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## ADDRESS BY THE DIRECTOR

2022 marked a successful year for the Geological Survey of Slovenia (hereinafter: GeoZS). Not only were our goals and expectations met and exceeded, but we also outlined starting points for a new long-term GeoZS strategy and welcomed aboard new staff members. One might even argue that 2022 was a watershed year for geology as a discipline, as it highlighted Europe's strong dependence on external sources of raw materials. In the aftermath of the COVID-19 crisis that had rattled supply chains, the aggression on Ukraine magnified the challenges of Europe's raw-material dependence, exposing serious issues.

For decades the geology community has been pointing out how dependent we are on the developing world for our raw materials. Moreover, the past decades saw Europe and Slovenia phasing out the extraction of primary raw materials and, most notably, relevant research in this field. Industry on the whole operated and developed on the assumption that there are no primary raw materials in Europe and that the solution is to rely on imports. As it turns out, this is not the case. Europe does in fact have its own mineral resources. It can also draw on the relevant knowledge of where and how to find them, how to extract them and how to process them. And do it sustainably, no less! Our discipline has played a key role in preserving this knowledge and know-how, and in providing expert support for the design of future policies that would steer us towards decreased raw material dependency. We realise that this knowledge will be necessary either today or tomorrow, thus we have never let this vital primary activity of geosciences fall by the wayside. Research may have become somewhat less diversified, but once the first serious discussions and policies began to arise in Europe about the need to find and rely on our own mineral resources, we were ready. In recent years, the GeoZS has also made a serious comeback to the field of mineral resources through its research work

in the framework of development and research programmes and projects, especially via its participation in the KIC EIT Raw Materials and GeoERA which ended last year. Our public mining service and research work equip us with knowledge and competencies that have received international recognition. Following several successful projects in the field of mineral resource information management, devising innovative ways of identifying, exploring, and extracting mineral resources – primary and secondary – it is in this area that we have made our strongest entry into the five-year project (Coordinated Support Action) aimed at establishing a Geological Service for Europe (CSA GSEU). In fact, under GSEU, we are leading the establishment of the European International Centre of Excellence on Sustainable Resource Management.

Just before the formal launch of the CSA GSEU, the most ambitious project in the history of EuroGeoSurveys (EGS) and a project set to change the format and impact of our and related disciplines on the development of Europe via science, the President of the European Commission, Ursula von der Leyen, announced in September 2022 that a new European Regulation will be put in place for Europe to address the issue of sustainable resource self-sufficiency. This announcement has also significantly increased the interest of decision-makers in engaging with us, the knowledge holders, both in Europe and at home in Slovenia.

2022 marked the 50th anniversary of EuroGeoSurveys (EGS) which we celebrated at a week-long event combined with the launch of the CSA GSEU. The expert discussions at the event were dynamic and interaction-driven, and the resulting collaboration and coordination efforts surely had an impact on the development of the draft regulations (CRM Act and Net Zero Industry Act) published in spring 2023. The drafts suggest a shift in the attitude towards mineral resources in Europe. It indicates the realisation that we will

have to become and remain more self-sufficient and, especially relevant for our discipline, it makes clear that Europe has indeed its own raw material supplies, although they will have to be located, explored, and sustainably extracted. At the time of writing, the regulations (CRM Act and Net Zero Industry Act) are still under preparation. It is our hope that neither of the frameworks will depart drastically from the first drafts, especially concerning ongoing extensive pan-European research of mineral resources. If that proves the case, we can expect a new era of subsurface use, this time rooted in interdisciplinary knowledge and with an emphasis on proper planning and sustainability.

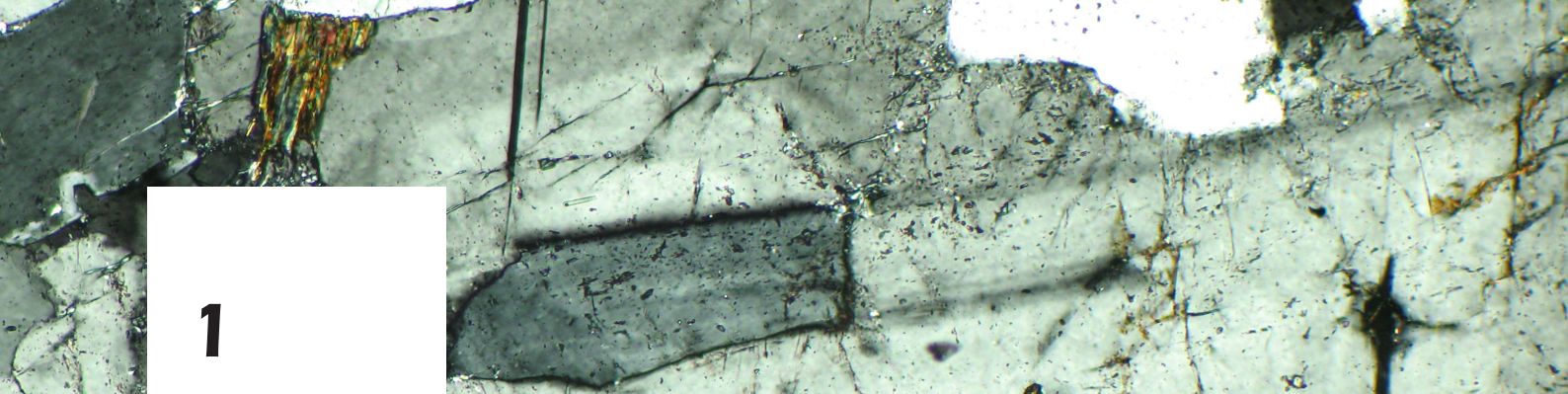
At the GeoZS, we are ready to rise to the challenge. Although we have been enhancing the research areas addressed by the two draft regulations in the last few years, there is still room to grow. During a series of participatory workshops involving our entire staff in 2022, the necessity to enhance this specific area of expertise was distinctly recognised. This also laid the groundwork for developing a new GeoZS strategy, which is set to take its final shape in 2023. The challenges ahead are considerable, and we are keen on embracing them. The state of our knowledge about Slovenia is currently mostly limited to the upper few hundred metres of the Earth's crust. Moving forward, we expect we will need to update the existing geological models and deal with the challenges of exploring greater depths. We seek to design a comprehensive 3D model of Slovenia's subsurface and surface and of its neighbouring regions, and to provide a rationale and expert basis for the sustainable use of the Earth's mineral resources and sound spatial management – on and below the Earth's surface. Our future is all about knowledge and geology without frontiers, and the present international embeddedness of the GeoZS stands as a testament to our dedication to this future vision.



2022 was also the first year of the new Scientific Research and Innovation Activities Act (Zakon o znanstvenoraziskovalni in inovacijski dejavnosti). The act resulted in a higher budget for the sciences and introduced a redesigned approach to the funding of a significant portion of research and infrastructure activities at research institutes and universities. Unfortunately, the GeoZS's science budget did not experience a substantial increase in 2022. However, the novel funding approach has introduced fresh opportunities that we have enthusiastically tapped into, with the first results already noticeable. Very importantly, we have been given greater flexibility in allocating the scope and focus of our long-term research work. It is equally important that in the future the Scientific Council of the GeoZS will be much more actively involved in the GeoZS's key strategic decisions, including staffing and HR. Our future sees us implementing and integrating an extensive array of interdisciplinary research that can no longer be referred to as merely geological. This type of research is focused on the state and processes on the Earth's surface and subsurface, where traditional labels for the specific discipline, field, or sub-field, in which we generate new findings, increasingly lose their relevance. Only progress is relevant!

dr. Miloš Bavec  
direktor





## OPERATING HIGHLIGHTS IN 2022

### FINANCIAL INDICATORS

Total revenue: EUR 6,988,954

Total expenditure: EUR 6,729,999

Operating result: EUR 215,755

Revenue from the Slovenian Research Agency (research projects and programmes): EUR 3,432,571

Revenue from public services and expertise in support of the functioning of the State: EUR 1,527,052

Revenue from international activities: EUR 704,911

Revenue from commercial activities: EUR 1,324,420

### NON-FINANCIAL INDICATORS

#### NUMBER OF RESEARCH PROJECTS

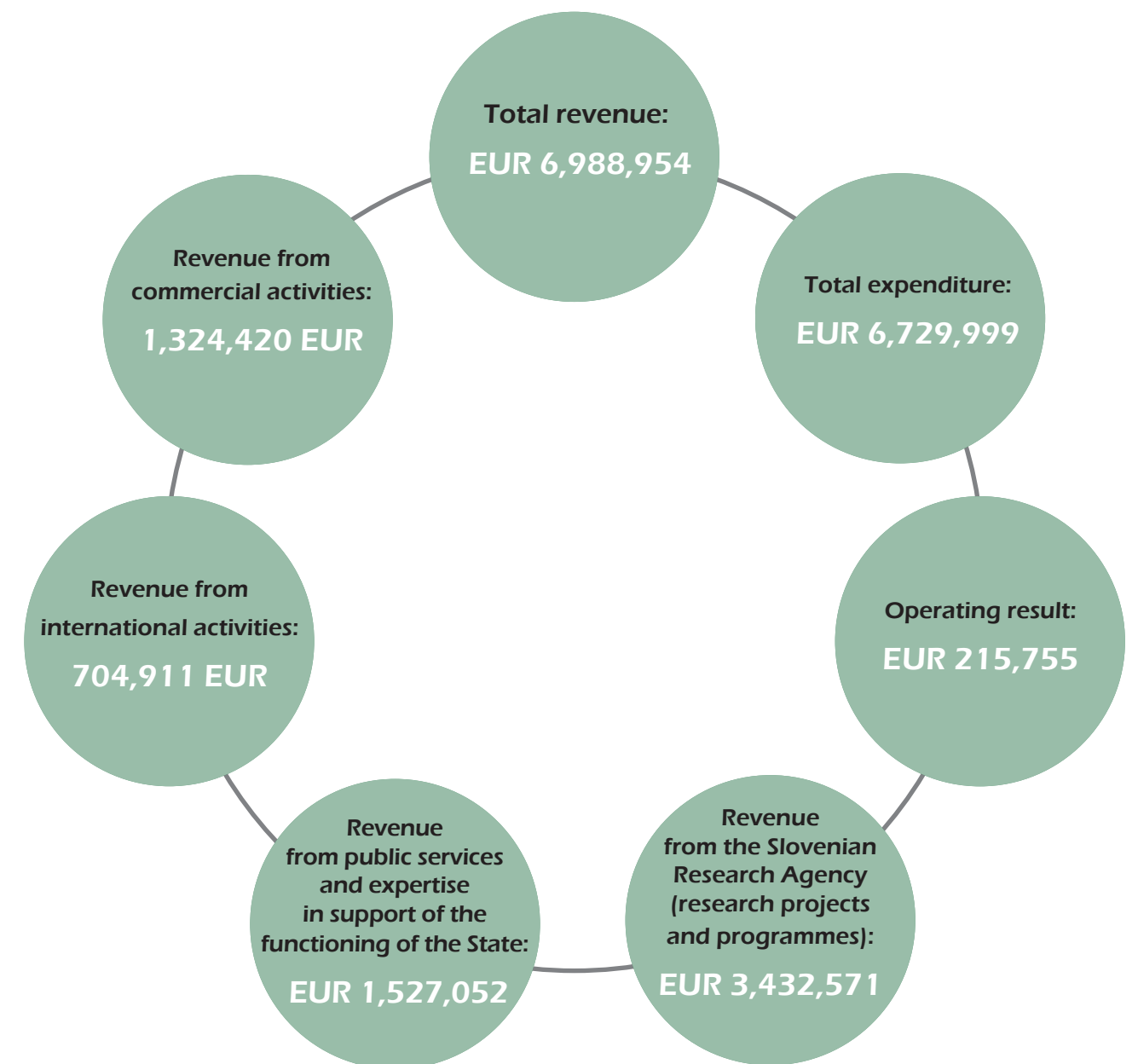
In 2022, the GeoZS carried out 13 research projects funded by the Slovenian Research Agency (ARRS – designation applicable in 2022). The number of projects carried out exceeded the number initially planned, as we successfully completed five additional projects beyond our initial target. Of these, three were core projects and two were target research projects. The GeoZS was leading nine projects, while it acted as a partner in four projects. The total amount of funding earmarked for these research projects was 6.3 FTE.

#### RESEARCH PROGRAMMES

In 2022, we carried out research as part of four ARRS research programmes:

- P1 - 0011 - Regional Geology,
- P1 - 0020 - Mineral Resources,
- P1 - 0025 - Groundwaters and Geochemistry,
- P1 - 0419 - Dynamic Earth

totalling 12.63 FTE, and implemented the infrastructure programme IO - 0007 - Geological information centre of 9 FTE.





**P1 – 0011 Regional Geology**  
Research programme leader: Dr. Tea Kolar Jurkovšek

The core purpose of the research programme is to continue with the fundamental geological research in Slovenia, integrating it into the broader European context. The ultimate objective of the fundamental geological research presented through state-of-the-art GIS-based geological maps, profiles, 3D models, and detailed studies is to grasp the structural characteristics of the Slovenian territory. A detailed understanding of these features facilitates the reconstruction of geological processes and the formation of the territory. Even more crucial is the broad applicability of the findings to the development and spatial planning. Within the programme, several interconnected tasks were carried out, the common denominator being a regional approach to addressing geological issues.

**P1 – 0020 Mineral Resources**  
Programme team leader: Dr. Gorazd Žibret

Directly addressing Slovenian, European, and global challenges in this particular field, the Mineral Resources Research Programme is the only research programme in Slovenia dedicated exclusively to this domain. The programme team deals with mineral resources throughout their entire life cycle, from geological formation studies, metallogenic studies, mine site investigations, research on mining waste and other secondary mineral resources, the impact of past and active mining on the environment, and processes related to the planning of mining activities to mineral processing and mine closure. The programme team also develops and outlines concepts, standards, and strategies for the sustainable exploitation and management of mineral resources at the local, national, and international levels. The main activities of the programme are related to non-metal, metal, and energy mineral resources, and also have strong interdisciplinary links with archaeology, robotics, chemistry, material sciences, mineral and thermal water research, geothermal energy, education, and data processing.

**P1 – 0025 Groundwaters and Geochemistry**  
Programme team leader: Dr. Mateja Gosar

The main objective of the Groundwaters and Geochemistry Research Programme is to analyse and understand the natural geological status of the environment and the impact of anthropogenic activities in relation to natural geological features. Our field of expertise is thus the hydrogeology and geochemistry of potentially harmful elements (PHE), a crucial and swiftly advancing area on a global scale. Ultimately, our research programme aims to examine the sources, transport routes, and consequences of potentially harmful elements in unpolluted and polluted environments. Of particular importance is the understanding of the processes that influence the release, transport, and uptake of pollutants and the link between the presence of these substances in different environments and their toxicity or harmfulness. It is

important to integrate the knowledge of geological conditions and an understanding of hydrogeological processes with regard to natural variability in groundwater quality with the risk of transfer of anthropogenic substances into groundwater. Our work involves evaluating the spatial variability of concentrations of chemical elements in natural, thermal, and mineral waters. Furthermore, we research and monitor the presence of modern organic pollutants and microplastics in groundwater. To this end, new monitoring tools are being designed. The research we carry out is crucial for the sustainable use of geothermal energy and also for efficient energy storage.

**P1 – 0419 Dynamic Earth**  
Programme team leader: Dr. Mateja Jemec Auflič

The Dynamic Earth Research Programme focuses on Earth's dynamic processes and the dynamic interactions between Earth's surface processes and tectonics. The multidisciplinary team of researchers focuses on the identification and characterisation of active geological structures, understanding seismic history and seismic sources for generating a seismic hazard assessment, understanding climate-induced processes at the Earth's surface, and identifying slope mass movements and their dynamics, with an emphasis on triggering factors and co-seismically triggered phenomena. The research programme aims to deepen and expand the current state of knowledge, with a particular focus on the challenges of environmental studies and geologically related hazards. The newly acquired insights support the operations of civil protection services to improve earthquake and landslide resilience, thus helping to minimise the vulnerability of populations, infrastructure, and cultural heritage. Finally, new knowledge of active tectonics also facilitates the identification and investigation of newly discovered potential mineral resources and energy mineral resources, while also boosting industry and tourism, and ultimately indirectly fostering a more sustainable use of these resources.

**IO - 0007 Geological Information Centre**  
Infrastructure programme leader: Jasna Šinigoj

The research conducted in all four research programmes overlaps across disciplines in several segments, most notably in the infrastructure programme.

Being the backbone of the GeoZS infrastructure programme, it is the primary purpose of the Geological Information Centre to ensure the availability and interoperability of consistent, high-quality geological data sets at the national level to address the needs of the research and the public sector, to facilitate the implementation of administrative procedures and European legislation, and to support economic development. Having quick access to reliable up-to-date geological data saves time and money. High-quality data that meets the accepted standards relating to spatial data is a reliable source of information for any end-user, whether they are a researcher relying on spatial data or an end-user from the industry sector.

## INTERNATIONAL ACTIVITIES

In 2022, the GeoZS was involved in the implementation of 30 international projects, of which were 12 Horizon 2020 and Horizon Europe projects.

Furthermore, the GeoZS carried out two research and development projects funded by the Norway Grants last year. One project each was co-funded by LIFE, EASME, Raw Materials Policy Support Actions, INTERREG Slovenia-Austria 2014–2020 programme, and one project each by the International Atomic Energy Agency and the European Space Agency.

Our involvement in the GeoERA programme over the past years has laid a solid foundation for a joint European geological service whose mission is to provide a comprehensive and coordinated response at EU level to future challenges related to geological topics (mineral resources, groundwater, geological structures, etc.). The idea of a joint European geological service is being continuously developed in the framework of the five-year Geological Service for Europe (GSEU) programme co-funded by the Horizon Europe programme. First launched in the autumn of 2022, the programme features 48 geological surveys across 35 European countries. The GSEU is a project aimed at establishing and facilitating ongoing collaboration among European geological surveys to provide European institutions, national decision-makers, the industry, the professional community, EU citizens, and other users with high-quality geological data on Europe's subsurface and among them the potential locations of mineral resources that are essential for the European industry which must take steps towards carbon neutrality. Drawing on expert research, the collaboration among European geological surveys will be centred on sustainable management and protection of the natural environment, including the protection of water resources, which is a prerequisite for a clean and safe living environment for the people of Europe.

The GeoZS stands out as one of the most proactive partners in the project. Our activities span the breadth of the project's thematic areas, from geo-

thermal energy and groundwater to information management and mineral resources. Most notably, we play a prominent role in the establishment of the European International Centre of Excellence for Sustainable Resource Management (EU ICE SRM), in the setting up of the information and technology framework of the future geological service (European Geological Data Infrastructure – EGDI), and in the implementation of the communication and dissemination activities of the project.

Being a partner of the largest Knowledge and Innovation Community (KIC) for mineral raw materials (KIC EIT RawMaterials), we have been involved in seven projects: RIS-ALICE, INSite, UNEXup, RM@SCHOOLS 4.0, RECO2MAG, TIMREX, and GeoRIS. Within the activities of the Regional Center Adria EIT RawMaterials Hub, we continued to organise a series of events aimed at informing, educating, and bringing together institutions and companies in the field of mineral resources in Slovenia, Croatia, and the Western Balkans. As part of the EIT HEI initiative (European Institute of Innovation and Technology: Innovation Capacity Building for Higher Education), we joined a consortium of six higher education institutions in a project aimed at boosting innovation capacity and realising sustainable development by applying the circular economy model into the raw materials sector.

