

Themes and Session descriptions

1 Earth and Society: Climate, Sustainability and Natural Resources

Earth processes impact society and vice versa. Climate change, global population growth, increasing welfare as well as geopolitical developments worldwide sharpened the awareness of resilient and sustainable energy, mineral and water supplies. Renewable geoenery and the exploration and storage of energy, heat and waste (geothermal heat, hydrogen, transitional gas, nuclear disposal and CCS) need innovative exploration concepts. Similarly, research on the formation and exploration of energy metals and raw materials for industrial processes and welfare result on yet unexplored alternative resources such as brine mining. Groundwater, overall, is the foundation of life and thus the most critical natural resource affecting society. We ask for contributions from both fundamental to applied sciences.

- Climate: mitigation & society
- Geo hazards & risks
- Geoenery & energy storage
- Lithium mining
- Underground storage (CCS, nuclear waste)
- Mineral exploration and recycling
- Groundwater / hydrogeology

1.01) Feedbacks between the Earth's surface and the carbon cycle - towards (carbon) sustainable landscapes of the future – merged with 1.02 to

1.01) Towards 'Net Zero' with negative emissions and sustainable landscapes

Frings, Patrick (1); Grasse, Patricia (2); Sachse, Dirk (1); Mollenhauer, Gesine (3)

1: GFZ German Research Centre for Geosciences, Potsdam; Germany

2: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig; Germany

3: AWI Bremerhaven, Germany

Keynote speaker: Carolin Löscher, University of Southern Denmark "Ocean alkalinity enhancement- a tool to mitigate climate change?"

The carbon cycle is our planet's thermostat. Before humans, interactions and feedbacks between carbon reservoirs kept global temperatures within a window that allowed life to form, establish and succeed. But with the industrialisation of human society, we have drastically altered the balance of fluxes within and between the long-term and the short-term carbon cycles. Limiting temperature rise to within a safe-operating space for human society will require better management of the carbon cycle, including as-yet unproven negative emission technologies (NETs) – techniques that actively remove CO₂ from the atmosphere. A wide variety of techniques are being investigated, with variable degrees of technological readiness and their own specific strengths and weaknesses, and requirements for land, energy or other resources. There is a growing awareness that a portfolio of techniques will be required, but in many cases the baseline understanding of landscape carbon cycling is not sufficiently well understood.

This session will explore advances in the suite of natural and anthropogenic processes transferring, transforming and storing carbon in landscapes, with a particular focus on NETs. We welcome basic and applied submissions at all scales, from laboratory to field studies, as well as numerical, geochemical and technoeconomic modelling studies. We also particularly welcome submissions that address issues related to Monitoring, Reporting and Verification (MRV) and to the cultural, political, economic and sociological implications associated with the active management of the carbon cycle.

1.02) Advances in Greenhouse Gas Removal via Negative Emission Technologies merged with 1.01

Frings, Patrick (1); Grasse, Patricia (2)

1: GFZ German Research Centre for Geosciences, Potsdam;

2: German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig.

1.03) Exploration of near-surface geological structures using active and passive seismic methods

Hobiger, Manuel (1); Wadas, Sonja (2); Polom, Ulrich (2); Spies, Thomas (1)

1: Federal Institute for Geosciences and Natural Resources (BGR);

2: Leibniz Institute for Applied Geophysics (LIAG)

The effects of near-surface geological structures and their physical characteristics are key issues in many geotechnical engineering and geoscientific applications. Important examples include the evaluation of ground stability for construction projects and, in particular, the assessment of seismic hazard and risk. From this point of view, the key factors are the local amplification of seismic waves, the so-called 'seismic site effect', which can increase the local ground shaking dramatically, and the presence of faults of which the location, geometry and activity have a major influence on the seismic hazard. Connected hazard factors to the seismic wave dynamics are the local soil liquefaction and landslide potential.

Based on ongoing scientific method developments in the recent decades, near-surface structures and physical characteristics can be investigated efficiently by specially adopted seismic methods, which offer also economical alternatives compared to common engineering approaches of geotechnical testing and drilling investigations. While active seismic methods rely on the generation of signals, passive seismic methods exploit ambient vibrations generated by both natural and anthropogenic seismic sources. This session addresses contributions targeted to seismic near-surface investigations and case studies from few meters to several hundred meters of depth. Applications of both active and passive seismic methods and joint investigations with other geoscientific and geotechnical methods are invited. Contributions using newly developed seismic devices, such as specialized sources, rotational sensors or distributed acoustic sensing, are highly welcome, as well as studies combining active P- and S-wave and passive seismic methods.

1.04) Hydrogen: energy carrier in nature and for society – from natural hydrogen occurrences to large-scale hydrogen storage

Hasch, Maximilian; Lutz, Rüdiger; Weniger, Philipp; Ostertag-Henning, Christian
Federal Institute for Geosciences and Natural Resources (BGR), Stilleweg 2, 30655 Hannover, Germany

*Keynote speaker: Christopher J. Boreham, Geoscience Australia
"Assessing natural hydrogen occurrences and options for underground hydrogen storage in Australia"*

During the last decade, there has been renewed interest in molecular hydrogen as an energy carrier and essential component of the energy transition in industrialized societies. The number of countries that are developing and have published hydrogen strategies and roadmaps for the future use of hydrogen is growing rapidly. This includes medium- to large-scale underground storage of hydrogen in caverns and porous rocks. The geoscientific investigation of these storage options is crucial for risk assessment and for site selection strategies in developing new storage space.

The emergence of numerous studies of naturally occurring hydrogen in the environment raised hopes that natural hydrogen might be available in economically significant quantities.

We encourage presentations from scientists studying geochemical processes, including hydrogen formation or oxidation at hydrothermal vent systems, deep subsurface radiolysis and microbial processes of hydrogen oxidation or conversion to methane.

Research on processes of hydrogen migration in the subsurface, gas mixing during storage in gas reservoirs and exploration strategies for natural hydrogen occurrences are equally welcome. This shall be framed by projections on hydrogen usage in the future, substitution potential of fossil energies and the interplay of renewables and hydrogen.

We would be delighted to jointly develop these topics with a good mixture of scientists using different methods, from field observations to laboratory experimentation and numerical modelling to geophysical exploration methods at the GeoBerlin 2023

1.05) Aquifer thermal energy storage (ATES): Potential, technologies and geoscientific challenges for a sustainable energy transition

Bauer, Sebastian (1); Bayer, Peter (2); Blum, Philipp (3); Virchow, Lioba (4); Neumann, Thomas (5); Scheytt, Traugott (6)

1: Institute of Geosciences, Christian-Albrechts-Universität zu Kiel, Germany;

2: Institute of Geosciences and Geography, Martin-Luther-Universität Halle, Germany;

3: Institute of Applied Geosciences, Karlsruhe Institute of Technology, Germany;

4: Helmholtz Centre Potsdam, Potsdam, Germany;

5: Institute of Applied Geosciences, Technical University Berlin, Germany;

6: Technical University Bergakademie Freiberg, Freiberg, Germany

Large scale and up to seasonal storage of heat in the urban subsurface allows to integrate renewable or fossil-free heat sources into the urban energy and heat supply systems. Aquifer thermal energy storage (ATES) may provide the large rates and storage capacities required. Successful application of this technology relies on an appropriate characterisation of the subsurface geosystem, the determination of spatially and temporally resolved heat supply and demand, the successful integration of the storage operation into the heat supply system and the characterization of coupled processes leading to performance reduction and impacts on the subsurface environment.

This session addresses all topics, technologies and concepts related to the successful implementation and operation of ATES systems as well as the characterization of induced impacts and aims at providing a state-of-the-art overview of current national and international activities.

Relevant topics include but are not limited to:

- Identification and characterization of suitable storage formations
- Identification and determination of key site-specific parameters
- Development and application of suitable simulation approaches
- Concepts for integrated energy systems and their analysis
- Evaluation of data needs and data availability
- ATES scenarios contributing to reduced electricity needs and low carbon future
- Determination of induced geochemical and microbiological effects during operation
- Quantification of spatial subsurface requirements
- Site investigations for groundwater quality and environmental impacts
- Monitoring strategies and indicators for efficiency changes and adverse reactions
- Presentation of pilot and operating ATES systems

1.06) Geothermal developments in the Munich area – merged with 1.08 to

1.06) Deep geothermal resources and projects

Tischner, Torsten (1); Wojatschke, Jasmaria (1); Koltzer, Nora (2);
1: Federal Institute for Geosciences and Natural Resources, Germany
2: Fraunhofer IEG, Germany

Keynote speaker: Dietfried Bruss (Stadtwerke München)

Geothermal energy is experiencing growing interest as a local, renewable and reliable energy resource for heating, cooling and power supply. The European Geothermal Energy Council estimates that more than 25 % of the heat and cooling demand in Europe and about 10 % of its electricity demand can be supplied by geothermal energy. Many countries pursue ambitious goals in developing their geothermal potential. Until 2030 Germany wants to increase its geothermal energy supply from deep resources by a factor of ten. More than 100 new projects shall be initiated until then. Despite these ambitious goals there are still challenges and obstacles, that may impede geothermal progress.

Geological structures for geothermal energy extraction can be, among others, porous aquifers, faults or fractured rock. In principle, these geological structures are often known. However, it's detailed geological and petrophysical characterization remains a challenge and hence, the estimation of local or regional geothermal potentials are a matter of great uncertainty. We invite contributions that provide examples for geological or petrophysical characterization of geothermal resources and sites. Beyond, examples of national as well as international geothermal projects, case studies and regional development plans are welcome

1.07) Understanding reactions and transport in porous, fractured, and tight media – from field work to rock analytics and predictive modelling

Busch, Benjamin (1); Kühn, Michael (2); Fischer, Sebastian (3)
1: KIT;
2: GFZ;
3: BMWK

Keynote speaker: Andreas Busch, Heriot-Watt University

Understanding coupled fluid transport for de-risking geological carbon and hydrogen storage

The interaction of fluid and rock, and the properties of pores and their connectivity are among the main controls during fluid production and storage in clastic and carbonate rocks. Other geoscientific applications like nuclear waste repositories or cap rock studies require impermeable lithologies with adequate sealing properties. Processes like compaction, cementation, dissolution, and alteration control the evolution of reservoir and sealing quality. Hence, profound knowledge of these pore-scale processes are key during exploration of geological storage sites (geothermal, hydrocarbons, nuclear waste, CO₂, H₂) and to better assess safe, long-term site operations. As the effect of some of these processes are already partially defined by the depositional environment and sedimentary processes, a broad spectrum of geoscientific core competencies need to be combined in order to evaluate geotechnical suitability of individual sites.

Numerical simulations are the only way to connect micro-scale processes, which may significantly alter the internal rock structure, with macro-scale processes that consequently affect reservoir-scale transport behaviour of the system. The process-based understanding of both micro- and macro-scale processes will aid in planning future subsurface applications by outlining possibilities for better assessment, prediction chances, and risks with a focus on classic and renewable energy and storage sites.

This session aims to highlight recent developments in reservoir characterization from a sedimentary and diagenetic perspective, integrating petrophysical, petrographic, geochemical, and geophysical methods and approaches like reactive transport modelling. We invite submissions presenting e.g., case studies, integration of novel methodologies, and new interpretations of legacy data that help tackling current and future energy and storage challenges.

