Topic 1) Mineralogy in the 21st Century: From Geological Processes to Crystallography and New Materials

1.1 Microstructure and texture analysis of rocks

Ruth Keppler[1], Jolien Linckens[2], Rüdiger Kilian[3], Reiner Kleinschrodt[4]

[1]Bonn University, Germany; [2]Frankfurt University, Germany; [3]Halle University, Germany; [4]Köln University, Germany

Microstructure and texture (CPO) often record the deformation history of rocks, which is usually related to the larger, i.e. tectonic scale history. On one hand, the microstructure of a rock yields information on the deformation mechanisms and processes and e.g. allows for a comparison of deformation in nature and experiments. This in turn leads to a better understanding of the rheology of the Earth's crust and mantle. On the other hand, textures and microstructures determine rock physical properties, such as elastic anisotropies, which are significant for seismic imaging and other geophysical sounding methods.

For CPO analysis different methods like neutron diffraction, synchrotron diffraction or electron backscatter diffraction (EBSD) are employed. EBSD analysis provides spatially indexed data which can be used to derive grain boundary character, phase distribution or other microstructural descriptors such as grain size or shape, which are essential for the determination of deformation mechanisms. Neutron diffraction and synchrotron diffraction on the other hand can benefit from a large analytical volume which in turn often provides good grain statistics or the ability to measure materials unsuitable for EBSD sample preparation.

For this session, we welcome contributions from the entire field of microstructure and CPO investigations and their applications to natural and experimental rock deformation, geomechanical and tectonic modeling, as well as petrophysical property studies.

1.2 Methods in Geochemistry and Mineralogy

Jens Fiebig[1], Clemens Prescher[2], Christian Vollmer[3], Frank Wombacher[4]

[1]Goethe Universität Frankfurt, Germany; [2]Albert-Ludwigs-Universität Freiburg, Germany; [3]Westfälische Wilhelms-Universität Münster, Germany; [4]Universität zu Köln, Germany

Keynote: Thomas Zack, University of Gothenburg

We welcome contributions regarding the development and advancement of methodologies in geochemistry and mineralogy and their application. The session is open to all kinds of analytical, experimental and modeling approaches, including for example mass spectrometry, synchrotron-based material characterization, electron microscopy, spectroscopic methods, ab inito methods and data management.

1.3 Bridging length and time scales in the modelling of geomaterials

Michael Fischer, Andreas Lüttge

Faculty of Geosciences, University of Bremen, Germany

Keynote: Dr. Daniel Tunega, Universität für Bodenkultur Wien

Computational materials modelling plays an increasingly important role in both geosciences and materials sciences. Individual applications often address vastly different length and time scales, from ab-initio molecular dynamics simulations that follow the motion of individual atoms over a few picoseconds via kinetic Monte Carlo calculations with system sizes at the meso scale to finite elements models for large scale systems. This session aims to bring together researchers who employ computational materials modelling methods including, but not limited to, electronic structure methods, force field calculations, kinetic Monte Carlo simulations, and finite element methods. All contributions should fall into the scope of the conference theme "Mineralogy in the 21st Century: From Geological Processes to Crystallography and New Materials". Both the development of new methods and the application of existing techniques to new scientific problems are of interest. Contributions reporting results from combined experimental and computational studies are explicitly welcome.

1.4 Multi-scale, dynamic interactions of minerals with fluids: From the shallow subsurface to the deep Earth

Oliver Plümper[1], Timm John[2]

[1]Department of Earth Sciences, Utrecht University, the Netherlands; [2]Institut für Geologische Wissenschaften, Freie Universität Berlin, Germany

Keynote: Anna Harrison, Géosciences Environnement Toulouse CNRS

Reactions between fluids and minerals have a fundamental impact on many natural and geo-engineering processes within the lithosphere. Examples of natural processes encompass the localization of deformation, earthquake nucleation caused by high pressure fluid pulses, as well as metamorphic reactions and rheological weakening triggered by fluid flow and fluid-mediated mass transport. Moreover, the efficiency of many geo-engineering processes is partly dependent on fluid-rock interactions, such as geothermal energy recovery, CO_2, and hydrogen storage as well as wastewater injection. To fully quantify and determining the operating mechanisms that govern fluid-rock/fluid-mineral interactions within natural and geo-engineered systems we need to take a multi-scale, multi-dimensional approach coupling observations, experiments, and models at the nanometre-scale with observations at larger length scales.