Outside the European framework, we are partners in the PanAfGeo2 project in which we transfer knowledge and share experiences, fostering cooperation between the EGS (Association of European Geological Surveys – EuroGeoSurveys) and OAGS (Organisation of African Geological Surveys).

### CARRYING OUT PUBLIC SERVICES AND EXPERTISE PROJECTS FOR THE REPUBLIC OF SLOVENIA

On behalf of the Ministry of the Environment and Spatial Planning of the Republic of Slovenia (MOP – designation applicable in 2022), the Slovenian Environment Agency (ARSO), and the Slovenian Water Agency (DRSV), we have been mostly implementing projects in the field of water resource management,

sustainable use of groundwater, and geohazards management (slope mass movements hazard maps and active faults research).

For the Ministry of Agriculture, Forestry and Food, we have completed the assessment of the possibilities for using geothermal energy in agriculture in Slovenia.

We continued work on the design of MASPREM, an automated landslide prediction system for rainfall-induced landslides. With the help of MASPREM, the GeoZS and the Administration for Civil Protection and Disaster Relief are in the position to issue early warnings in the event of an increased risk of landslide occurrence.

We were actively carrying out the public mining service based on a commission by the ministry in charge of mining to address the ministry's specific needs. Our expertise and development tasks include implementation monitoring of the objectives, guidelines, and conditions of the national mining strategy, development and maintenance of the IT-based Mining Database and Mining Registry Book, monitoring of geological exploration works, sample collection, and preparation of expert opinions.

### COMMERCIAL ACTIVITIES

Below is a brief outline of our most notable projects. We carried out nature conservation monitoring at the construction sites of eight tunnels and interpretation of the geological conditions along the entire route of the second track of the railway line between Divača and Koper, and provided structural monitoring and control of excavations in the second tube of the Karavanke tunnel, as well as the identification and assessment of seismic hazards for the design of the second unit of the Krško Nuclear Power Plant, with a focus on characterisation and parameterisation of seismic sources. Next, we have wrapped up research phase 1 for the location of a new exploratory borehole for the extraction of mineral water (Donat type), which included the production of a detailed structural-geological map and a preliminary structural model. Our

activities included the elaboration of programmes and the implementation of concession monitoring for thermal water and natural mineral water. Moreover, we have been developing technical groundworks for the abstraction, utilisation, and protection of drinking water sources, as well as for evaluation of the shallow geothermal potential. We continued efforts for the maintenance, implementation, and interpretation of existing geotechnical and hydrogeological monitoring of some large-scale landslides. Several detailed expert reports were drawn up for various clients, focusing on crushed stone deposits, including structural and lithostratigraphic investigations of the deposit sites, as well as assessment of the expansion potential for the extraction areas.

### MOST PROMINENT SCIENTIFIC ACHIEVEMENTS

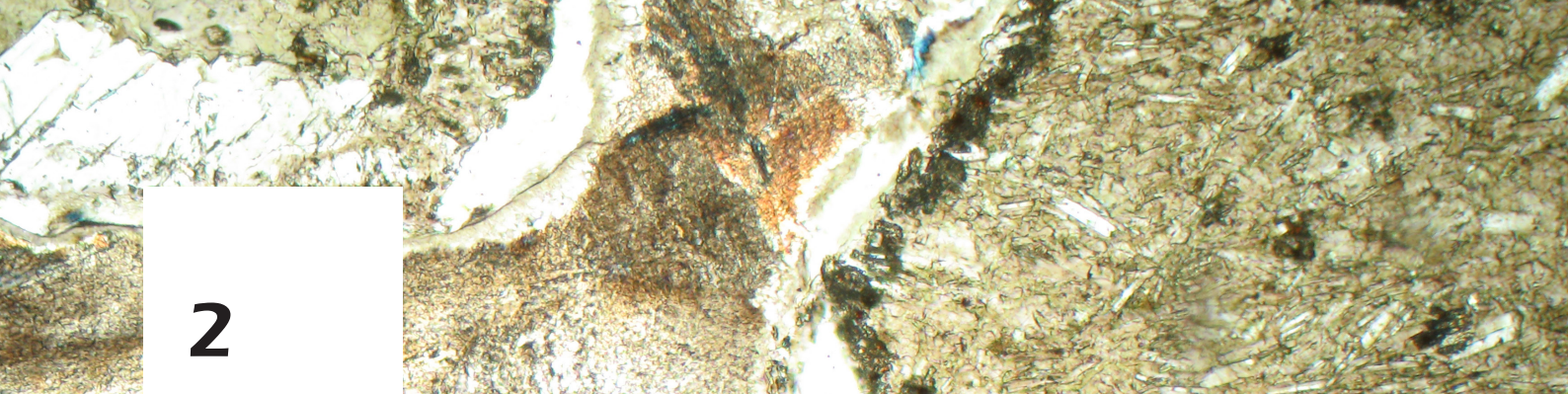
The highlight reel of our scientific achievements shows the entire spectrum of GeoZS research activities and the interdisciplinarity of research topics, ranging from scientific excellence at international level to scientific achievements with relevance for the Slovenian context. Below is a shortlist of five distinct areas of research in which our researchers made high-profile publications last year:

- the chemical properties of materials and pollutants in different media, their impact on the environment, and the potential for re-use;
- active tectonics, seismotectonics, earthquake geology, and palaeoseismology;
- multidisciplinary research on the dynamics of slope mass movements, with an emphasis on the combination of in-situ and remote sensing data;
- basic research on geothermal energy;
- geological research in archaeology, archaeometry.

A comprehensive overview of the projects carried out in 2022 and a list of scientific publications will be presented in Chapters 7 and 8 of this report.







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## EVENT HIGHLIGHTS IN 2022

### MARCH

#### WORLD WATER DAY 2022

The central theme of World Water Day 2022 was “Groundwater: making the invisible visible”. On this occasion, four expert associations in the field of water protection teamed up to host an online press conference, with the GeoZS’s own experts contributing their input for discussion, namely Joerg Prestor with "Groundwater as a source of drinking water, protection of water resources”, and Janja Svetina, junior ARRS researcher, with "Young people's view on the challenges of hydrogeology in our country”. Prof. Dr. Mihael Brenčič delivered a presentation about groundwater and its importance (SKIAH – International Association of Hydrogeologists).



### APRIL

#### GEOZS AWARDS OUTSTANDING SCIENTIFIC RESEARCH ACHIEVEMENTS IN THE FIELD OF GEOLOGY

At a ceremony held on 21 April 2022, the GeoZS awarded prizes for outstanding scientific research achievements in the field of geology. The Mark Vincenc Lipold Lifetime Achievement medal was awarded to Prof. Dr. Jože Čar, the Lipold Plaque for outstanding scientific research achievements in the field of geology was awarded to Dr. Mateja Jemec Auflič, Dr. Anja Koroša and Dr. Manja Žebre, and the Geological Survey of Slovenia’s honorary distinction was conferred on TNO – The Geological Survey of the Netherlands.



### MURmap PARTNERS’ KICK-OFF MEETING

We organised the kick-off meeting of the partners involved in the MURmap project (Holistic geochemical tracking of inorganic pollutants in the Mur/Mura River Catchment), funded by ARRS and the Austrian Science Fund (FWF – Der Wissenschaftsfonds). The project leader is Dr. Gorazd Žibret of GeoZS. Furthermore, the project consortium includes representatives from the University of Leoben and the National Institute of Chemistry. Participants at the kick-off meeting field-tested the equipment needed for water and sediment sampling in the River Mura and discussed the activities of the international project lying ahead.



### JUNE

#### EXPERT LECTURE ON THE USE OF STABLE ISOTOPES FOR WATER QUALITY ASSESSMENT

As part of the project organised by the International Atomic Energy Agency (IAEA) with the title "Strengthening Agricultural Land Use and Management to Reduce Emerging Contaminants and Improve Water Quality", the GeoZS hosted IAEA experts Dr. Joseph Adu Gyamfi, and Dr. Janine Halder, as well as Dr. Vesna Zupanc from the Biotechnical Faculty, University of Ljubljana. We held a lecture with the title “The use of stable isotopes for water quality assessment”. Lectures were delivered by Dr. Anja Koroša, Katja Koren, and Dr. Nina Rman, alongside other guest lecturers.

### MAY

#### 37<sup>th</sup> GEOSCIENCE INFORMATION CONSORTIUM CONFERENCE IN PRAGUE

At the end of May, Prague hosted the 37<sup>th</sup> Geoscience Information Consortium Conference (GIC). Attended by 67 members from 26 countries, they re-elected Jasna Šinigoj as Executive Secretary of the Consortium in the course of the event. The GIC is a global network of geological surveys invested in promoting the exchange of knowledge on geological data management and information systems between its



**AUGUST**

**CLOSING EVENT OF THE KaraWAT PROJECT**

At the closing event of the KaraWAT project for Sustainable Management of Water Resources in the Karavanke/Karawanken UNESCO Global Geopark, which took place at the administrative centre of the Karavanke UNESCO Global Geopark, our experts presented the conclusions of the project and the joint strategy for sustainable water resource management in the transboundary area of the Karawanken/Karavanke UNESCO Global Geopark.



**DR. TEA KOLAR JURKOVŠEK RECEIVES THE PANDER MEDAL FOR LIFETIME ACHIEVEMENT IN THE FIELD OF CONODONT PALAEONTOLOGY**

Dr. Tea Kolar Jurkovšek received the Pander Medal for Lifetime Achievement in the field of conodont palaeontology at the European Conodont Symposium in Utrecht, the Netherlands. The award is a recognition of her outstanding commitment to scientific work, in which she has left her mark with numerous scientific and popular science articles and monographs, and furthermore acknowledges the Regional Geology (P1-0011) research programme she has successfully helmed for almost a decade.



**SEPTEMBER**

**INTERNATIONAL CONFERENCE ON ALPINE GEOLOGICAL STUDIES – ALPINE WORKSHOP**

From 12 to 14 September, the Department of Geology at the Faculty of Natural Sciences and Engineering hosted the cream of the crop in geological research with a focus on the geology of the Alps, also joined by colleagues from the wider Apennine, Carpathian, and Dinaric regions. The conference was the result of a combined organisational effort of the GeoZS and the Slovenian Geological Society, under the auspices of the European Geosciences Union. The field trips taking place over the course of the conference were led by Dr. Matevž Novak, Dr. Kristina Ivančič and Rok Brajkovič.

**LAUNCH OF THE GEOLOGICAL SERVICE FOR EUROPE – GSEU PROJECT**

The kick-off meeting in Brussels brought together all GSEU partners. The opening remarks by representatives of EuroGeoSurveys (EGS), the Directorate-General for Research and Innovation (DG RTD), the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW), and the European Environment Agency were followed by presentations by the heads of the various project-specific technical work packages. These covered the following topics: critical mineral resources, geothermal energy and underground energy storage, groundwater, coastal vulnerability, and fundamental

geological data and models. Next up were presentations and discussions on the infrastructure, integration, and management activities designed to support the implementation of the work packages over the following five years.

**OCTOBER**

**6<sup>th</sup> SLOVENIAN GEOLOGICAL CONGRESS IN ROGAŠKA SLATINA**

The 6<sup>th</sup> Slovenian Geological Congress was held in Rogaška Slatina from 3 to 5 October. During the opening speeches, the attendees were greeted also by the Director of GeoZS, Dr. Miloš Bavec. The congress saw the attendance of 115 participants who showcased their activities through 63 presentations and 25 posters. Dr. Jure Atanackov delivered a plenary lecture titled “On the Specifics of the Šoštanj and Labot Faults in the Wider Rogaška Slatina Area”.

The Congress included a panel discussion under the title “Knowing the (In)Visible – the Role of Geology in our Society”. The discussion revolved around how geoscientists can contribute to addressing the challenges of our society, such as climate change, self-sufficiency, resilience, the green transition, the circular economy, and the active material cycle. The roundtable discussion was attended by the GeoZS's expert Joerg Prestor.

Representatives of the GeoZS have also been involved in organising field trips.

**5<sup>th</sup> IAH-CEG INTERNATIONAL CONFERENCE IN ROGAŠKA SLATINA**

The scope of activities of Slovenian geologists went beyond the national boundaries, extending into the international arena. The congress events continued until 7 October, when the Slovenian Geological Society and the Slovenian chapter of the International Association of Hydrogeologists organised the 5th Central European IAH-CEG Conference. The researchers of the GeoZS guided field trips to the mineral and thermal waters of Rogaška Slatina, around the hydrogeological characteristics of the Dolenjska Karst, and the vulnerable aquifers of Dravsko polje. Also held in the framework of the conference was the annual meeting of the IGCP Project 636 (Geothermal resources for the energy transition: direct uses and clean and renewable base-load power). The congress saw the attendance of 65 experts and scientists from Slovenia, Austria, Algeria, Belgium, Chile, Croatia, Hungary, Canada, Colombia, Colombia, Portugal, Poland, Serbia, Spain, and the USA.



60<sup>th</sup> ANNIVERSARY OF THE INTERNATIONAL UNION OF GEOLOGICAL SCIENCES (IUGS)

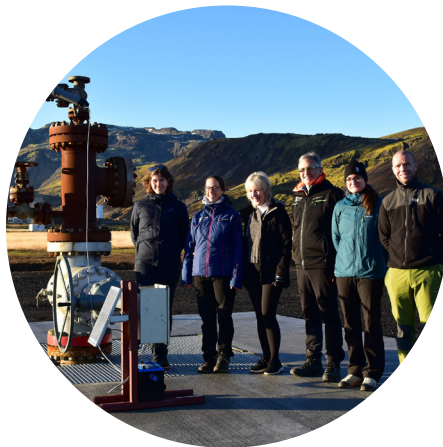
The programme accompanying the 60th anniversary celebration of the IUGS featured a presentation of the Slovenian geosite Škocjan Caves in the Classical Karst among other iconic World Geological Heritage sites designated as The First 100 IUGS Geosites that are used as benchmarks for the interpretation of geological phenomena and processes or are of great historical importance for the advancement of geoscience. The presentation was delivered by Dr. Matevž Novak in the Basque Coast UNESCO Global Geopark, Zumaia.



also touched on funding and political/legislative barriers, was to chart the course for the implementation and commercialisation of innovations developed through the EIT RawMaterials schemes.

STUDY VISIT TO ICELAND UNDER THE INFO-GEOTHERMAL PROJECT

As part of the INFO-GEOTHERMAL project, a group of five GeoZS experts participated in a study visit to Reykjavik, Iceland, and its wider area. In addition, the workshops with field trips and the expert lectures were attended by 16 representatives from the Ministry of Infrastructure of the Republic of Slovenia, the Ministry of Environment and Spatial Planning of the Republic of Slovenia, the Association of Municipalities and Towns of Slovenia, the municipalities of Benedikt, Beltinci, Dobrovnik, Piran, and Podlehnik, the GOLEA



ADRIA INNOVATION DAY 2022

The central emphasis of the Adria Innovation Day 2022 was on the impact of the activities performed by the Regional Center Adria, EIT RawMaterials Hub since its establishment in 2018, and to highlight numerous EIT RawMaterials projects that had been successfully realised across the region during this time, with the ultimate goal to enhance the innovation potential in the field of raw materials. The Adria Innovation Day 2022 was a great opportunity for showcasing the innovations tested, networks created, best practices implemented, and lessons learned from projects across the region. The aim of the discussion, which

agency, and the companies Kronoterm, Veling-Deol, and GeoGreen. Our host was the Iceland School of Energy. During the visit, we gleaned valuable insights into cogeneration technologies, district heating systems, geothermal park operations, and risk insurance schemes for geothermal project development, as well as the importance of land management and management of natural resources.

NOVEMBER

GEOLOGICAL SERVICE FOR EUROPE’S (GSEU) PROJECT MEETINGS AND PRESENTATIONS

The GeoZS hosted the kick-off meeting of the core members of the working group responsible for executing communication and dissemination activities over the course of the GSEU project. We discussed the communication strategy and tools, and the processes of engaging stakeholders in the development of services and products as the cornerstone for a successful setup of the GSEU.

Dr. Meta Dobnikar attended the Raw Materials Week 2022 in Brussels, where she introduced the International Centre of Excellence for Sustainable Raw



Materials Management to be established within the GSEU, at “Accelerating Implementation of UNFC in Europe” event.

DECEMBER

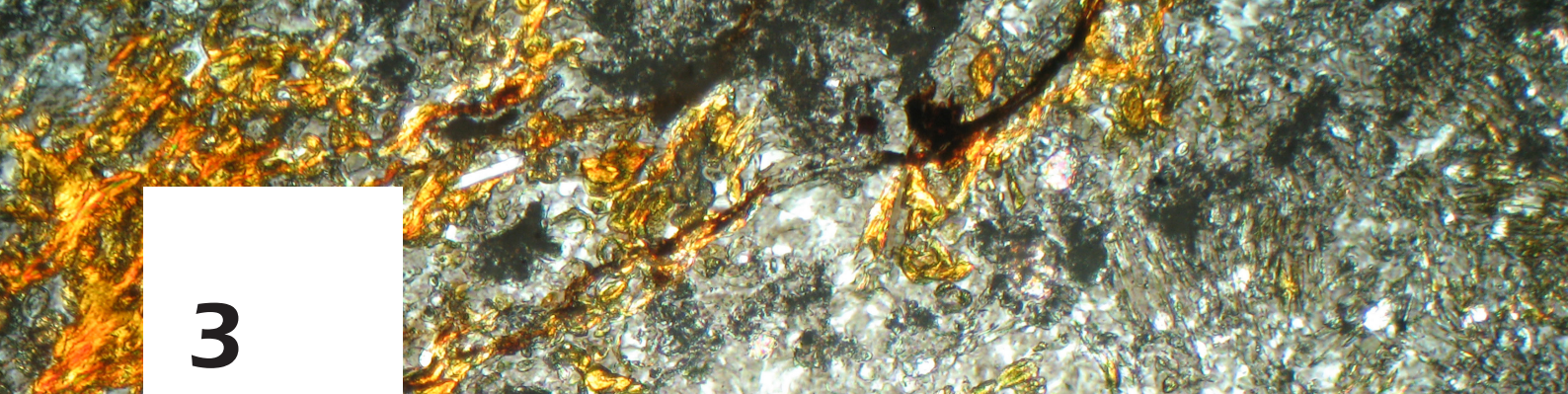
GeoZS RESEARCHERS RECEIVED THE EXCELLENCE IN SCIENCE 2022 AWARD

The members of the Scientific Council for Natural Sciences operating under ARRS have selected the outstanding achievement of Dr. Martin Gaberšek, Dr. Michael J. Watts, and Dr. Mateja Gosar with the title Attic dust: an archive of historical air contamination of the urban environment and potential hazard to health? for the Excellence in Science 2022 award.

In the follow-up of the event, Dr. Martin Gaberšek publicly presented the lecture “Attic dust - more than a nuisance” at the ARRS Day 2022: Supporting Excellence







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## ABOUT THE GeoZS

### MISSION AND VISION

#### MISSION

The GeoZS is a multidisciplinary public research institute working in various fields of geosciences, carrying out its activities in a mix of fundamental scientific research, applied activities in domestic and foreign markets, and providing public service in support of the Republic of Slovenia and the European Union.