1.08) Integrated geological exploration for geothermal reservoirs for direct-heat – merged with 1.06

Niederau, Jan Frederik; Koltzer, Nora; Wellmann, Florian
Fraunhofer IEG, Germany

1.09) Lithium Resources in Continental Brines, Hard Rock Deposits, and Geothermal Fluids – merged with 1.10

1.10) Lithium - merged with 1.09 to

1.10) Lithium resources

Stechern, André (1); Schmidt, Michael (1,2); Kolb, Jochen (3,5); Borg, Gregor (4,5)
1: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR);
2: Deutsche Rohstoffagentur (DERA)
3: Karlsruhe Institute of Technology, KIT, Germany;
4: Institute For Technologies and Economics of Lithium, ITEL, Germany;
5: Fachsektion Energie & Rohstoffe FUTURE, DGGV

*Keynote speaker: Valentin Goldberg, Institut für Angewandte Geowissenschaften, Karlsruher Institut für Technologie (KIT), Deutschland
Challenges and opportunities for lithium extraction from geothermal systems in Germany.*

The world is experiencing a rush for lithium driven by the demand for lithium-ion batteries for electric vehicles and renewable energy storage. Lithium is key to the green revolution and reaching climate goals. Over the next few years, regulatory induced lithium demand will rise from approximately 400,000 tons of lithium carbonate equivalent (LCE) in 2020 to some 1.5 to 3 million tons in 2030. 100 kt LCE have been produced from mainly two resources, pegmatite and salar brines. The increased need for lithium results in research and development in various fields: (1) defining exploration criteria for magmatic and sedimentary deposits; (2) developing new extraction and

beneficiation technologies for primary ores and recycling; and (3) developing new, unconventional lithium resources such as geothermal brines. A better understanding of the characteristics and origins of these deposits will boost future exploration activities and assessment of undiscovered resources. We welcome contributions from the broad field of lithium research starting from geology and the development of exploration tools to extraction and beneficiation technologies. We also welcome contributions dealing with public acceptance of possible mine projects in Europe.

1.11) Unlocking CO₂ storage potentials for Germany

Kuhlmann, Gesa (1); Bauer, Sebastian (2); May, Franz (1)

1: BGR, Germany;

2: CAU, Germany

The capture and geological storage of carbon dioxide (CO₂) is one approach within climate protection strategies to effectively reduce anthropogenic emissions of the greenhouse gas CO₂. To explore the CO₂ storage potential for Germany, many aspects of geological storage have to be considered. Besides geological aspects including the properties and integrity of the reservoir and seals and their behaviour under thermal, mechanical, hydraulic and chemical stress, also site selection criteria, monitoring strategies as well as socio-economic and technical assessments, spatial planning and the legal and regulatory framework have an influence on the overall feasibility of CO₂ capture, transport and storage.

Topics for this session are all aspects of geological storage at all scales from laboratory experiments to full-scale storage projects, including aspects of capture and transport relevant to storage. Contributions are invited from national and international storage projects, capacity assessments and case studies.

Special focus is on following topics:

- Regional and local characterisation of storage formations and their seals
- Rock behaviour during injection and storage, including long-term response
- Geotechnically relevant physico-chemical processes
- Capacity estimation
- Assessing geological seal-bypass systems
- Injection concepts and numerical modelling of CO₂ storage processes
- Monitoring concepts and innovative tools
- Spatial planning, legal and regulatory requirements
- Industrial and political developments

1.12) Innovative concepts and sustainability with hydrogen: from underground hydrogen storage to business concepts

Cheng, Chaojie; Schulz, Marcel; Schilling, Frank; Hilgers, Christoph
Karlsruhe Institute of Technology (KIT), 76131 Karlsruhe, Germany

*Keynote speaker: Dr. Katriona Edlmann, School of GeoSciences, University of Edinburgh
"Geological storage of Hydrogen for Net Zero"*

Hydrogen from renewable energy is considered an energy carrier to balance the daily/seasonal fluctuations of power generated by renewable energy sources. Additionally, it is an essential raw material for industrial processes and carbon capture and utilization. In terms of the hydrogen volume needed for the successful energy transition, a scale of G-TWh is required beyond the scope of surface-based storage facilities, which are less reliable and cost-efficient. Thus, Underground Hydrogen Storage (UHS) in porous reservoirs and salt caverns and a supporting regulative and economic environment are essential to make such an energy transition happen. However, challenges, e.g., hydrogen consumption/contamination, degradation of reservoir properties, and geological/environmental risks, remain obstacles before the expansion of large-scale UHS and transition to a hydrogen economy.

This session aims at combining fundamental processes on reservoir integrity and new concepts related to large-scale implementations. We welcome experiments and case studies from the laboratory to the field scales to enlarge the database for the UHS community. We are also delighted for any contributions focusing on business concepts. Suggested topics include but are not restricted to, New techniques for utilization of existing infrastructures for safe and economical storage Identification of key parameters affecting the storage integrity and reservoir performance Integrated monitoring approaches towards a long-term safe operation of UHS Numerical simulation for up-scaling and coupling processes for UHS Characterization of hydrogen consumption/contamination due to abiotic reactions and microbial activities Potential developments for geo-bioreactor and large-scale bio-methanation Regulative and economic challenges from science to operation.

1.13) Site selection for a nuclear waste repository – Data acquisition, host rock characterisation and analogue studies

Richter, Lisa (1); Geckeis, Horst (2); Kühn, Michael (3); Winhausen, Lisa (4)

1: BGR, Department 3.2 Geological-geotechnical Exploration;

2: KIT, Institute for Nuclear Waste Disposal;

3: GFZ, Section 3.4 Fluid Systems Modelling;

4: RWTH Aachen, Department of Engineering Geology and Hydrogeology

*Keynote speaker: Michael Schnellmann (National Cooperative for the Disposal of Radioactive Waste – Nagra), Switzerland
"Decision of NAGRA to propose the site Nördlich Lägern to host the Swiss nuclear waste repository"*

The safe and permanent deep geological disposal of nuclear waste is a key challenge for society in the 21st century. Geological information such as lithology, depth and extent of potential host rock formations and the characterisation of material properties (e.g. mechanical strength, thermal conductivity, sorption capacity, etc.) serve as valuable input parameters for subsurface models and numerical simulations regarding the long-term integrity of a potential repository.

In Germany, where the current stage of the site selection procedure does not allow data acquisition in areas considered favourable for the safe and final disposal of high-level radioactive waste, model input parameters typically originate from existing data or from the study of natural and artificial analogues.

This session invites contributions presenting geological and geophysical field studies as well as in-situ and laboratory investigations of potential host rocks, suitable analogues and their material properties within the context of nuclear waste disposal.

1.14) Secondary raw materials: Geoscientific approaches to enable a circular economy

Gentzmann, Marie (1); Schraut, Katharina (2); Mählitz, Paul (3)

1: Bundesanstalt für Geowissenschaften und Rohstoffe;

2: Bundesanstalt für Materialforschung und –prüfung;

3: Deutsche Rohstoffagentur (DERA) in der Bundesanstalt für Geowissenschaften und Rohstoffe

Current societal and environmental challenges such as the energy transition are directly connected to raw materials, leading to a considerable increase in demand and creating supply risks. Tackling these issues requires interdisciplinary approaches that equally give attention to the potentials of primary ore deposits and of secondary raw materials and to the opportunities that arise by exploiting them. The entirety of strategies included in the concept of circular economy is needed and former wastes and residues have to be investigated in terms of recovery, reuse and recycling potential. Applied geoscientific research is one of the key-disciplines delivering knowledge about raw material markets, geochemical, geometallurgical, geophysical and mineralogical aspects of waste and residue valorization. Understanding the properties of these materials enables the determination of future applications and potential challenges. This session therefore addresses contributions dealing with geoscientific research on all kinds of secondary raw materials from various waste streams, including industrial and mining wastes and residues. The recovery of critical minerals and metals as well as the reuse of materials in the construction industry or other raw material intensive industries should be considered (e.g. stemming from research within the ReMin funding initiative). Interdisciplinary research from all fields as well as data driven or analytical approaches to quantitatively understand the potential of secondary raw materials are furthermore welcome. We particularly encourage young researchers to present their work in this session.

1.15) Mineralogy of complex ore deposits – from exploration to ore processing – merged with 1.18

Graupner, Torsten (1); Frenzel, Max (2); Korges, Maximilian (3); Walter, Benjamin (4); Kolb, Jochen (4)

1: BGR, Germany;

2: Helmholtz-Institut Freiberg für Ressourcentechnologie, Germany;

3: University of Potsdam, Germany

4: Karlsruher Institut für Technologie, Germany

The transition of our society towards the increased usage of climate-friendly technologies forms one of the major challenges of the next decades. This requires continuous exploration for ore deposits as well as research and technology development for efficient and eco-friendly exploration, mining and ore processing, particularly of unconventional resources.

Relevant high-tech metals like the platinum group metals, In, Ga, Ge, Ta, Te, Sb, Sc and the rare earth elements are often enriched in complex ore deposits of various genetic types. However, modern analytical methods are required to characterize their concentration levels and distribution characteristics in potentially ore-grade mineralized bodies. In addition, the combination of various mineralogical, experimental and geochemical tools is essential for the development of comprehensive exploration models and ore processing concepts.

This session is dedicated to research that improves our understanding of complex ore deposits worldwide, but particularly work conducted using mineralogical and geochemical tools (e.g., geochemical modeling, fluid inclusion analysis, optical and CL microscopy, SEM, EPMA, LA-ICP-MS, isotopic studies, geochronology, automated mineralogy, numerical modeling, experiments).

In addition to contributions on active mines and recent discoveries of complex ore deposits worldwide, we also welcome contributions on the investigation of mining residues and other geological materials with significant resource potentials.

1.16) Submarine magmatic-hydrothermal processes and associated mineral resources – merged with 1.17

1.17) Marine mineral deposits: Formation, exploration, and environmental impacts of human activities

Fuchs, Sebastian (1); Kuhn, Thomas (1); Petersen, Sven (2); Patten, Clifford (3); Keith, Manuel (4); Kleine, Barbara (5); Junge, Malte (5)

1: Bundesanstalt für Geowissenschaften und Rohstoffe, Germany

2: GEOMAR -Helmholtz Centre for Ocean Research Kiel

3: KIT, Germany;

4: GeoZentrum Nordbayern;

5: Mineralogical State Collection Munich

Keynote speaker: Dr. Carsten Rühlemann, Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)

Seafloor mineral deposits could make a significant contribution to ensure the future supply of base and critical metals for the transition to green energy and e-mobility. Many of these metals are concentrated in occurrences at or underneath the modern seafloor and contain several different commodities, including polymetallic massive sulfides & metalliferous sediments, Ni-Co-bearing nodules, Fe-Co-crusts, and REE-enriched phosphorites. Because of growing metal demand, risks in their supply, and geopolitical constraints, a lot of effort has been spent to gain a comprehensive understanding on the economic potential of the deposits and on the associated deep-sea environment. The exploration for, and the potential mining of marine mineral deposits, however, raises technical, geological, environmental, social, and regulatory questions.

Therefore, this session invites abstracts covering the broad topic of marine mineral deposits including: 1) deposit formation, characterization, and mineralogy; 2) geochemical and biogeochemical processes between oceanic crust, hydrothermal fluids, and seawater; 3) habitat analyses, ecosystem functioning, and microbial processes; 4) the use of and advances in exploration technology; 5) environmental impact studies; as well as 6) legal, social, political, and economic issues.

We welcome all topics that spark a balanced and objective discussion on the economic significance, environmental impact, and scientific advances in the research of marine mineral deposits.

1.18) Ore-forming processes: from traditional to advanced techniques – merged with 1.15

Beranoaguirre, Aratz; Patten, Clifford; Walter, Benjamin; Kolb, Jochen
Karlsruher Institut für Technologie, Germany

1.19) Raw Materials, Society, Politics

Kolb, Jochen (1,2)
1: KIT, Germany;
2: FURURE, DGGV

Raw materials are key to the transition into a defossilized society. Electrical cars, industrial processes and renewable energy require much more metals and a much more diverse suite of raw materials than fossil fuel-based technologies. There is no metal mining in Germany in order to serve the demand locally at the moment. German industry and society are strongly dependent on import. Recycling and circular economy cannot solve the problem alone, but are an important pillar. In order to reduce supply chain risk and to keep the entire value chain in Germany, we have to rethink about using our own resources and other strategies that secure raw materials supply.

