the well-organized secondments with immediate and long-lasting benefits for each partner.</p>
<p>Impact 2. Novel materials were developed by incorporating Fe-based nanoparticles on activated carbon (AC) matrices, in such a way that the AC retained their ability to remove organics and metals, while the incorporated Fe NPs efficiently remove metalloids such as arsenic, chromium, etc. The Fe NPs were introduced by two different techniques: the nano-electrospray technique (NU) and the solution precipitation on AC matrix. Their adsorption properties towards organics (synthetic dyes) and toxic metals (Cd, Cu, As) were studied and the novel adsorbents were characterized by advanced analysis techniques.</p>
<p>Impact 3. Dyeing factory wastewater clean-up Mechanism of degradation and transformation of RB5 dye was described on demand of SME partner HERMES S.A., Thessaloniki, GR, a company for dyeing, bleaching and finishing of fabrics since 1978. A lab scale electrochemical oxidation reactor was constructed for degradation of synthetic reactive dyes with Aristotle Uni of Thessaloniki, GR. First, various model dye solutions were studied and degraded successfully with complete decoloration and significant carbon mineralization. COD and TOC values were decreased by more than 75%. Even highly concentrated model solutions were treated successfully. Various electrode materials were tested and the process parameters were optimized for successful degradation of mixtures of synthetic dyes of industrial grade. The results were applied successfully to real contaminated wastewater of HERMES company. Advanced electrochemical oxidation processes were applied successfully to the highly concentrated wastewaters coming out directly from the dyeing machine without any pre-dilution. Electrochemical and chemical oxidation for RB5 dye effluents treatment were compared and key degradation /transformation products were identified by HPLC-ESI-MS. The identified species are a starting point for textile wastewaters toxicity assessment. This work also resulted in new ideas to improve and/or develop new electrode materials with improved characteristics. Graphene oxide on stainless steel substrate offers unconventional physico-chemical properties that can improve significantly the removal efficiency while at the same time restrict the negative impact to the environment and human health. Removing the initial high load of colors from the water streams makes possible the recycle-reuse of water in the company. Water streams from the last washing steps would be easily reused for the first washings. It is expected that more than 50 % of fresh water shall be saved.</p>

<p>Impact 4. Pilot test of polycyclic aromatic hydrocarbons (PAH) decontamination</p> <p>Advanced bioreactor was developed by IGTSAS. The biodegradation of polyaromatic hydrocarbons found in contaminated soils was tested and optimized in collaboration with SME partner Environcentrum s.r.o. Removal and degradation techniques of PAHs such as adsorption, electrooxidation, biodegradation were optimized by consortium. Finally, the integrated remediation technology was designed in lab conditions and then scaled up at a PAH-contaminated site. WaSClean produced suitable remediation technology for the treatment of industrial waste waters and liquid effluents (e.g. from contaminated soils, landfill leachates etc.).</p>
<p>Impact 5. Patent application for Integrated technology of water clean-up from mixed contaminants started in November 2021 (See Chapter 2.1.7 for further information).</p>
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<p>Case Study: BioLeach: Innovative Bio-treatment of Raw Materials</p>
<p>Summary</p> <p>Strengthening the economy of Slovakia in raw materials (RMs) can be achieved by focus on local sources, which represent financially attractive option to imported RMs. The project is focused to development of low-cost, effective, environmental friendly biotechnologies enabling extraction and recovery of metallic RMs (REE, CRMs, metals) and releasing of undesirable components from nonmetallic RMs for their better industrial utilisation.</p> <p>The main aim of the project EIT RIS Raw Materials KIC No. 18259/BioLeach under Horizon Europe partnership was to improve the technology, which can be applied to local deposits to obtain RMs appropriate for industrial utilisation. While currently used technologies are usually expensive and environmentally not acceptable, a low-cost and ecological method of bioleaching was suggested. Bioleaching is an alternative way of improving deposits via activity of bacteria, which induce changes of chemical and structural features of rocks and minerals. The challenge of the project is to configure/improve this effective, economical and innovative method for specific local sources. The project is still running.</p>
<p>Details of impact</p> <p>Technical University of Košice as the BioLeach project coordinator invited IGTSAS as a RIS Task Partner to provide 3 major studies and pilot tests of bioleaching possibilities. Within the BioLeach project, the bioleaching of the tetrahydrate concentrate was performed in acidic oxidizing conditions at ambient temperature using iron-oxidizing bacteria. Laboratory stirred slurry and percolating columns techniques and pilot-plant percolating columns technique were used.</p>

Impact 1. Bioleaching of metals from tetrahedrite $\text{Cu}_{10}(\text{ZnFe})_2\text{Sb}_4\text{S}_{13}$

The ore sample obtained from the Strieborná (silver) vein at the Mária Mine (Rožňava ore field in Eastern Slovakia) contained 2 main minerals of economic interest: silver bearing tetrahedrite and siderite. Three strains of chemolithotrophic, acidophilic iron-oxidizing bacteria were used in the bioleaching tests: *Acidithiobacillus ferrivorans* SS3 (DSM 17398), *Acidithiobacillus ferrooxidans* (DSM 14882), and *Leptospirillum ferriphilum* (DSM 14647). After the laboratory tests, the on-site pilot heap bioleaching tests of siderite-tetrahedrite ore were arranged at the Rožňava mine site. Future efforts and intensive focus can lead to the optimization of the tetrahedrite bioleaching process. They may generate an integrated view of the effective extraction of valuable metals from tetrahedrite and potentially biohydrometallurgical application in the industry.



Impact 2. Bioleaching of iron impurities from silica sand

Laboratory slurry and percolating columns techniques and pilot-plant percolating columns, techniques were carried out in 2021. The amount of Fe- and Ti- coloring oxides is often decisive for evaluation of the quality of raw materials for glass and ceramic industry. In contrast to a wide commercial exploitation of acidophilic iron-oxidizing bacteria for treatment of sulfide minerals, acidophilic heterotrophic iron-reducing bacteria have not yet been applied beyond the laboratory.

The samples of eolian sand from the company KERKOSAND, Ltd., Šajdíkové Humence (west Slovakia) were used in the laboratory bioleaching assays. The heavy fraction of the raw material containing coloring oxides was separated by gravity and the light fraction was further upgraded by bacterial leaching. The light fraction still contained iron impurities, in quantities that exceeded the limits for the raw material for glass production.

Pilot test in percolation columns was designed after laboratory tests. Based on the results of laboratory tests, the pilot test bioleaching was arranged at the TUKE premises (due to Covid-19) from the sands provided by KERKOSAND, Ltd. from locality Šajdíkové Humence (west Slovakia).



Impact 3. Evaluation of bacterial colony amount, characteristic of their living environment and effective microorganisms for different types of raw materials

The environmental samples were collected from the mine drainage effluents of the Mária mine (Rožňava, Slovakia) that flows to the Slaná River (Fig 4.1). The water samples contained a bacterial consortium with different bacterial strains in direct relation to this environment.

Sources to corroborate research

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2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))

Title	Contractor	Revenue	Purpose
2017			
Joint investigation project for decontamination of environ. pollution at Bratislava Vrakuňa, deposition of Chemical Enterprise of J.Dimitrov	Bratislava Self-Governing Region	75,000 €	Expert report on measurements of biodegradation rates of organic pollution in subsoil leaching underground towards the rich groundwater reservoirs of Žitný ostrov
2018			
Recycling of noble metals from catalysts	Global Zero Emission Research Center, National Institute of Advanced Industrial Science and Technology, Tokyo, Japan	10,000 €	10-month research stay of Dr.Ryo Kasuya focused on training themechanical activation in a planetary ball mill, XRD and specific surface area analysis, leaching of noble metals from model samples
Analyses	FMMR TU Košice	1,158 €	Determination of mineral composition of Mn steel samples by SEM and XRD analyses
2019			
Chemical identification of solid samples surfaces	Faculty of Materials, Metallurgy and Recycling, TU Košice	6,605 €	Chemical characterization and SEM analyses (local elements analysis) of solid samples surfaces – specific materials based on Zn
Expert report	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	2,500 €	Analysis of waste samples: NiCoMn pastes and copper sulphates from used batteries and metallic iron from slag
Expert report	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	2,000 €	XRD of FeSi, CaSi, FeMn and FeSiMn dust outlets
Expert report	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	1,000 €	Analysis of samples from refuse heaps at Rudabánya (Hungary)
Measurement of specific surface	PRIF Comenius Uni, Bratislava	1,000 €	Analysis of surface properties of powdered samples, surface determination by BET method
Analyses	FMMR TU Košice	411 €	XRD and FTIR analyses of waste batteries samples
Analyses	FMMR TU Košice	350 €	Determination of mineral composition of dead burnt magnesia samples from the INTOCAST Slovakia company using XRD

2020			
SEM/EDX a FTIR analyses of samples	FMMR TU Košice	400 €	Characterization of waste batteries samples by SEM/EDX and FTIR analyses
BioLeach: Innovative Bio-treatment of Raw Materials EITRM106357 WP3.1 - Report on collection of and laboratory works on raw materials samples with spectrographic analyzes	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	15,000 €	1) Characterization of light and heavy products from gravity concentration of eolian sand, 2) Characterization of tetrahedrite-bearing siderite ore and flotation tetrahedrite concentrate 3) Bioleaching of the tetrahedrite concentrate
2021			
BioLeach: Innovative Bio-treatment of Raw Materials EITRM103125 WP3.1 – Final Report	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	15,000 €	1) Bioleaching of metals from tetrahedrite 2) Bioleaching of iron impurities from silica sand 3) Chemical leaching of iron impurities from silica sand using organic and inorganic acids 4) Pilot test in percolation columns 5) Evaluation of bacterial colony amount, characteristic of their living environment and effective microorganisms for different types of raw materials
Chemical analysis of steel	FMMR TU Košice	200 €	Determination of elements concentration of Mn steel samples by AAS
Assessment of deformation properties of rocks	Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice	5,000 €	Young´s modulus, Poisson´s number and Uniaxial Compressive Strength were determined on the various rock samples (mainly talc and accompanying rocks)

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

Title	Contractor	Revenue	Purpose
2016			
Expert report	Geotest, a.s., Brno, CZ	3,900 €	Characterization of bauxite ores and red mud
Measurements report	TESLA Stropkov, a.s.	224 €	Measurements of recrystallized grain size of PZT ceramics
Analytical works	CGB Slovakia s.r.o., Sučany	125 €	Morphology and surface comparison of plastic products
Expert report	FECUPRAL s.r.o., Veľký Šariš	1,141 €	Element and phase assessment of recycled products
Chemical analyses for student competition	Gymnázium a ZŠ sv. Mikuláša, Prešov	400 €	Determination of carbon, hydrogen, nitrogen and sulphur in samples of biomass