The mission of the GeoZS is to provide a comprehensive understanding of the geological structure of the Slovenian territory. This information provides the foundation for addressing national challenges in terms of environmental and health protection, drinking water supply, protection against natural disasters, land management, the exploration and evaluation of reserves, and sustainable management of mineral resources. Moreover, the GeoZS's mission also lies in the field of energy supply and facilitating energy efficiency. The scope of GeoZS's activities includes the collection, storage, and interpretation of geological data and making it accessible to the public.

The main job and objective concerns the exploration and maintenance of various geological data sets serving the state and society. The Survey thus carries out geological mapping, scientific research, and research projects, and maintains databases and geological archives. Drawing on its expertise of the country's geological structure, it provides valuable support to the authorities, the economy, and institutions in other fields.

Moreover, the GeoZS partakes in domestic and international scientific research activities and actively networks with related organisations at home and abroad. The GeoZS is actively engaged in various European Union programmes geared at sustainable living projects, climate action, and the efficient and sustainable use of resources and raw materials. It is invested in ensuring the comprehensive accessibility and application of its expertise in society and the economy, the transfer of research achievements into practice, the popularisation of science, the spread of scientific culture, and keeping the public informed.

#### VISION

In line with its vision, the GeoZS seeks to position itself as the frontrunner in the field of geology in South-Eastern Europe and beyond. On this path, it will continue to solidify its standing in Slovenia by pursuing cutting-edge research to uphold its status as a leading research institution in the geosciences. Going forward, its goal remains to be recognised as the provider of top-quality publicly available data sets and interpretations on the geosphere to boost the sustainable development of Slovenian society.

The GeoZS first implemented ISO 9001:2015 in 2016 to facilitate effective quality management, and ever since then its commitment to quality remains the driving force of its vision.

### ETHICS AND INTEGRITY IN SCIENCE

The GeoZS is committed to upholding the highest standards of ethics, integrity, and equal opportunities in research. We consider research ethics to engender a respectful and accountable stance towards society, ecosystems, and cultural and natural heritage, as well as the environment. Integrity in research furthermore includes an unwavering commitment to reliability, honesty, and accountability in the design, conduct, publication, and reporting of research, nurturing respectful relationships between colleagues, and the utmost responsibility to the profession and society.

Everyone working at the GeoZS acts in accordance with the ethical standards in geoscience adopted by the International Association for Promoting Geoethics. Staying true to the principles of geoethics, we uphold our values while being conscious of our role and accountability to society as a whole, with the European Code of Conduct for Research Integrity serving as our example. Our core values include intellectual freedom, research integrity, and creating an inclusive environment that is sensitive to the needs of broader society and our business partners.

The target-specific results of our endeavours are geared at fostering sustainable development and a circular economy, mitigating the effects of global environmental and climate change, and reducing and managing natural hazards and hazards caused by anthropogenic interference with the natural environment. Continuous learning is the cornerstone of deepening our expertise, allowing us to attain a high professional profile and adeptness in international research projects, which, in turn, fosters and preserves the trust of our business partners.

Relationships are built on trust, transparency and professional credibility. The GeoZS Integrity Plan covers the identified risks and a set of measures and actors for managing them. The Integrity Plan is a roadmap for the GeoZS to reach our targets, maintain our image, and push the advancement of the

wider environment. One part of the Integrity Plan is to regularly deliver annual reports to the Commission for the Prevention of Corruption.

### MANAGEMENT AND ORGANISATIONAL STRUCTURE

The GeoZS is managed by a seven-member Board of Governors. Three members are appointed by the founder, namely the Government of the Republic of Slovenia, of which one by the ministry in charge of science, one by the ministry responsible for the environment and the third one by the ministry responsible for mining. Three members are appointed by the Scientific Council of the GeoZS among the users of our services or the interested public. Finally, one member is elected by the staff from among themselves.

At the helm of the GeoZS is the director who acts as the leader and representative. The survey is structured into five departments: the Geological Information Centre, Mineral Resources and Geochemistry, Groundwater – Hydrogeology, Regional Geology, and General Services. The Department of Mineral Resources and Geochemistry operates the Public Mining Service. The Geological Information Centre operates the Application Infrastructure, the Data Infrastructure, and the Computer Infrastructure, as well as the Archives and Library. General Services include the Main Office, Finances and Accounting, Project Management Office, Knowledge Transfer Office, and Public Relation Services and Publishing, as well as Technical Services.

Serving as the survey's professional body, the Scientific Council convenes to deliberate and make decisions concerning matters related to the survey's professional activities.

The survey has in place research groups for each of its research areas: Fundamental Geology, Geohazards, Regional Geology, Mineral Resources, Geochemistry and Environmental Geology, Groundwater, Geoinformatics, and Geoenergy.

MANAGEMENT

Dr. Miloš Bavec, Director GeoZS  
Dr. Jure Krivic, Assistant Director GeoZS

BOARD OF GOVERNORS 2022

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**Marko Fatur**, Member  
Urban Institute of Ljubljana, d. d.

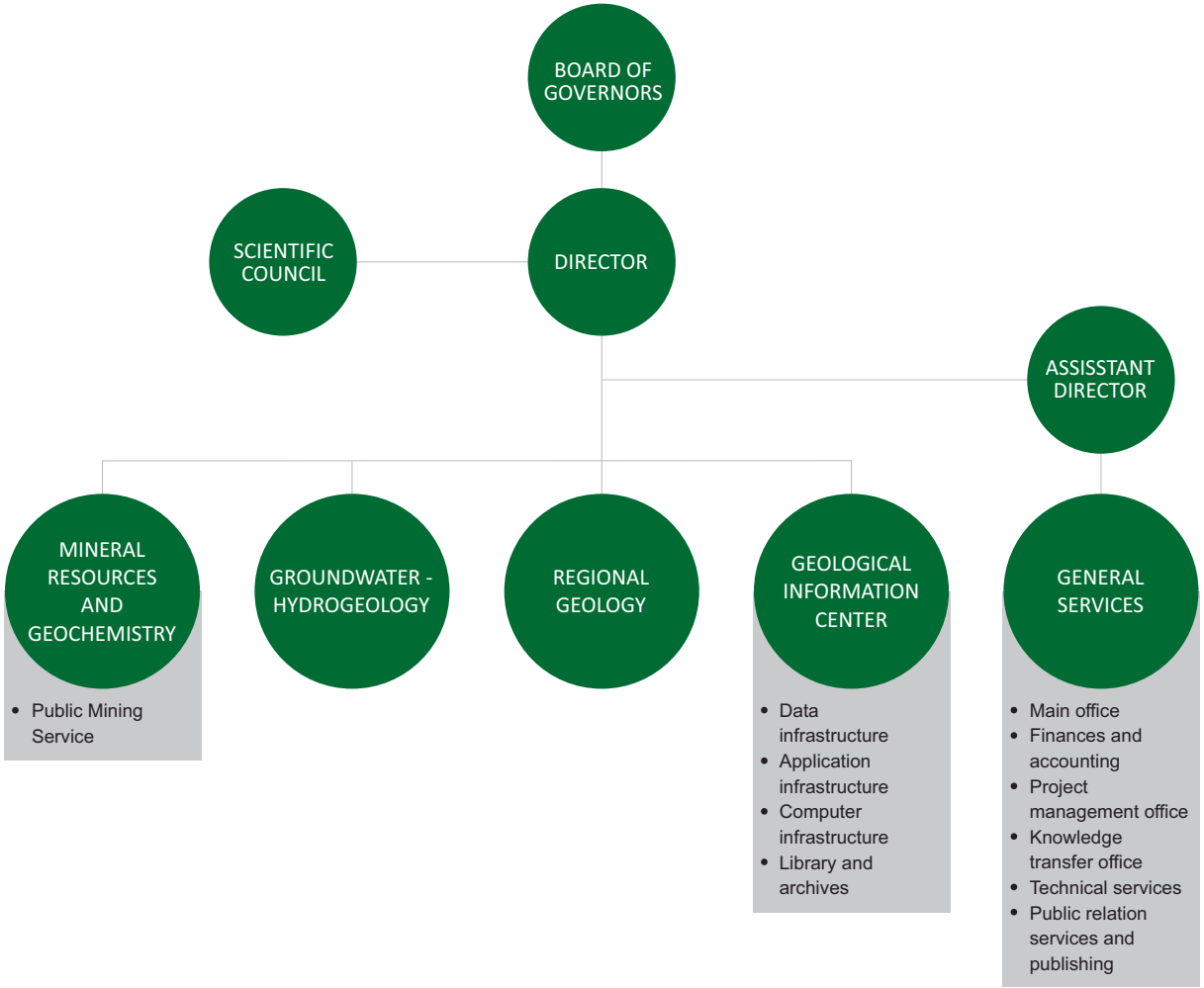
**Tatjana Dizdarevič**, Member  
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**Jurij Crnkovič**, Member  
Ministry of Natural Resources and Spatial Planning of the Republic of Slovenia

**Dr. Mateja Jemec Auflič**, Member  
GeoZS

SCIENTIFIC COUNCIL IN 2022

Dr. Nina Mali, Chair  
Dr. Gorazd Žibret, Vice Chair  
Dr. Miloš Bavec, Director GeoZS  
Dr. Mateja Gosar, Member  
Dr. Mitja Janža, Member  
Dr. Tea Kolar-Jurkovšek, Member  
Dr. Polona Kralj, Member  
Dr. Miloš Markič, Member  
Dr. Matevž Novak, Member



HEAD OF DEPARTMENTS IN 2022

Dr. Meta Dobnikar - Mineral Resources and Geochemistry  
Dr. Nina Rman - Groundwater - Hydrogeology  
Dr. Klemen Teran - Regional Geology  
Jasna Šinigoj - Geological Information Centre  
Dr. Jure Krivic - General Services



STRATEGIC ORIENTATIONS AND OBJECTIVES IN 2022

OBJECTIVES SET, ACTIONS IDENTIFIED TO ACHIEVE THEM, AND MEASUREMENT AND EVALUATION OF ACHIEVEMENTS IN 2022

OBJECTIVES	ACTIVITIES PERFORMED	MEASURING METHOD	ASSESSMENT
Securing funding vital for stability and growth	Performance of public service tasks on time and up to standard, increased activity in securing assignments on domestic and foreign markets, and streamlining of costs	Operating result	We have generated a revenues surplus of EUR 258,954 before corporate income tax.
Cultivating cutting-edge science	Nurturing a stimulating and supportive environment for research and ensuring enough time to produce quality scientific articles	Publications and citations in reputable journals	We have increased the total number of scientific performance points by +27% and the number of citations by +17% (according to SICRIS records as of 14 February 2023)
Growing a top-tier team	Nurturing a stimulating and supportive environment for research	Successful defence of one postgraduate researcher's doctoral thesis and election to scientific titles	1 young researcher has successfully completed her PhD. There have been 11 promotions to higher academic ranks.
Maintaining and growing our international and national profile – embarking on new projects	Networking with potential partners, keeping abreast of calls for proposal and submitting quality applications to international calls	Newly awarded projects abroad and at home, with more than 50% of newly awarded ones stemming from applications and bids	We have been awarded 8 projects, of which 3 Horizon Europe projects, 2 Norway Grants projects, 1 EIT RM (RawMaterials) funded project, 1 EIT HEI (Higher Education Initiative) funded project and 1 ESA (European Space Agency) funded project.

OBJECTIVES	ACTIVITIES PERFORMED	MEASURING METHOD	ASSESSMENT
Knowledge transfer to users	Organisation of workshops/ meetings	At least 3 workshops or meetings with service users, and hosting at least 1 visit by geology students to showcase GeoZS operations	We held more than 3 planned consultations and 2 major presentations for students.
Continuous organisational optimisation for improved flexibility and streamlined flow of information, both content and business-related	Continuous improvement of the interdepartmental information flow (for coordinated actions in terms of content) and adapting the organisation to the changing requirements of project implementation (to optimise the work process)	Third certification audit in accordance with ISO 9001:2015	We have successfully passed the quality management system audit in accordance with ISO 9001:2015.
Equipment upgrades and enhancing infrastructure	Securing funding and implementing public procurement	Refurbishment of depreciated field and office equipment to the greatest possible extent	In 2022, EUR 275,436 was earmarked for equipment purchases and EUR 14,897 for maintenance costs.
Sustaining market activities	Keeping staff well informed and encouraging the acquisition of commercial projects	Amount and scope of commercial assignments	Revenue generated from commercial activities in 2022 amounted to EUR 1,324,420 or 19% of total GeoZS revenue. Of this, revenue generated from commercial activities for the business sector amounted to EUR 1,137,074.2 or 16% of total GeoZS revenue.



ASSESSING THE SUCCESS OF ACHIEVING THE SET OBJECTIVES

The financial performance of the GeoZS was positive, having generated 106.6% of planned revenue and 104.4% of planned expenditure, resulting in a surplus of revenue over expenditure. Our assessment of how the work programme for 2022 was implemented by areas of activity is shown below.

- In terms of research funded by the state budget, we continued with the tasks set out in the Terms of Reference or programmes according to plan and to great success, furthermore, we have started new ones, whose outcomes will be used to address complex environmental issues in Slovenia going forward. We have made improvements in terms of scientific excellence and optimised knowledge transfer to the business sector.
- With regard to public service indirectly financed from the budget of the Republic of Slovenia, we have successfully carried out all the tasks outlined and financed.
- In the area of research and development co-funded by the EU budget we carry out activities in compli-

ance with the Terms of Reference of the projects. This practice continued in 2022 in the context of ongoing and newly launched projects.

- With regard to the financial management of public funds, we exceeded the planned targets, with a final result of EUR 28,285, indicating sound management of public funds considering the volume of work.
- In the area of financial management of EU budget funds, the generated revenue is consistent with the project-specific contracts.
- In the area of financial market operations, the planned surplus of income over expenditure was exceeded. The surplus realised amounts to EUR 230,669 before corporate income tax.

Overall, the GeoZS wrapped up 2022 with revenues of EUR 6.989 million and expenses of EUR 6.730 million. In 2022, a surplus of revenues over expenses of EUR 259 thousand was recorded. Our public service activities have yielded a surplus of revenues over expenses of EUR 28 thousand and a surplus of revenues over expenses of EUR 231 thousand from our commercial activities, both before corporate income tax.

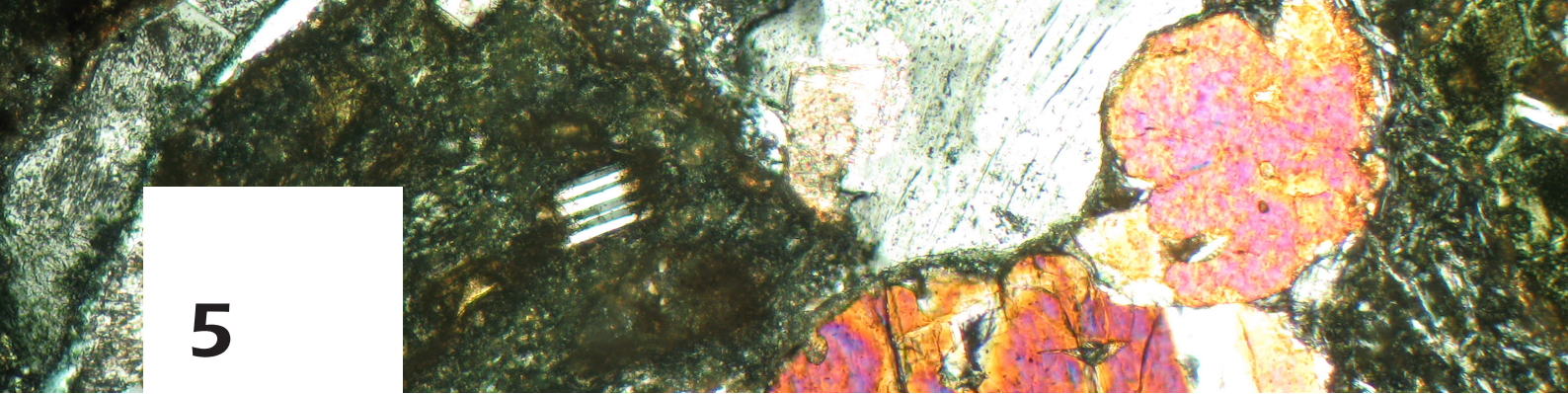
BUSINESS OBJECTIVES	INDICATORS	2022 OBJECTIVES	2022 RESULTS
Fulfilment of all contractual obligations under public service contracts for ARRS, MZl, MOP, ARSO, DRSV, and EU institutions	Review and analysis of service delivery against plan and contractual milestones	All contractual obligations positively assessed	All contractual obligations positively assessed
Fulfilment of all contractual obligations under contracts for the market	Review and analysis of service delivery against plan and contractual milestones	All contractual obligations positively assessed	All contractual obligations positively assessed
Scientific publishing	Regular publication of scientific papers, regular reviews of researchers' publications and citations	Increase in the total number of scientific performance points and citations	3,145.62 points taken into account**, 7,000 citations (10-year period) ***
Maintaining and growing an international and domestic profile	Percentage of newly awarded projects based on applications and bids in a calendar year	Percentage of newly awarded projects above 50%	62.01 per cent
Implementation of the research programme defined in the contracts with ARRS	Amount of funding for research and infrastructure programmes	Maintaining the volume of funds	EUR 1,789,405.31

BUSINESS OBJECTIVES	INDICATORS	2022 OBJECTIVES	2022 RESULTS
Carrying out a commercial activity	Scope of assignments for commercial clients, income/expenditure tracked separately on a monthly basis against the plan	Maintaining revenue, surplus of revenue over expenditure from commercial activities	The volume of funds raised from commercial projects is 64% higher than in 2021, surplus of revenue over expenditure from commercial activities EUR 230,669
Sound economic performance in the financial year	Cost management	Economic efficiency index greater than 1	Economic efficiency index 1.17
Top-level equipment	Equipment upgrades	New equipment according to plan	Adequate equipment, new equipment purchased with deviations from plan
Organisational climate	Staff evaluation	Score at least 3 out of 5	4.0
Exemplary cooperation with relevant trade unions	Trade union score	Score at least 3 out of 5	5
Ensuring solvency	Prudent business management	Sustainable solvency	Solvency guaranteed
Client satisfaction	Client satisfaction score	Score at least 4 out of 5	4.84
Maintaining international co-operation	New project applications	Apply for at least 15 international projects	Applied for 23 projects

COMPARISON OF KEY PERFORMANCE INDICATORS BETWEEN 2021 AND 2022

INDICATORS	2021	2022
Financial result	147,280	258,954
Total number of scientific performance points*	2,472.12	3,145.62**
Citation index (10 years)	5,974	7,000***
Number of young researchers	9	10
Number of successfully completed doctoral programmes	1	1
Number of ARRS projects implemented	9	13
ARRS funding in EUR	3,559,510.38	3,476,810.28
Number of international projects implemented	37	27****
Revenue from international projects in EUR	690,426	704,911
Performance of public funding in EUR	96,844	28,285
Performance of the commercial activity in EUR	50,437	230,669

\* The number of points in the 2021 annual report differs. The difference is attributed to changes in the JCR data used by SICRIS to calculate the points, which are subject to a mid-year adjustment for the previous year, and to departures/retirements of researchers.  
\*\* Points according to the ARRS criteria for researchers employed according to SICRIS records as of 14 February 2023.  
\*\*\* Number of citations according to SICRIS records as of 14 February 2023.  
\*\*\*\* The number of implemented projects is lower due to the completion of 10 projects under the GeoERA umbrella project of the ERA-NET funding scheme of the EU research, development, and innovation programmes, in which the GeoZS participated.