In this session, we want to discuss challenges and strategies for solutions for the transition of our strongly industrialized.

1.20) Resource management tools – as a knowledge base for the availability of raw materials and for decision-making

Wittenberg, Antje (1); Heuss-Assbichler, Soraya (2)
1: Federal Institute for Geosciences and Natural Resources (BGR), Germany;
2: Ludwig-Maximilians Universität München (LMU), Germany

*Keynote speaker: Christian Masurenko, ECTerra (Aus) Pty Ltd, Australia
From boring needs to cool instruments. – Can codes and standards assist to ensure fair, responsible and legal mining?*

Raw materials are playing an increasingly important role in the well-being of our society, and are essential for climate-friendly and forward-looking technologies. At the same time, first-hand knowledge about exploration and mining is shrinking here in Germany and elsewhere. Understanding the challenges associated with resource exploitation requires drawing on a large amount of detailed information. It is a challenge to prepare the multidisciplinary collected scientific data, including detailed technical information, in a comprehensible way for a wide range of interested parties. Reliable information and coherent data are certainly key, but they need to be evaluated and interpreted to be useful for resource management.

What information does the general public need compared to decision-makers? In this session/workshop, we want to share experiences and ideas on how to promote a better understanding of the importance of raw materials in our society. Therefore, time for discussion will be reserved. Contributions from different sectors, e.g. industry, administration, NGOs or academia, are invited to bring in their experience, including those with standards and codes such as CRIRSCO and United Nations Framework Classification of Resources (UNFC) or the recently published United Nations Resource Management System (UNRMS).

We particularly encourage young researchers to present their ideas in this session.

1.21) Distribution, reactivity and behaviour of TCEs in aquatic systems: surface-, ground-, hydrothermal- waters and brines

Gil-Díaz, Teba; Eiche, Elisabeth
Institute for Applied Geosciences (AGW), Karlsruhe Institute of Technology (KIT), Karlsruhe

Keynote speaker: Montserrat Filella, University of Geneva, Switzerland

The European Union has identified rare earth elements (REEs), platinum group elements (PGEs), and a series of complementary elements (i.e., gallium, germanium, niobium, indium, tellurium, tantalum and thallium) as Technology-Critical Elements (TCEs). Despite their emerging use and on-going studies/reviews in aquatic systems and other environmental compartments, there are still several knowledge gaps remaining in the field of TCE research. For instance, some TCEs still require analytical development to achieve a better understanding of their environmental levels, behaviour, and toxicity. For others recent studies are scarce and generally driven by toxicity concerns, either related to specific elements regarding human health risk assessment (e.g., Tl and Gd) or to highly contaminated areas with identified point sources. Overall, this results in an unbalanced knowledge among the TCEs regarding their environmental distribution, reactivity, behaviour and fate in different aquatic systems (surface-, ground-, hydrothermal waters and brines). We welcome contributions from field campaigns or laboratory experiments addressing either one or more of the following points:

- Analytical challenges and alternatives to unavailable Certified Reference Materials
- Speciation and complexes (e.g., redox transformations, inorganic vs organic species)
- Identified hot-spot areas and potential toxicity
- Transport mechanisms (e.g., truly dissolved vs colloidal vs nanoparticles)
- Transfer between environmental compartments along the water cycle
- Surface complexation and reactive transport models
- Sources and process proxies
- Extraction methods for recycling/industrial use

1.22) Contaminants in groundwater – curse and blessing

Schipperski, Ferry (1); Warner, Wiebke (2)

1: TU Berlin, Germany;

2: Ruhr Universität Bochum, Germany

Groundwater is an important freshwater source. Yet, the impact of anthropogenic pollutants on groundwater is ubiquitous. The fate of contaminants in the aquatic environment is difficult to predict and the origin and transport behaviour is as diverse as the chemical properties of compounds themselves. Understanding sources, transport, attenuation and degradation processes in short and long term is crucial for sustainable and resilient groundwater protection. Some (micro)pollutants might even be feasible for gaining insights into the origin, as well as transport and attenuation processes within aquifers. Gaps in our knowledge about aquifer systems could be filled if more is known about the fate of specific groups of substances in groundwater.

In this session we welcome contributions on topics such as urban groundwater, new tools for water quality characterization, organic micropollutants in groundwater, groundwater remediation, and water quality monitoring in all types of aquifers.

1.23) Sustainable Groundwater Management to mitigate Water Scarcity: Innovative monitoring strategies, new modelling tools, and integrative management concepts

Engelhardt, Irina (1); Dietrich, Peter (2,3); Sauter, Martin (4,5)

1: TU Berlin, Germany;

2: Helmholtz-Zentrum für Umweltforschung, Germany;

3: University Tübingen, Germany;

4: Leibniz-Zentrum für Angewandte Geophysik, Germany;

5: University Göttingen, Germany

*Keynote speaker: Prof. Georg Teutsch, Helmholtz-Zentrum für Umweltforschung, Germany
“Scientifically based system solutions for climate mitigation and climate adaptation”*

Groundwater is the world's most important freshwater resource. It is intensively used by humans and primary source for drinking water supply and irrigation, hence critical to the water-food-energy security nexus. Groundwater is sensitively affected by land-use change, population growth, and shifts in climate, which all alter groundwater recharge, water supply and demand. Especially dry regions face increased water stress and are expected to expand globally. Beside regions that already suffer from a water deficit, we observe new regions, such as catchments in Central Europe with continental climate, e.g. the German capital Berlin or the federal states Brandenburg and Saxony-Anhalt, begin to be subjected to water stress. For example, mean precipitation in Brandenburg decreased to rates characteristic for the Mediterranean region. Germany's hotspots for water stress are either intensively used for agricultural purposes or face severely land-use changes, e.g. from the discontinuation of lignite mining. Furthermore, often wastewater and stormwater are not wisely managed in these regions.

We invite contributions, which identify new management strategies for a sustainable use of groundwater. This implies adapted modelling techniques in complex geological environments. Modelling strategies shall focus on coupling climate models with hydrological models and/or soil water- and groundwater models, respectively. Furthermore, this also includes studies into groundwater quality changes. We invite contributions about appropriate observational field studies and developments of innovative monitoring technologies that ideally link real-time measured data with modelling analyses. Due to frequently associated data scarcity strategies addressing uncertainty and limited data availability are of interest for this session.

1.24) Reclamation and transformation of post-mining landscapes: Biogeochemical processes, ecological and geochemical remediation strategies for open-cast mining lakes and sustainable water management

Hildmann, Christian (1); Nixdorf, Brigitte (2); Cremer, Nils (3); Schultze, Martin (4); Engelhardt, Irina (5)

1: Forschungsinstitut für Bergbaufolgelandschaften e.V., Germany;

2: BTU Cottbus-Senftenberg, Germany;

3: Erftverband, Germany;

4: Helmholtz-Zentrum für Umweltforschung, Germany;

5: TU Berlin, Germany

Keynote speaker: Dr. Javier Sanchez-Espana, Mine Waste and Environmental Geochemistry Research Group, Department of Geological Resources (IGME-CSIC)

“Geochemical and microbial processes controlling metal mobility affected by mine water (e.g. mine pit lakes, acid mine drainage)”

Following efforts in reducing global CO₂ emission, a phase-out of opencast lignite mining has taken place already, especially in Europe, and can be expected to be intensified in the near future. After lignite mining had been discontinued, new large water surfaces will develop requiring specific engineering techniques and management concepts with respect to prevailing geological environmental and climatic conditions. New research investigations and governmental initiatives cover strategies to i) manage these lakes areas ecologically, ii) improve the lake water quality, or iii) use the surface water resources wisely for enhancing groundwater storage in downstream located catchments, river discharge, and protection of aquatic ecosystems. Beside these ecological, chemical, and hydrological challenges also a socially and ecologically responsible transformation of former mining areas is essential. Thus reuse of former open-cast mines for energy production or storage are conceivable among other uses such as tourism.

We invite contributions identifying monitoring, modelling and management strategies to enable a sustainable transformation of open-cast mining lakes into aquatic ecosystems with good ecological potential. This requires improved understanding of the interactions between pit lakes and groundwater using adapted modelling techniques to assess biogeochemical processes at field scale. This also includes pilot-studies into engineering techniques for an ecological and geochemical remediation. We invite contributions about appropriate concepts for a reuse of open-cast mining water volumes for large-scale water storage in winter/autumn and release in summer periods. Contributions analysing strategies for open-cast lignite mining areas for energy storage or renewable energy production and the associated environmental impacts are invited.

1.25) New Challenges to the oldest part of the hydrologic cycle: Groundwater - cancelled

Barth, Johannes A.C. (1,3,4); Grathwohl, Peter (2,3,4)

1: Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany;

2: Eberhard Karls Universität Tübingen, Germany;

3: International Association of Hydrogeologists, German Chapter (IAH-D);

4: FH-DGGV

*Keynote speaker: Prof. Jean-Michel Lemieux from Université Laval in Québec, Département de géologie et de génie géologique
"Addressing seasonal local-scale to long-term continental-scale groundwater flow problems in cold environments"*

1.26) Methane seepage at wells and natural faults and the impact on the ecosystem – merged with 3.16 (see 3.16)

Jordan, Sebastian (1); Schmale, Oliver (2); Blumenberg, Martin (1)

1: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Germany;

2: Institut für Ostseeforschung Warnemünde (IOW), Germany

1.27) Young Scientist Session

Matthies, Fiene (1); Arndt, Iris (2); Lang, Moritz (3); Sawall, Joshua (4)

1: GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel;

2: Institut für Geowissenschaften, Goethe Universität, Frankfurt am Main;

3: Institut für Geographie und Geologie, Universität Greifswald;

4: Institut für angewandte Geowissenschaften, Angewandte Geochemie, Technische Universität Berlin

The Young Scientist Session offers all young scientists the opportunity to present their latest research among peers. Anyone without a PhD as well as anyone who obtained their PhD within the last 3 years will be considered a young scientist. We especially encourage young scientists who attend a conference for the first time or who are not sure whether their topic fits in another session, to submit contributions. This session invites contributions from all areas within the geosciences. This includes, but is not limited to, contributions based on the latest project, the BSc or MSc thesis, or the progress of a PhD project. The Young Scientist Session aims to give young scientists a platform to present and discuss their latest research in a conference environment with a diverse audience.

1.28) From research to impact on people – how can geosciences be applied in development cooperation?

Hublitz, Manuel; Rehmann, Thomas; von Baggehuft, Ulrike; Lorenzen, Lena Maria; Schirmacher, Wolfgang

BGR, Germany

Geoscientific research regularly unearths new and spectacular results and allows humans to better understand their basis of life, planet Earth. It is already challenging to communicate scientific results to society – and even more challenging to apply those results with the aim of improving the living conditions of people in all parts of the world, especially in the global south.

Various geoscientific and governmental institutions accept this challenge and focus on the implementation of their geoscientific expertise into development cooperation with countries in Africa, Asia and Latin America. For example, the BGR - together with its project partners - applies current research results and latest methods to enable the population in the project regions to make better use of their habitat in a sustainable way and to develop a better livelihood. In the course of the joint implementation of the project, the application of geoscientific methods is followed by data analysis, development of scenarios and eventually technical recommendations for an improved development framework and political decision-making. Thus, geosciences, its research results and people in a certain geographic entity are connected by means of applied geoscientific expertise.

The session provides the space to present best practice examples in which geoscientific methods and research results as well as modern technologies have been successfully applied in such a way that people can develop their habitat and improve their living conditions in a sustainable, climate-friendly and socially equitable way. Presentations from areas outside of development cooperation are also welcome.