Expert report	OVIMEX, s.r.o	331 €	Determination of particles size distribution of powdered samples by DLS, quantitative and qualitative evaluation
Expert report	SABAR, s.r.o., Markušovce	140 €	Grain size analyses of barite samples
Microbiological analyses	GEO Slovakia, s.r.o.	322 €	Microbiological analyses of oil and heterotrophic bacteria in organic-contaminated soils Power plant Vojany, Nr.of geological task 2016-022
2017			
Training	Nihon Seiko Company Ltd., Japan	7,500 €	Education & training of a technician for operation of Fritsch P6 planetary mill and other selected laboratory equipment, provided at IGTSAS
Biodegradation tests of organic pollution	Penta Investments, SKY PARK s.r.o.	4,965 €	IGTSAS provided measurement and testing of biodegradation rates of organic pollution in real samples of subsoil for civil construction
Expert report on rock abrasiveness	DPP Žilina, s.r.o	1,800 €	Abrasiveness assessment of rock samples from geological survey in the route of the planned road tunnel Soroška
Expert report	CEIT Biomedical Engineering, s.r.o.	518 €	Quality assessment of titanium components surface morphology using SEM
Expert report	TESLA Stropkov, a.s.,	175 €	Quality assessment of pore size of plastic products
Expert report	Sabar, s.r.o., Markušovce	31 €	Grain size analyses of barite samples
Analysis	NaturalPharm Slovakia, s.r.o.	41 €	Analyses of chemical composition of solutions
Analysis	Trix, s.r.o.	41 €	Study of metal matrix morphology
Analysis	CorOne, s.r.o.	180 €	Determination of sulphur nature content on metallic samples by FTIR spectroscopy
Expert report	VSK Mineral, s.r.o. Košice	292 €	Chemical and XRD analyses of steelworks slag samples
Expert report	VSK Mineral, s.r.o. Košice	98 €	Chemical analysis of sample from dolomite quarry at Sedlice, East Slovakia
Expert report	HC LOGISTIK, s.r.o. Bratislava	490 €	CHNS analysis of carbon black samples from pilot thermal cracking unit
Expert report	Správa mestskej zelene, Košice	150 €	Analysis of asbestos content in construction waste for Administration of Urban Greenery in Košice

2018			
Water cleaning technology for U.S.Steel	U. S. Steel Košice	4,307 €	New technology for tenside removal and softening of wastewaters was designed/tested
Expert report on rock abrasiveness	DPP Žilina, s.r.o	1,800 €	Measurement and assessment of rock abrasiveness from Soroška tunnel site
Expert report	GEO Slovakia, s.r.o.	1,260 €	Determination of heterotrophic microorganisms and hydrocarbon degrading microorganisms
Analysis	NTE development, s.r.o, Bratislava	124 €	CHNS analysis of carbon black samples from pilot thermal cracking unit
Analysis	Kerkosand, Šajdíkove Humence	80 €	Chemical analysis of sand, identification of possible final product contamination during its transport to customer
Analysis	TESLA Stropkov, a.s.	295 €	SEM analyses of fracture surface of plastic connectors
2019			
Expert report on rock abrasiveness	CADECO, a.s.	550 €	Assessment of rock abrasiveness for Čebrať tunnel
Expert report	GEOLAB s.r.o.	1,900 €	Microbiological analyses of rock samples and groundwater
Expert report on rock abrasiveness	DPP Žilina, s.r.o.	1,500 €	Testing of abrasive properties of rock samples from the geological survey in the new route of the road tunnel
Expert report	Environcentrum, s.r.o. Košice	1,650 €	Testing of acid tar degradation from Predajna location
Expert report	Geotest a.s. Brno	1,000 €	Mechano-thermal synthesis of Raney nickel alloy
Analysis	Enjoy Coffe & Drink Bar Michalovce	250 €	Measurement and analysis of concentration of suspended particles PM
2020			
Expert report	GEOLAB s.r.o. Košice	1,140 €	Microbiological analyses of rock samples and groundwater
Analyses	Ligamed, s.r.o. Košice	120 €	HPLC-MS analyses of natural extracts
Analyses	Ľubomír Drgáň - TRIX, Trstená	260 €	SEM/EDX, AAS and FTIR analyses
2021			
Analysis	Maana Electric S.A. Luxembourg	500 €	Determination of silicon content in 4 samples of Sn-Si alloy
SEM Imaging	VSK PRO-ZEO, s.r.o. Košice	250 €	Making of zeolite SEM pictures for advertising brochure of the company
Expert report	SPP – distribúcia, a. s., Bratislava (natural gas distribution)	430 €	Identification of the origin and size of dust particles for the protection of technical equipment of the station
Expert report	ŽOS Vrútky, a.s	900 €	Air quality control in a production hall with precise engineering production - technological

			measurement of concentration of suspended particles
Analyses	GEOLAB, s.r.o. Košice	480 €	Microbiological analyses of groundwater samples
Expert report	TESLA Stropkov a.s.	400 €	Assessment of nature of fracture surface of plastic products

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

Method of obtaining needle-like nanocrystals of copper sulfide			
<p>BURKITBAYEV, Mukash M. - SHALABAYEV, Zhandos S. - KHAN, Natalya Vladimirovna - <u>BALÁŽ, Matej</u> - URAKAEV, Farit. National Institute of Intellectual Property, Ministry of Justice of the Republic of Kazakhstan : Al-Farabi Kazakh National University Republican State Enterprise on the Right of Economic Management of the Ministry of Education and Science of the Republic of Kazakhstan, 14.08.2020. Patent 5287. The presented patent describes the method of obtaining needle-like copper sulfide nanostructures using mechanochemistry. The key is in the utilization of sodium thiosulphate as an additional source of sulfur which causes the nucleation of the produced nanomaterial.</p>			
Method of copper extraction from waste copper slags			
<p>NADIROV, Rashid Kazimovich - MUSSAPIROVA, Lyazzat Arkhatovna - <u>BALÁŽ, Matej</u>. National Institute of Intellectual Property, Ministry of Justice of the Republic of Kazakhstan : Al-Farabi Kazakh National University“ Republican State Enterprise on the Right of Economic Management of the Ministry of Education and Science of the Republic of Kazakhstan, 28.04.2020. Patent 4900. In this case, the methodology of selectively leaching our copper from copper smelter slag with the assistance of the mechanical activation performed in a wet stirred media mill is described. By applying proper conditions, it was possible to recover more than 80% of copper present in the slag, whereas the majority of zinc and iron remained in the solid.</p>			
Monitoring system of the degree of environmental pollution in an industrial environment and construction of measuring sensor			
<p>KOLCUNOVÁ, Iraida – KURMISKÝ, Juraj – DOLNÍK, Bystrík – CIMBALA, Roman – <u>BRIANČIN, Jaroslav</u> – PETRÁŠ, Jaroslav – ZBOJOVSKÝ, Ján – <u>FABIÁN, Martin</u> – DŽMURA, Jaroslav. Industrial property Office of the Slovak republic (Úrad priemyselného vlastníctva Slovenskej republiky), Švermova 43, 974 04 Banská Bystrica 4, 16.10.2020, Utility model application No. PUV50107-2019. Patent application Nr. PP50061-2019. Utility model No. 8919. Owner/co-owner of utility model: Technical University of Košice & IGTSAS The investigation within the joint project APVV-15-0438 with Faculty of electrical engineering and informatics TU Košice, where significant scientific and technical results were obtained, resulted in submission of both patent and utility model applications. The utility model is focused on the novel method for monitoring of the degree of environmental pollution by sensor containing two electrodes, signal generator, analog-digital interface and detector. Electrodes are prepared by vapour deposition of conductive metal with thickness of several micrometers. This invention can be used in ecology, electricity industry and electrical engineering.</p>			
Integrated Technology for Water Clean-up from Mixed Contaminants			
<p>Inventor: MVDr. Daniel KUPKA, co-inventors: Ing. Miroslava VÁCLAVÍKOVÁ, PhD., Mgr. Gergo BODNÁR, PhD. The technology resulted from the research project FP7-WaSClean. Patent application process started by submission of Notification of creation of an object of industrial rights to the Technology Transfer Office of Slovak Academy of Sciences on Nov 30, 2021.</p>			

Microbiological deferritization – quartz sand purification by heap bioleaching

Inventor: Ing. Iveta ŠTYRIAKOVÁ, PhD.

A patent application was registered at Technology Transfer Office of Slovak Academy of Sciences on Aug 2, 2016 with notification of the creation of an industrial property. The technology resulted from the project “Development of in-situ bioleaching method to clean quartz sands and application through testing prototype pilot plant” on demand from Chilean industrial partner Cristalerías de Chile S.A., a quartz sand producer. The heap bioleaching with the recycling of leachates provides the development of new economic technology suitable for the quality improvement of quartz sand. Principal researcher of the project responsible for IGTSAS (author of intellectual property) left the Institute in 2017 and patent application discontinued.

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

n/a

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

n/a

2.7. Popularisation of Science (outreach activities)

Institute of Geotechnics SAS has presented its research activities within several regular popularization events (see European Researchers’ Night, Open Door Day, Science in the Library, etc.). However, during the coronavirus pandemic years 2020-2021, most of such activities have moved to virtual online space, offering new channels for promotion of the science.

2.7.1. List of the most important popularisation activities, max. 20 items

1. European Researcher’s Night, Optima Shopping Mall, Košice, Slovakia

IGTSAS has participated on everyone’s favourite event Researcher’s Night almost every year since 2010 in the accreditation period. The exhibition kiosks of IGTSAS at European Researcher’s Night have become very popular among the visitors, bringing them possibility to touch the real science. All five departments take part in ERN according to their available time schedule.