# 5

## STARTING POINTS OF THE GeoZS DEVELOPMENT STRATEGY – 2030

### DESIGNING THE DEVELOPMENT STRATEGY

In 2022, the GeoZS put together a series of participatory workshops for employees to brainstorm and develop the starting points for a long-term sustainable strategy.

Thus, as a result, the workshops outlined the following key long-term directions for the operation and development of the GeoZS going forward:

- cutting-edge scientific research;
- applied research, investigations and expert opinions delivered up to the highest professional standards of conduct and quality, based as far as possible on the results of scientific research;
- fostering international cooperation in research and commercial projects;
- the professional and high-quality provision of public services in compliance with the legislation and the requirements of founding authority;
- efficient transfer of newly acquired knowledge into practice to meet the needs of national and local authorities and economic entities.

### THREE MAIN PILLARS OF ACTION – TOWARDS A THRIVING SOCIETY

Scientific and professional research programmes	Geological public services and expertise	Applied (commercial) activities
Geoscience research with a focus on addressing societal challenges and needs	Acquiring, sharing, and providing geological data and information	Transferring new knowledge into practice with projects for Slovenian and foreign markets
Permanent upgrade of the geological data infrastructure		

### HUMAN RESOURCES ARE KEY

Top-level scientific research is founded on a top-level workforce. Thus, it is its staff who is at the very heart of the GeoZS, laying the groundwork for all its endeavours. The GeoZS operates in the research sphere while also providing public and commercial services. This triple nature of the survey’s undertaking brings with it different types of work and a very dynamic work pace, highlighting our commitment to cultivating a respectful workplace for all employees across the board, fostering good relationships, providing opportunities for promotion, and recognising the value of each employee's contributions. We acknowledge how important it is to keep employees motivated and foster their company affiliation, and to give due credit to outstanding achievements.

### CREATING ADDED VALUE THROUGH KNOWLEDGE SHARING

Our professional credo is rooted in acquiring, sharing, fostering, and expanding knowledge. To successfully achieve the strategic objectives the GeoZS has set for itself, we must put knowledge sharing, education, and engagement in national, international, and multidisciplinary research at the forefront of our endeavours. In view of this, the GeoZS is focused on pursuing complementary partnerships with other scientific disciplines and communities such as chemistry, biology, meteorology, physics, mining, mechanical engineering, environmental sciences, etc.

### RESPONDING TO TODAY'S GLOBAL CHALLENGES

As it stands, there are six key areas in which the GeoZS’s operations will have to respond to national, European, and global challenges:

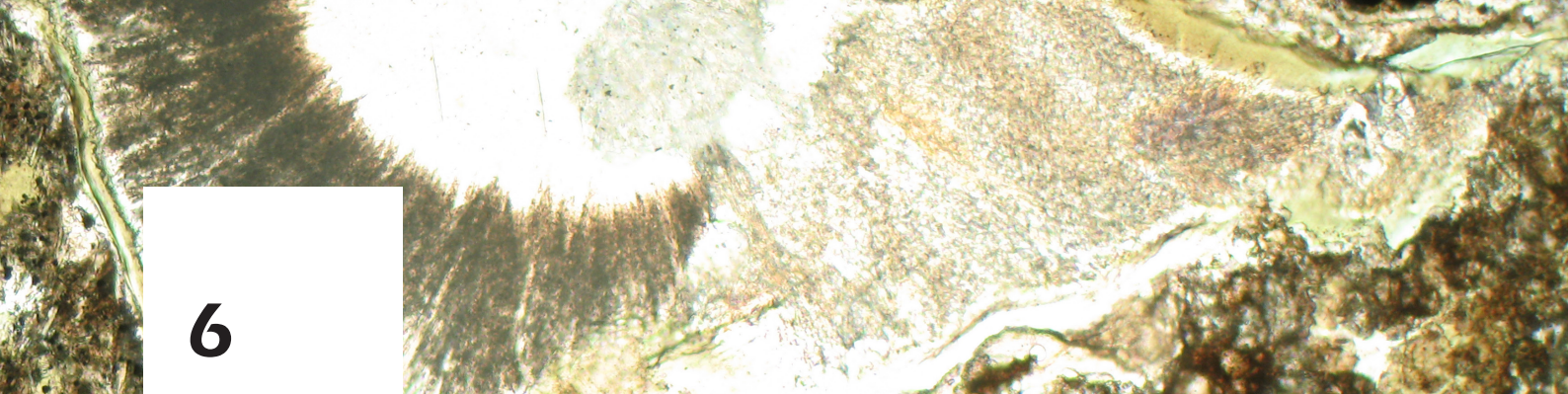
- environmental change and quality of life;
- geohazard – geologically induced hazards;
- energy transition and the use of carbon-free sources;
- sustainable use of mineral and energy resources;
- digital transformation;
- building of knowledge and trust in society.

**GEOZS'S SUSTAINABILITY MODEL**

At the very core of the GeoZS's sustainability model lies the idea that our knowledge should support the development of a healthy, safe, and innovation-driven society and bolster the sustainable management of the Earth's surface and subsurface. Our strategic orientations should steer us toward creating a social environment that celebrates research, development, and innovation. However, to put these strategic orientations into reality, it is paramount to invest in the knowledge and equipment of researchers, foster working conditions that encourage engagement and out-of-the-box thinking, create a stable business, and effectively communicate geological knowledge to society. As an important member of the international geological research community, we intend to strengthen this role under the Geological Service for Europe project, and reach out to other European researchers and institutions to foster cutting-edge scientific research.







6

EMPLOYEES

EMPLOYEE DATA

At the end of 2022, the GeoZS employed a staff of 120, with a total of 117.15 FTE.

NUMBER OF EMPLOYEES BY GENDER

As at 31 December 2022, the GeoZS employed 48 researchers, of which there were 29 females and 19 males occupying posts in group H01. Together with researchers in other post groups (director, assistant director, head of department, etc.), 51 researchers were employed. By gender, 30 female researchers and 21 male researchers were employed.

The number of employees at the end of 2022 has increased slightly compared to 2021, both in the group of researchers and in the group of experts and support team, and there has been an increase of one with young researchers. At the end of 2022, there were 14 more female employees than male employees. Women comprise the majority of researchers, young researchers and experts, while the genders are equally represented among support team. There are more women among both young and senior researchers. Among individuals holding scientific titles, the number of women surpasses that of men, among professional researcher titles the number of women and men is the same, whereas more men than women hold development titles.

Number of researchers involved in the teaching process

In 2022, seven researchers were involved in the teaching process as habilitated lecturers at the University of Ljubljana. In addition, several GeoZS researchers participated in the implementation of individual study activities (mentoring, occasional lectures, fieldwork, etc.) at the University of Ljubljana.

In 2022, we hosted a distinguished scientist from abroad.

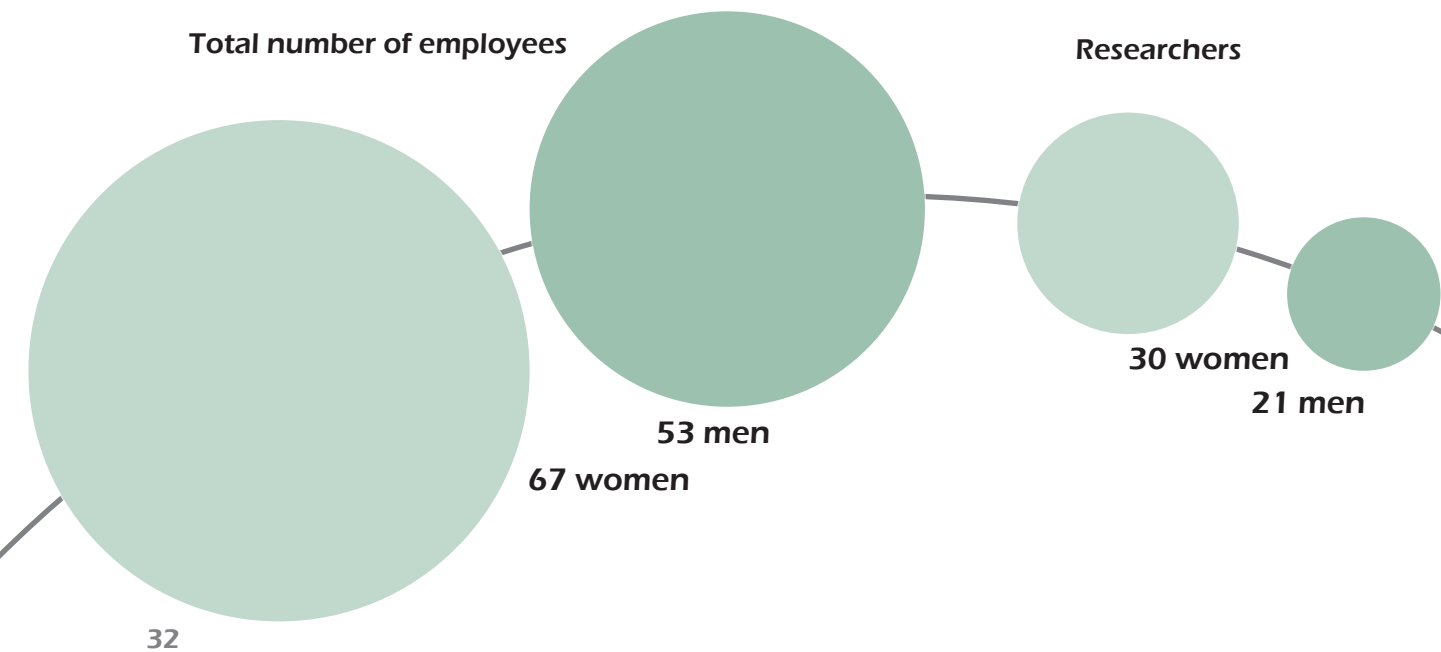
Number of young researchers

At the end of 2022, nine young researchers were studying at GeoZS. All had a fixed-term position at the GeoZS.

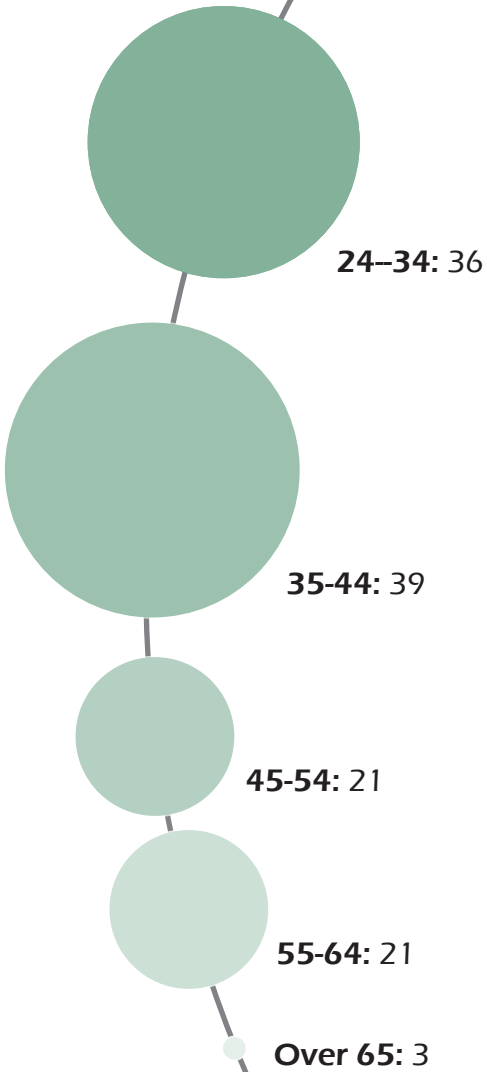
ENSURING GENDER EQUALITY

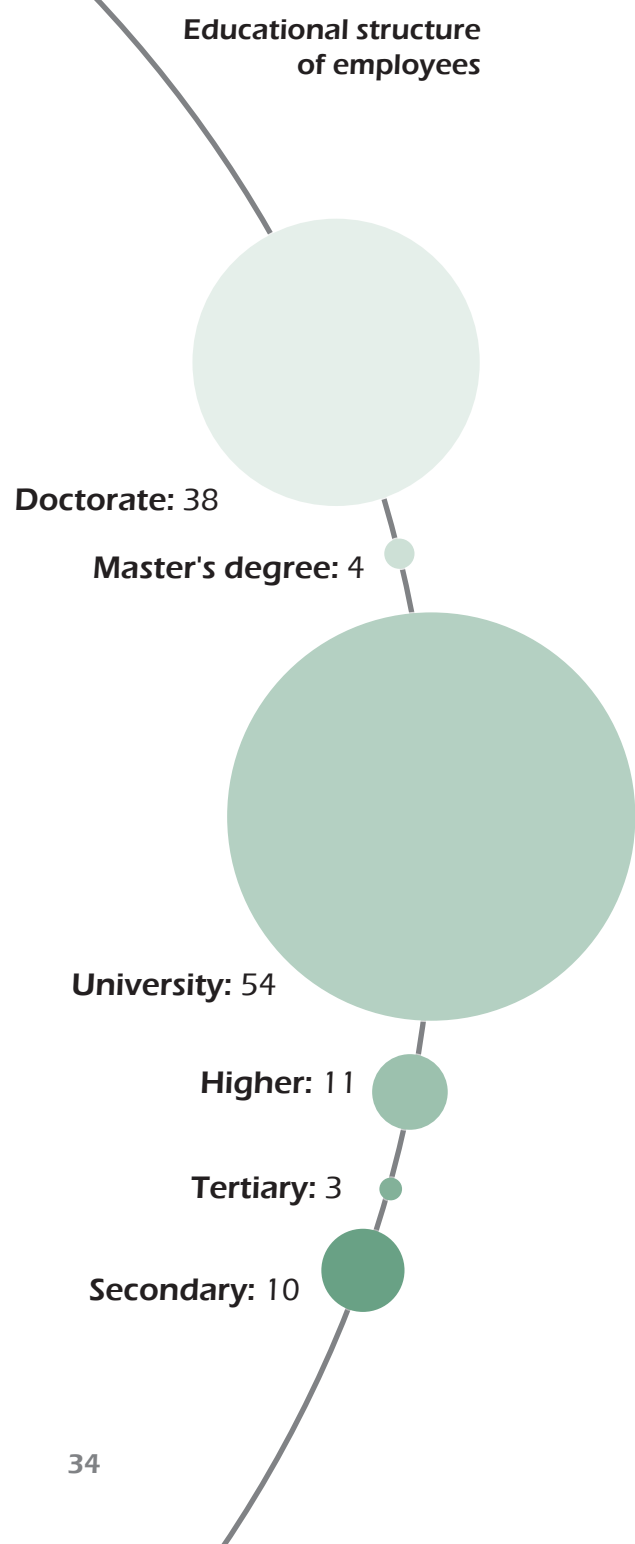
In December 2021, the GeoZS implemented a Gender Action Plan to underscore its commitment to gender equality. This area is covered by the Regulation on Employer Measures to Protect Civil Servants from Sexual and Other Harassment and Ill-Treatment in the Workplace. The Action Plan is subject to annual updates by the Gender Equality Group. The plan draws on the research of the broader social factors affecting the opportunities for women researchers in Slovenian society and takes a look at the specificities of the organisational structure, culture, and prevailing practices of the GeoZS. Achieving the targets outlined in the plan enhances gender equality at the GeoZS.

Overall, the Gender Action Plan covers five areas, namely work-life balance, gender balance in leadership positions, rewarding scientific excellence, equal opportunities in employment and career advancement, the use of gender-inclusive language, and measures to prevent violence. For each area, activities and indicators have been identified to track progress.



Number of employees by age





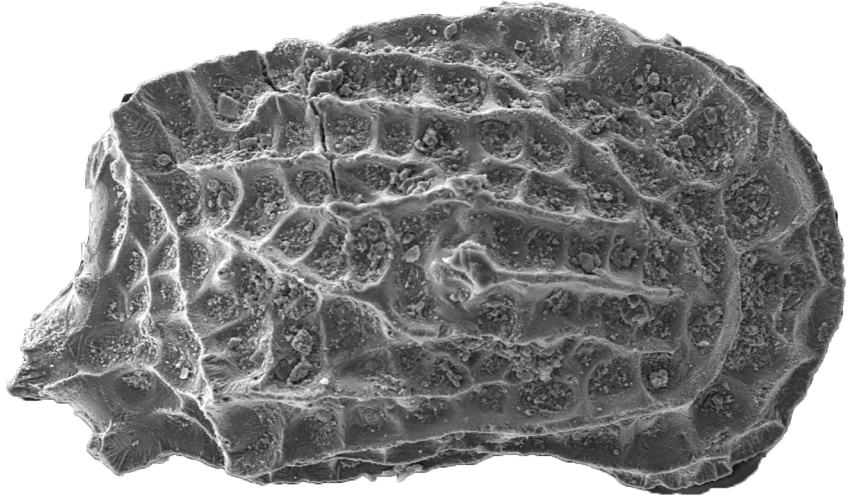
There have been positive changes in work-life balance, such as an increase in the take-up of paternity and family care leave by male employees. However, there has been a slight decline in the take-up of parental leave by women. Other indicators, including flexitime and working from home, remained positive.

There have been positive shifts in gender balance in leadership positions, and in rewarding scientific excellence. In 2022, four men and four women were nominated for the Lipold Prize (awards for outstanding achievements in geology). At the same time, the gender ratio in the top publications has also balanced out, going from 60% women and 40% men in 2020 to 56% women and 44% men in 2022.

In terms of equal opportunities in recruitment and career advancement, the gender balance has shifted in favour of women for new hires and students. In 2020, the rate stood at 55% women and 45% men, shifting in 2022 to 60% women and 40% men for new hires, and 70% women and 30% men in terms of students.

The use of gender-inclusive language in official documents, research and promotional material is gaining traction, with a noticeable rise in the use of gender-inclusive language in official documents in 2022. In this vein, terms in this report used in the masculine form are used neutrally and apply equally to both genders.

In terms of violence prevention and raising awareness on gender equality, employees have been provided with training on preventing workplace sexual violence through a YouTube channel.



# 7

## PRESENTATION OF PROJECTS IN 2022

The research work of the GeoZS integrates the four essential, life-sustaining elements.

Our inherently interdisciplinary research endeavours combine earth, water, air, and fire, all coming together in one universal science: geology.

**The Earth** is not only the very ground we stand on, but also our point of reference. The central focus of the GeoZS's endeavours are the resources hidden within the bowels of the Earth. Gradually unveiling the imprints of the past, the earth, as the only solid substance of the four elements, holds significant importance for geologists. Historically, the GeoZS facilitated the understanding of Earth by creating the first fundamental geological maps, and preparing geological studies to support the opening of mines. Today, our expertise in mineral deposits is enhanced by fundamental research and the implementation of a public mining service, while also studying the

impact of mining and other anthropogenic influences on the environment. The underlying goal is to bolster the country's self-sufficiency in raw materials and also conserve our environment. Now as before, our focus is on identifying and understanding the basic geological structure of Slovenia and its surrounding area, and on the increasingly relevant processes taking place on and beneath the Earth's surface, such as geologically induced hazards, active tectonics, and natural and anthropogenic geochemical soil status, to name but a few of the pressing subjects that are at the forefront of our scientific research.