1.29) Breakthrough technologies and innovations along the mineral raw materials supply chain — towards a sustainable and secure raw material supply

Al Barazi, Siyamend (1); Ericsson, Magnus (2)

1: BGR, Germany;

2: Luleå University of Technology, Luleå, Sweden

Our societies live at a turning point in history. The future of geopolitical and geo-economic relations is changing. These developments are catalyzed by (i) sweeping new climate political concepts and legislations around the globe, (ii) a growing demand for fossil-free energy technologies, (iii) an increasing share in demand by emerging economies for infrastructure and goods together with rising political tension between autocratic and democratic worlds, and (iv) the questioning of international conventions on peace, trade, and investment.

Current challenges such as poverty reduction, the energy transition, new mobility concepts, and digitalization cannot be managed without reliable, predictable, and sustainable access to mineral raw materials and smooth supply chains. Mineral raw materials are indispensable to our daily lives. They are a cornerstone for industrial supply chains and strategic to the functioning and integrity of a wide range of industrial and social ecosystems. Many of these minerals and intermediates are potentially critical, because global supply and trade are highly concentrated in certain, partly geologically favorable, regions or in a few suppliers.

This session addresses contributions dealing with game-changing innovations along the supply chain from innovative exploration technologies tapping unknown mineral resources to new autonomous mining technologies, new processing/metallurgical approaches, as well as digital solutions to track supply disruptions and market volatility.

1.30) UAVs in geosciences: applications, tools and case studies with the view from above - merged with 4.06

1.31) Bergbau in Deutschland – Quelle des Wohlstandes in der Vergangenheit – Zankapfel in der Gegenwart – gesellschaftliche Notwendigkeit der Zukunft

Alisch, Olaf (1); Rauche, Henry (2)

1: Verband Bergbau, Geologie und Umwelt e.V., Berlin, Germany

2: ERCOSPLAN Erfurter Consulting- und Planungsbüro GmbH, Germany

Seit Jahrtausenden geht in Deutschland und Mitteleuropa insgesamt Bergbau um. In mannigfaltiger Weise zeugen unsere Kulturlandschaften davon. In der Gegenwart ist die Rohstoffgewinnung nicht selten Anstoß gesellschaftlicher Auseinandersetzungen, was für den Bergbautreibenden oftmals zum Verlust an Planungssicherheit führt. Rohstoffe, auch die heimischen, werden in der Zukunft aber weiterhin von großer Bedeutung für unseren Wohlstand sein, weshalb auch der Bergbau in der Balance von Ökologie und Ökonomie einen dauerhaft tragfähigen gesellschaftlichen Kompromiss erfordert.

2. Early Earth Processes and Long-Term Earth and Planetary Evolution

We welcome session suggestions covering the formation and long-term evolution of the Earth and other planetary bodies. This includes specifically session covering experiments, observations, and modelling approaches from the formation of the solar system, accretion and differentiation of the Earth (including delivery of volatiles) and the early settings for the formation of life. Furthermore, we invite sessions focussing on global planetary processes of the changing world, including the initiation of plate tectonics on early Earth, volcanic activity over geological timescales, and the coupled evolution of planetary interior and atmosphere (incl. global climate changes and great oxygenation of the atmosphere). Sessions may focus on Earth alone or on comparative planetology within and beyond the solar system, including active or planned space missions.

- Late accretion processes and delivery of volatiles
- Building a habitable, early Earth
- Great oxidation events
- Structure and evolution of planetary bodies
- Long-term feedbacks between interior and atmosphere
- Onset of plate tectonics, habitable conditions and life
- Exoplanets

2.01) Late accretion processes from impacts to planetary differentiation - a multidisciplinary approach

Allibert, Laetitia (1); Schwinger, Sabrina (2)

1: Natural History Museum, Berlin, Germany;

2: DLR, Berlin

Keynote speaker: Alessandro Morbidelli, Institution: C.N.R.S. -- Conseil National de la Recherche Scientifique, Laboratory: Lagrange, Observatoire de la Côte d'Azur, Nice, France

"Early evolution of terrestrial planets: provenance & composition of the late accreted bodies"

The formation and growth of terrestrial planets is characterized by several evolutionary stages involving various physical processes that act on protoplanetary solids of different sizes. After Moon formation, protoplanetary bodies have typically reached sizes in the order of ~1000 km, which marks the onset of the late accretion stage. In its interplay with internal processes of planetary differentiation and its effects on the planets' chemical composition and heat budget, late accretion sets the initial conditions of further planetary evolution. In this respect, late accretion onto the terrestrial planets is of critical importance for understanding the early chemical differentiation, the physical processes at play and the individual evolutionary paths of terrestrial planets in our Solar System.

This session aims at discussing these processes from a multidisciplinary perspective, by bringing together geodynamics, (isotope) geo- and cosmochemistry, experimental petrology, and numerical modeling with a particular focus on the Earth, Moon and Mars.

We welcome contributions from any of these disciplines, especially contributions aimed at improving our current understanding of key processes involved in the early evolution of the terrestrial planets including the provenance and composition of late accreted bodies, the role of giant impacts in volatile loss processes and core formation, the formation and evolution of magma oceans, early convection processes in planetary mantles, and the cooling history of terrestrial planets.

2.02) The divergent evolutionary pathways of Earth, Venus, and Mars - canceled

Kislyakova, Kristina (1); Scherf, Manuel (2); Lammer, Helmut (2)

1: University of Vienna, Austria;

2: Space Research Institute, Austrian Academy of Sciences, Graz, Austria

2.03) Setting the stage for a habitable planet: Solid Earth processes during the Hadean and Archean – merged with 2.05 to

2.03) Setting the stage for a habitable planet: Solid Earth processes through time

Convener: Hoffmann, Elis (1); Vulpius, Sara (1); Hoare, Liam (2); Münker, Carsten (3); Ravindran, Arathy (3); Pakulla, Josua (3); Jentzsch, Carsten (3,4); Homrighausen, Stephan (5)

1: Freie Universität Berlin, Germany; 2: Ruhr University Bochum, Germany; 3: Universität zu Köln, Germany; 4: Universität Bonn, Germany; 5: GEOMAR Helmholtz Zentrum für Ozeanforschung Kiel, Germany

Keynote speaker: Dr. Craig D. Storey, University of Portsmouth

Keynote speaker: Dr. Bradley James Peters

"Identification of (ancient) mantle heterogeneities in hot spots using trace elements, highly siderophile elements, long-lived isotope systems, and short-lived isotope systems"

The Hadean and Archean eons were critical times for the evolution of planet Earth. During this period, Earth's crust began to differentiate and stabilize, and Earth's mantle had a profound influence on the transformation of Earth's atmosphere. The mantle had undergone multiple changes in its composition over time due to many processes such as mantle melting, formation of the continental crust and recycling. Whilst we have a clear understanding of plate tectonics and the mechanisms of crust formation in modern-day Earth, ambiguities remain on the style of tectonics, including the question when and how plate tectonic processes began to operate during the Hadean and into the Archean. Further debate exists on the style of initial continental crust formation and the influence and mechanisms of crustal recycling, early and later introduced heterogeneities in the mantle and the influence of Earth's geodynamic processes on the subsequent atmospheric evolution. In this multidisciplinary session we invite contributions from a broad range of fields including geochemistry, field observations, experiments, geochronology, petrology and modelling – all on various scales addressing how Earth's operated during its evolution through time.

2.04) Letters From a Strange Planet - The Early Earth Sedimentary Record as an Archive of Environmental Processes - **cancelled**

Janse van Rensburg, Deon (1); Mißbach-Karmrodt, Helge (2); Runge, Eric (3,4); Weimann, Lena (4)

1: Friedrich-Schiller-University Jena, Germany;

2: University of Cologne, Germany;

3: Eberhard-Karls-University Tuebingen, Germany;

4: Georg-August-University Goettingen, Germany

2.05) Identifying the evolution of the mantle through time using quantitative evidence of differentiated and undifferentiated rocks - **merged with 2.03**

Ravindran, Arathy (1); Pakulla, Josua (1); Jentzsch, Carsten (1,2); Homrighausen, Stephan (3)

1: Universität of Cologne, Germany;

2: University of Bonn, Germany;

3: GEOMAR Helmholtz Center for Ocean Research, Germany

2.06) Surface processes on terrestrial planets, moons, and small bodies – **merged with 2.07 + 2.08 to**

2.06) Interior, surface and atmosphere processes on rocky worlds

Adeli, Solmaz (1); Höning, Dennis (2); Rauer, Heike (1,3); Noack, Lena (3); Kislyakova, Kristina (4)

1: Institute of Planetary Research, German Aerospace Center (DLR) – Berlin

2: Potsdam-Institute for Climate Impact Research, Potsdam, Germany;

3: Freie Universität Berlin, Germany

4: University of Vienna, Austria;

Keynote speaker: Dr. Giulia Magnarini from Department of Earth Sciences, Natural History Museum, London, UK

"Surface processes on the Moon, Mars and the Earth"

Keynote speaker: Prof. Stephen Kane, Department of Earth and Planetary Sciences, University of California

"Atmospheric Dynamics of a Near Tidally Locked Earth-Size Planet"

The long-term evolution and habitability of Earth and other terrestrial planets is controlled by feedback processes between the planet's deep interior, surface, atmosphere, and a potential biosphere. These processes range from outgassing of volatiles from the mantle into the atmosphere, crust growth and crust and volatile recycling into the mantle, surface processes, and atmospheric loss to space, to the generation of a magnetic field and changes in the tectonic regime. Understanding these processes will provide insights into the geologic history of terrestrial planets and moons within our solar system. Furthermore, it will allow us to discuss and perhaps even predict the evolution and habitability of exoplanets, which may be tested by future observations with advanced space telescopes.

To this interdisciplinary session, we invite contributions from numerical modeling, laboratory experimental studies, as well as observations of planets and their atmospheres. We particularly welcome work that contributes to the understanding of the relationship between the interior evolution of a planet and observables on the planet's surface, in its atmosphere, or magnetosphere, as well as studies on comparative planetology and planetary analogues.

2.07) Interior-exterior feedback, long-term evolution, and habitability of terrestrial planets - merged with 2.06 + 2.08

Höning, Dennis (1); Spohn, Tilman (2)

1: Potsdam-Institute for Climate Impact Research, Potsdam, Germany;

2: International Space Science Institute, Bern, Switzerland

2.08) Exoplanets Session - merged with 2.06 + 2.07

Rauer, Heike (1,2); Grenfell, J. Lee (1); Tosi, Nicola (1); Noack, Lena (2)

1: DLR Institute of Planetary Research;

2: Freie Universität Berlin, Germany

3. Understanding the Earth System – From Endogenic to Exogenic Processes that Shape the Earth

This theme aims at understanding the Earth system and the interplay among endogenic, exogenic and biogenic processes, and includes topics ranging from dynamic interactions between deep Earth and surface processes, tectonic processes, mid-ocean ridge formation to sedimentary systems.

Session proposals and contributions related to the one of the following topics:

- Earth surface and sedimentary processes
- Stratigraphy and time scales of Earth system processes
- Role of the biosphere in marine and continental systems
- Subduction and collision processes
- Rifting, continental breakup and MOR processes including hydrothermal systems
- Dynamic interactions between deep Earth and surface processes
- Magmatic and volcanic processes
- Regional geology

3.01) Foreland basins: Decoding feedbacks between tectonics, climate, and biota - Cancelled

Andrić-Tomašević, Nevena (1); Stutenbecker, Laura (2); Bernhardt, Anne (3); Vasilyan, Davit (4,5)

1: Institute of Applied Geosciences, Karlsruhe Institute of Technology, Germany;

2: Institut für Geologie und Paläontologie, WWU Münster, Germany;

3: Institute of Geological Sciences, Freie Universität Berlin, Germany;

4: Jurassica Museum;

5: University of Fribourg

3.02) Mineralogical, Geochemical and Biogenic Transformations in the Critical Zone: what, where, when and how?