30-Sep-2016: *Hard Rock Party* (Ivaničová, Lazarová, Feriančíková, Kruľáková)

Journey to Nanoworld (M.Baláž, P.Baláž, Turianicová, Fabián, Mrážiková)

29-Sep-2017: *World of Minerals* (Znamenáčková, Dolinská, Danková, Szabová)

Invisible Dust All Around (Hančulák)

Mechanochemistry: environmentally feasible method for nanomaterial synthesis

(public lecture by M.Baláž)

28-Sep-2018: *Rockquarrium – Magic Stone World* (Ivaničová, Lazarová, Kruľáková, Feriančíková)

Mechanochemistry Around Us (Lukáčová Bujňáková, P.Baláž, M.Baláž, Kováčová, Kasuya, Dobrozhan)

Mineral Wealth of Slovakia (Znamenáčková, Dolinská, Danková, Tomčová)

Bacteria in Environment – helping or not? (Jenčárová, Mačingová, Bekényiová,

Rudzanová, Bodnár, Bártová)

27-Sep-2019: *(Un)Known Mechanochemistry* (Lukáčová Bujňáková, M.Baláž, Skurikhina, Kováčová,

Stahorský, Gáborová)

Dust Around Us (Hančulák)

Rock and Mineral Cycle (Znamenáčková, Dolinská, Zubrik, Matik, Melnyk, Yankovych, Kyshkarova)

24-Sep-2021: *What Can We Find Out from Waste Water ?* Online studio (Yankovich)

<p>2. Visit Your School</p> <p>PhD students and postdocs participate at education by giving lectures at primary and high schools</p> <p>24-Sep-2021: <i>World Under the Electromagnetic Zoom</i>; Visit Your School – lecture at Gymnasium Fábryho, Veľké Kapušany (Bodnár) <i>Biotechnologies in Remediation of Environmental Loads in Slovakia</i>; Visit Your School, lecture at Gymnasium D.Tatarku, Poprad (Bártová) <i>Role of a Stone in Human's Life</i>; Visit Your School - lecture at primary school (Znamenáčková, Dolinská) <i>Magic Pencil</i>; Visit Your School – lecture at primary school SNP 1, Humenné (Marcin Behunová) <i>Minerals Around Us</i> (Visit Your School – 2 lectures (20-Sep-21 & 27-Sep-21) at primary school Jenisejská 22, Košice (Znamenáčková, Dolinská)</p>
<p>3. Science in the Library</p> <p>Popular events where IGTSAS loved to participate. Involves reading for kids, demonstration of experiments, talks and interviews with the scientists.</p> <p>21-Feb-2016: <i>Dust Around Us</i>; primary school Bernolákova 16, Košice (Fedorová, Bekényiová) 22-Feb-2016: <i>Minerals in Science and Industry</i>; primary school Gemerská 2 in LitPark, Košice (Znamenáčková, Szabová) 30-May-2016: <i>Dust Around Us</i>; Kulturpark Košice (Fedorová, Bekényiová) 14-Jun-2016: <i>Minerals in Science and Industry</i>; primary school Krosnianska 4, Košice (Znamenáčková, Szabová) 06-Jun-2017: <i>Scientists Read to Kids</i> – Youth Library Humenská 9, Košice (Dolinská, Szabová)</p>
<p>4. Excursions</p> <p>IGTSAS invites students of primary and high schools to attend its labs and touch the real science.</p> <p>09-May-2017: <i>Excursion of students ZŠ Lechkého, Košice - industrial minerals</i>; (Dolinská, Znamenáčková) 13-Nov-2018: <i>Excursion of students ZŠ Bruselská 18, Košice – microscopic analysis of minerals, magnetic separation, measurement of magnetic properties of minerals</i> (Znamenáčková, Dolinská, Danková, Lovás, Briančin) 27-Sep-2018: <i>Excursion of Gymnasium Alejová 1, Košice – mechanochemistry and planetary milling</i> (M.Baláž) 13-Nov-2019: <i>Excursion of students ZŠ Krosnianska 4, Košice – origin of minerals, use of minerals in industry and human life, microscopic observation, mineral fluorescence</i> (Znamenáčková, Dolinská)</p>
<p>5. Public Lectures</p> <p>29-Mar-2017: <i>Wandering Egg: Easy Journey to New Materials and Environmental Protection</i> – Lecture at the Science Café, Kulturfabrik Tabačka, Košice (M.Baláž) 31-Mar-2017: <i>Use of Bacteria in Environmental Protection – Upside Down Day - Parents Teaching Kids</i> lecture at elementary school Fábryho 44, Košice (Békényiová) 12-Apr-2017: <i>Egg Wandering to the Mills</i> – lecture at the Science Café, Libresso Books&Coffee, Prešov (M.Baláž) 11-Apr-2019: <i>Mechanochemistry as environmentally acceptable method in chemistry</i>, lecture at Faculty of Natural Science, UPJŠ Košice (M.Baláž) 16-Jul-2021: <i>Water: Time, Distance and Amount</i> – popularization lecture on water cleaning, remediation of environmental loads in Gombasek summer camp, invited by the Diákhálózat student organization (Bodnár)</p>
<p>6. Open Door Days & Science and Technology Week</p> <p>IGTSAS has actively participated in popularization activities within the European Science Week by opening its laboratories thus attracting students from the primary and high schools, universities and also wide public.</p> <p>09-Nov-2017: <i>Open Door Day - mineral processing, electron microscopy, mechanochemistry</i> (Dolinská, Znamenáčková, Lovás, Žaková, Briančin, M.Baláž) 06-Nov-2018: <i>Open Door Day - magnetism, mineral wealth of Slovakia, mineral exploitation</i>,</p>

<p>separation of minerals (Znamenáčková, Dolinská, Danková, Lovás, Briančin)</p> <p>10-Nov-2020: <i>Science and Technology Week 9-15/11/2020</i> <i>Modern Methods of Water Cleaning</i> – short film (Marcin Behunová) <i>Mechanochemistry: Chemistry without Solvents</i> – live online lecture (M.Baláž)</p> <p>12-Apr-2021: <i>Virtual Open Door Week</i> - presentation of PhD study at IGTSAS (Václavíková, Hančulák, Lazarová, Marcin Behunová)</p> <p>16-Apr-2021: <i>Young Scientists of SAS</i> – commented presentation for the SAS Young Scientists Platform Within the SAS Open Door Week 12-16/apr/2021 (Marcin Behunová) https://eraportal.sk/podujatia/zoom-s-vedcami-sav/ http://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9520</p>
<p>7. TV, Radio, Internet & Press</p> <p>31-Aug-2017: Promotion of INCOME 2017 International Conference on Mechanochemistry and Mechanical Alloying (Slovak Syndicate of Journalists, SAS News, Radio Košice, Cassovia News, etc.) https://www.cassovia.sk/news/20573 https://www.sav.sk/index.php?lang=sk&doc=services-news&source_no=20&news_no=7120 http://www.ssn.sk/17451/v-kosiciach-9-medzinarodna-konferencia-o-mechanochemii-mechanickom-zlievani/</p> <p>19-Aug-2018: <i>Prospective of Egg Waste</i> - paper in Quark 8/2018, a science-popularization journal (M.Baláž)</p> <p>05-Dec-2018: <i>Nanoparticles based on Silica and Magnetite Help in Water Cleaning</i> - contribution for web portal Science To Reach (Melnyk) https://vedanadosah.cvtisr.sk/priroda/chemia/vyskum-castic-na-baze-kremika-a-magnetitu-ma-pomoc-pri-cistení-vod/</p> <p>21-Dec-2018: <i>When Chemistry Works Both in Lab and Between the People</i> – contribution to SAS News (Melnyk) https://www.sav.sk/index.php?lang=sk&doc=services-news&source_no=20&news_no=8022</p> <p>07-Jan-2019: <i>Research in Nanotechnologies</i> - contribution in Rádiožurnál, Rádio Slovensko (Lukáčová Bujňáková)</p> <p>25-Feb-2021: <i>Revolution in Water Cleaning?</i> - paper in Quark 2/2021, a science-popularization journal (Marcin Behunová)</p> <p>01-Oct-2020: <i>Breaking the Wall of Solution-based Chemistry</i> – online lecture within the event Falling Walls Lab Slovakia 2020 (M.Baláž)</p> <p>23-Mar-2021: <i>Fascinating World of Nanoparticles</i> – webinar of AZU organization (Marcin Behunová) https://www.facebook.com/aktivitazvysuieuspech/photos/gm.2846456105593662/3757204424328637</p> <p>24-Mar-2021: <i>Important Connections to Industry</i> – director S. Hredzák interviewed in Správy SAV, vol.57, nr.2/2021, s.11-15. http://akademia.sav.sk/uploads/news_sas/04271202spravysav_202102.pdf</p> <p>18-May-2021: <i>SAS Provides Help in Saving the Groundwater of Žitný Ostrov</i> – contribution focused on remediation of Vrakuňa chemical disposal site (Kupka), https://domov.sme.sk/c/22662562/sav-ponuka-pomoc-pri-zachrane-podzemnych-vod-zitneho-ostrova.html? https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9624 https://www.enviroportal.sk/clanok/sav-ponuka-pomoc-pri-zachrane-podzemnych-vod-zitneho-ostrova</p> <p>29-Jun-2021: <i>SAS Prizes 2020: M.Baláž – Prize for Science Popularization and Social Applications</i> https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9742</p> <p>28-Jul-2021: <i>Even the Mechanochemistry Helps in Efficient Waste Recycling</i> – contribution in SAS News (M. Baláž) https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9786</p> <p>03-Sep-2021: <i>Silver Nanoparticles Formed Using the Milling with Help of Lichen</i> – contribution in SAS News (M. Baláž) https://www.sav.sk/?lang=sk&doc=services-news&source_no=20&news_no=9443</p> <p>05-Oct-2021: <i>Discussion of ESET Science Award Finalists – Science Helping</i> – outstanding Slovak young scientists discussed on science in pandemic time and their future goals (M. Baláž as one of 5 finalists) https://vedanadosah.cvtisr.sk/podujatie/diskusie-veda-pomaha-eset-science-award-vynimocni-slovenski-mladi-vedci/ https://www.youtube.com/watch?v=Jnswl6D83N0 https://www.esetscienceaward.sk/sk/finalisti/matej-balaz</p> <p>25-Oct-2021: <i>Environmental Technologies in Industrial Wastewater Cleaning</i> - short film (Václavíková, Kupka, Bártová) https://www.youtube.com/watch?v=7-XtSJ2Yq8c</p> <p>Dec-2021: <i>Mechanochemistry as a Multidisciplinary Tool for Material Science</i> – paper in Engineering/Strojárstvo/Strojírntví, 12/2021, https://www.engineering.sk/clanky2/chemicky-priemysel/24200-mechanochemia-akomultidisciplinarny-nastroj-pre-materialove-vedy</p>