We invite multidisciplinary contributions that investigate fluid-rock/fluid-mineral interactions across the full spectrum of length scales, including natural observations, microstructural and microchemical investigations, experimental approaches as well as numerical models from ab initio to the continuum scale. We particularly encourage studies that take a dynamic approach to fluid-rock/fluid-mineral interactions by using in operando techniques and studies that using machine learning for multi-scale analysis.

1.5 Fundamentals and applied aspects of nucleation and crystal growth

Helen E. King[1], Elena V. Sturm[2], Guntram Jordan[2]

[1]Utrecht University, Netherlands, The; [2]LMU Munich

Keynote: Prof. Dr. Dirk Zahn

Whether geogenic and biogenic minerals, or synthetic and engineered materials, their formation is controlled by nucleation and crystal growth phenomena. For example, solid phase formation from an aqueous solution requires new building blocks to nucleate and subsequently either grow into crystals or agglomerate into aggregates and mesocrystals. Crystallization by addition of particles (ranging from multi-ion complexes to nanocrystals) is now recognized as an alternative phenomenon to classical crystallization by monomer-by-monomer attachment. The ease of these processes and final crystal morphology is frequently dictated by the presence of other minerals,

additives or impurities as well as the physicochemical parameters and hydrodynamics of the solution. It is often observed that metastable phases form initially followed by multiple dissolution-reprecipitation events that drive the system to the most thermodynamically stable mineral phase. Even if the most stable phase does nucleate directly, there may be textural re-equilibrations that occur, which are also governed by dissolution-reprecipitation. Similarly, exposure of biological mineralised tissues to different environments during diagenesis, may lead to chemical and structural alteration of minerals. Within the 21st century, we have made great strides into understanding what controls the ways crystals can nucleate and grow and how minerals finally respond to changes in their chemical and physical environment through dissolution-reprecipitation processes. In this session, we invite theoretical and experimental studies of crystal nucleation and growth. Investigations treating applied aspects of crystallization in engineered or natural systems as well as studies that provide fundamental insights into the thermodynamics and kinetics of these processes are welcome equally.

1.6 Probing (bio)geochemical reactions at mineral interfaces using micro- to nanoscale techniques

Jeffrey Paulo Perez[1], Luis Carlos Colocho Huarte[2]

[1]GFZ German Research Centre for Geosciences, Germany; [2]European Synchrotron Radiation Facility, France

Keynote: Dr. Julie Cosmidis, University of Oxford, UK

Interfacial reactions at mineral surfaces (e.g., dissolution-precipitation, sorption-desorption, etc.) greatly influence several key (bio)geochemical processes including mineral weathering, soil genesis, biomineralization, nutrient and trace element cycling and contaminant dynamics. Recent advancements in solid-state characterization has allowed us to acquire crucial kinetics and mechanistic information on the molecular (bio)geochemical processes taking place at the micro- to nanoscale. This session aims to showcase (bio)geochemical research employing state-of-the-art high-resolution techniques that probe elemental speciation and spatial distribution, chemical bonding environment, structure and composition of (nano)minerals in geo- and environmental matrices. These techniques include, but not limited to, electron microscopy (TEM, SEM), atomic force microscopy, atom probe tomography, vibrational spectroscopy (IR/Raman), secondary mass ion mass spectroscopy (nano-SIMS), synchrotron-based techniques (XRD, XAS, XRF, X-ray scattering, tomography) or a combination of these. We welcome contributions from both laboratory and field-based experiments, as well as computational and theoretical studies.

1.7 Experimental Petrology and Geochemistry

Chris Ballhaus[1], Raúl O.C. Fonseca[2]

[1]University of Cologne, Germany; [2]Ruhr-University Bochum, Germany

Keynote: Dr. Paolo Sossi, SNF Ambizione Fellow, Institute of Geochemistry and Petrology, ETH Zürich, Switzerland

Experimental techniques are now an integral part of petrological and geochemical research. Without experimental modelling, we would find it challenging to understand how magmatic and metamorphic rocks from the Earth's crust form. Without knowledge of high-pressure phase relations, the shell structure of the Earth's interior would be almost impossible interpret, let alone be correlated with geophysical data. Many natural compositions are too complex to be modelled experimentally and thermodynamically. One goal of experimental approaches therefore is to simplify natural systems to a few components without losing the context to natural analogues; ideally to an extent that experiments follow the phase rule. The session invites contributions from all fields of experimental petrology and geochemistry, including phase relations at low and high pressure in simple and complex systems, experiments involving fluid phases at low and high temperature, and all technical aspects of experimental petrology.