Grathoff, Georg H (1); von Blanckenburg, Friedhelm (2)

1: University of Greifswald, Germany;

2: GFZ Potsdam

Keynote speaker: Paul Schroeder: Dept of Geology, University of Georgia, Athens, GA USA

"Clay Mineral Reactions and Transport in the Critical Zone"

Dörte Tetzlaff: Organization(s): 1: HU Berlin, Germany; 2: IGB Leibniz-Institute of Freshwater Ecology and Inland Fisheries Berlin, Germany; 3: School of Geosciences, -- University of Aberdeen, Scotland, UK

"Ecohydrological partitioning through the critical zone drives groundwater recharge: an isotopic approach"

The Critical Zone (CZ) is defined as the dynamic skin of the Earth, extending from the top of the vegetation canopy through the soil and weathered bedrock including the extent of fresh groundwater. The CZ is a vulnerable georesource of critical importance to a sustainable future. Research in the CZ by its nature is interdisciplinary. We invite scientists that perform research in the CZ with emphasis on the mineralogical, geochemical and biological transformations observed, where they occur within the CZ; how elements (and their isotopes), water, and organisms are transported between the different zones, the time scales of processes and how a warming climate will influence these transformations. All this can be placed into an Earth System Science context. Topics can include results from CZ observatories, experimental, and field studies.

3.03) Advances in paleoclimate proxy development and application

Bajnai, David (1); Davies, Amelia (2); Tagliavento, Mattia (2); Klipsch, Sweda (3)

1: University of Göttingen;

2: Goethe University Frankfurt;

3: University of Cologne

Reliable information about past temperature, atmospheric gas concentration, ocean chemistry, and other aspects of the Earth's climate system is crucial to understand past (and future) climate change. Quantitative paleoclimate proxy data (physical, chemical, or biological indicators of past climate conditions) that are preserved in terrestrial and marine archives underpins a large portion of our knowledge on changes in Earth's climate.

The accuracy of the, e.g., temperature, redox, and pCO₂ records depends on appropriate statistical treatment of data and a thorough mechanistic understanding of both old and new proxy methods, such as the impact of secondary controls, such as mineralization kinetics, vital effects, and diagenesis. This session focuses on recent developments in the field of paleoclimate proxy research, including the development of new proxies (clumped isotopes, triple oxygen isotopes, metal isotopes) or the application of existing proxies to new research questions.

We seek contributions related to advances in analytical techniques and studies that provide fresh insight into the mechanistic basis of both traditional and novel proxies. We also welcome examples of how applying new approaches improves our understanding of Earth's climate history from the Archean to the present. Possible topics include concurrently applying multiple independent proxies or integrating paleoclimate proxy data with climate model simulations. We particularly welcome contributions from early career scientists.

3.04) From outcrop to modelling: New advances in siliciclastic and carbonate sedimentology and stratigraphy - cancelled

Spychala, Yvonne (1); Brooks, Hannah (2); Krencker, Francois (1)

1: Leibniz University Hannover, Germany;

2: RWTH Aachen

3.05) „Geomorphology and Sedimentology Beyond Boundaries“ - towards integrating geomorphology and sedimentary system science

Tofelde, Stefanie (1); Bufer, Aaron (2); Krautblatter, Michael (3); Bernhardt, Anne (4)

1: Universität Potsdam;

2: GFZ Potsdam;

3: Technische Universität München;

4: Freie Universität Berlin, Germany

*Keynote speaker: Dr Alex Whittaker (he/him), Imperial College London
“Geomorphology & Sedimentology of the Corinth Rift (or similar)”*

The shape of landscapes is the result of topography-building processes such as tectonic uplift and topography-reducing processes such as erosion and weathering processes, which are largely driven by climate conditions. The sedimentary products of erosional processes in mountain areas get transported via sediment routing systems towards depositional sinks. In turn, sediment transport and depositional processes are also controlled by tectonic and climatic – but also by intrinsic – processes and shape landscapes preferably along the low-relief stretches of the sediment routing system.

If tectonic or climatic conditions change, landscapes consequently adjust their shape to the new prevailing conditions during a transient adjustment phase. Information on past landscape adjustments, and hence past tectonic and climatic conditions, is thus stored in two types of ‘archives’: (1) in landscape morphologies and (2) in their sedimentary deposits. This session aims to integrate geomorphological and sedimentological approaches to improve our understanding on how landscapes react to changing boundary conditions, i.e. future climate changes. We invite contributions from analog experiments, field studies and numerical modeling approaches that operate within or at the interface of the disciplines of geomorphology and sedimentary system science. We especially encourage interdisciplinary submissions that trespass traditional Earth system boundaries such as the continent-to-ocean transition or terrestrial to limnic systems by integrating them into amphibious systems.

The session aims at bringing together geomorphological and sedimentological concepts beyond boundaries within or at the interface of the disciplines.

3.06) Present and past sediment routing systems

Stutenbecker, Laura (1); Hinderer, Matthias (2)

1: University of Münster, Germany;

2: Technical University of Darmstadt, Germany

The analysis of sediment routing systems is concerned with all steps linking sediment generation in the erosional engine, transfer and mixing processes, and the deposition of sediment in the depositional sink. This session focuses on recent advances in sediment routing analysis, e.g. quantification of sediment fluxes in all portions of the sedimentary system, fingerprinting of source rocks, sedimentary provenance analysis, grain-size partitioning from source to sink, sediment mixing and recycling, propagation of signals through the sedimentary system, and the identification of allogenic or autogenic control mechanisms from the sedimentary archive. We invite contributions from various geoscientific disciplines such as sedimentology, stratigraphy, and geomorphology. Studies both in modern and ancient sediment routing systems are welcome.

3.07) High-resolution topography: From irregular point clouds to gridded digital elevation models - cancelled

Bookhagen, Bodo; Mueting, Ariane; Rheinwald, Aljoscha

University of Potsdam, Germany

Keynote speaker: Dimitri Lague, University of Rennes “Point cloud applications in the geosciences”

3.08) Ocean, lake and estuarine sediments as biogeochemical reactors through time: Drivers, processes and products - cancelled

März, Christian; Roeser, Patricia
University of Bonn, Germany

Keynote speaker: Prof. Dr. Sandra Arndt (Universite Libre de Bruxelles)

3.09) Continent-Ocean feedbacks – merged with 3.29

Thiede, Rasmus C. (1); Hathorne, Edmund (2); Bernhardt, Anne (3); Scherler, Dirk (3,4)
1: Christian Albrecht Universität zu Kiel, Germany;
2: GEOMAR, Helmholtz Centre for Ocean Research Kiel;
3: Freie Universität Berlin;
4: Helmholtz-Zentrum Potsdam, Deutsches GeoForschungsZentrum GFZ

3.10) Constraining the rate of change in the Earth System through integrated stratigraphic approaches

Kaboth-Bahr, Stefanie (1); Zeeden, Christian (2); Sardar Abadi, Mehrdad (2); Wichern, Nina (3); Ulfers, Arne (4); Voigt, Silke (5)
1: University of Potsdam, Germany;
2: Leibniz Institute of Applied Geophysics (LIAG), Germany;
3: University of Münster, Germany;
4: Federal Institute for Geosciences and Natural Resources (BGR), Germany;
5: Goethe University Frankfurt/Main, Germany

*Keynote speaker: Dr. Margriet Lantink, Department of Geoscience, University of Wisconsin-Madison, USA
"Milankovitch cycles in 2.5-Ga iron formations as archive of the early Earth & Earth-Moon system"*

The geological record is characterized by major extinction events, perturbations of the global biogeochemical cycles, rapid climate shifts and tipping points. To investigate these events throughout the geological past accurate and integrated stratigraphy approaches are needed such as combining astrochronology and paleomagnetism.

This session invites contributions detailing a variety of tools for deciphering sedimentary records and their stratigraphy across intervals of major environmental change. An emphasis is placed upon case studies showcasing new theoretical approaches and measurement techniques to spatially and temporally correlate sedimentary sequences, constrain the age of the deposits, as well as disentangle paleoenvironmental conditions.

3.11) Triassic Revolution

Benton, Michael J. (1); Dunne, Emma (2)
1: University of Bristol, United Kingdom
2: Friedrich-Alexander-Universität Erlangen-Nürnberg (FAU), Erlangen, Germany

*Keynote speaker: Dr Kimi Chapelle, University of the Witwatersrand, Johannesburg, South Africa
"Insights into the Late Triassic extinction from the Stormberg Group of South Africa"*

The Triassic has long been recognised as a time of major upheaval in the history of life. For example, it was the time when Sepkoski's 'Modern fauna' of marine life replaced the 'Paleozoic fauna' and it was identified by Van Valen as the one point at which the evolution of life was reset. The reset was caused by the end-Permian mass extinction, and the revolution resulted from the huge opportunity for new groups of organisms to diversify in the oceans and on land. New work, especially from China, shows the speed of recovery of some organisms during the Early and Middle Triassic but against a time of continuing global hothouse and tropical dead zone. Further, new fossil finds suggest that the Mesozoic marine revolution of Vermeij began earlier than expected in the Early Triassic. Further, the Carnian Pluvial Episode drove more climate change and triggered the rise of dinosaurs to ecological dominance on land, as well as the origins of many modern clades (modern conifers, flies, crocodylians, lizards, mammals) on land, and new life modes in the oceans (swimming in bivalves; durophagous predation; new phytoplankton). The session will encompass current research on these early-emerging novel clades and functional modes, in context of evidence for sharply changing climate and taxon distributions. Further relevant themes include physical environmental conditions and palaeobiogeography of major regions and clades, the key mass extinctions that triggered much of the mayhem, including the end-Permian, the Carnian, and the end-Triassic crises.

3.12) Past climates and environments inform our future

Blanchet, Cécile (1); Kaboth-Bahr, Stefanie (2)
1: GFZ Potsdam, Germany;
2: University of Potsdam

*Keynote speaker: Niels de Winter, Vrije Universiteit Amsterdam, Netherlands
"Reconstructions of climatic seasonality and decadal variability in deep time from bioarchives"*

The anthropogenic-forced climate warming poses a serious socio-economic challenge by pushing Earth's climate to a warmer state for which there is no historical precedent. Although there exists no perfect analogue for the expected climate change, Earth's history includes past climate states that could hold lessons for the future of our warming world. Geosciences, and in particular the study of past climates and environments, play an important role by providing a long-term context and benchmarks for the modelling community. In our session, we welcome studies focusing on past climatic and/or past environmental reconstructions from orbital to annual time scales. Multi-proxy or data-model comparisons are particularly encouraged. We aim at providing an overview of current research in the "paleo"-community and provide a platform to exchange ideas on Earth climate system changes of the past. Submissions that investigate

a wide range of topics, such as rapid climate changes, hyperthermals, past oceanic circulation or paleo-ecology, and how these interact with the carbon cycle are welcome. Finally, we encourage and commit to uplift submissions from early-career scientists and under-represented groups in the Geosciences.