8. Scientist of the Year 2018

M. Baláž was appreciated for his significant publications and innovations in the category Young researcher by the prize Scientist of the Year 2018. Numerous popularization activities related to this event helped to popularize his research, such as:

Science to Reach - <https://vedanadosah.cvtisr.sk/ocenenie-vedec-roka-sr-2018-v-kategorii-mlady-vedecky-pracovnikziskal-matej-balaz>
Secret of the Eggshell, SAS News 3/2019, p.21-22 https://akademia.sav.sk/uploads/news_sas/06260734spravysav_201903.pdf
 13-May-2019: interview in Radio Slovensko
 18-May-2019: TV show VAT Special – Scientist of the Year, RTVS1 <https://www.rtvs.sk/televizia/archiv/14067/187902>
 20-May-2019: interview in Radio Regina West “Club: Science, Research, Innovations, Patents”
 16-Oct-2019: interview in radio Košice “Something New in the East”

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	4	3	2	3	3	10	25
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	2	1	0	6	0	1	10
Public popularisation lectures	10	9	4	5	2	17	47

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	3	12	3	0	3	8	3
Female	0	22	0	0	0	12	10

I. – director of research with a degree of doctor of science/DrSc.

II.a – Senior researcher

II.b – PhD holder/Postdoc

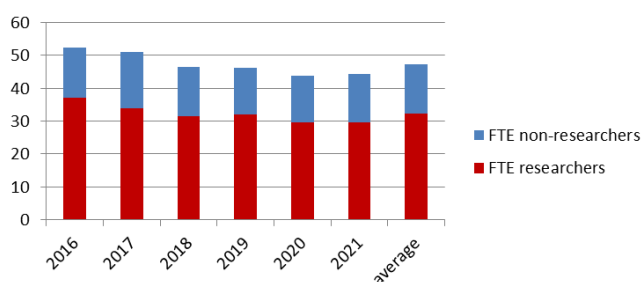
2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	1.0	1.0	2.0	2.0	2.0	2.0	1.0	1.0	0.0	0.0	3.0	3.0	3.0	2.3	1.0	1.0	3.0	2.5
Female	3.0	3.0	1.0	1.0	2.0	2.0	4.0	4.0	3.0	3.0	4.0	4.0	5.0	5.0	2.0	2.0	0.0	0.0

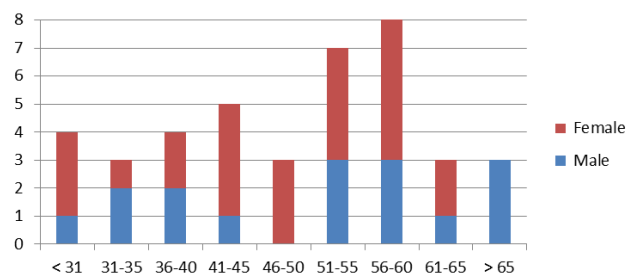
A – number

B – FTE

FTE structure of IGTSAS



Age and gender structure of IGTSAS researchers



Trends in personal development

Institute of Geotechnics SAS changed its management after elections of director in 2018. The new directoriat is shown in Table 1.3. Slightly decreasing trend of FTE-researchers number has been caused by numerous parental leaves (duration of maternity leave in Slovakia: 3 years, paternity leave: 6 months).

All researchers are supported and encouraged to increase their qualification by promoting to higher qualification degrees. Five young researchers received the Senior Scientist degree (II.a by SAS), eight PhD students defended their dissertation theses and were promoted to the Research Fellow degree (II.b) if continued working at IGTSAS. Qualification changes are documented in the following list:

Researcher or PhD student	Promoted to higher qualification degree
2016	
RNDr. Matej Baláž, PhD.	Senior Scientist II.a
Mgr. Zdenka Bujňáková, PhD.	Senior Scientist II.a
2017	
prof. RNDr. Peter Baláž, DrSc.	Doctor honoris causa, University of Miskolc, HU
Mgr. Dávid Jáger	PhD. / Research Fellow II.b
Ing. Darina Štyriaková	PhD.
2018	
RNDr. Marek Matik, PhD.	Senior Scientist II.a
Inna Melnyk, PhD.	Senior Scientist II.a
Mgr. František Bendek	PhD.
Ing. Jaroslav Šuba	PhD.
2019	
Ing. Dominika Behunová	PhD. / Research Fellow II.b
Ing. Dominika Rudzanová	PhD.
MVDr. Jana Tomčová	PhD.
Ing. Martin Tešínský	PhD.
2020	
Mgr. Zuzana Bártová, PhD	PhD. / Research Fellow II.b
2021	
Mgr. Gergő Bodnár	PhD. / Research Fellow II.b
Mgr. Lenka Hagarová	PhD. / Research Fellow II.b

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

SASPRO MSCA Fellowship
<p>Dr. Inna Melnyk, 1.3.2016 – 31.12.2018, 3 years - SASPRO project <i>BISILMAG: Bifunctional Silica and Magnetite Spherical Particles with Tailored Porosity and Surface Chemistry for Complex Water Treatment</i></p> <p>Dr. Melnyk studied at Faculty of Natural Science, National Pedagogical Dragomanov University in Kyiv, Ukraine, focused on biology and chemistry. She finished her PhD study at the Chuiko Institute of Surface Chemistry, National Academy of Sciences of Ukraine in surface physics and chemistry. Since SASPRO project, Dr Melnyk has been working and the IGTSAS until present (currently as a principal investigator of an APVV project, etc.)</p>

2.8.2.2. Stefan Schwarz fellowships

Schwarz Fellowship
<p>RNDr. Martin Fabián, PhD. (Jun 1, 2012 – Feb 17, 2016)</p> <p>Dr. Fabián defended his PhD study in 2008. Since 2012 his position at IGTSAS was partially covered by the Stefan Schwartz Fund for the 4 years period. The project was focused on mechanochemical synthesis and structure/properties determination of selected complex oxides. The scholarship helped to create his own scientific character, and during the fellowship he has received funding for several scientific projects (VEGA, Bilateral cooperation supported by SAS (Bulgaria, Serbia) and V4-Japan project). During this period he also published several papers (registered in CC databases). After the fellowship termination, he has been working as a senior researcher in the Department of Mechanochemistry at IGTSAS until present.</p>
<p>RNDr. Matej Baláž, PhD. (Jan 1, 2016 – Dec 31, 2019)</p> <p>Dr. Baláž studied at Faculty of Natural Sciences at P. J. Šafárik University in Košice. After graduating in 2011, he finished a PhD. Study at IGTSAS and successfully defended in 2015. Since 2016, he was partially funded by the Stefan Schwarz fund for 4 years (until the end of 2019). The S. Schwarz fellowship project dealt with the mechanochemical valorization of eggshell waste and mechanochemical synthesis of nanomaterials based on sulfides and silver. Within the duration of the fellowship project funding, he took part in more projects (principal investigator of VEGA Slovak Grant Agency; Short-Term Scientific Missions coordinator of a COST project CA18112: Mechanochemistry for Sustainable Industry) and his scientific achievements were awarded several times (Young Scientist Award of 2018 in Slovakia). He has published more than 50 CC articles during the fellowship. After the termination of fellowship, he has been working as a senior researcher in the Department of Mechanochemistry at IGTSAS until present.</p>
<p>Ing. Dominika Marcin Behúnová, PhD. applied and was awarded the S. Schwarz fellowship in 2021 (with start in January 2022). She started new research based on wastewater treatment using graphene composites. Her PhD thesis was focused on synthetic nanoparticles in water and soil clean-up and their interaction with the environment. Within the FP7-WaSClean project she attended the Marie Currie Fellowship in the textile industry (Greece), where she worked with real wastewater with organic substances. As a H2020-NanoMed project participant, she spent two months in Moldova in a company that produces carbon sorbents for the wine, oil and pharmaceutical industries. During her PhD study, she worked at the Aristotle University of Thessaloniki in the School of Chemistry by National Scholarship Programme of Slovak republic participating via SAIA (Slovak Academic Information Agency).</p>
<p><i>Note: Mgr. David Jáger, PhD. applied for S.Schwarz fellowship in 2018 and 2019, however was not funded with his project Determination of persistent organic pollutants (POPs) in environmental matrices.</i></p>

2.8.2.3. Postdoctoral positions from other resources (specify)

Young researchers at IGTSAS are encouraged to apply for fellowships for long-term research stays at top scientific institutes in Europe, as documented by applications for individual fellowships within H2020 Marie Curie Sklodowska Actions, National Study Fellowship Programme, APVV projects or short-term research stays abroad within new submitted or implemented projects (see list in Chapters 2.3, 2.4, 2.5).

In-house postdoc fellows
<p>RNDr. Matej Baláž, PhD. (09/2015 – 06/2019), postdoc position via APVV-14-0103 project Mechanochemistry of Semiconductor Nanocrystals: from Minerals to Materials and Drugs (07/2019-present) postdoc position via APVV-18-0357 project Chalcogenides as emerging eco-friendly and low-cost nanomaterials for energy- and medicine- related sectors. M. Baláž finished his PhD study at IGTSAS in August 2015 focused on mechanochemical valorization of eggshell waste by turning it into an efficient adsorbent of heavy metals, or using it as a reagent for mechanochemical dechlorination of PVC waste and for the synthesis of lead sulfide nanocrystals. His research then continued at the IGTSAS, focusing on the mechanochemical synthesis of various sulfides and silver nanoparticles by mechanochemical synthesis.</p>
<p>Ing. Dominika Marcin Behunová, PhD. (03/2019), postdoc secondment via National Scholarship Programme of Slovak republic, SAIA agency, at the Aristotle University of Thessaloniki, Greece, School of Chemistry. The project was focused on the synthesis and characterization of carbon materials. (09/2021-12/2021), postdoc position via APVV-19-0302 project COMWAT – Hybrid Composites for Complex Treatment of Industrial Waters. Finished her PhD study at IGTSAS in August 2019 focused on synthetic nanoparticles in water and soil clean-up and their interaction with the environment. Her research then continued at the IGTSAS, focusing on synthetic carbon nanomaterials and the degradation of pollutants by electrochemical oxidation technique. She also studied morphology and microstructures of prepared materials using SEM/EDX.</p>
<p>Mgr. Gergo Bodnár, PhD. (10/2021 – 04/2022), postdoc position via the APVV-19-0302 project COMWAT – Hybrid Composites for Complex Treatment of Industrial Waters G. Bodnár finished his PhD study at IGTSAS in 2021, focused on analysis of industrial pollutants and their decomposition products using the GC-MS and HPLC-MS. His research then continued at the IGTSAS, focusing on HPLC-MS and mineral biotechnologies for remediation of environmental pollution.</p>
Hosted research fellows
<p>Liudmyla Storozhuk, PhD. (02/2018 - 11/2018), Chuiko Institute of Surface Chemistry of National Academy of Sciences of Ukraine, Kyiv, Ukraine; her main activities were within the project “Development of new approaches for the synthesis of poly(lactide-co-glicolide)-coated magnetic nanoparticles as efficient carriers for nanomedicine” supported by the National Scholarship Programme of the Slovak Republic. New chemical approaches to the creation of nanomagnetic particles, the formation of their polyfunctional surface layer, in particular by immobilization of bioobjects of various nature for theranostic applications, and the investigation of their processing-structure-property relationships were developed. 1 abstract and 1 paper were prepared.</p>
<p>Mariia Pasichnyk, PhD., Mykolaiv V.O.Sukhomlynskyi National University, Mykolaiv, UA (10/2019 - 03/2020): Activities during the stay were devoted to the implementation of the project “Creation and characterization of multifunctional polymer coatings based on inorganic nanoparticles for complex water treatment”, supported by the National Scholarship Program of the Slovak Republic. The composite film based on the styrene-acrylic dispersion, the melamine crosslinking agent, and ZnO nanoparticles as the filler were developed. Polymer nanocomposite film with ZnO nanoparticles distinguished themselves as promising adsorbents for the removal of methylene blue from the wastewater with 2 times higher adsorption than for</p>