**Water** is a source for sustaining life, water is also where life on Earth started. Slovenia's drinking water supply comes almost entirely from groundwater. Drinking water is an invaluable resource and we have to do everything in our power to safeguard it for the generations of today and those to come. Our activities revolve around fundamental hydrogeological research and applicative hydrogeological research in order to support construction projects, and around protecting water resources through the designation of water protection areas and promoting their sustainable use. The hydrogeological and hydrogeochemical research we conduct is essential for addressing environmental issues. Our job, rooted in technical expertise and sustainability, is to create the groundwork for ensuring that the quality of drinking water from groundwater remains up to standard.



**Air** is of particular interest as a medium through which various pollutants travel over both short and long distances. The increased focus on air studies can be attributed to the urgency of understanding the implications of climate change. It is in the context of climate change that geologists play a vital role as reading rocks is essential to gaining an insight into the planet's climate history. In fact, climate change is quite literally recorded in rocks, sediments, and ice, from where we are able to infer the progression of climate change. The atmosphere is where our planet touches space. It is the layer through which meteorites, parts of large and small celestial bodies, as well as cosmic rays or particles pass as they fall down to Earth. When they do, cosmogenic nuclides are deposited in terrestrial materials, thus allowing us to determine ages of geological events.



**Fire** is the energy that fuels life. It can be manifested either directly as magma, lava, and geothermal energy, or indirectly as energy stored in organic matter created by geological processes. The need to secure energy sources such as coal and oil led to the founding of the current GeoZS in 1946, with its research endeavours continuing into the present day. Another topic of our research are igneous rocks. Over time, we have established ourselves as the leading authority in the field of geothermal energy on the national and international scale. Yet, our ambitions go deeper: we are interested in what lies deep below the Earth's crust where we seek to identify new sources of energy. We firmly believe that nature has much more to offer than what we currently know and use. In fact, it well may be that volcanoes, magma and active tectonic movements are the strongest connection between geology and people.





## RESEARCH PROJECTS FUNDED BY THE SLOVENIAN RESEARCH AGENCY

### Deep-seated landslide prediction modelling based on a combination of physical modelling and a data-driven approach

led by Dr. Tina Peternel



The main focus of the research project was the investigation of rotational deep-seated landslides, which are a frequent natural process in Slovenia and elsewhere in Europe. In most cases, such natural phenomena pose a threat to people, property, and infrastructure. The main objective of the project was to apply a holistic approach to addressing landslide dynamics, the ultimate goal being to design a prediction model based on physical modelling and data-driven methods. The methodology was based on the monitoring and identification of landslide triggering mechanisms and how they interact. The project activities took place in the landslide-prone area in the hinterland of the settlement Koroška Bela which has seen several deep-seated landslide events over the years (most notably, the Urbas and Čikla landslides) in weathered siltstone and claystone, thus posing an immediate threat to the settlement of about 2,200 inhabitants below. The analyses and results of the postdoctoral research project mark an important contribution to the understanding, modelling, and prediction of such processes. The data and results obtained in the course of this postdoctoral project furthermore contribute to reducing uncertainties in monitoring and forecasting, and provide valuable inputs to develop a warning system and to establish how certain factors influence the modelling of deep-seated landslide dynamics.

### Past climate change and glaciation at the Alps-Dinarides junction

led by Dr. Manja Žebre



Formerly glaciated mountain landscapes are progressively more recognised as important archives for the study of climate change during the Quaternary. The European Alps are one of the regions where geological markers of past glaciations are most abundant and well-studied. The same cannot be said for the south-eastern corner of the Alps and neighbouring northern Dinarides. In this project, we will improve our understanding of past climate-glacier dynamics at the Alps-Dinarides junction by combining field work and model-based approaches. In particular, we will explore the spatiotemporal patterns of glacier fluctuations during the last Ice Age, the influence of different bedrock on subglacial conditions and glacier dynamics, and the past climate conditions driving the growth and recession of glaciers. Overall, this project will deliver new findings about how Pleistocene and Holocene glaciers shaped the landscape and how they reacted to past climate variability.

### Deciphering the sensitivity of rock faces to climatic changes and freeze-thaw cycles in permafrost-free regions

led by Dr. Mateja Jemec Auflič



The central focus of the project is to investigate the impact of climate change on the freeze-thaw cycles as long-term factors influencing the occurrence of rock slope failures in permafrost-free regions. Applying a multi-method approach, it will consist of in-situ measurements, observations, and monitoring. These data sets will provide the input for numerical modelling and numerical simulations based on the finite element method to determine the temperature changes that occur during freeze-thaw cycles. The project's results will be used as the basis for developing a methodology for managing the risk of rockfalls, and to identify mitigation and early warning measures against their occurrence. The project shall yield new scientific insights into the effects of climate change in permafrost-free regions, which have been scientifically understudied in the past

### Karst3Dge – Uncovering Adria-Dinarides Cenozoic evolution and structural influence on groundwater through 3D geological modelling

led by Dr. Ana Novak



The steady convergence of the Adriatic and Eurasian plates was and continues to be the driving force behind many important geodynamic events and mountain formations in the wider Adriatic region. In the Cenozoic, convergence led to a compression phase that gave rise to the Dinaric fold-and-thrust belt. At the end of the Miocene, the external Dinarides underwent a further contraction episode, which continues to this day. Despite a great number of research in the past focusing on Cenozoic compression in the Dinarides, the distinction between the different compression phases and the assessment of contractions in this mountain range is still debated. This postdoctoral project seeks to provide new insights in the field of Cenozoic structural evolution of the Dinarides. Its main focus area will be Slovenian Istria, which lies at a key transitional area between the Adriatic plate and the external Dinarides. It will specifically hone in on the area of the Karst Edge, a prominent geomorphologic feature formed between the two units. Not only is this specific area intriguing because of its complex multiphase tectonic history, but also because it holds significant groundwater reserves, often on the structurally caused contact zone of permeable and poorly permeable lithological units.

### Urban hydrogeology: Improved methods for determining the occurrence, transport processes, and origin of pharmaceuticals in groundwater resources

led by Dr. Anja Koroša



The aim of the postdoctoral project, which was completed in August 2022, was to apply and demonstrate improved methods for determining the occurrence, transport processes, and origin of drug residues in groundwater resources. Specific focus was given to the study of transport processes in the unsaturated zone of three drug residues belonging to nonsteroidal anti-inflammatory drugs. The studies were in situ field experiments in a lysimeter in Selniška dobrava under natural conditions. The transport of selected substances through the unsaturated zone was investigated and the retention times per compound were determined. The sorption coefficient, degradation and half-life, and the potential of flow (leaching) of three selected drug residues were determined for each selected compound. The second part of the assignment involved various techniques for the determination of the presence of pharmaceutical residues in groundwater. The project investigated the entire journey of pharmaceutical residues through the aquifer, from the source to transport in the unsaturated zone and detection of the contaminant in the unsaturated zone or groundwater. Special focus was placed on understanding the migration and degradation processes of selected contaminants through the aquifer and their presence in groundwater in pilot sites on the areas of gravel aquifers in Ljubljansko polje and Vrbanski plato.

### MURmap – Holistic geochemical tracking of inorganic pollutants in the Mur/ River Mura catchment

led by Dr. Gorazd Žibret



The MURmap project, in which the GeoZS has partnered up with the University of Leoben, Austria, and the Slovenian National Institute of Chemistry seeks to provide a comprehensive overview of the geochemical composition of the water and sediments of the River Mura and its tributaries. Mining, industrialisation, urbanisation, and intensive farming have put a strain on the environment in the past, but today, modern technological development, especially in the fields of telecommunications, medicine, and green technologies, relies heavily on the use of technology-critical elements (TCEs), which include rare earth elements (REEs), yttrium, titanium, niobium, tantalum, indium, etc. The goal is to determine the natural geochemical background of the catchment, the influence of specific lithological units on the elemental and isotopic composition of water and sediments, the historical and possible current anthropogenic sources of the elements in the environment, and the differences in the elemental composition of water and suspended sediments between different water regimes.

### Use of the non-invasive GPR method and remote sensing for determining groundwater vulnerability due to anthropogenic impacts

led by Dr. Marjana Zajc



Diffuse pollution from agriculture is one of the biggest pressures on groundwater. In order to relieve these pressures, it is essential to understand the underlying bed-rock, soil properties, and the dynamics of hydrogeological processes. Non-invasive GPR and aerial drone data will be integrated with hydrogeological parameters and soil pedological analyses and computer models on selected agricultural land. Since knowing the chemistry of percolation water is prerequisite to understanding the impact of agricultural activities on groundwater quality, percolation water samples from lysimeters will also be periodically collected and analysed. In addition, data on soil water content will be collected and statistically analysed using dielectric probes. Integrating the chosen techniques will help us generate final spatial models in GIS that will include information on the natural characteristics of the areas in question and on anthropogenic influences on the transport of contaminants to groundwater.

### GeoCOOL FOOD – Cold food storage using shallow geothermal energy

led by Dr. Nina Rman



The overarching objective of GeoCOOL FOOD is to devise, based on an interdisciplinary approach (combining geology, biology, technology, energy, and management), a methodology for investigating the potential of shallow geothermal energy (SGE) and technological solutions for the construction of new cold storage facilities for the vegetable farming or redesign existing ones. By designing SGE systems that align most closely to local natural conditions and selecting the most pertinent technology, we are able to come up with economically viable solutions to increase the level of energy and food self-sufficiency. A possible after-effect of this are lower prices of local products for the final consumer. To this end, we need to locate existing cold storage facilities run by farms, cooperatives, and interest groups, focus on measuring the energy needs of those storing cabbage or lettuce, and drill and test a geoprobe at a selected pilot site to determine its typical geothermal parameters. As a result, we will be able to identify the best areas for the development of SGE-based cold storage facilities in Slovenia and review them with measurements and numerical models in the selected pilot area. These simulations will serve as the basis for optimising technology solutions for running agricultural cold storage facilities that are energy-efficient, cost-effective, and environmentally sound. The project is a collaborative effort by GeoZS, the Biotechnical Faculty, the UL, and the Jožef Stefan Institute.



Dynamics and matter flow of potentially toxic elements (PTEs) in the urban environment  
led by Dr. Miloš Miler



The project tested the assumption that environmental media in the urban environment are correlated and driven by different geogenic and anthropogenic processes. The geochemical associations of PTEs in different environmental media and their main sources were defined. The main solid carriers of PTEs and their chemical, mineralogical, and morphological properties reflecting the individual sources in different types of urban environments were determined. The material flow of PTE varies from one area to another and depends on the PTE sources, the properties of the PTE carriers, and the environment. The material flow takes place in solid and partially dissolved form. In the aquatic environment, PTE sinks are fluvial and alluvial sediments, whereas on land they are various dusts, soils, and humans. The stability of the solid forms of PTEs depends on their mineral composition and the conditions of the urban environment in which they reside and the retention time. The changes are mainly morphological but also chemical, resulting in the release of PTEs into the environment. Nevertheless, most of the released PTEs are re-bound into stable secondary phases.

The project ended in June 2022, and its results will enhance the understanding of the environment and support actions to improve it. They have been presented in the Journal of Hazardous Materials, Journal of Environmental Management, Science of the Total Environment, Environmental Geochemistry and Health, at 35 conferences. SEGH 2019, 23. IMA 2022, 6. SGK 2022 and in the Slovenian media (Ugriznimo znanost, Pogled v znanost).

RESEARCH PROJECTS IN WHICH THE GeoZS IS A PROJECT PARTNER



**SLOKIN – Geokinematic model of Slovenian Territory**  
led by Dr. Petra Jamšek Rupnik



**Evaluation of hazard-mitigating hybrid infrastructure under climate change scenarios**  
led by Dr. Mateja Jemec Auflič

**Assessment of the potential impact of incineration and co-incineration of waste on human health effects: a model study on the case of the Salonit Anhovo cement plan**  
led by Dr. Mateja Gosar, project partner



**HaČloRi – Research activities for identification and prevention of the Jelševniščica and Otovec catchment area pollution with a special emphasis on black proteus habitat**  
led by Dr. Nina Mali, project partner

PUBLIC SERVICE AND OTHER STATE-FUNDED PROJECTS

Ministry of Infrastructure of the Republic of Slovenia (designation applicable in 2022)



- Implementing the public mining service and geological expertise within the GeoZS, led by Dr. Duška Rokavec

Slovenian Environment Agency



- Seismotectonic mapping for 2022, led by Dr. Jernej Jež



- Hydrogeological mathematical model of heat transfer in a deep geothermal groundwater body of north-eastern Slovenia – model update in 2022, led by Dr. Nina Rman



- Review and analysis of measurement sites for national groundwater quality monitoring and preparation for sampling in 2022, led by Marko Hoetzl
- Analysis of groundwater pollution monitoring programmes and reports in the area of landfills and entities subject to IED Decree for 2021, led by Dr. Nina Mali
- Simultaneous groundwater measurements and analysis in the area of water body 3012 Drava basin, Phase II, led by Mag. Andrej Lapanje
- Conceptual model of the Pliocene aquifer in the wider area of the Skorba pumping station for the establishment of a mathematical model – I. faza, Phase I, led by Mag. Andrej Lapanje



Slovenian Water Agency



- Programme for the production of hazard maps due to processes of slope mass movement and erosion for the territory of the Republic of Slovenia, led by Dr. Jernej Jež
- Hydrogeological mapping, led by Dr. Nina Mali



- Analysis of the monitoring of geological phenomena acquired via the reports of groundwater exploration permits, led by Mag. Andrej Lapanje
- Setting up an inventory of abandoned wells, observation wells in the Republic of Slovenia, led by Mag. Andrej Lapanje



- Expert support for operational groundwater monitoring in the field of water permits, led by Mag. Andrej Lapanje
- Expert support for decision-making in spatial and environmental documentation assessment procedures of the Department for Spatial and Environmental Documentation Assessment, led by Dr. Sonja Cerar
- Preparation of expert opinions for the work of the DRSV Regional Sectors, led by Mag. Joerg Prestor
- Expert support for decision-making in spatial and environmental documentation assessment procedures of the Department for Spatial and Environmental Documentation Assessment, led by Simona Pestotnik
- Development of a decision-making support system for groundwater use, led by Dr. Mitja Janža
- Technical support for the enforcement of records in the water cadastre, in particular water protection areas, landslide-prone areas, and groundwater bodies, led by Lidija Levičnik

Ministry of the Environment and Spatial Planning of the Republic of Slovenia  
(designation applicable in 2022)



- Preparation of expert groundworks and expert support for the implementation of the Water Framework Directive (Directive 2000/60/EC) in the field of groundwater–water management plan (NUV III), led by Dr. Sonja Cerar
- Preparation of expert groundworks for the groundwater concession regulations, led by Dr. Nina Rman
- Expert groundworks for water protection areas (2022–2023), led by Dr. Nina Mali
- Analysis of groundwater pollution monitoring programmes in the area of landfills and baseline reports in the area of entities subject to IED for 2022, led by Dr. Nina Mali

Ministry of Agriculture, Forestry and Food of the Republic of Slovenia



- EIP Water – Reducing the pressures from agriculture on surface water and groundwater, led by Dr. Janko Urbanc



- AT mobil – Setting up geo-referenced mobile sampling for soil analysis with the aim of optimising fertiliser use and reducing negative environmental impacts, led by Dr. Janko Urbanc



- Assessment of the potential of geothermal energy in agriculture in Slovenia, led by Dr. Nina Rman

COMMERCIAL PROJECTS

Structural geology research



- Probabilistic Seismic Hazard Analysis for JEK2, commissioned by: GEN energija, d.o.o., led by Dr. Jure Atanackov
- Characterisation of the Drnovška anomaly and Gorjan structure, commissioned by: GEN energija, d.o.o., led by Dr. Jure Atanackov
- Preliminary geological check of the variants for the JEK2 nuclear plant project (West and East variant), commissioned by: Savaprojekt, d.d., led by Dr. Miloš Bavec



- Geological supervision during the construction of the second track of the railway line Divača–Koper, commissioned by: 2TDK, družba za razvoj projekta, d.o.o., led by Dr. Jernej Jež
- Geological and geotechnical monitoring during the construction of the eastern tube of the Karavanke tunnel with associated facilities and connecting motorway, commissioned by: DARS, d.d., led by Anže Markelj

Mineral resources investigations



- Report on the classification and categorisation of the calculated deposits and resources of gravel and sand in the Trstje exploration area, and preparation of a reserves calculation for the proposed Krapje 2 exploitation area, commissioned by: SEGRAP, rudarstvo, proizvodnja in gradbeništvo, d.o.o., led by Anže Markelj

Geohazards, engineering geology and geotechnical investigations



- Maintenance of existing monitoring, implementation and maintenance of electronic geotechnical monitoring and interpretation of monitoring data and reporting for the Urbas and Čikla landslide, commissioned by: Municipality of Jesenice, led by Dr. Tina Peternel
- Geological and hydrogeological works for the planning of the rehabilitation of the landslide above the Polhov Gradec primary school, commissioned by: Municipality of Dobrova – Polhov Gradec, led by Dr. Mitja Janža
- Rockfall hazard study with proposals for remediation for the area of Bled’s castle rock, commissioned by: Zavod za kulturo Bled, led by Anže Markelj
- Technical observation during the construction of the second track of the railway line Divača–Koper, commissioned by: 2TDK, družba za razvoj projekta, d.o.o., led by Mag. Joerg Prestor
- Technical observation of the Cinkarna Celje dams, Bukovžlak and ONOB dams and behind Travnik, commissioned by: GI-ZRMK, Cinkarna Celje, d.d., led by Mag. Joerg Prestor

Geothermal research



- CRM-Geothermal: Raw Materials from geothermal fluids: occurrence, enrichment, extraction, commissioned by: Slovenian Geological Society, led by Dr. Nina Rman
- Assessment of the geothermal potential in the area of the Municipality of Velenje, commissioned by: Municipality of Velenje, led by Dr. Mitja Janža

Hydrogeological research



- Investigations for the location of a new exploratory borehole for the extraction of Donat Mg type mineral water, commissioned by: Atlantic Droga Kolinska, d.d., led by Dr. Matevž Novak



- Hydrogeological investigations in the area of the Peričnik reservoir in the Vrata Valley, commissioned by: Municipality of Jesenice, led by Dr. Luka Serianz
- Construction of two new piezometers with pumping test along the eastern bypass on Litjska cesta Road, commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- Hydrogeological report and conceptual model for the IED plant HELIOS TBLUS, d.o.o. – Količevo site, commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- Hydrogeological report and conceptual model for the Fric Galvanisation IED plant, commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- Upgrading of automatic groundwater monitoring meters and basic hydrogeological monitoring of groundwater in the area of the Rdeče blato and Pepelišče landfills and IED plants of Talum, d.d. – PE Aluminij, PE Aluminij (Livarna), PE Rondelice and PE Uli, commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- Hydrogeological report and conceptual model for the IED plant MELAMIN, d.d., Kočevje, commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- Hydrogeological report and conceptual model for the IED plant ISKRA ISD Galvanika, d.o.o., commissioned by: Talum, d.d., led by Dr. Sonja Cerar
- VD - Hydrogeological reports for the modification of water permits for the Areh, Pivola, Sv. Duh na Ostrom vrh, Gaj, Srednje and the MO-2/1930 wells, commissioned by: MB Vodovod, led by Dr. Nina Mali
- Expert groundworks for the rehabilitation of the Bohova 2 well, commissioned by: Municipality of Maribor, led by Dr. Nina Mali
- Preparation of hydrogeological expert groundworks and construction plan for the implementation of a reserve water source (borehole) for the Trebnje water supply system – Komunala Trebnje, commissioned by: Komunala Trebnje, led by Marko Hötzl
- Pilot measurements of microplastics in groundwater in the area of the Municipality of Ljubljana, commissioned by: IZVRS, Municipality of Ljubljana, led by Dr. Nina Mali
- Execution of hydrogeological works for the construction of the pumping borehole PŠ-2/2022 for the Polšnik-Marmolj water pipeline, commissioned by: Municipality of Litija, led by Marko Hötzl
- Isotopic analyses in the flow of the pumping test at the Mrzlek pumping station, commissioned by: Vodovodi in kanalizacija Nova Gorica, d.d., led by Dr. Janko Urbanc
- Pumping test on a borehole for irrigation – Municipality of Sevnica, commissioned by: Municipality of Sevnica, led by Marko Hötzl
- Identification of options for additional drinking water volumes for the Golo-Zapotok water supply system, commissioned by: Municipality of Ig, led by Dr. Janko Urbanc
- Delivering services for HealingPlaces – unit D.T.3.3.3, commissioned by: Razvojni center Novo mesto, Svetovanje in razvoj, d.o.o., led by Dr. Nina Rman



## INTERNATIONAL PROJECTS

### INFO-GEOTHERMAL – Supporting efficient cascade use of geothermal energy by making available official and public information, EEA and Norway Grants

led by Dr. Nina Rman, lead partner



INFO-GEOTHERMAL is the first project aimed at the innovative strengthening of institutional capacities by the national authorities involved in managing geothermal energy use, of local authorities who provide spatial framework for investors, and the biggest players in exploration of deep geothermal potential in Slovenia. From transferring knowledge from the worldwide leading geothermal country – Iceland, our joint activities will result in significantly improved formal support schemes for investments.