3.13) Identifying tectonics and climatic signals in deep-time: challenges and opportunities

Caracciolo, Luca (1); von Eynatten, Hilmar (2); Meinhold, Guido (3)

1: Friedrich-Alexander Universität, Germany;

2: Georg-August Universität, Germany;

3: Bergakademie Freiberg

Keynote speaker: Prof. Dr. David De Vleeschouwer, Westfälische Wilhelms-Universität (WWU) Münster, Institute of Geology and Paleontology, Germany

“Pre-Cenozoic palaeoclimate responses to astronomical forcing”

Sedimentary archives store the history of our planet and are used by many disciplines to unravel the evolution of orogens, climatic shifts, and the consequent adaptation of sediment routing systems as well as life on Earth. Tectonics and climate are the main drivers shaping the Earth's surface. Disentangling and quantifying the interactions between climate and tectonics and their control on sediment production and dispersal is critical in sedimentary basin analysis. It requires understanding the processes and characteristic timescales of the responses of routing systems to perturbations. Constraining the sedimentary response to such perturbations is critical for many Geoscience disciplines such as structural geology (to constrain tectonic processes), or palaeoclimatology (to ground-truth numerical models). Accurate reconstructions are endangered by the difficulties in obtaining precise time constraints for tectonic events, short- (e.g. extreme events) and long-term climatic shifts as well as various sedimentary archives which are further complicated by (i) the diachronous propagation of environmental signals, (ii) the shredding effect due to subsequent erosion and (iii) the overall increase of uncertainty with deep time. Both the proliferation and improvement of analytical tools and the advancement of numerical modelling are increasing the resolution to which the evolution of planet Earth can be reconstructed. Higher accuracy requires deep integration of structural geology, climatology, and sedimentary geology, and this is yet far from being achieved. We encourage contributions from structural geologists, palaeoclimatologists, and sedimentary geologists aiming tackling problems in relation to the time-constrained interplay of external forcing with sediment production, reworking and sedimentation

3.14) Applied stratigraphy of Central European basins

Erbacher, Jochen (1); Herbig, Hans-Georg (2); Mann, Thomas (1); Wilmsen, Markus (3); Bornemann, André (1); Meinsen, Janine (4)

1: Bundesanstalt für Geowissenschaften und Rohstoffe;

2: Universität zu Köln;

3: Senckenberg Dresden

4: Landesamt für Bergbau, Energie und Geologie, Hannover, Germany;

Keynote speaker: Prof. Dr. Andrew Gale, University of Portsmouth, UK

Stratigraphy is an essential discipline of Geosciences. Recent trends in stratigraphy benefit from advances in biogeochemistry, planetary dynamics, palaeoceanography, and mantle/crustal processes, which in the past two decades have led towards the development of long, integrated, high-resolution records in diverse depositional settings that improve our understanding of the Earth system. Accordingly, stratigraphy also provides crucial contributions to solve applied geoscientific problems such as in hydrogeology, geothermal research, carbon capture and storage as well as in economic geology. This session invites contributions from the fields of biostratigraphy, lithostratigraphy, geochronology, chemostratigraphy, magnetostratigraphy and sequence stratigraphy. We especially encourage contributions from both, applied and basic research in order to provide a forum for a closer cooperation of these two “antipoles”.

Lithostratigraphy in Germany experienced an uncontrolled growth of regionally used lithostratigraphic units and names during the 19th and 20th century. This resulted in a large number of informal stratigraphic termini and small-scale local to regional subdivisions, with often insufficiently defined spatiotemporal delimitations. The impetus to overcome this confusing situation foremost came from the geological state agencies that were in need of a uniform lithostratigraphic approach for geological mapping and their digitization as well as cross-border harmonization. The time-consuming process to define lithostratigraphic units was primarily advanced by the German Stratigraphic Commission (DSK) and its subcommissions over the last two decades. Landmark products of these joint efforts are the stratigraphic charts of Germany published in 2002 and revised in 2016 (STD-2002 and STD-2016), along with their explanatory publications, and, finally, the lithostratigraphic lexicon (LithoLex, since 2006; <https://litholex.bgr.de>). LithoLex is a joint venture of the DSK and the Federal Institute of Geosciences and Natural Resources (BGR). The DSK and its subcommissions are providing the content for this database, i.e. definitions and descriptions of the lithostratigraphic units, whereas the BGR is maintaining the database and provides these geo-information to the public. This session invites new contributions to German lithostratigraphy, technical advances in developing general legends and the role of LithoLex.

3.15) Lithostratigraphy in Germany and its applications – merged with 3.14

3.16) Assessing biosphere geosphere interactions from the continental and marine subsurface to surface vents and seeps – merged with 1.26 to

3.16) Assessing biosphere geosphere interactions in the subsurface, at leaking wells, and natural vents and seeps

Jordan, Sebastian (1); Schmale, Oliver (2); Kallmeyer, Jens (3), Schubotz, Florence (4)

1: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Germany;

2: Institut für Ostseeforschung Warnemünde (IOW), Germany

3: GFZ, Potsdam Germany

4: Uni Bremen, Germany

Keynote speaker: Giuseppe Etiope, Natural Gas Geology and Geochemistry, INGV Roma, Italy

Current understanding of sources and quantities of geological and biological methane emissions into the atmosphere

Keynote speaker: Malin Bomberg, VTT Technical Research Centre of Finland

Fennoscandian Deep biosphere – similarities, differences and functions

3.17) Environmental control on the fossil record of marine ecosystems - cancelled

Raddatz, Jacek (1); Rüggeberg, Andres (2)

1: Goethe University Frankfurt, Germany;

2: University of Fribourg, Switzerland

3.18) Structure and kinematics of subduction terminations: the western Hellenic Subduction System and other global analogues – merged with 3.19 and 3.20

Mouslopoulou, Vasiliki (1); Crutchley, Gareth (2); Bocchini, Gian Maria (3)

1: National Observatory of Athens, Greece;

2: GEOMAR;

3: Ruhr University Bochum

3.19) Unravelling tectonic processes at convergent margins using geodynamic modelling - merged with 3.18 and 3.20

Thielmann, Marcel (1); Duretz, Thibault (2)

1: Universität Bayreuth, Germany;

2: Goethe Universität Frankfurt, Germany

3.20) Metamorphism and Deformation across scales - merged with 3.18 and 3.19 to

3.20) Multiscale Investigations of Convergent Margins: Unraveling Subduction Dynamics from Kinematic Transitions to Metamorphic Reactions

Simon Schorn (1); Vasiliki Mouslopoulou (2); Thibault Duretz (3); Gareth Crutchley (4)

1: University of Graz, Austria;

2: National Observatory of Athens, Greece;

3: Goethe Universität Frankfurt, Germany

4: GEOMAR;

Keynote speaker: Prof. Stefan Schmalholz, Quartier UNIL-Mouline, Bâtiment Géopolis

"Subduction and collisional orogenesis: comparison of model predictions and observations with application to the Alpine orogeny"

Keynote speaker: Laura Wallace, GNS Science, New Zealand

Convergent margins, encompassing subduction zones, orogens, and their associated seismicity, play a pivotal role in plate tectonics and their study is crucial to constraining seismic hazard. Understanding the physical and chemical processes associated with subduction and collision remains a major scientific challenge. These processes, which are interdependent, range from microscopic to lithospheric scales and from co-seismic slip along kinematic transitions to complex long-term metamorphic reactions, therefore calling for interdisciplinary scientific approaches. Here, we focus on characterising subduction-related processes and quantifying their effects, using multiscale investigations in various margin environments, such as the upper and lower-plate, the subduction plate-interface and subduction terminations. Our aim is to encourage multidisciplinary research by bringing together datasets of empirical observations, numerical models and analogue experiments, to advance our understanding of subduction dynamics. The session will encompass the fields of metamorphic processes, petrology, structural geology, geodynamics, and geophysics.

3.21) Tectonic Systems - TSK Open Session

Dielforder, Armin (1); Keppler, Ruth (2); Stipp, Michael (3); Nagel, Thorsten (4); Ustaszewski, Kamil (5)

1: Leibniz Universität Hannover;

2: Rheinische Friedrich-Wilhelms-Universität Bonn;

3: Martin-Luther-Universität Halle;

4: Technische Universität Bergakademie Freiberg;

5: Friedrich-Schiller Universität Jena

The open session on tectonics, structural geology, and crystalline geology provides a forum to present and discuss recent research results from active and fossil tectonic settings. We welcome both process-oriented and regional studies that provide insights into a wide range of geodynamic processes, from rifting and ocean spreading to subduction, collision, and intraplate deformation. This session will

bring together a diverse community that builds on and advances multimethodological research including mapping, microstructural, geochemical and geochronological analyses, as well as analogue and numerical modeling, and concept development. As such, we invite both overarching and thematic presentations from early career to senior scientists.

3.22) From the ocean floor to the deep mantle and the arc: Element cycling through subduction zones and in orogens

Halama, Ralf (1); Schwärzenbach, Esther (2); John, Timm (3)

- 1: Keele University, United Kingdom;
- 2: University of Fribourg, Switzerland;
- 3: Freie Universität Berlin, Germany

The subduction of altered oceanic lithosphere is a key process that enables transfer of material from the Earth's surface into the deep mantle and its return through arc magmatism. Understanding the processes that affect elemental concentrations and isotopic signatures of rocks that are part of the subduction cycle is therefore of fundamental importance to assess global cycling of elements. A variety of fluid-rock interaction processes, from hydrothermal alteration on the ocean floor via dehydration and decarbonation reactions in the subducting slab to metasomatism by slab-derived fluids and melts with the mantle wedge, influence the elemental behaviour as well as rheological and thermodynamic properties in the subduction system. Volatile components, such as H₂O, CO₂, Cl, S, N and the noble gases, are of particular interest due to their role in the evolution of the Earth's hydrosphere and atmosphere. Recent advances in computation modelling of subduction zone processes based on thermodynamic and thermomechanical models, application of established and novel geochemical tracers, advances in analytical capabilities for spatially resolved analyses of minerals, fluid and melt inclusions, and experimental work on element partitioning and isotopic fractionation have all improved our understanding of the controls on input and output fluxes in subduction zones. This session aims to bring together field-based, geochemical, computational and experimental studies that address the behaviour of elements and relevant isotopic systems through the subduction cycle from regional to nanometre scales to investigate element redistribution during fluid-rock interaction and the global element exchange in subduction zones and continental collision zones.

3.23) Mountain Building in the Alpine-Mediterranean domain – from mantle imaging to crustal and surface processes back in time - AlpArray and AdriaArray

Handy, Mark (1); Crosetto, Silvia (2); Metzger, Sabrina (2); Faccenna, Claudio (2); Meier, Thomas (3); Le Breton, Elie (1)

- 1: Freie Universität Berlin, Germany;
- 2: GFZ Potsdam, Germany;
- 3: CAU Kiel, Germany

The Alpine chains and basins have been intensively studied by earth scientists for more than a century and provide a unique natural laboratory to deepen our understanding of orogenic processes. Although many concepts underlying the dynamics of mountain building were born in the Alps, recent results of the AlpArray project and its ancillary projects have reshaped our view not just of the Alps, but more generally of the way Alpine-type mountains form.

This session focuses on the ongoing interpretation of results gleaned from AlpArray, and its German arm, Mountain-Building in 4-dimensions (4D-MB), as well as on activities of a new European initiative, AdriaArray. These multidisciplinary projects draw on broad expertise from many European institutions to combine state-of-the-art seismological investigation of the orogenic mantle with detailed studies of the Alpine crust and surface. The goal has been to obtain a comprehensive picture of orogenic processes back in time. We invite contributions from the Earth Science community that highlight new results and that identify key questions of the present and past structure and dynamics of the central Alpine-Mediterranean mountain belts and basins, particularly the Alps, Apennines, Carpathians, Dinarides and Hellenides. Both disciplinary and multi-disciplinary contributions are welcome from geophysical imaging, (seismo)tectonics, structural geology, gravimetry, geodesy, geodynamics, petrology, geochronology and surface processes, combined with various modelling approaches.

3.24) Shaping divergent plate boundaries and associated georesources through tectonic, magmatic and hydrothermal processes

Perez-Gussinye, Marta (1); Olive, Jean-Arthur (2); Glerum, Anne (3)

- 1: Geo-phy-sics - Geo-dy-na-mics, University of Bremen, Germany;
- 2: Laboratoire de Géologie de l'Ecole Normale Supérieure, France;
- 3: GFZ German Research Centre for Geosciences, Potsdam, Germany

Continental rifts and mid-ocean ridges are key components to global plate tectonics and provide the ideal conditions for the formation of renewable natural resources such as geothermal energy, hydrogen and mineral deposits. These divergent plate boundaries exhibit elevated temperatures and temperature gradients from lithospheric thinning, pervasive fault networks that facilitate fluid flow, and in sub-aerial cases, ample sediment supply from rift shoulders. This session explores how the large-scale tectonics of rifts and ridges interact with a range of magmatic and hydrothermal processes, thereby facilitating the development of natural resources. We invite contributions based on geological, geophysical and geochemical observations as well as numerical modeling that characterize these processes and quantify their role in the formation of georesources.