<p>similar films without nanoparticles. 2 abstracts and 1 paper were published. (03/2021 - 07/2021): her activities during the stay were devoted to the implementation of the project 'Creation and characterization of multifunctional polymer nanocomposite coatings on the surface of textile materials for the water filtration process' supported by the Visegrad Scholarship Program (ID #52010756). The present work applied polystyrene-acrylic/ZnO nanocomposite on the polyester surface by blade coating and one-bath pad methods. Features of surface chemical modifications were determined by FTIR, SEM analysis, WCA, N₂ adsorption-desorption isotherms. Water purification occurred by 60% from methylene blue and 40% from methylene orange flowing through the padded polyester filter and the covered polyester filter for 2 min, respectively. 2 abstracts and 1 paper were published.</p>
<p>Andrii Kusyák, PhD (09/2021 – 12/2021), Zhytomyr State University of Ivan Franko, Zhytomyr, Ukraine; his main activities during the stay were within the project 'New doped Bioglass 60S composites for bone tissue engineering applications' supported by the National Scholarship Program of the Slovak Republic. Nanoscale magnetite (Fe₃O₄) and nanocomposite using meso-2,3-dimercaptosuccinic acid (Fe₃O₄/DMSA) were synthesized. The study of Hg(II) adsorption processes on the surface of Fe₃O₄/DMSA indicates a high ability to remove Hg(II) ions from acidic (pH = 3) aqueous solutions (under experimental conditions - up to 98%). It was shown that synthesized Fe₃O₄/DMSA nanocomposites can be promising adsorbents when extract Hg²⁺ ions from aqueous solutions at low pH values. 1 abstract and 1 paper were published.</p>
<p>Senior scientists fellowships and long-term research visits</p>
<p>From IGTSAS</p>
<p>Mgr. Marcela Achimovičová, PhD. The cooperation between IGTSAS and the Institute of Mineral and Waste Processing, Waste Disposal and Geomechanics, TU Clausthal, Germany has a long history with several joint projects. Dr. Marcela Achimovičová has been working at TU Clausthal 07/2011 until 01/2019, participating in project Low-emission synthesis of titanium alloys (Funding by DFG, Erkenntnistransferprojekt GO 383/29-1 (04/2016-12/2018)). During her working stay at TU Clausthal, a bilateral German-Slovak project INHEMES: Industrial production of metal sulphides by mechanochemical activation in vibration mills, BMBF 01DS15022 (10/2015-10/2017) was applied with her and IGT participation. Her working stay delivered benefits for both IGTSAS and TU Clausthal. Rich transfer of knowledge was granted by combination of her skills in mechanochemical processes acquired at IGTSAS, and experience with industrial milling trained at TU Clausthal, which shall result in future collaboration on project proposals within basic and applied research.</p>
<p>Ing. Ján Vereš, PhD. Dr. Vereš has been working at a post-doc position at Energy Research Center, VŠB Ostrava since 2013. The project Biomass energy utilization and process safety in industry allowed for the expansion of the foundation of research teams in relation to the research field defined by VŠB - Technical University of Ostrava and IGTSAS: raw materials, energy, and ecology, information technology, new materials, construction, and technology. His stay delivers not only the coordination of research efforts, moreover it allowed integration into international scientific research structures.</p>
<p>Prof. RNDr. Vladimír Šepelák, DrSc. Prof. Šepelák has been working at Technical University of Braunschweig, Germany (since 2002) and at Institute of Nanotechnology, Karlsruhe Institute of Technology, Germany (since 2009). His research is focused on determination of local structure of nanocrystalline solids prepared by mechanochemical synthesis. The in-sight information, achieved by implementation of spectroscopic methods, was correlated to the functional and physical properties of synthesized materials. He still keeps ongoing cooperation at the institute by participation on several projects, new joint proposals and training PhD students and young scientists at our institute.</p>

To IGTSAS
<p>Dr. Klebson Lucenildo da Silva, UEM, Paraná, Brazil. Hosted at IGTSAS via National Scholarship Programme of the Slovak Republic (10/2018 – 7/2019) and sabbatical from UEM, Maringá, Brazil (8/2019 – 9/2021). His research stay was focused on synthesis and study of nanocrystalline complex oxides with perovskite and mullite structures, and explanation of their physical properties in context to the nanocrystalline nature of investigated samples. Achieved results were analyzed in order to understand and explain physico-chemical properties of synthesized samples when compared to their natural mineral counterparts.</p>
<p>Dr. Ryo Kasuya, Global Zero Emission Research Center, National Institute of Advanced Industrial Science and Technology, Tokyo, Japan. (2018, 10-months). Hosted at IGTSAS via contract research focused on training mechanical activation in a planetary ball mill, XRD and specific surface area analysis, leaching of noble metals from model samples.</p>
<p>Liudmyla Nosach, PhD. (09.2021-12.2021), Chuiko Institute of Surface Chemistry of National Academy of Sciences of Ukraine, Kyiv, Ukraine; her work plan was realized within the project 'Novel effective nanoscale cloud seeding materials for weather modification' supported by the National Scholarship Programme of the Slovak Republic. New effective methods for modifying highly disperse nanoscale silica with inorganic salts was developed. The research results have proved that the use of nanoscale highly disperse silica carrier and the gas-phase solvate-stimulated adsorption modification method of its modification with active ice-forming substances allows obtaining effective powder reagents for potential application as weather modifiers based on the levelity principle. 1 conference paper was published.</p>

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding (max. 2 pages)

New high-tech expensive infrastructure was purchased in previous Accreditation period 2021-2015 predominantly from seven ERDF projects. However in current Accreditation Period 2016-2021, due to political decisions, the ERDF Calls supporting purchase of new infrastructure were either not even published, or they were cancelled during the evaluation of the proposed projects. This extremely unhealthy situation diminished our efforts in acquiring the new infrastructure using the ERDF funds, thus forcing us to find new funding resources, even if limited.

Two issues to solve still remain: active search and applying for projects that might deliver financial support for cost-consuming operation of new high-tech devices, and searching for financial resources for supporting the salaries of highly-skilled personnel for operation of research devices.

Research infrastructure	Purpose	Source of funding
<i>Elemental and mineralogical analysis</i>		
D8 Advance XRD diffractometer software upgrade (ICDD, USA + EVA, TOPAS, Bruker, Germany)	phase identification, quantitative and qualitative analyses of XRD data	Revenues from BSK Vrakuňa project contract
Single disc grinder Saphir 320 (ATM, Germany)	preparation of samples for microscopy analyses	Visegrad Fund V4-Japan Adox project
3x Milling jars 20 ml, agate (Fritsch, Germany) 2x Milling jars 80 ml, ZrO ₂ (Fritsch, Germany)	refinement of samples (micro-, nano-size, homogenisation, synthetic reactions)	COST + VEGA projects
<i>Surface and particle size analysis</i>		
PC Alza battle box ADLER core	quantum chemical calculations of the behavior of atoms on the surface of adsorbents and catalysts	Revenues / own resources of IGTSAS

<i>Mineral biotechnologies</i>		
Compressor MSM2, 2/10 MDW-200	preparation of dry and clean, compressed air (up to a pressure of 8 bar) for subsequent nitrogen separation in N2 generator. Pure nitrogen is used as the process gas for mass spectrometry (HPLC-MS-MS)	FP7-WaSClean project
Ultra Low Temperature Freezing Box ULTF 80 Arctiko	cryostat for storing bacterial cultures and other materials at low temperatures below -80 °C.	Revenues from BSK Vrankuňa project contract
Electrochemical reactor CONDIACELL® Cell Model CC 1500	Electrochemical Advanced Oxidation Processes (EAOP) aiming to treat wastewater streams with high COD load to achieve total or partial oxidation	Revenues from BSK Vrankuňa project contract
HERASAFE KS18 Biohazard Biological Safety Cabinet Class II	wide variety of applications that require a clean environment	NIHON SEIKO contract
2 x 3-Channel gas mass flow controller Bronkhorst IQ+ FLOW	monitoring and control the gas flow rate in biological, chemical and electrochemical reactors/applications	Combined revenues from BSK Vrankuňa contract, Skypark Penta contract and own IGTSAS revenues

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

As referred in the chapters above, the IGTSAS possess significant international and national reputation in all its research activities. The Institute offers a scientific group with a strong interdisciplinary background, which comprises senior scientists, junior research fellows, PhD students and technicians. IGTSAS provides favourable climate to perform high level research on both international and national level, respectively. IGTSAS successfully competed and coordinated substantial number of national and international research projects such as FP7, NATO, APVV, VEGA as well as industrial projects on demand. Institute of Geotechnics SAS has been asked frequently to provide testing, measurements, assessment reports, etc. by the Slovak companies active in civil engineering, chemistry, environment, etc.