Project objectives will be achieved by mapping the deep geothermal potential for direct use of thermal water and geothermal electricity, organisation and publication of data as grounds for a future one-stop-shop in geothermal, training experts of national authorities, research organisations, and project developers from Slovenia and Iceland, organisation of a national geothermal network and establishing a business-attractive environment with clear guidelines and rules on the development of geothermal projects.

The project falls under the Climate Change Mitigation and Adaptation sub-programme and brings together four Slovenian institutions: the GeoZS as the project leader, the Ministry of Infrastructure of the Republic of Slovenia, the Ministry of the Environment and Spatial Planning of the Republic of Slovenia, and the Association of Municipalities and Towns of Slovenia acting as project partners. The Iceland School of Energy from the University of Reykjavik is participating as a project partner from the donor country Iceland.

### KaraWAT – Strategy for the Sustainable Management of Water Resources in the Karavanke/Karawanken UNESCO Global Geopark, Interreg V-Slovenia-Austria

led by Dr. Nina Rman, lead partner



The main objective of the project was to design a strategy for sustainable water management in the cross-border Karawanken/Karavanke UNESCO Global Geopark which comprises 14 municipalities. This strategy should serve as an instrument of action and generate a catalogue of recommendations for measures that allow bilaterally harmonised water management procedures in this delicate mountain area. A number of workshops have been held to analyse the most pressing issues regarding the status, pressures, uses, and risks to sustain sufficient water quantity and quality in the geopark. Elaborate geological grounds for the municipalities Ravne na Koroškem and Eisenkappel have been drawn up so that the land use in future can become better adapted to the natural features. In the long run, this will reduce the risk of natural hazards (floods, storms, landslides, etc.) and support faster measures to protect water resources from accidents (pollution, droughts). Much effort will be

focused on the development potential of mineral waters, such as Rimski vrelec at Kotlje and several mineral water springs in Eisenkappel.

The highlight of the project is the interactive Slovenian-German-English viewer <https://geopark-karawanken-waters.eu/>. The viewer is a single entry point for access to the official spatial layers of Slovenia and Austria, which contribute to a better understanding of the setting, natural conditions and risks, water resources, and tourist potential of the Geopark. By choosing “Experience Geopark” visitors can find ideas for trips to geological and water features, including mineral springs, whereas users with a keener interest can choose “Water management” and actively browse cross-border spatial information. The viewer also shows the results of continuous measurements of groundwater quantity and temperature at the Mežica and Topla mines. The characteristics of the water cycle of the transboundary karst aquifer Peca are on display in the new GEO.DOM visitor centre in Peca.

### EO4MASRISK – Ground Deformation and Risk Detection Information Service, European Space Agency - ESA

led by Dr. Mateja Jemec Auflič, lead partner



The chief objective of the project is to set up an online service that will use Sentinel-1 satellite data for avalanche detection and assessing potential damage. To this end, we will develop a method for detecting surface displacements based on radar interferometry and use geological data on landslide areas to determine the areas of displacement. Using spatial data on infrastructure and facilities located in landslide-prone areas and economic values, we will determine the risk and estimate the damage that could result from a landslide occurrence. Once developed, the online service will be running on the existing MASPREM system used by the GeoZS and the Administration for Civil Protection and Disaster Relief for spatiotemporal landslide warnings.

### RECO2MAG – Grain boundaries engineered Nd-Fe-B permanent magnets, EIT RawMaterials

Dr. Meta Dobnikar, project partner



RECO2MAG aims to leverage the latest research on optimising permanent magnet (PM) microstructures through novel grain boundary processing to produce resource-efficient sintered Nd-Fe-B PMs with lower dysprosium (Dy) content and improved energy products that can be used in novel electric motors. As part of the project, a life-cycle analysis (LCA) and life-cycle cost analysis (LCC) of the developed permanent magnets will be performed.

The GeoZS is responsible for preparing an updated analysis of the availability of rare earth elements (REE) for use in the production of permanent magnets in South East Europe. This study will identify potential deposits of REE and connect them with developers of processing technologies, potential processors, and users, helping to further reduce imports and ensure more sustainable and independent production of permanent magnets in Europe.

#### **FutuRaM – Future Availability of Secondary Raw Materials, Horizon Europe**

led by Dr. Gorazd Žibret, project partner



The project revolves around the future availability of secondary raw materials, with a focus on testing and promoting the use of the UNFC classification, which could be applied not only to primary raw materials but also to secondary raw materials. The GeoZS is a member of a consortium of 28 partners from 11 European countries. The project will develop a Secondary Raw Materials knowledge base on the availability and recoverability of secondary raw materials (SRMs) within the European Union (EU), with a special focus on critical raw materials (CRMs). It will establish a methodology, reporting structure, and guidance to improve the raw materials knowledge base by 2050.

#### **ROBOMINERS – Resilient Bio-inspired Modular Robotic Miners, Horizon 2020**

led by Dr. Gorazd Žibret, project partner



The project aims to develop an autonomous mining robot. It is a bio-inspired solution taking a cue from burrowing and boring organisms. The robot parts can be sent underground via a borehole due to its modular design. Once there, it can self-assemble and extract mineral resources. Alongside the development of the robot prototype, we will be working out the conceptualisation of other support systems, such as the power supply system, ore transport to the surface, sensors, etc. The ultimate goal of the project is to develop a robotic ecosystem by 2050, capable of mining without human assistance and making economically feasible the many mineral deposits that are unfeasible with conventional mining. The project aims at delivering a proof of concept in laboratory conditions at a Lower Technology Readiness Level (TLR) and delivering a prototype robotminer corresponding to a slightly higher TLR.

#### **PanAfGeo-2 – Support to Geological Sciences and Technology in Africa – EU Partnership, EU DG-INTPA**

led by Špela Kumelj, project partner



PanAfGeo-2 emerges as a collaborative initiative between the European Geological Surveys (EGS) and the Organisation of African Geological Surveys (OAGS), whose first part was successfully implemented in 2016–2019. The project aims to enhance the professional expertise of professionals from various African geological surveys through an innovative training scheme that includes the acquisition and development of the necessary professional and technical skills to complement their professional qualifications. As a project partner, the GeoZS will continue to play an important role in delivering training in the areas of geological mapping, mineral resource evaluation and management, geohazards, geothermal energy, and geoinformatics even in this second phase (2021–2024).

#### **RIS-ALiCE – Al-rich industrial residues for mineral binders in ESEE region, EIT RawMaterials**

led by Dr. Gorazd Žibret, project partner



The GeoZS was a project partner in RIS-ALiCE, the aim of which was to develop a network of relevant stakeholders in South East Europe (SEE) working on the recycling of aluminium-rich waste and boosting the innovation potential of SEE.

As part of the RIS-ALiCE project, the GeoZS has developed an online register of aluminium-rich secondary raw materials in SEE. These resources would be necessary for the potential production of low-carbon belite-sulfoaluminate cements. These are produced at 100 to 200°C lower firing temperatures, thereby generating savings and reducing CO<sub>2</sub> emissions. The RIS-ALiCE Registry of secondary mineral raw materials will serve as a matchmaking tool between holders/producers of industrial residues and potential end-users (cement plants and other stakeholders). Data on the types of materials, their locations, quantities, physico-chemical properties, and other information can be found in the registry, which is available at [www.alice-registry.eu](http://www.alice-registry.eu).

#### **LIFE IP RESTART – Boosting waste recycling into valuable products by setting the environment for a circular economy in Slovenia, Life 2020**

led by Dr. Špela Bavec, project partner



The project focuses on overcoming the obstacles to achieving EU recycling targets, and on achieving the full implementation of the National Waste Management Programme and Waste Prevention Programme (WMPP). The project's main objective is to deploy a holistic set of complementary technical, digital, environmental, social, and circular solutions to unlock all the potentials of the WMPP, to achieve maximum material self-sufficiency and increased circular yield in the waste-to-resource sector.

In order to achieve the objectives, project activities will be aimed at providing a continuous WMPP assessment mechanism and ensuring its ongoing improvement and actualisation, based on digital, technical, and social excellence, demonstrating six circular solutions for several problematic and voluminous waste streams, ensuring wider uptake of best available solutions and to achieve a coherent and integrated implementation of WMPP objectives.

The project will contribute to the implementation of the EU Waste Framework Directive, Roadmap to a Resource Efficient Europe, European Green Deal, and the Circular Economy Action Plan for a cleaner and competitive Europe. A total of 17 partners are involved in the project.



**GEORIS – Innovative technologies for waste processing in ESEE region,  
EIT RawMaterials**

led by Dr. Gorazd Žibret, project partner



The two-year project will test the use of geopolymer technology in recycling secondary raw materials. We will pilot and test building materials (various prefabricated panels and refractory panels) and catalysts for specific chemical reactions. Deployment of geopolymerisation technology has a number of advantages, from lower energy consumption and lower gas emissions to ultimately lower production costs. The project brings together 11 partners from four countries, with plans to build one test field in Slovenia.

**SI-Geo-Electricity – Pilot geothermal power plant on the existing Pg-8 gas well,  
pilot project, EEA and Norway Grants**

led by Dr. Nina Rman, project partner



The SI-Geo-Electricity project aims to increase the production of renewable electricity by harnessing the potential of geothermal energy. The main results of the project will be a groundbreaking 50 kW pilot geothermal power plant powered by patented Slovenian technology for harnessing the geothermal energy of unproductive oil and gas wells with a geothermal gravity heat pipe. The pilot project is being implemented in the municipality of Lendava and concerns the exploitation of the existing but abandoned Pg-8 well. It will mark the first geothermal electricity production undertaking in the country. The electricity will be generated through a closed-circuit refrigerant, where super-heated ammonia vapour will be fed to a gas turbine. The pilot plant draws on Slovenia's expertise in geothermal gravity heat pipe exploitation. Based on the test operation, the total geothermal potential of abandoned oil and gas wells in NE Slovenia will be assessed. By April 2024, guidelines for the development of such projects on a larger scale will be in place. The lead partner is Dravske elektrarne Maribor, d.o.o., with Petrol Geo, proizvodnja ogljikovodikov, d.o.o., University of Maribor, Faculty of Chemistry and Chemical Engineering, and the GeoZS acting as project partners.

**UNEXUP – Upgrading and commercialisation of Underwater Explorer for Flooded  
Mines, EITRawMaterials**

led by Dr. Gorazd Žibret, project partner



Even today, there are tens of thousands of flooded and abandoned underground mines across Europe, many of which still contain large quantities of ore reserves worth exploiting. Due to their complex tunnel networks such mines, especially those where no documentation is available, are currently unsafe to explore with conventional methods. The objective of the UNEXUP project was to level up the technologies that had been developed in the preceding project called UNEXMIN enabling autonomous 3D mapping of flooded mines, to develop the UX-1Neo – the next-generation autonomous underwater robot with improved performance and additional equipment, and to commercialise innovative underwater exploration by launching UNEXUP technology into the market.

**INSite — Insitu ore grading system using LIBS in harsh environments,  
EIT RawMaterials**

led by Dr. Gorazd Žibret, project partner



In collaboration with an international team of experts coordinated by INESC TEC, Portugal, the GeoZS is working on an innovative real-time ore grading system. Based on Laser Induced Breakdown Spectroscopy (LIBS) technology, the system enables real-time detection of the elemental composition of solid material or material in slurry. Acting as the head of field testing within the project, the GeoZS is on the lookout for suitable sites to put this equipment to the test. The aim of the project is to develop an efficient system for real-time ore grading to be used for active mines and recycling operations going forward.


**RM@Schools-4: Raw Matters Ambassadors at Schools 4.0, EIT RawMaterials**

led by Rok Brajkovič, project partner



RM@Schools 4.0 is an innovative programme that aims to enhance science and promote RM career options among youngsters. RM ambassadors (experts in RM-related issues and trained teachers/professors) will actively teach students about RM by involving them in various activities, such as hands-on experiments, field trips to companies, and using communication tools. The students will have the chance to become Young RM Ambassadors themselves (science communicators) by creating dissemination products focused on issues related to RM for the general public (e.g. videos, maps, comics) and collaborating with experts in supporting public events. There will be local and international competitions for rewarding the best communication materials, as well as an annual European Conference with delegates from European schools. These events will facilitate the exchange of ideas and experiences in an atmosphere of inclusion and collaboration. In addition, teachers will have the chance to train to become RM Ambassadors themselves and to develop new educational and communication tools together with the students. All the produced materials will be open and accessible online to everyone via the Virtual Centre, an online platform devoted to the project, furthermore, the best communication materials made by pupils will be uploaded on the website to be shared with the wider public.


OTHER INTERNATIONAL PROJECTS IN WHICH GeoZS WAS INVOLVED IN



**RIS Education –** RIS Education and Entrepreneurship, EIT RawMaterials  
led by Urša Šolc, project partner

**SCREEN2 –** Solutions for CRITICAL Materials – a European Expert Network 2, Raw materials policy support actions for the circular economy  
contact Dr. Klemen Teran, advisory role


**HEI4S3-RM –** Building Ecosystem Integration Labs at HEI to foster Smart Specialization and Innovation on Sustainable Raw Materials, EIT Higher Education Initiative  
led by Urša Šolc, project partner



**RASTOOL –** European ground motion risk assessment tool, DG ECHO  
contact Dr. Mateja Jemec Auflič, advisory role


**TIMREX –** T-Shaped Master Programme for Innovative Mineral Resource Exploration, EIT RawMaterials  
led by Urša Šolc, project partner

**RASTOOL –** European ground motion risk assessment tool, DG ECHO  
contact Dr. Mateja Jemec Auflič, advisory role




**TRANS-ALP –** Transboundary Storm Risk and Impact Assessment in Alpine regions, Union Civil Protection Mechanism (UCPM) Programme  
contact Dr. Mateja Jemec Auflič, stakeholder role deležnika

**PARC –** Partnership for the Assessment of Risks from Chemicals, Horizon Europe  
contact Dr. Špela Bavec, associated partner with IJS



**CROWDTHERMAL -** Community Based Development Schemes for Geothermal Energy, Horizon 2020  
contact Dr. Nina Rman, advisory role

**REFLECT –** Redefining geothermal fluid properties at extreme conditions, Horizon 2020  
contact Dr. Nina Rman, advisory role



**EMODnet 5 –** Operation, development and maintenance of the European Marine Observation and Data Network, EASME  
led by Dr. Ana Novak, project partner



**RER7013 –** Evaluating Groundwater Resources and Groundwater-Surface Water Interactions in the Context of Adapting to Climate Change, International Atomic Energy Agency – IAEA  
led by Dr. Nina Rman, project partner

**WATSON –** WATER isotopeS in the critical zONE: from groundwater recharge to plant transpiration, COST Programme  
led by Dr Nina Rman, project partner



## SCIENTIFIC PUBLICATIONS IN 2022

### ORIGINAL SCIENTIFIC ARTICLES

#### LEAD AUTHOR FROM GEOZS

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## RELATIONS WITH OUR STAKEHOLDERS

**Creating value for our stakeholders is based on fulfilling our mission and pursuing sustainability values.**

Taking a proactive stance and effectively nurturing relationships with stakeholders is the cornerstone of the GeoZS's operations and its efforts to solidify the profile of the geosciences in Slovenia and Europe.

The active involvement of our stakeholders is indispensable on our quest toward collectively formulating a policy for the sustainable management of our subsurface. Sustained confidence in our services at all levels is generated by us staying accountable in all our relationships, encouraging dialogue, and considering stakeholders' interests.



## GeoZS COMMUNICATION AREAS AND TOOLS

### COMMUNICATION AREAS

### COMMUNICATION TOOLS

Information and promotion

Annual report, GeoNovice, website, media relations (appearing in electronic media broadcasts, writing articles for print media, publications in national, regional, and local media)

Awareness-raising and education

Organisation and participation in various educational events (GeoZS Open Day, events for local communities), cooperation with the media and journalists covering scientific research in electronic and print media at national, regional, and local level, educational events for young people, designing learning tools, involvement in formal education processes

Changing attitudes, behaviours, or decision-making, active involvement of stakeholders

Direct forms of personal and written communication, organisation, and participation in professional events (GeoZS Open Day, events for specific stakeholder groups, regional, and local communities), attending various professional events organised by other professional associations and decision-makers, writing specialised content for media outlets (clarification of expert decisions, proposing initiatives, responding to expert opinions from other scientific disciplines in print and electronic media outlets at national, regional, and local level, involvement in EuroGeoSurveys, EIT RawMaterials, European Raw Materials Alliance/ERMA, International RawMaterials Observatory/IN-TRAW



WHAT DO OUR STAKEHOLDERS THINK ABOUT THE GeoZS

Below is a summary of feedback from our stakeholders regarding how we are addressing their interests and needs, proper and effective communication, and ways to improve our relationships at a professional level and in communications.

Political and decision-making public

Overall, it is a very good collaboration. We will continue to work together in the areas set out in the Mining Act. I see your role as being indispensable in providing assistance in designing, adopting, and implementing Slovenia's strategy for managing mineral resources, i.e. the national mining strategy, in supporting decision-making regarding granting mining rights for exploration and exploitation of mineral resources, regarding establishing, managing, and maintaining a mining data collection, conducting geological activities related to mining, and providing opinions for spatial plans, as well as in processing applications for obtaining new mining rights, extending existing mining rights, and issuing decisions for the assessment of mining site concession fees and reclamation fees to name but a few.

So-called legacy issues remain a hot topic. The abandoned mines and quarries, which closed down in the way they did, present an issue for numerous municipalities.