3.25) Linking deep-seated and surface processes in mountains building: Insights from field-based, analytical, and numerical methods – merged with 3.26 to

3.25) The links between deep-seated mechanisms, surface processes and landscape evolution

Lorenzo Gemignani* (Institut für Geologische Wissenschaften, Freie Universität Berlin, Berlin, Germany)
Riccardo Reitano* (Department of Science, University of Rome "Roma TRE", Laboratory of Experimental Tectonics, Rome, Italy)
Alexander Rohrmann (Institut für Geologische Wissenschaften, Freie Universität Berlin, Berlin, Germany)

Silvia Crosetto (Lithosphere Dynamics, Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), Potsdam, Germany)
Romano Clementucci (Department of Earth Sciences, ETH Zurich, Zurich, Switzerland)
Frank Zwaan (Geodynamic Modelling, Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), Potsdam, Germany)
Richard F. Ott (Earth Surface Process Modelling, Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), Potsdam, Germany)

*Keynote speaker: Yan Yan Wang, ETH Zurich, Geological Institute
"Divide Migration and Escarpment Retreat in Madagascar and the Western Ghats of India"*

The interplay between tectonics, climate, and erosional events shape the Earth's surface, regulating mountain formation and landscape evolution. Deep and shallow processes interact over different time and spatial scales, making it challenging to discriminate their individual contribution. The combination of geochronology, bio-geochemistry, and modeling techniques as laboratory-based support to field observation is fundamental to unravel the different mechanisms at work and to quantify their rates. In this session, we aim at bringing together original research using diverse approaches spanning geophysical datasets, geomorphic and sedimentary records, thermochronology, cosmogenic nuclides, paleoaltimetry, bio-geochemistry, provenance analysis, and modelling.

3.26) Magnitude, rates, and timing of landscape evolution: from modeling to quantifying techniques - merged with 3.25

Reitano, Riccardo (1); Clementucci, Romano (1); Crosetto, Silvia (2); Zwaan, Frank (2); Ott, Richard Frederik (2)
1: University of Rome "Roma Tre", Italy;
2: Helmholtz Centre Potsdam, German Research Centre for Geosciences (GFZ), Potsdam, Germany

3.27) Alkaline rock and carbonatite related magmatism

Giebel, R. Johannes (1,2); Walter, Benjamin F. (3)
1: Technische Universität Berlin, Germany;
2: University of the Free State, South Africa;
3: Karlsruhe Institute of Technology

Alkaline silicate and in particular carbonatite complexes are relatively rare in the world's rock records. Nevertheless, they are an important source of raw materials (especially for REE and other critical metals such as Nb, Zr, F, etc.), but also an important basis for understanding deep Earth processes. These rocks are essential for gaining insight into the segregation of diverse melts, the ascent and emplacement of volatile-rich magmas, and the mobilization and enrichment of certain metals. In this context, the transition from the magmatic to hydrothermal stage in alkaline and carbonatite systems often plays an important role. Recent studies have furthermore shown that contamination is an important and diverse process that should not be neglected. This session invites contributions on all aspects of alkaline and carbonatitic magmatism, that aim to develop a comprehensive understanding of their genesis, evolution, alteration and mineralization, and provide insights into the mantle and crustal sources of related magmas and metals.

3.28) Developments and progress in regional geology

Meinhold, Guido (1); Kley, Jonas (2); Röhling, Heinz-Gerd (3)
1: TU Bergakademie Freiberg, Germany;
2: University of Göttingen, Germany;
3: DGGV in Berlin, Germany

*Keynote speaker: Professor Jiří Žák, Charles University, Prague, Czech Republic,
"Shaping the northern Gondwana margin before the Variscan orogeny: large-scale geodynamic processes and paleogeography"*

Regional geology is an essential cornerstone of geoscience, encompassing multiple geological disciplines to study important geological features of a region. The size and the borders of each region are usually defined by distinct geological boundaries and by the occurrence of a specific suite of geologic rock strata. Regional geology is used to solve a wide range of questions in geoscience and provides important information in the search for natural resources. This broad session offers the opportunity to explore the diversity of methods and approaches used to study regional geology and how information about regional geology is made available and transferred to the geoscience community in academia, industry, government, or the public. We welcome contributions on all aspects of geology that contribute to better understanding regional geology on Earth or other terrestrial planets.

3.29) Latest Achievements in Scientific Ocean and Continental Drilling – merged with 3.09 to

3.29) Latest achievements in scientific drilling and ocean-continent feedbacks

Uffers, Arne (1); Grob, Henrik (2); Kunkel, Cindy (3); Thiede, Rasmus (2); Hathorne, Edmund (4)
1: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR);
2: Christian-Albrechts-Universität zu Kiel (CAU);
3: Helmholtz-Zentrum Potsdam
4: GEOMAR, Helmholtz Centre for Ocean Research Kiel

*Keynote speaker: Prof. Yani Najman, Department of Geological Sciences, University of Colorado Boulder and Lancaster Environment Centre (LEC), Lancaster University, UK
"The marine sediment archives of Himalayan erosion"*

National and international Earth science programs are utilizing Scientific Drilling as a critical tool to understand climate and environmental variability, natural hazards such as earthquakes and volcanic eruptions, natural resources, the deep biosphere and other topics of socio-economic relevance. The principal goal of the session is to summarize latest scientific achievements in ocean, continental and polar drilling and better understanding the links between these archives.

Linking oceanic and continental climate and sediment deposition dynamics, in the cratons and along its margins, involves understanding the interactions between earth surface and crustal deformation processes on one hand and sediment dispersal pattern towards the ocean as well as of its deposition in marine fans forming the archives recording this on the other hand. Near the surface, the interplay of global atmospheric circulation systems and precipitation pattern with rapid erosion in tandem with active tectonics, sea-level oscillations, and ocean circulation pattern produces and triggers the dynamic of major source-to-sink systems. With silicate weathering being the natural process to ultimately remove anthropogenic CO₂ from the atmosphere and oceans, focus is on the geological record to better constrain the factors controlling continent wide erosion and weathering under different boundary conditions. Contributions investigating the amount, type, source and composition of sediments produced by weathering and erosion and factors influencing their transport and deposition are welcomed.

Furthermore new technical developments in scientific drilling and innovations in the systematic evaluation of well logging data are also welcomed.

3.30) Recent advances in geoscientific investigations of the ocean floor

Bohrmann, Gerhard (1); Huvenne, Veerle (2); Bach, Wolfgang (1)

1: University of Bremen, Germany;

2: National Oceanography Centre, UK

Keynote speaker: Dr. Isobel Yeo, National Oceanography Centre, Southampton

"Recent Tonga volcanic explosion - results from high resolution sea floor mapping" (tentative title)

The ocean covers 71% of our earth's surface and is much more difficult to access for geoscientific investigations than the land surface. Although scientists have been studying the ocean from research vessels for more than a century, interest in a global understanding of the earth system and its causal loop processes has led to increased efforts in marine research in recent decades. Methodological developments in seabed studies have led to new insights in ocean crust formation and evolution, including interactions with seawater, ice caps, the atmosphere and the living world today and in the past. State-of-the-art research vessels with advanced deep-submergence technology, such as robotic sea-floor drill rigs and giant-piston coring, submersibles, ROVs and AUVs, as well as acoustic and seismic systems are used to investigate various processes on the seafloor and in the sub-seafloor, some in 4D. In this session we would like to encourage all geoscientists to present exciting results from ship expeditions and marine studies over the past few years.

4. Managing the Future of Earth Sciences: Data, Citizen Science, Education, Outreach

Availability of data has exploded in all scientific disciplines. This requires innovative data driven workflows and infrastructure. In particular, research and geodata management, data accessibility and credit need major advances. At the same time, major geoscientific themes around the changing Earth systems still receive limited attention in education and the public. An increasing number of schools, universities, museums, science centres, temporary exhibitions and geoparks try to improve this situation and develop innovative learning and teaching concepts.

Session proposals and contributions related to one of the following topics:

- Open Science (data repositories, research infrastructure, FAIR principles)
- Geoscience and Research Data Management
- Geo-Analytics (machine learning, artificial intelligence, big data)
- Advances in computational geosciences: new methods, integration of scientific data, software, and workflows
- Analytical data management and methods development
- Science communication and outreach
- Citizen science
- Geoscience education at schools and universities
- Nonformal education, museums, geoparks
- World heritage sites, geotopes, nature protection

4.01) Harnessing Global Geoanalytical Data to Enable Research into the Future Grand Challenges of Earth System Sciences – merged with 4.03

Klöcking, Marthe (1); Elger, Kirsten (2); Hezel, Dominik (3); Klein, Sabine (4); Siebert, Christian (5)

1: Georg-August-Universität Göttingen;

2: Deutsches GeoForschungsZentrum GFZ;

3: Goethe-Universität Frankfurt;

4: Deutsches Bergbau-Museum Bochum;

5: Helmholtz-Zentrum für Umweltforschung, UFZ

4.02) Within and Beyond - Research infrastructures that strengthen Open Science Practices in Geosciences

Lorenz, Melanie (1); Pörsch, Andrea (2); Eger, Kirsten (3)

1: FID GEO Specialised Information Service for the Geosciences;

2: Helmholtz Metadata Collaboration HMC;

3: GFZ German Research Centre for Geosciences

Keynote speaker: Joachim Müller, wemove digital solutions GmbH (Germany)

"Data Management for the App UmweltNAVI of the Federal State of Lower Saxony in Germany"

The change towards Open Science practices is increasingly demanded by (science) policy and affects the whole geosciences community along with the required research infrastructures. This includes the transition to Open Access publications, as well as the growing need to make data, scientific software and samples underlying scientific results available for the general public.

The world of geosciences is very broadly positioned on the path to Open Science. Research data repositories, on the one hand, support researchers in publishing their data and scientific software and, on the other hand, are faced with the need to present the data in a way that easily fits into the ecosystem of modern scientific communication, as required by the FAIR Data Principles. Public geodata of the federal, state and local governments is made openly available in a standardized and simple way on Geoportals within the framework of the Geodateninfrastruktur/ Spatial Data Infrastructure Germany (GDI-DE/ SDI Germany), which is integrated into the European Spatial Data Infrastructure created by the INSPIRE Directive.

This Session provides a forum to show case the range of practices in all kinds of research infrastructures. We invite contributions from repositories, data portals (such as Geoportals of federal institutions, EPOS, NFDI), data bases and all projects beyond to discuss challenges they face in meeting their best practices for the community.

4.03) Open Science and Data – challenges, opportunities and best practices - merged with 4.01 to

4.03) Open Science and Data – challenges, opportunities and best practices

Eger, Kirsten (1); Grötsch, Jürgen (2); Nüst, Daniel (3)

1: GFZ German Research Centre for Geosciences, Germany;

2: Friedrich Alexander Universität Erlangen-Nürnberg (FAU), Germany;

3: Technical University Dresden, Germany

Keynote speaker: Kerstin Lehnert, Columbia University (USA)

"OneGeochemistry: Global Cooperation for FAIR Geoanalytical Data Policy and Practice"

Open Science practices are increasingly embedded in institutional and federal data policies and require a cultural change in the scientific community. The challenges here are both technological and societal.

With the advent of data-driven workflows and AI/ML techniques in the geosciences, scientists spend a large amount of time to search and collect data from various sources, often not even available in digital formats, not to mention standardised data types and data interoperability supported by APIs in modern data repositories. This generates inefficiencies and hampers the scientific progress particularly when it comes to integrated Earth System investigations which require inter-disciplinary collaboration between a wide range of expertise and the use of a large variety of different geoscience data types.