Moreover, individual researchers of IGTSAS were awarded for their activities by several national and international awards. They are regularly invited for expert reviews on international and national project proposals, expert reports from regional authorities, asked for reviews of scientific papers, they act as members of program committees of major scientific conferences, they are members of decision-taking bodies, etc.

Members of advisory governmental bodies, decision-taking bodies, etc.		
Name	Position	Advisory societies, etc.
Baláž Peter	Emeritus Fellow	The Learned Society of Slovakia
	member	VEGA Committee No. 6
	member	SAS Committee for International Projects Evaluation
	member	Scientific Council of the Slovak Academy of Sciences for Electronics, Materials Research and Technology

Krúpa Víťazoslav	member of Board of Supervisors	Slovak Mining Chamber
	member of selection committee of District office in Košice	Chairman of the Selection Committee for the Evaluation of Proposals for the Transfer of the Michalovce Mining Area to another organization
	member	Scientific Council of the Slovak Academy of Sciences for electronics, Materials Research and Technology
	member	Scientific Board of The Faculty of Civil Engineering, TU Košice
Kupka Daniel	member of Expert Working Group	Expert Working Group for National Implementation Plan Stockholm Convention on Persistent Substances under Management Ministry of Environment of the Slovak Republic
	member	SAS Committee for Environment and Climate Change
Hančulák Jozef	member	SAS Committee for Environment
	member	Committee VEGA no. 6
	member	Sector Council for Mining and Processing Raw Materials, Geology. The Ministry of Labour, Social Affairs and Family of the Slovak Republic
Hredzák Slavomír	member	Scientific Council of the Slovak Academy of Sciences for the Earth and Space Sciences
	member	Scientific Board of The Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice
	vicepresident	Slovakian Mining Society
	member	Sector Council for Metallurgy, Metalworking and Blacksmith. The Ministry of Labour, Social Affairs and Family of the Slovak Republic
	vice-chair of presidium	National Technological Platform for research, development and innovation of raw materials
	member	Committee for classification of mineral reserves. Ministry of Environment of the Slovak Republic
Labaš Milan	member	Committee VEGA no. 6
Lazarová Edita	member	Committee VEGA no. 6
Luptáková Alena	vicepresident	Committee VEGA no. 6
	member	Member of Expert Group 1. for the Creation of the Concept of Water Policy until 2030 with a view to 2050, Ministry of Environment of the Slovak Republic
	member	Member Extended of Presidium of VEGA
Marcin Behunová Dominika	member	Vicechairwoman and Member of the Young Scientists of the SAS Platform
Melnyk Inna	member	Expert of the Chemistry section of the Scientific Council of the Ministry of Education and Science of Ukraine
Šepelák Vladimír	Fellow	The Learned Society of Slovakia
	member	Scientific Council of the Slovak Academy of Sciences for Electronics, Materials Research and Technology
Miroslava Václavíková	member	Committee VEGA no. 6
	member	SAS Committee for International Projects Evaluation
	member	SAS Committee for International Scientific and Technical Cooperation
	member	SAS Committee for Environment and Climate Change
	member	Scientific Board of The Faculty of Mining, Ecology, Process Control and Geotechnologies, TU Košice

IGTSAS' institutional memberships of international/national professional associations
National Technological Platform for research, development and innovation of raw materials – member of the ETP SMR (The European Technology Platform on Sustainable Mineral Resources)
Slovakian Mining Society – member of the Association of Slovak Scientific and Technological Societies
Slovak Mining Chamber – member of the EUROMINES and the EURACOAL
Slovak Association of Aggregates Producers - a member of the UEPG (Union Européenne des Producteurs de Granulats - European Aggregates Association)
Slovak Tunnelling Association (member of ITA/AITES International Tunneling Association)

IGTSAS takes part in the projects related to the recovery of the environment and development of new materials and technologies. Such projects significantly improve the environmental conditions as well as health and quality of life of humans and thus indirectly increase the social and economic level of society. Moreover, these projects correspond to the priority areas of Slovak RIS3 SK strategy as well as with the strategy of sustainable development (See Chapter 4).

Considering the possibilities of decarbonization of industry, IGTSAS joined the project proposal for the ERDF project of a long strategic research of the large-scale energy storage of **hydrogen** in the geological structures. (ADFB01 KOTULOVÁ, Júlia - KORČÁK, Martin - PAVLÍK, Viliam - KUPKA, Daniel - FRANKOVSKÁ, J. - KYŠKA-PIPIK, Radovan. High-capacity hydrogen-based energy storage as a solution for the future (In Slovak). Veľkokapacitné úložisko energie na báze vodíka ako riešenie budúcnosti. In *SlovGas*, 2016, vol. 4, no. 4, p. 8-12. ISSN 1335-3853). However, the ERDF project call was cancelled.

Roadmap to the WATERS scientific programme

Elaborated by Slovak Academy of Sciences based on JRC Technical Reports Water in Slovakia: Pressures, Status and Outlook (2016)

Coming from the indicated gap of knowledge about water resources in Slovak Republic, Slovak Academy of Sciences has intended to prepare a proposal for new scientific programme concerning water management (acronym WATERS).

The main goal of the proposed programme WATERS was to assess the present status and prediction of water resources availability in terms of climate and land use changes. The broader context of water resources, environment and society were addressed by multidisciplinary research based on complex modelling of water dynamics, transported substances and ecosystem services in relation to the society and its sustainable development. Roadmap to the WATERS scientific programme identified the most important problems concerning water management and water use in Slovak Republic. Planned IGTSAS tasks: 1. Complex database of mine waters involving data on location, geological background, water quality, and quantitative yields & Proposal for using and protection of mine water resources and the socio-economic benefit potential assessment. 2. Separation of various industrially and environmentally important trace contaminants from mine water, which concurrently increase the quality of water as strategic resource.

Partner organizations: SAS Institutes: Earth Science Institute, IGTSAS, Institute of Geography, Institute of Hydrology, Institute of Landscape Ecology, Centre of Social and Psychological Sciences, Institute of Ethnology, Plant Science and Biodiversity Centre.

Responsible partner at IGTSAS: W / MVDr. Daniel Kupka, PhD.

IGTSAS as a member of Slovak Mining Society and Slovak Mining Chamber actively participates in panel discussions on new “Mineral Policy of Slovak Republic” with all stakeholders in Slovakia within the regular meetings and conferences. The New Mineral Policy shall represent a vision of mining enterprise / business focused on critical minerals, base and precious metals and industrial minerals considering the affordability of mineral raw materials for the smooth performance of the EU's Economy. Latest version of new Mineral Policy of SR was prepared within the National Technological Platform for Research, Development and Innovation of Raw Materials, which was commissioned to elaborate the policy by 3 Slovak ministries – Economy, Environment and Education.

3. Implementation of the recommendations from the previous evaluation period

**Rating in scale from A to D, where A is excellent, B is very good, C is good and D is week.*

OVERALL ASSESSMENT

Comments on the past performance

The publication output in terms of papers published in peer reviewed international journals is patchy with some departments having no papers in this category.

The engagement of the Institute with local groups through outreach activities is impressive.

Comments and recommendations for further improvement of the institute

In addition to the general comments that apply to all institutes to a varying extent, the following specific recommendations and comments are made:

The strategic work of the Institute impressed the panel and should be continued. It demonstrated good awareness of and participation in international programmes such as NATO, FP7 WaSclean, etc. They expressed confidence in ability to generate more external funding from enterprise and project funding.

There may be some opportunities to consolidate work programmes with other Institutes. (e.g. Department of Environment and Hygiene in Mining.)

The gender balance among PhD candidates and Postdocs (as observed on site) is good and the general gender balance suggests a better trend for the future.

Overall, this Institute gave a very coherent presentation of its work and it impressed the panel with its approach to carving out its future direction. It is outward looking and builds on strong local alliances. By comparison with other Institutes, the collaboration with the University seemed particularly constructive and mutually productive.

It will benefit from greater external input to the strategic planning process as well as administrative support to achieve greater success in international, competitive grant proposals.

Proposal of overall institute rating: B

The research is visible at the European level. The institute has made valuable contributions in the field in Europe.

In the previous assessment (2012-2015) the IGTSAS was assessed as “B” category. In order to improve the IGTSAS position, the management body carefully revised the situation and together with Scientific Board of IGTSAS took the following measures:

- annual evaluation of scientific outputs of researchers, where priority is given to publication activity, citations, project proposals, teaching activities, collaborations with industry, popularization, presentations, reviews of proposals and scientific articles,
- strong support of international collaboration via HE, H2020, NATO, COST, APVV, etc.,
- support of the collaboration with industry and of transfer of knowledge between industry and academia;
- support of international mobility of researchers and PhD fellows;
- motivating young researchers to apply for prestigious international individual fellowships,

- organizing the annual seminar of PhD students in English to improve the communication and presentation skills of research community, along with lectures of hosted fellows and senior scientists.

As documented throughout the whole Questionnaire, the Institute of Geotechnics SAS achieved the results on appropriate international level comparable with similar institutions worldwide.

The Institute performs an interdisciplinary research supporting the intensive collaboration across all departments. In order to secure sustainable growth in long-term scale, the managing body of the institute carefully evaluates annually the strong and weak points of its research community and tries to fill the gaps in skills by opening new PhD positions and/or new Post Doc positions as well as improve training to gain language, presentation, leadership skills of researchers along with the improvement of research infrastructure.

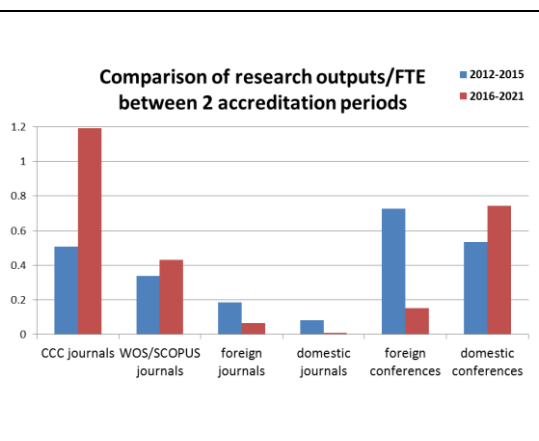
The final recommendations of previous accreditation had a general character. In 2017, the IGTSAS elaborated the Strategy and Action Plan, where the particular issues to implement were analysed as follows:

1. Improve the quality of research outputs

Scientific Board of IGTSAS has elaborated an internal methodology (Rules of Regular Evaluation of Researcher) for annual assessment of scientific activities of a researcher, which not only acknowledges impact factor of published journal paper, however covers all aspects of activities performed during whole year (publishing, citations, project proposals and project implementation, education, contracts, popularization, etc.). The criteria are revised annually and modify according to the current demands of SAS Evaluation Rules. Both quality and quantity of publications of individual researchers are assessed annually.