Dr. Leopold Vrankar,  
Ministry of Natural Resources and Spatial Planning,  
Directorate for Nature, Mining Division

Media

For us, the most valuable aspect of our collaboration is receiving compelling topics for our shows from you, and working together on presenting them to the public.

Your professional expertise carries great weight. It is also vital that we trust each other to do our respective jobs properly. Sometimes we have to condense the intricacies of your research and skip the details for the viewers, so it is really important that we work together. Another aspect we greatly appreciate is that you make the effort to share your knowledge on your own accord. Due to the fast pace and tight deadlines in our line of work, we wouldn't be able to do it otherwise.

I am a big fan of your newsletter (GeoNovice), as it gives us ideas for future topics. It is a great way of communicating with the public, letting people know of your existence, sharing your achievements, and that you deserve to have your voice heard.

You could even amp up the efforts with regard to showcasing what you do, perhaps with fun facts about our planet's surface or science news delivered in bite-sized format. This would underscore the public understanding of your work and spark greater interest.

Renata Dacinger, journalist,  
host of Ugriznimo znanost,  
Televizija Slovenija (national television)

## Scientific research community

For several years now, we have been teaming up with the GeoZS in the educational and the research sphere, with both holding equal significance. With regard to the educational sphere, GeoZS researchers deliver specialised lectures to our students and act as, at minimum, working mentors for undergraduate, graduate, and doctoral students. The conditions for pedagogical co-mentorship of PhD theses are relatively strict, therefore only a handful researchers at the GeoZS qualify. Young researchers working at the GeoZS carry out part of their assignments at our faculty. In addition, many geology undergraduates undertake their student placement at the GeoZS. A stellar example of educational cooperation is the joint implementation of the International Geothermal Summer School, which was held in 2021 and 2023.

In terms of research work, many of the members of our Department of Geology collaborate on projects and joint research, and also publish co-authored papers with the GeoZS. Furthermore, there is an agreement in place between us and the GeoZS on the shared use of research equipment owned by each party.

For decades now, the library at the Department of Geology and the one at the GeoZS have been engaging in a fruitful collaboration, resulting in an agreement on the free exchange of books and other resources, benefiting both.

The reciprocal exchange of knowledge and experience emerges as the added value of this cooperation, both in the domain of research as well as via implementing specialised topics within the academic curriculum at the faculty. Another area in which added value is generated is the acquisition of practical skills by students during their placement. In terms of improvement opportunities, improvements could be made with regard to increasing the frequency of our communication. In view of this we put forward to restore the coordination committee to include the director of the GeoZS and the Head of the Department of Geology, along with two members from each institution, one for research and one for education.

Assoc. Prof. Dr. **Barbara Čenčur Curk**,  
Head of the Department of Geology, Faculty of Natural  
Sciences and Engineering, University of Ljubljana

Our collaborative efforts with the GeoZS extend across two domains. First, as members of EIT RawMaterials, we now have the option to tap into the world's largest network of organisations engaged in raw materials and pursuing a sustainable access to raw materials and their usage via the Regional Center Adria, EIT RawMaterials Hub coordinated by the GeoZS. Second, our collaboration also covers the field of popularising science, as both the National Institute of Chemistry and the GeoZS are partners in the consortium of the project under the name “Noč ima svojo moč” aimed at promoting a science-oriented lifestyle.

Regional Center Adria served as our springboard to a fount of information on ongoing projects, development, and innovations influencing the implementation of state-of-the-art technologies and practices in the raw materials sector. The perk of being a member is the support we can leverage regarding networking and sector-specific knowledge transfer, both on a regional and global scale. Knowledge transfer is particularly important in terms of being a part of development-driven and innovation-oriented activities in the field of sustainable raw materials management.

Being fairly recent members of EIT RawMaterials, we are happy to report that our cooperation thus far has been most satisfactory. We are confident that our collaboration will be just as strong moving forward, and that it will facilitate consistent knowledge exchange, technology transfer, and networking with potential partners from the research and business spheres. In this way, we will be able to fully tap into the development and innovation potential in raw materials management.

Prof. Dr. **Gregor Anderluh**,  
Director of the National Institute of Chemistry

The number one priority of our collaboration with the GeoZS is scientific research. In fact, we have worked extensively on meteorite research in the past. In addition, we still cultivate close contacts with individual experts for sporadic collaborations in research, publishing or for promotional campaigns. We work closely with the now retired Dr. Bogdan Jurkovšek and Dr. Tea Kolar Jurkovšek on account of their extensive palaeontological collection, as well as with Dr. Matevž Novak in the domain of palaeontology, whereas individual GeoZS experts write up reviews of our papers.

Arguably, the greatest added value emerging from our cooperation is the knowledge exchange we engage in. Going forward, it is important for us to keep up collaboration with regard to analyses, seeing as our staff features just two geologists, leaving us with virtually no capacities to analyse samples as per the scientific method.

The Slovenian Museum of Natural History holds a treasure trove of our country's geological heritage (and thus has many specimens of minerals and fossils that are either typical examples or are important for analysis). Perhaps in the future, the GeoZS could make use of our collections, either in full or in part, for its own research programmes or projects, as we, for instance, keep ancient samples of limonite ores from Sitarjevac, a sampling of 100-year-old seawater, etc.

As always, there's room for improvement when it comes to communication. The Slovenian Museum of Natural History organises occasional exhibitions, lectures, and similar events. While this involves a degree of cooperation, it remains far below the potential capacity of both institutions.

Dr. **Miha Jeršek**,  
Director of the Slovenian Museum of Natural History



From our perspective, the cooperation with the GeoZS is indispensable for designing expert groundworks to inform our business decisions, formulating replies to inquiries made by competent inspection services, providing counsel during procedures at various ministries related to the areas covered by the GeoZS, as well as in regards to maintaining communication with ARSO, establishing an understanding of the complexities of the geothermal management/exploitation system, and in advising and assisting with drawing up reports and supporting documents for the competent authorities.

The GeoZS has been our collaborator in the continuous monitoring of water extraction in order to swiftly respond to possible faults, defects, and other deviations, delivering 95% of the measurements per year, and has been involved in the preparation and production of other documentation required to comply with concession regulations.

The biggest plus of working with the GeoZS is the high degree of professionalism and response speed of its team, their willingness to engage in dialogue, showing understanding for non-standard situations, and responsiveness when required. We have been partners in various projects related to thermal wells and how they compare to other countries. Moreover, cooperation is essential for fostering the transfer of best practices relating to thermal water usage to keep the concession fee in check.

Going forward, we would like to see the GeoZS deliver professional training on the topic of interpreting production diagrams and forecasting production dynamics for the next ten years, as well as urging the relevant authorities to treat all users of geothermal energy in the Pomurje region equally across the board. Finally, we would be interested in receiving recommendations on new technologies and management systems for geothermal energy resources, as well as annual modelling and forecasting of the behaviour of the geothermal water body (reserves, recharge, impact of reinjection, etc.) and expert guidance in seeking out efficient water options based on historical production data.

**Andrej Pogačnik,**  
Director of Investments and Maintenance, Sava Turizem, d.d.

**Business partners**

The GeoZS and Atlantic Droga Kolinska, d.o.o. have been fostering a constructive partnership in Rogaška Slatina for over 80 years. As investors we can say that we are happy with the outcomes of the research conducted by the GeoZS. In fact, we are getting ready to resume geological and geophysical surveys designed to determine the precise geometry of the andesite aquifer and seek out the location for a new borehole for the Donat Mg mineral water.

**Peter Junež,**  
Atlantic Droga Kolinska, d.o.o.



## Educators

Speaking as a primary school science teacher, the most important aspect of your work for me is definitely your didactic contribution, your efforts to engage students and organising activity-oriented days. The greatest added value of the GeoZS from a teacher's perspective is the organisation of engaging, enriching, and exciting science days for students. Over the course of a morning, our pupils not only get to observe various fascinating experiments, they can also get hands-on, with the organisers actively including and motivating them throughout. It would be difficult to cover so many different topics and practical demonstrations in school, especially in such a concise and systematic way.

**Kristine Mazmanyán**, chemistry and science professor,  
Livada Primary School

First of all, I need to commend the cooperation with the GeoZS, as the experience was very pleasant indeed. Two years ago, I had the opportunity to work with Katja Koren and Rok Brajkovič on some research I was doing, and I found them to be highly professional, approachable, and detail-oriented. So later in 2022, I asked them if they would consider co-mentoring my students for their research assignment. Both my students and I learnt a lot from them.

Working together with the GeoZS is rewarding with regard to educational topics that are not covered by the school curriculum. This includes research and interdisciplinary content. I believe it is important for institutions such as the GeoZS to be accessible to all schools, including those outside of Ljubljana, as the expert institutions in their local environment lack the capacities to provide knowledge beyond the required standards. Therefore, teachers having the option of reaching out to such institutions is a great asset.

Compared to lessons in a regular classroom setting, the teacher's role becomes different when conducting research and interdisciplinary work with the students, requiring additional expertise as such work raises deeper questions that extend beyond the expected curriculum and veers into domain-specific territory. In fact, it is in these scenarios where there is a need to have the option to conduct analysis of water, soil, rocks, the use of special measuring equipment, access to specific maps, and additional expert clarification or expert support. I really cherish that there are experts such as the GeoZS out there who are willing to do field work with our students, and that we, in turn, also have the opportunity to go and see their place of work.

I have an extensive track record of professional collaborations with various organisations (institutions, faculties, institutes, etc.), and I can confidently say that this partnership with the GeoZS was highly rewarding. I would be hard pressed to pinpoint areas that need improvement, although I sincerely hope that the GeoZS continues to maintain its openness and willingness to interact with children, as I personally have had students who decided to enrol in geology after being involved in these activities. This implies that they were able to identify their area of interest during secondary school. For the upcoming school year, I have a new research project entitled "VARUHI REKE KOLPE" planned, and I hope to be able to count on your support.

**Vesna Fabjan**, geography and history professor,  
Črnomelj Secondary School





## European stakeholders

The central goal of EuroGeoSurveys (EGS) and its members is to support the EU and its policies on all subsurface topics (co-funded by the EU). This means providing pan-European data and information on the geological dimension of European societal challenges, advising European institutions on subsurface related policies and actions, and providing a platform for exchange of knowledge and best practices, thereby also supporting the development and implementation of national, regional, and local policies. In addition, EGS members are committed to bi- or multilateral joint research and cooperation projects to create added value. The GeoZS is highly and actively engaged in this process. After the successful finishing of the ERA-NET on Applied Geology (GeoERA), the European Commission granted the Coordination and Support Action Geological Service for Europe (CSA-GSEU) in 2022. The GeoZS has taken a leading geoscientific role in the transnational research project as well as in the Coordination and Support Action.

The GeoZS has proven to cooperate as a highly competent and reliable partner. The data science skills of the GeoZS are highly appreciated. The GeoZS has taken the lead for the EGDI (European Geodata Infrastructure) core task and the establishment of the EU International Centre of Excellence on Sustainable Resource Management. The GeoZS is also involved in the overall organisational structure and functioning of the EGS on a more personal level, its director being a member of the Executive Committee, and GeoZS experts serving as Deputy Chairs of two Expert Groups. The level of involvement goes significantly beyond the organisation's size. The continuation of the current cooperation would be highly appreciated.

**Ralph Watzel,**

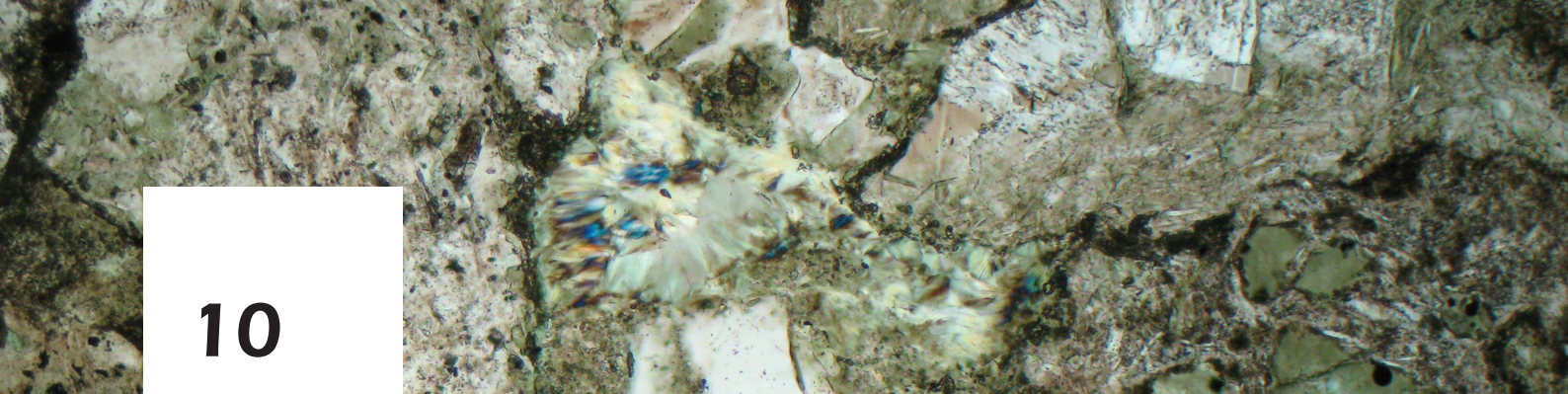
former President of EuroGeoSurveys,  
German Federal Institute for Geosciences and Natural Resources

Th GeoZS is involved in several working groups within the Geological Service for Europe (GSEU), but I personally work more closely with colleagues involved in the mineral resources, EGDI, and communication and dissemination. Your expertise in these fields enhances our ability to reach the goals of the project. The colleagues involved are highly motivated, which makes the work of the coordination team easier. The greatest added value we derive from our cooperation with the GeoZS is the trust and reliability that the GeoZS brings to the table. Your commitment to the success of the GSEU is undeniable. We greatly appreciate the professionalism and expertise demonstrated by the GeoZS, which contributes significantly to the overall success of our project.

I appreciate the suggestions and insights I receive from the GeoZS regarding the best way to communicate and operate with the partners from your regions. And while, on the whole, our collaboration with the GeoZS is excellent (and I genuinely mean it), there is room for improvement in communication. Specifically, it would serve the coordination team to receive timely notifications when tasks are completed or if unexpected delays occur, without the need for reminders. This would improve our management of the project timeline and ensure smooth coordination between partners. Strengthening our communication channels will further enhance the efficiency of our collaboration and reinforce the already positive working relationship we have built with the GeoZS.

**Francesco Pizzocolo,**

GSEU Project Coordinator, EuroGeoSurveys



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## ADVANCING SOCIETY THROUGH KNOWLEDGE-SHARING

By implementing knowledge transfer, educational efforts, and awareness-raising campaigns we uphold our social responsibility to champion geoscience as a scientific research discipline addressing sustainable management issues concerning the Earth's subsurface among a wide array of stakeholders and target audiences.

The GeoZS took an active role in the development and fleshing out of the programme, themes, and contents, as well as the preparation of the programme concept for the future Slovenian Science Centre, which was drawn up by a group of renowned experts from all scientific domains for the then Ministry of Education, Science and Sport of the Republic of Slovenia. The mission statement of the science centre with the name jU3 is: Inspiring research and sparking curiosity through communication and collaboration. At the heart of the Science Centre's programme is the idea that it should be a hub for the communication, promotion, and popularisation of science, while encouraging multidisciplinary dialogue. It is an introduction to scientific thinking, while creating a space for inclusive, critical thinking about the role of science in individual and community life.

### INVOLVEMENT IN FORMAL EDUCATION

In 2022, seven of our researchers were involved in the teaching process as habilitated lecturers at the University of Ljubljana. In addition, several GeoZS researchers participated in the implementation of individual study activities (mentoring, occasional lectures, field work, etc.) at the University of Ljubljana.

### HOSTING INTERNATIONAL STUDENTS AT THE GeoZS

In 2022, the GeoZS hosted two MSc students as part of the RIS Internship programme (financed by the EIT RawMaterials). Wambui Wamunyu was hosted by us as part of her international SINReM master programme at Uppsala University in Sweden. She completed her internship under the supervision of Dr. Miloš Markič.

Kamila Kozyra was a guest as a master's degree student from the Wrocław University of Science and Technology and the Montanuniversität Leoben. Under the mentorship of Dr. Nina Rman, she acquired new skills in hydrogeology and geothermal energy.

We also hosted Rudolf Dugovič, a doctoral student and associate of the State Geological Institute of Dionyz Stur in Bratislava. The four-week training at the Department of Groundwater – Hydrogeology took place under the project RER7013: Evaluating Ground-

water Resources and Groundwater–Surface Water Interactions in the Context of Adapting to Climate Change, funded by the International Atomic Energy Agency (IAEA). During this time, he worked with stable isotopes of hydrogen and oxygen in water under the supervision of Dr. Nina Rman and Dr. Katja Koren.

### YOUTH SCIENCE OUTREACH

#### Participation at the 13<sup>th</sup> Znanstival Science Festival

In 2022, the GeoZS also participated at Znanstival, the largest public science outreach event in the country. Once again, various research organisations gathered at the Experiment Garden to share with the general public science-related topics in an engaging, playful way through hands-on experiments. Our young researchers were happy to share their knowledge about underground water, rocks, minerals, and fossils and answered the questions of the curious visitors.

#### Teacher training in the school year 2022/23

Topics related to minerals, rocks, and fossils are the cornerstone for understanding the forms and processes on the Earth's surface and subsurface, as well as evolution. Teaming up with the Department of Geology of the Faculty of Natural Sciences and Engineering and the Museum of Natural History, we conducted the lectures "Teaching and Learning about Miner-





als and Rocks in the Classroom and in Nature” and “Interactive Teaching and Learning about Fossils and Rocks in the Classroom and in Nature” as part of the in-service training of educational professionals for the 2022/2023 school year.

#### Exploring the habitat of the black proteus in the Bela krajina region with students from the Črnomelj Secondary School

In the school year 2021/2022, we initiated a cooperation with the Young Researcher Club of the Črnomelj Grammar School. Our colleagues Katja Koren and Rok Brajkovič took over the expert mentoring and Vesna Fabjan, a geography professor at Črnomelj Secondary School, took over the pedagogical mentoring. Between June and December 2021, the students sampled springs across the black proteus habitat in order to obtain a basic hydrogeological characterisation of the springs. The work was completed in May 2022, with the students having successfully defended their research paper entitled Hydrological parameters as a basis for establishing communication between springs in the black proteus habitat area in the Bela krajina region. The research paper provides a number of important findings for the field of groundwater protection on the western outskirts of Bela krajina. The research paper earned the students a silver science award from the Association for Technical Culture of Slovenia (ZOTKS).

#### EXPERT LECTURES

##### Guest lecturers at the 60<sup>th</sup> AGRA International Fair of Agriculture and Food

Dr. Nina Rman and Simona Adrinek presented the geothermal potentials in Slovenia for agriculture at the AGRA fair on 23 August 2022. Their presentation highlighted the main findings of the assignment commissioned by the Ministry of Agriculture, Forestry and Food of the Republic of Slovenia about the current use of geothermal energy in agriculture, and the potentials for new geothermally heated greenhouses, either with thermal water or shallow geothermal energy technologies, depending on the location.

#### International conference Welcome, Future

Dr. Mitja Janža presented his contribution on the established methods of geothermal energy use in district heating systems, and the current state-of-knowledge of the geological conditions and geothermal potential in the Šalek Valley region at the International Conference on the Transformation of District Heating Systems in Europe, which was held in Velenje on 21 September 2022.