On the other hand, this shift to Open Science is impossible without scientists making their data available. Although there are increasing requests for open data (by journals, funding agencies, institutions) there is still a lack in tangible rewarding mechanisms and incentives for researchers to make their data available in reusable form. What information do I need to provide along with the data themselves? Research data repositories can be valuable partners supporting researchers on this way. However, an ever-increasing number of data repositories are being developed – but how do I know which is the best repository for my data? How can data management facilitate data-driven approaches?

This session provides a forum to exchange challenges and best practices enabling cultural change and international collaboration in scientific communities in connection with open data infrastructures.

4.04) Artificial Intelligence and Virtual Reality for Exploration and Mining Companies - cancelled

Pizano, Luis (1); Knobloch, Andreas (1); Bendorf, Jörg (2); Restrepo, Diego (2); Barth, Andreas (1); Bock, Peter (1)

1: Beak Consultants GmbH, Germany;

2: TU Bergakademie Freiberg

4.05) Digital methods for the planning and construction of geothermal plants - cancelled

Kaiser, Holger

Bauer AG, Germany

4.06) From the Field to Mixed-Reality Visualisations: Digital Outcrops and 3D Models - merged with 1.30 to

4.06) From Unoccupied Aerial Vehicles (UAVs) to Mixed-Reality Visualizations: Expanding Frontiers in Field Data Acquisition, 3D-Model-Design and Geo-Visualization

Jackisch, Robert; (1), Winterleitner, Gerd (2,3); Braun, Anika (1); Schuetz, Felina (2); Grützner, Christoph (4); Zeilinger, Gerold (5)

1: TU Berlin, Germany;

2: VFG-Lab GmbH, Germany;

3: Fraunhofer IEG, Germany;

4: University of Jena, Germany;

5: University of Potsdam, Germany

Keynote speaker: Simon Buckley, Research Professor, NORCE Research Centre Norway

This session explores the transformative role of UAVs and digital advancements in geosciences. UAVs have become essential tools for geoscientists, offering new possibilities in research, mapping, and monitoring. We seek to present the latest applications, workflows, and case studies that show case UAVs' unique contributions across various geoscientific fields.

Themes to be covered include natural hazards, geomorphology, geologic mapping, geophysics, mineral exploration, mining, and more. We welcome examples of UAV mission planning, data acquisition (photogrammetry, spectral imaging, Lidar), processing, integration, interpretation, visualization, and regulation.

Parallel to UAV advancements, geosciences have experienced a digital revolution, introducing novel techniques and workflows. This session focuses on digital geologic fieldwork, 3D modeling, and state-of-the-art visualization applications, with a special emphasis on virtual and augmented reality. Topics include virtual fieldwork, 3D modeling, immersive visualization, virtual teaching, geological digital twin development, and geoscientific data communication.

By bringing together UAV technologies and digital advancements, this session provides a platform for knowledge exchange, collaboration, and pushing the boundaries of geoscientific research and visualization.

4.07) Data-driven digital twins of the subsurface and their applications

Gomez Garcia, Angela Maria (1); Bott, Judith (2); Kumar, Ajay (2); Scheck-Wenderoth, Magdalena (2);

Tsy-pin, Mikhail (2)

1: Geosciences Barcelona (Geo3BCN-CSIC), Spain;

2: GFZ German Research Centre for Geosciences, Germany

*Keynote speaker: Laurent Ailleres; Monash University, Australia; 2University of Western Australia, Australia
"The LOOP Project: towards multi-scale digital twins of geology?"*

Subsurface utilization and the assessment of associated potential seismic hazard require robust knowledge of the rock physical properties, as well as the processes controlling state variables, pressure and temperature, from reservoir to lithospheric scale. The interpretation of subsurface observations is often non-unique due to the scarce data or inherent non-linearity. Integration of different types of data (e.g., geological, well-log, active and passive seismic, potential field, GNSS, InSAR data) and their joint inversion allows to narrow down the solution space and help to build robust and reliable models of the solid Earth, useful for process simulations and predictions beyond the spatiotemporal restrictions of direct observations.

The data integration process, however, is challenging. Direct relationships between different physical properties are mostly empirical, realistic models are complex, and inversions (including sensitivity tests) are computationally expensive. Such data-driven integrative digital twins of the subsurface are the basis for various studies targeted at, for instance, geothermal energy, groundwater utilization, energy and waste storage, mining, and even fundamental geodynamic questions. With this session, we would like to bring together people from various disciplines to exchange their experience in across-scales data integration methods and resulting applications. In particular, we invite contributions that present multidisciplinary data management and visualization software, as well as innovative methods for joint inversion and interpretation.

4.08) Geological surveying as services for the public delivered by the State Geological Surveys of Germany - Current Issues

Futterer, Birgit (1); Panteleit, Björn (2)

1: Landesamt für Bergbau, Geologie und Rohstoffe, Cottbus, Germany;

2: Geologischer Dienst für Bremen, Bremen, Germany

*Keynote speaker: Hr. Baumberger, Bundesamt für Landestopografie swisstopo
"Aktionsplan digitaler geologischer Untergrund"*

The State Geological Surveys of the Federal Republic of Germany are the neutral specialist institutions of the federal states that can provide information on all questions relating to soil and the geological subsurface. As service authorities the geological survey represents its core task, which, since 2020, has also been anchored in the Geological Data Act (GeoIDG) for the transmission, securing and public provision of geological data and for making geological data available for the fulfilment of public tasks.

The focus of the session, some contributions may be held in German, will thus be on the entire range of its tasks, from mapping to the preservation of data in geoarchives to the provision of data in accordance with GeoIDG, also against the background of current issues.

The aim is to present new results and methodological approaches of geological mapping, but also to discuss challenges from enforcement. In addition to the discussion of scientific results, the session also intends to be an interdisciplinary platform for the presentation of current tasks and applied work.

Contributions on the following topics are welcome:

Investigation and evaluation of the subsurface to provide the basis for fertile soils (climate change and soil protection), clean groundwater (water supply from groundwater reservoirs),

Land use planning for sustainable use of resources, interpretation of geopotentials, secured raw material deposits

geoscientific assessments for various land use claims

Interpretation/prevention of geohazards and disaster control, stable structures

Tasks of the SGDs in the Site Selection Act (StandAG)

Collection of data and data provision, geoinformation

4.09) 3D models in education and outreach - synergy of research, geotourism, conservation and georisk assessment

Hoffmann, Gösta (1); Knaak, Mathias (2); Grigowski, Edouard (3); Decker, Valeska (4)

1: Deutsche UNESCO Kommission, Germany;

2: Geologischer Dienst NRW;

3: Universität Bonn, Institut für Geowissenschaften;

4: RWTH Aachen Universität, Geologisches Institut

Within this session we aim to highlight recent advances in 3D modelling in geosciences. We hope to attract presentations on 3D visualisation of outcrops and geological features, as well as 3D models of subsurface structures at all scales. Applications of virtual as well as augmented reality that help to communicate geological history in tourism as well as applications in industry and science are appreciated. 3D-modelling approaches of private individuals are welcome as well as the presentation of whole projects.

The session will cover the entire process including data collection, processing and handling and finally potential ways of publishing 3D-models. Hereby, a broad range of methods including structure from motion, terrestrial and airborne laser scanning should be visualised. Difficulties and challenges that can be faced during these processes shall be discussed.

4.10) Geoscience Education Research - What do we Know About Learning and Teaching geosciences?

Felzmann, Dirk (2); Hlawatsch, Sylke (1)

1: Richard Hallmann Schule, Germany;

2: Universität Koblenz - Landau, Natur- und Umweltwissenschaften

*Keynote speaker: Prof Nir Orion, Department of Science Teaching, The Weizmann Institute of Science, Israel
"Earth System Education"*

Schools should enable young people to make informed decisions regarding sustainable development of planet Earth. However, German geoscientists and geoscience institutions have repeatedly expressed their concern about the lack of basic geoscience knowledge among the general public and the limited geoscience school education. This is disturbing, because an in-depth understanding about the functioning of the Earth as a system, e.g. the development of natural resources or the climate is an essential prerequisite. Research into teaching and learning has shown that problem solving is not possible without knowledge of the subject matter (Weinert, 2014). Invited are researchers that have been involved in geoscience school education and teacher training, also as part of geography, biology, chemistry, physics education to present and discuss their findings. With this session we aim to illustrate the field of geoscience education research ("fachdidaktische Forschung" in German). We are looking forward to learn for example about prerequisites of the learners and teachers (e.g. their interests, their conceptions, their competencies), the effects of geoscientific learning environments on the cognitive, social, motivational development of the learners, the analysis of alternative teaching concepts or assessments on the situation of geoscience education in various nations.

References

Weinert, F. E. (Ed.). (2014). Leistungsmessungen in Schulen (3. Aufl.). Beltz.

4.11) Geo-scientific methods in Archaeology, Archaeometry and Experimental Archaeology

Klein, Sabine (1); Ferreiro Mählmann, Rafael (2)

1: Deutsche Bergbaumuseum Bochum - Leibniz-Forschungsmuseum für Georessourcen;

2: Technische Universität Darmstadt

*Keynote speaker: Branimir Segvic, Texas Tech University USA
"Investigating material culture (dis)continuities of Iron Age insular communities of Eastern Adriatic at the time of Greek settlement"*

The title of the session is chosen in very general terms to invite all geo-scientist working with geo-materials in archaeology from the smallest artefacts to monuments. Specifically, inter-disciplinary projects between geosciences and archaeology are welcome and focused on physical and chemical properties of rocks and metals. Thus studies in Geophysics, Petrography, Petrology, Mineralogy, Geochemistry and Metallurgy, but also with links to Palaeontology, Stratigraphy or Soil Sciences (specifically related to provenience studies) are highly appreciated.

4.12) Geoethics – fostering ethical perspectives in the Geosciences

Hildebrandt, Dominic (1); Bohle, Martin (2); Zambelli, Bárbara (3)

1: Department of Earth Sciences, ETH Zurich, Switzerland;

2: Ronin Institute for Independent Scholarship, Montclair, USA;

3: TU Bergakademie Freiberg, Germany

*Keynote speaker: Dr. Angélica de Freitas, Belo Horizonte MG, Brazil
"Geoethics and Transgenerational Climate Crimes - holding States and corporations accountable"*

The potential for the Geosciences to make meaningful contributions to great societal issues is immense. Yet, this also implies huge internal challenges for the Geoscience community itself. Geoethics helps to guide these efforts as a conceptual framework dealing with ethical aspects of Geoscience activities. As an expression of critical thinking and taking responsibility Geoethics is fundamental to all kinds of Geoscience subdisciplines, although it may rise different implications depending on the specific context. Often these are intimately linked to peculiarities of our discipline, e.g. its historically male-dominated character, the image of geoscientists in the public as well as a strong focus on field work. These factors may become a barrier for geoscientists' ability to answer societally relevant problems. Therefore, with this session we aim to provide a dynamic environment for discussions and works featuring a critical analysis of 1) geoscience history and its implications, 2) intra-scientific issues such as inequalities and discriminations of all kinds, 3) working methods and their implications for the environment, research objects and local communities, 4) geosciences at the interface with society, politics and other stakeholders as well as 5) geo-communication and geo-education.

4.13) Museen als Fenster in die Forschung

Ifrim, Christina

Staatliche Naturwissenschaftliche Sammlungen Bayerns, Jura-Museum Eichstätt, Germany

Wissenschaftskommunikation ist wichtiger denn je. Naturkundemuseen sind vor allem für die Kommunikation geowissenschaftlicher Themen eine gute Plattform. In dieser Session sollen Projekte und Konzepte vorgestellt werden, in denen direkt aus der Forschung berichtet wird. Die Session soll einen Überblick über existierende Projekte geben und zum Ideenaustausch anregen. Von Wissenschaftler:in bis Museumpädagog:in sind alle eingeladen, Projekte aus ihrem Museum vorzustellen.