There was a substantial increase by 135% in number/FTE of CCC journals papers and 28% in WoS/Scopus journals papers compared to the previous accreditation period 2012-2015. All departments have been actively involved in publishing in CCC and impacted journals. Decrease in foreign conference papers showed stronger motivation to publish in journals. There is a general trend of international conference organizers to publish peer-reviewed conference papers in WoS/Scopus journals. Two years of Covid-19 restrictions in travelling also showed in only a few foreign conference papers. Domestic conference papers slightly increased in the last years, as travelling inside Slovakia had less limits due to Covid-19, so researchers could visit more domestic scientific events.

Categories	Type of research output	Average nr./FTE/year 2012-2015	Average nr./FTE/year 2016-2021
ADCA, ADCB, ADDA, ADDB	CCC journals	0.507	1.19
ADMA, ADMB, ADNA, ADNB	WOS/SCOPUS journals	0.338	0.433
ADEA, ADEB	foreign journals	0.186	0.067
ADFA, ADFB	domestic journals	0.084	0.01
AECA, AFA, AFC	foreign conferences*	0.727	0.154
AEDA, AFB, AFD	domestic conferences*	0.535	0.742



**Note: In 2015 there was a change in the rules for publication category assignment, so previous accreditation period 2012-2015 covered conference papers in categories AECA/AEDA, while current accreditation period 2016-2021 in AFA/AFB/AFC/AFD (when comparing the Tables 2.1.9 of two accreditation periods). The graph shows joint numbers for conference papers category).*

2. Improve the quality of PhD study

The PhD study quality depends on two major issues: selection of high-quality supervisors and selection of high-quality students. Supervisors have to be active with both their publishing and projects activities in the study field, and may open the PhD topic only if it is related to a running project to cover the PhD experiments. Admissions of PhD applicants involve an interview and test exam by the Admission Committee. The quality control runs annually at the PhD seminar

organized by the Scientific Board and on the students' conference "Metalurgia Junior" organized by the Faculty of Materials, Metallurgy and Recycling, Technical University of Košice.

PhD students are encouraged to apply for the DoktoGrants (6 funded projects from 7 submitted proposals), National Scholarship Programme, Erasmus+ and other fellowships for long-term research stays abroad (See Chapter 2.5.8 Supplementary information to PhD study).

There are 8 PhD students at IGTSAS nowadays (June 30, 2022), with 4 students from Ukraine, which shows a progress in „internationalization“ of the PhD study. Major progress is awaited after accreditation of the study field in English language.

3. Career growth of postdocs and researchers

Postdocs, after their employment at IGTSAS, are encouraged to apply for S.Schwarz Supporting Fund for a postdoctoral position at the institute (partially) covering their salaries. Postdoc positions have been also funded by APVV projects (See Chapter 2.8.2).

SAS has established Criteria for Assigning the Qualification Degrees IIa (Senior Scientist) and I (Leading Senior Scientist), and all researchers are encouraged to apply for a higher degree once they fulfil the required criteria (See Chapter 2.8.1).

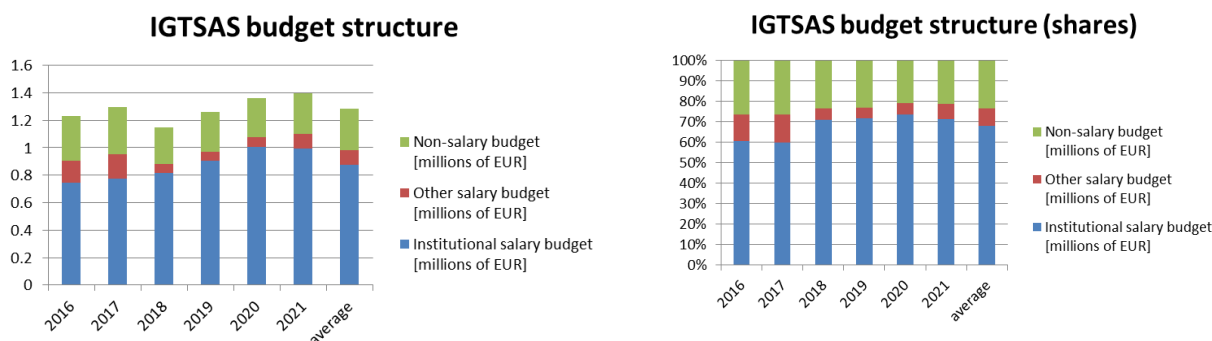
4. Improve the success rate in major European projects

IGTSAS has been very active in proposals of collaborative international research in ERA-NET, H2020, Horizon Europe, COST, NATO and other major European project calls. Even the unfunded proposals obtained very high ranking from evaluators. The joint projects consortia have been established with academic and industrial partners across Europe within the funded projects, but also in formation of project consortia during writing proposals of submitted but unfunded projects (See Chapter 2.4.1).

5. Financial management

The IGTSAS has been managed financially within the legislation valid for contributory organization (financial contribution from SAS and financial resources acquired from projects and contract revenues). Since January 2022, the legal form of the institute has changed to Public Research Institution, which shall deliver different (hopefully better) funding rules for SAS institutes in the future.

FP7-WaSClean project helped to support the salary budget in substantially, which showed in higher salary sources of funding in budget structure in the first 2 years of accreditation period (See Chapter 1.6.1). Other major projects shall contribute to the salary budget in the future as well.



6. IPR issues

IPR issues run within the valid legislation. One utility model was registered in Slovakia, one patent application started, but discontinued. Recently, a patent application process started for the technology resulting from a major FP7 project coordinated at IGTSAS. Two foreign patent/utility models are registered in Kazakhstan. See Chapters 2.1.6 and 2.1.7 for more details.

7. Financing of research infrastructure

As there has been a major gap in ERDF project calls, which usually support the purchase and operation of research infrastructure (See Chapter 2.4.5 for details), this was covered from indirect costs, overheads and contract revenues (See Chapter 2.8.3).

Two issues to solve still remain: active search and applying for projects that might deliver financial support for cost-consuming operation of new high-tech devices, and searching for financial resources for supporting the salaries of highly-skilled personnel for operation of research devices.

8. Others

As the name of the Institute was commented in previous accreditation, the intraacademic discussion within the institute and argumentation took place, whether to stay with the so-called “trademark” or if to reflect the current research focus. So far we agreed that we stay with the name Institute of Geotechnics SAS as a trademark.

Older name “Mining Institute of SAS” (until 1993) was undesirable in the beginning of 90s of 20th century due to Metal Ore Mining Cut Down in Slovakia (similarly in all countries of Central and Eastern Europe and due to total unfriendly position of public opinion against mining). Thus, our predecessors proposed the current name “geotechnics” as an interaction of geosphere, as an object of research and technology, as tool for investigation of earth sources utilization, pollution of geological matrices, identification and remediation, and mineral-based materials applications in various fields of human/industrial activities.

Yes, it is not in concordance with its technical definition, but now it was/is accepted by research staff and partners of the institute.

Naturally, as to future we cannot exclude changing the name of the Institute, however now it is not a topic of the day. Topic of the day is successful projects granting from various sources and intensification of cooperation with industry to meet all three principles of SAS development, accepted by Presidium of SAS: working efficiency – sustainability – usefulness.

4. Research strategy and future development of the institute for the next five years (Recommended 3 pages, max. 5 pages)

Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)

Research strategy of the Institute has been published by Scientific Board of IGTSAS in the document “**Strategy and Action Plan of the Scientific Organization SAS**” in Sep 2017 in line with SAS guidelines, RIS3 2014-2020 and other valid European strategies.

RIS3 SK 2014-2020 was a Research and Innovation Strategy for Smart Specialisation of the Slovak Republic for programming period 2014-2020, which main objective was to boost the innovation potential of Slovak economy via enhanced collaboration of industries with research organizations. Interdisciplinary background of IGTSAS ensured the ability to take part in the collaborative research in priority areas defined by RIS3 SK 2014-2020:

Priority research area of RIS3 SK 2014-2020
Material research and nanotechnologies
Information-communication technologies
Biotechnologies and biomedicine
Agriculture and environment, including environment-friendly modern chemical technologies
Sustainable energy

SK RIS3 2021+ (Research and Innovation Smart Specialisation Strategy of the Slovak Republic 2021-2027) was adopted On Dec 8, 2021 as a new strategy of Slovak Government.

IGTSAS’ research strategy covers also the priority areas of RIS3 SK 2021+ defined as:

Domains and priority areas of RIS3 SK 2021+	
Domain of smart specialization	Priority areas of the domain (IGTSAS potential in Bold)
Innovative industry for the 21 st century	(1) Automation and robotisation of industrial production, Industry 4.0 , ensuring resilience to external influences; (2) Processing of raw materials and semi-finished products into products with higher added value ; (3) Progressive technologies and materials ; (4) Increasing energy efficiency in the economy; (5) Efficient waste management ; (6) Energy security of the Slovak Republic.
Mobility for the 21 st century	(1) Connected and autonomous mobility; (2) Smart mobility services and intelligent transport systems; (3) Decarbonisation and sustainability of mobility .
Digital transformation of Slovakia	(1) Smart and connected sensors and devices; (2) Increasing the utility value of all types of data and databases; (3) Smart energy systems; (4) Cybersecurity and cryptography.
Healthy Society	(1) Personalised/precision medicine; (2) Innovative products (including biomaterials and biotechnologies), processes and procedures in healthcare; (3) Breakthrough technologies in healthcare.
Healthy food and environment	(1) Resilient and healthy local food systems; (2) Biomass-based circular production systems; (3) Society within the environment; (4) Sustainable natural resources (soil, water, air, biodiversity, ecosystems) .