#### EIT OPEN DAYS SLOVENIA 2022 – Raw materials needs for ensuring the transition to sustainable and smart mobility

The event, organised by the EIT Urban Mobility RIS Hub Slovenia in cooperation with the Regional Center Adria, EIT RawMaterials hub and SPIRIT Slovenia, addressed key challenges and opportunities for cooperation between the two sectors (raw materials and mobility) directly involved in the transition towards more sustainable forms of mobility. Divided into four segments, the event addressed financial incentives and mechanisms to make the transition a reality, including through the use of new and innovative lightweight alloys and hydrogen and battery-electric technologies. The opening session addressed different financial mechanisms, followed by 14 experts who addressed the following questions: What is the future of lightweight and innovative alloys in the transport industry?, Is hydrogen a long-term and sustainable

technological solution for clean mobility? and Can we ensure a sufficient supply of raw materials for the transition to e-mobility?

#### Expert consultation upon the completion of the GeoERA project, and the launch of the Geological Service for Europe (GSEU) at GeoZS

At the end of the four-year GeoERA programme, in which 48 partners join forces to establish the European Geological Surveys Research Area, we shared with the professional community the topics and main conclusions of ten projects involving our researchers and experts. These projects specifically have produced important geoscience-related results that will benefit our own country as well. The second part of the event was devoted to presenting the roadmap toward the establishment of a joint Geological Service for Europe (GSEU). Thus, over the next five-year journey, we will be working on strengthening the integrity of geosciences in a concerted effort with 48 partners from 36 European countries, seeking to amplify its relevance and impact in addressing the challenges arising on the way to a sustainable future.

#### Regional Center Adria EIT RawMaterials Hub at the UNI.MINDS Festival

UNI.MINDS is Slovenia's largest online festival for building innovation communities and long-term partnerships between academia and business. UNI.

MINDS 2022 was one of the events taking place as part of Science Month 2022, providing an insight into the technologies and expertise of researchers from the University of Ljubljana, the University of Maribor, and the University of Primorska. Last year, the focus was on good practices of cooperation with local representatives of the European Institute of Innovation and Technology (EIT) and all Knowledge and Innovation Communities involving partners from Slovenia. The Regional Centre Adria was involved in co-creating the raw materials part of the programme. The opening speech by Krzysztof Kubacki, General Manager of EIT RawMaterials' Eastern Co-Location Centre, showcased the global trends and European challenges in the field of raw materials. Next, there was a presentation of the opportunities that EIT RawMaterials can unlock in the Slovenian innovation ecosystem, which was followed by case studies of projects funded by EIT RawMaterials, and a panel discussion between Slovenian experts from business, research, and academia who jointly reflected on how to foster innovation in Slovenia going forward.

#### LECTURES AND EVENTS FOR THE INTERESTED PUBLIC

##### Opening of the exhibition “Dihanje Zemlje” – Mofettas in the Slovenske gorice region at Negova Castle

In March 2022, the permanent exhibition “Dihanje Zemlje” – Mofettas in the Slovenske gorice region





was put on display at Negova Castle. Put together by Prof. Dr. Dominik Vodnik from the Biotechnical Faculty at the University of Ljubljana and Dr. Nina Rman from GeoZS, the authors gave a professionally guided tour upon its opening. At the expert panel that followed, a group of national and international experts in the fields of geology, biology, and nature conservation discussed the phenomenon of mofettas and its relevance in the scope of natural heritage.

### GeoZS Open Day on European Researchers' Night 2022

On the last day of September, the GeoZS opened its doors to take in visitors and lead them into the world of geosciences as part of the “Noč ima svojo moč” project. The day started with a morning visit from the pupils of Livada Primary School who, through presentations and workshops, learned about geochemical soil analysis, microscopy of rocks and minerals, hydrogeological measurements in a borehole in our backyard, and what we can find out from the core of the borehole that geologists drill into the ground. The afternoon was dedicated to popular science lectures for interested visitors and lab tours for students.

### International Geodiversity Day

To celebrate the first International Geodiversity Day, which was on 6 October 2022, the Institute of the Republic of Slovenia for Nature Conservation put the

spotlight on the Dovžan Gorge near Tržič as a prime example of the country’s geologically most fascinating area. Under the expert guidance of Dr. Matevž Novak and Dr. Irena Mrak, the participants toured the area’s geologically most intriguing sites.

### Information centre for the second railway track Divača–Koper in Klanec pri Kozini

At the invitation of 2TDK, the GeoZS participated in the installation of an information centre on the second track of the railway line from Divača to Koper. The permanent exhibition showcases the geological structure of the second railway track with an illustrative cross-section. The presentation and description of the various formations is complemented with polished cores of exploration boreholes from along the route of the second track, displaying the diversity of the individual rock formations, while also allowing visitors to observe structures and fossils. Also provided are additional descriptions of the occurring karst phenomena, explaining their importance for groundwater, and descriptions of typical fossils found in the area. There is also a nice explanation of the tectonic conditions that led to the formation of the Karst Edge. Adding a multisensory dimension to the experience, the exhibit features a geological musical instrument made from rocks of different formations extracted from the exploration borehole cores which visitors can drum on.

The exhibition is set inside the restored facility of a former water pump for steam locomotives in Klanec pri Kozini.

### Opening of the renovated Rimski vrelec spring in Kotlje and the new Geo.Dom information centre in Peca within the KaraWAT project

The KaraWAT project has created an online viewer of water resources in the transboundary groundwater body of the Karavanke, and technical groundworks for their joint management by Austria and Slovenia. Our investigation efforts centred on the mineral water well called Rimski vrelec or Kotuljska slatina which is a special type of groundwater. Dr. Nina Rman presented the water’s properties at the official opening of the new fountain, sports fields, and café of the Rimski vrelec in Kotlje at the end of September.

The second set of studies focused on groundwater flow through the transboundary mountain massif of Mt Peca. The journey of a droplet from the cloud to the karst spring, and the geological features of the Karavanke-Karawanken UNESCO Global Geopark can now also be explored through virtual reality in the new Geo.Dom information centre, located at the top station of the gondola at Mt Peca.

### Participation in activities for the establishment and sustainable development of the Kras-Carso cross-border Geopark

GeoZS was involved in the project GeoKarst – Implementation of activities for the establishment and sustainable development of a transboundary geopark in the Karst, co-financed under the Interreg V-A Italy-Slovenia Cooperation Programme 2014–2020 by participating in the selection and description of geological points of interest in the transboundary geopark Kras-Carso, in the formulation of a code of ethics for visitors, and a book presenting the geopark. We drafted the Geopark's application for the UNESCO Global Geoparks Network (UGGP) and a handbook for tourist guides operating in the Geopark. We have also been involved in several workshops for thematic working groups consisting of Geopark residents from various sectors.

### Animated journey to the centre of the Earth as part of the VODA-(IZ)VIR ŽIVLJENJA / WATER THE SOURCE OF LIFE project in Dolenjske Toplice

The GeoZS also played a part in the production of an animated journey to the Earth's core, with a focus on cold and warm water and rocks at depths of up to 1,000 metres. The presentation starts at the 1,200 m deep borehole in Dolenjske Toplice. Before you reach the end of the borehole, you travel through some 125 million years of geological history, which is be-



tween 100 and 225 million years before the present time. Dolenjske Toplice is a distinctive area where you can literally dip one hand into a cold karst spring of 10°C and the other into a thermal spring of 38°C. The properties of the groundwater and the way it flows depend on the type and composition of the rocks and the tectonic processes that moved the rocks to where they are today, creating zones with varying degrees of permeability to water. Our job was to prepare the expert groundworks and script ideas for the gamification and video, to help finalise the script, and provide the material featured in the video and gamification.

## MEDIA OUTREACH

Building relationships with media is the key to successful science promotion, raising our profile and solidifying our professional reputation within the wider community. In 2022, we authored several popular-science and expert contributions in various newspapers, general and specialised journals, and made appearances on television and radio broadcasts. Moreover, we have been regularly approached by various media

outlets regarding our statements on ongoing developments in our field at home and abroad.

The science-focused supplement of Delo daily featured interviews with Dr. Mateja Jemec Auflič and Dr. Anja Koroša, both recipients of the Mark Vincenc Lipold Plaque for outstanding scientific research achievements in geology. A special article was published on Dr. Teja Kolar Jurkovšek, recipient of the Pander Medal for Lifetime Achievement in the field of conodont palaeontology.

Our researchers participated in a number of radio shows/podcasts, such as Frekvenca X, Nedeljska reportaža, Podobe znanja, Pogled v znanost, and Frekvenza della scienza.

Dr. Nina Rman appeared on national television on the TV show Ugriznimo znanost (Science bites) speaking about geothermal energy, and Mag. Andrej Lapanje and Dr. Klemen Teran discussed the topic of strategic raw materials in Slovenia.



GeoNovice – Newsletter by the Geological Survey of Slovenia (in Slovene)

GeoNovice, March 2022 –

<https://mailchi.mp/2caab95aa527/geonovice-marec-2022>

GeoNovice, June 2022 –

<https://mailchi.mp/d59c0069a326/geonovice-junij-2022>

GeoNovice, September 2022 –

<https://mailchi.mp/8d8e49c8b35c/geonovice-september-2022>

GeoNovice, December 2022 –

<https://mailchi.mp/ce5b086c57fe/geonovice-december-2022>



Geologija. Ljubljana: Geološki zavod Slovenije, 1953-. ISSN 0016-7789. <http://www.geologija-revija.si/>. [COBISS.SI-ID 5636866] Vol. 65, no. 1, 2, 2022.



Mineral resources in Slovenia 2022. Ljubljana: Geološki zavod Slovenije, 2008-. ISSN 1855-4725. <http://www.geo-zs.si/index.php/en/products/publications2/periodicals/mineral-resources>. [COBISS.SI-ID 241105408]



Mineralne surovine v letu 2021. Ljubljana: Geološki zavod Slovenije, 2005-. ISSN 1854-3995. <https://www.geo-zs.si/index.php/za-javnost/publikacije2/periodi%C4%8Dne-publikacije/mineralne-surovine>. [COBISS.SI-ID 223872512]



Letno poročilo 2021. Ljubljana: Geološki zavod Slovenije, 2005-. ISSN 1854-3995. [https://www.geo-zs.si/PDF/Porocila/Porocilo\\_2021.pdf](https://www.geo-zs.si/PDF/Porocila/Porocilo_2021.pdf). [COBISS.SI-ID 223872512]



EIT OPEN DAY SLOVENIJA 2022 – Surovinske potrebe za zagotavljanje prehoda na trajnostno in pametno mobilnost. Ljubljana: Zavod za gradbeništvo Slovenije, Geološki zavod Slovenije, Javna agencija SPIRIT, 2022. ISBN 978-961-7125-04-7 <https://www.zag.si/dl/eit-open-day-slovenija-2022.pdf>. [COBISS.SI-ID 137798147]







FINANCIAL REPORT

REVENUES

Total revenue in 2022 amounted to EUR 6,988,954, of which 70.1% was from the state budget, 19% from the sale of goods and services on the market, 10.1% from the co-financing of European projects, and the remainder from other revenue.

Total revenue was up by 12% compared to the previous year. Revenue from the sale of goods and services amounted to EUR 6,952,595, financial revenue to EUR 5,911, other revenue to EUR 652 and revaluation operating income to EUR 29,796.

The surplus of revenue over expenditure amounted to EUR 258,954.

TOTAL REVENUE (in EUR)	6,988,954
Revenue from the sale of products and services	6,952,594
ARRS revenue	3,432,571
Other appropriations	1,447,567
Other revenue from public finances	18,477
Revenue market - domestic	1,121,503
Revenue market - foreign	15,571
Revenue market - budget users	183,644
Rental income	20,477
Revenue - EU projects	704,911
Other revenue	7,873
Financial revenue (Public Funds/Market)	5,907/4
Other revenue (Public Funds/Market)	631/21
Revaluation operating income (Public Funds/Market)	26,119/3,677

EXPENDITURE

In 2022, the GeoZS’s total expenditure stood at EUR 6,729,999, marking an uptick of 4.5% compared to the previous year, as a result of an increase in labour costs due to new hires, an increase in length-of-service allowances, annual leave and reimbursed meals, higher salary grades as of October 2022, higher performance bonuses arising from increased volumes, and the sale of goods and services on the market.

The cost of materials and services increased by 15% against the previous year due to the increased volume of business, the largest increase was in relation to business travel costs, which were lower in 2021 due to the COVID-19 mitigating measures. The cost of materials and services, which represents 30.6% of total expenditure, amounted to EUR 2,060,338.

Labour costs, which accounted for 63.3% of total expenditure, stood at EUR 4,259,942, marking a 9.6% increase compared to the previous year.

Average labour costs per employee amounted to EUR 37,698, which is 8.7% higher than the previous year. Total revenue per employee was 11% higher than the previous year, standing at EUR 61,849, whereas total expenditure per employee was 9.5% higher than the previous year at EUR 59,558.

There were no significant variations in the cost of materials and services compared to 2021.

TOTAL EXPENDITURE (EUR)	6,729,999
Cost of materials and services	2,060,338
Labour costs	4,259,942
Depreciation	323,345
Other costs	74,870
Financial expenditure	405
Other expenses	8,927
Revaluation operating expenses	2,172

Financial performance in 2022 compared to plan

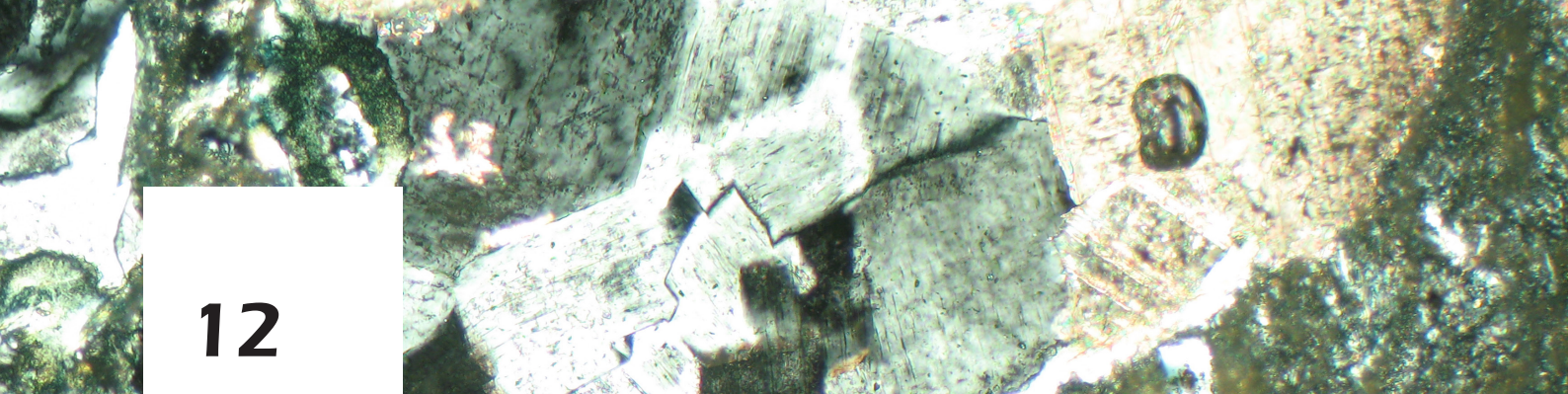
	Realisation 2022	Plan 2022	Index realisation/ plan
TOTAL REVENUE	6,988,954	6,556,113	106.6
Operating income	6,952,595	6,526,313	106.5
Financial revenue	5,911	0	/
Other revenue	652	0	/
Revaluation operating expenses	29,796	29,800	100.0
TOTAL EXPENDITURE	6,729,999	6,447,377	104.4
Cost of materials and services	2,060,338	1,994,271	103.3
Labour costs	4,259,942	4,033,106	105.6
Depreciation	323,345	315,000	102.6
Other costs	74,870	105,000	71.3
Financial expenditure	405	0	/
Other expenses	8,927	0	/
Revaluation operating expenses	2,172	0	/
Revenue surplus	258,954	108,736	238.1

Comparison by activity – realisation and plan for 2022

	Realisation 2022 Public funds	Realisation 2022 Market	Plan 2022 Public funds	Plan 2022 Market	Index realisation PF/plan	Index realisation M/plan
TOTAL REVENUE	5,664,534	1,324,420	5,441,651	1,114,462	104.1	118.8
Operating income	5,631,877	1,320,718	5,411,851	1,114,462	104.1	118.5
Financial revenue	5,907	4	0	0	/	/
Other revenue	631	21	0	0	/	/
Revaluation operating expenses	26,119	3,677	29,800	0	87.6	/
TOTAL EXPENDITURE	5,636,249	1,093,751	5,441,651	1,005,726	103.6	108.8
Cost of materials and services	1,704,445	355,893	1,553,608	440,663	109.7	80.8
Labour costs	3,553,118	706,825	3,500,951	532,155	101.5	132.8
Depreciation	302,859	20,486	297,092	17,908	101.9	114.4
Other costs	73,605	1,265	90,000	15,000	81.8	8.4
Financial expenditure	321	84	0	0	/	/
Other expenses	0	8,927	0	0	/	/
Revaluation operating expenses	1,901	271	0	0	/	/
Revenue surplus	28,285	230,669	0	108,736	/	212.1







Reporting following GRI Standards

Reporting on the operation of GeoZS follows the international guidelines for sustainable reporting GRI Standards (Global Reporting Initiative Standards). The critical contents presented in the report come from the performance of GeoZS activities. We also report on the impact of GeoZS operations on broader society and the environment. The report covers January to December 2022 and is prepared per GRI standards, standardizing the organization's reporting on economic, social, environmental, and management effects and performance results.

In the annual report, we reveal information about organizational management, the values, and benefits that GeoZS creates for its stakeholders and broader society, care for employees, and the connection between strategy and commitment to the sustainable development of GeoZS.

GRI STANDARD and disclosers	DESCRIPTION	PAGE
GENERAL DISCLOSERS		
GRI 102: General disclosers		
Presentation of organization		
102 -1	Name of organization	88
102 -2	Activities, products, and services	6-12, 20, 21
102 -3	Headquater of organization	88
102- 4	Geographical area of operation	20
102 -5	Ownership and legal form	21-23
102 -6	Market of operation	6-11, 20
102-7	Size of the organization (number of employees, number of operations and services, income, capital)	6,7, 27, 32-34, 36-55, 56-61, 82-84
102 -8	Employees information	32-34
Strategy		
102 – 14	The statement of the higher decision-maker in the organization about the importance of sustainable development for the organization and the strategy for dealing with sustainable development	4,5
Ethics and integrity		
102 – 16	Description of values, principles, standards, codes of conduct and codes of ethics and organizational integrity	20-21
Management		
102-18	Management structure	21-23
102 -22	The structure of management bodies	21-23
Stakeholders involvement		
102-40	Stakeholders map	62
102-42	Identification of stakeholders	62
102-43	Ways of involving stakeholders	63-71
SPECIFIC STANDARDS DISCLOSURES		
GRI 201 Economic disclosures		
201-1	Directly created and distributed value	82-84
Indirect economic impact		
203 -1	Development of critical infrastructure and services	11
Employees		
401-1	New employees and staff turnover	32-34
Diversity and equal opportunities		
405-1	Management and employees structure (gender, age, minorities)	21-23, 32-34
Local communities		
413-1	Local communities' involvement, impact assessment, and development programs	62-63, 74-80

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