Beside that, the research priorities of IGTSAS are in line with European strategies:

Strategies of EU
A Clean Planet for all. A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy. Brussels, 28 November 2018.
The European Green Deal, Brussels, 11.12.2019
Circular Economy Action Plan: For a cleaner and more competitive Europe. European Union, 2020.
A New Industrial Strategy for Europe, Brussels, 10.3.2020
Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability, Brussels, 3.9.2020. (The 2020 EU Critical Raw Materials List)

Integration and diversification of IGTSAS research – what connects and separates us

Researchers in the departments of IGTSAS all work with various forms of minerals. The mineral represents a research object as a part of rock mass and raw material, but also represents a research tool being a functional material (sorbent, catalyst, medicine, etc.). Different aspects of mineral as natural compound of Earth crust and environment are given in the following scheme:

5M of a mineral	
M1	♦ Mineral as a part of rock mass, compound of intact rock, part of raw material - primary occurrence
M2	♦ Mineral / mineral synthetic phase as a part of by-product and waste after mining and processing, after metallurgical process, electrotechnical, chemical or energy production - secondary occurrence
M3	♦ Mineral as a individuum from technological aspect i) utility mineral – target mineral of processing or exploitation, ii) barren mineral – not usable, iii) adverse / harmful / derogative mineral – quality degradation of a target mineral/product
M4	♦ Mineral either natural or synthetic as i) functional utility material, ii) precursor for subsequent production, iii) final product, iv) part of a final product.
M5	♦ Mineral and its compounds as a product of weathering, natural leaching, mineral element, metal/metal ion/ion complex as a component of environmental matrix (water, soil, air)

Scientific departments of IGTSAS focus on different aspects of minerals:

Mineral as research object and research tool – integrating and diversifying factor						
Scientific department of IGTSAS	M1	M2	M3	M4	M5	Σ
DDCG	XXXXXXXX	X		X		10X
DMMP	X	X	XXXX	XX	XX	10X
DM	X	X	X	XXXXXX	X	10X
DMB	X	XX	X	XX	XXXX	10X
DEHM	X	X			XXXXXXXX	10X

Strategy of future research activities within the Departments

Department of Destructional and Constructional Geotechnics

DDCG shall investigate core-drilling of rocks, assessment of interaction of drill bit and rock, energy interpretation of strength properties of rock mass, monitoring and optimization of rock cutting processes and study of the accompanying vibration and acoustic signal for the optimization of rock drilling process. Methods involve experimental studies on the laboratory drilling rig simulating the real operational conditions with monitoring of input and output process data, including vibration and acoustic emissions.

Comprehensive evaluation of large datasets in real-time shall involve artificial intelligence means, data mining, fuzzy logic, statistical mathematics, frequency analysis and black box methods in rock drilling in line with the Industry 4.0 concept. Physical interpretation of rock characteristics, application of the patterns of fracture mechanics into rock mechanics in rock cutting processes, and investigation of rock debris formed in drilling shall be deployed for differentiation of drilling conditions using the experimental core-drilling rig. All of the above shall serve for lowering both energy consumption and costs for exchange of drill bits during underground construction and exploitation of mineral resources, and deliver significant automation of the drilling process.

Department of Physical and Physico-Chemical Methods of Mineral Processing

The research in DMMP shall focus on raw materials and mineral processing related to environmental technologies, which involves a synthesis of advanced materials for contaminant removal from environment, use of advanced oxidation processes in degradation of organic pollutants, composite materials for elimination of industrial contaminants (AOX, absorbable organic halogens) from environment, and extraction of selected compounds or critical elements from secondary raw materials and industrial waste using progressive treatment approaches.

Department of Mechanochemistry

Future research in DM will be focused on the synthesis and characterization of the mechanochemically synthesized binary and ternary sulphides Cu-Sb-S, Cu-Bi-S, Cu-Fe-S and/or their nanocomposites and selenides Ag_2Se , $\text{Cu}_{2-x}\text{Ag}_x\text{Se}$, CuCr_2Se_4 -nanostructured semiconductors by high-energy milling. These nanomaterials represent perspective materials for future optoelectric, thermoelectric and energy storage applications. Moreover, the synthesis of new compounds based on oxides and halides as potential components of ion batteries or solid oxide fuel cells will be investigated. The relationships between structure and electrochemical properties and the contribution of the surface to the value of capacity and electrical conductivity will be studied.

In the future, also the sustainable side of mechanochemistry will be targeted. Particular topics will include the valorisation of eggshell waste as an adsorbent of heavy metals and an intrinsic source of sulphur and carbon for the preparation of sulphides to be utilized in energy applications (e.g. CO_2 reduction or thermoelectrics). Also, the plant biomass will be used as a source of chlorine and processed together with silver nitrate powder to yield AgCl/Ag nanocomposites applicable, e.g. in photocatalysis. As part of a successful ERA-MIN3 POTASSIAL project, CO_2 sequestration on the mechanically activated feldspathic ore will be studied for the first time, as an innovative activity. Optimally milled feldspathic ore samples will be tested for the possibility of CO_2 uptake using ex-situ methods (separate milling followed by CO_2 adsorption) and/or in-situ methods (simultaneous milling and CO_2 adsorption). The possibility of nanocomposite formation in this system will be also studied.

Department of Mineral Biotechnologies

From predicted global trends in exhaustion of strategic raw materials, but even more from the European perspective, there is a great emphasis on the development of efficient new or modified technologies, that can be used for the extraction of a group of elements from complex polymetallic ores, concentrates, mine wastes and tailings.

In the field of biohydrometallurgy, the priority will be the identification and selection of (new) bacterial species capable of surviving in extreme conditions of these environments. The parameters of the leaching process will be optimized in order to effectively use the potential of microorganisms, and to approximate metal extraction rates, suitable for practical consideration

In the management of mine impacted waters we will focus on:

- application of passive or low-energy (solar powered) systems for sustainable mine water remediation, long-term monitoring and maintenance
- use of selective rather than bulk recovery methods, allowing concentration of elements of interest at both precipitation/adsorption and recovery stages,
- application of advanced chemicals, adsorbents, membranes, materials with regeneration and/or recycling capabilities,

- treatment of mine impacted water for the recovery of drinking water and other saleable products, as many countries around the world suffer from water shortages, with drinking water becoming a strategic commodity and a matter of national security,
- application of flexible modular and scalable approach allowing versatility and targeting of different mine sites and target elements for recovery or elimination from treated water.

In collaboration with DMMP, development of new electrode materials and new integrated technologies is planned, utilizing advanced electrochemical processes, for a range of wastewater treatment scenarios, delivering positive outcomes for local communities and the environment, and leaving a positive legacy for future generations.

Department of Environment and Hygiene in Mining

Air quality research will focus on the study of suspended particulate matter (PM) and atmospheric deposition of dust particles which represents serious environmental and health risks. The specific characteristics of these particles will be studied in relation to their anthropogenic and natural emission sources and their impact on selected environmental constituents.

Greater emphasis in particle research will be placed on the use of microtechniques such as electron microanalysis and microdiffraction in collaboration with external workplaces. In the area of research on contaminated soils and sediments, research will focus on the development and potential use of rapid progressive screening methods to assess their quality and diagnose environmental risk.

Summary of main highlights for the sustainable growth of IGTSAS

- Increase the activity of leaders and individual researchers in project applications within the major agencies and programmes, such as Horizon Europe, ERDF, APVV, NATO, COST, etc;
- Encourage PhD students, young and experienced researchers to apply for prestigious individual fellowships within the Horizon Marie Skłodowska-Curie Actions, ERA-NET, ERC, European fellowships, National Scholarship Programme of SR, etc;
- Support the international mobility of researchers to establish new research contacts and collaborations;
- Search for funding to create a new Post Doc positions;
- Motivate and encourage researchers to increase their qualification by promoting to Professor (prof.) and/or Doctor of Sciences (DrSc);
- Motivate researchers to protect the intellectual property and apply for patents;
- Develop the IPR policy of the Institute.

Possible future impacts of IGTSAS

Research running at IGTSAS is focused on current global challenges, such as climate change, sustainability of groundwater, soil and air quality, environmental risk management, biotechnologies, protection of biodiversity and population health. Our institute pays special attention to the issues of complex processes of managing the environmental burdens as significant society problems.

The main features of the technologies developed at IGTSAS:

1. energy savings to reduce operating costs, which will ultimately result in a reduction in the carbon footprint,
2. remediation of environmental matrices to improve the quality of the environment,
3. material recycling as one of the basic steps in transformation of a linear raw material chain into a raw material cycle within the implementation of the circular economy in the raw material industry,
4. innovative methods of materials preparation.



Technology Readiness Levels of IGTSAS-developed technologies
Assessment and quantification of pollution sources share on dust deposition at specific location TRL 9: Methodology is directly applicable after considering local emission and immission conditions
AMOS – Automated monitoring and optimization system for full-profile tunnel boring machines and drilling rigs TRL 7: Demonstration of prototype in full operation at various underground mining and tunneling sites
In-situ monitoring of degradation of organic pollutants in soil and rock mass TRL 7: Technology was tested in pilot conditions
Progressive integrated technologies of water clean-up TRL 5: Technology was tested in pilot conditions
Mechanochemical synthesis of Sn and Cu nanosulphides TRL 5: Technology was tested externally in pilot conditions
Selective acquisition of metals and semi-metals from mining drainage TRL 4: laboratory validated approach
Complex treatment of material from heaps and settling pits after mining, mineral processing and metallurgical industrial activities – processing of materials with low quality to usable/tradable products TRL 4: individual technological nodes of separation methods have to be validated first in laboratory scale
De-ferrization of (alumino)silicate and carbonate raw materials TRL 4: validation necessary first in laboratory scale
Gold extraction from gold-bearing concentrates and goldsmith' waste using electrolyser with 3D cathod TRL 4: constructed and validated apparatus with electrolyzer in lab conditions
Synthesis of components for ion batteries and fuel cells from solid oxides TRL 4: technology tested in laboratory conditions
Recycling of metals and abrasives from cutting operation of metal components TRL 3: decomposition of waste clods and separation of utility compounds have to be validated in lab scale separately for magnetic and non-magnetic metals or alloys
Extraction of CdTe from solar cells TRL 3: ground solar panel: procedure of CdTe extraction of separation of CdTe from Ca-Mg glass has to be validated at larger samples in lab scale

The common denominators of the final outputs of IGTSAS:

- new functional bi/poly-component materials based on various mineral phases and additives/modifiers with high performance (e.g. sorption capacity, catalysis, energy storage, photovoltaics, medicine, ...)
- new efficient remediation processes of ecologically burdened land (water and soil treatment, detoxification/inactivation of hazardous substances in landfills, processing of heap and sludge material after mining, mineral processing and metallurgical activities) as well as detailed identification of pollution sources and determination of their damage to the environment,
- increase of process efficiency / energy, material, time, costs savings.



We deliver our very best. IGTSAS.

Košice, June 30, 2022