1.8 Minerals and Mineral Properties

Maria Wierzbicka-Wieczorek[1], Christian Lengauer[2]

[1]University of Cologne, Germany; [2]Universtiy of Vienna, Austria

This broad session offers the opportunity to show the studies/results on minerals and their properties (structural, physical, chemical, optical) explored by the diverse methods and approaches. We welcome contributions on all aspects of mineralogy, including general and applied mineralogy, industrial mineralogy, analytical mineralogy, environmental mineralogy, biomineralogy, gemmology and extra-terrestrial mineralogy. This session aims also to discuss on new minerals, nomenclature and classification.

Topic 2) Early Evolution of the Earth and the Solar System: Building Habitable Worlds

2.1 Changes of solid Earth´s processes through deep time

Jonas Tusch[1], Elis Hoffmann[2], Mathias Schannor[2]

[1]Universität zu Köln, Germany; [2]Freie Universität Berlin

Keynote: Helen Williams, University of Cambridge - Department of Earth Sciences

Within the first half of Earth’s history, Earth’s major reservoirs (core, mantle, crust, ocean and atmosphere) underwent major coupled changes leading to compositional differentiation and element cycling. In particular geodynamic processes of solid Earth, such as the onset of plate tectonics, the emergence and evolution of continental crust and the appearance of flood basalt provinces, induced coupled changes within the geosphere that provided the framework for early life forms and an oxygenated atmosphere. The interrelationships between the major terrestrial reservoirs and their temporal evolution often remain ambiguous and reveal a complexity that requires interdisciplinary approaches to decipher an overall picture.

For this session we invite a broad range of contributions from radiogenic and stable isotope geochemistry, magmatic and metamorphic petrology, sedimentology, to geophysics and geodynamic modelling that address one or more aspects of ‘System Earth’ during the Precambrian.

2.2 From dust to planets

Mario Fischer-Gödde[1], Ottaviano Rüsch[2], Christian Vollmer[2], Markus Patzek[2]
[1]Universität zu Köln, Germany; [2]Westfälische Wilhelms Universität Münster, Germany
Keynote: Audrey Bouvier

In this session, we welcome contributions from geo-cosmochemical, mineralogical, experimental, geophysical, astronomical, and numerical studies of planetary bodies, moons, meteorites, comets, analogue materials, extrasolar systems, sample return and space craft missions, that have advanced our understanding on the origin and evolution of the solar system.

New findings from different fields of expertise, including studies on presolar dust, chronology and evolution of the solar system, nucleosynthetic heritage of solar system materials, analogue materials, volatile element depletion processes, material transport in the protoplanetary disk, disk photochemistry, meteorites and their components, planetary accretion and differentiation, and dynamical modelling are solicited for this session. We also welcome studies of planetary surface modification processes, such as impact processes, using remote sensing data and numerical or laboratory simulations.

2.3 Uniformitarism of crustal processes

Thomas Müller[1], Matthias Willbold[1], Alexander Webb[2]
[1]Georg-August Universität Göttingen, Germany; [2]The University of Hong Kong, China
Keynote: Emilie Bruand, Université Clermont Auvergne

Crustal processes are the ultimate expression of the major driving forces governing the evolution of the Earth shaping it into a habitable environment, very much in contrast to other terrestrial planets. It is generally agreed that our planet experienced transitions from magma oceans to proto-lithosphere and finally the formation of tectonic plates as we know them today – diverse periods which are documented sparsely in the terrestrial rock record. A first order question is whether these processes can be described using modern geological analouges based on uniformitarian concepts or whether these processes can equally be explained using non-uniformitarian or hybrid models. The crustal rock record provides the best source of knowledge for studying this prevalent question. At the same time, recent technological as well as methodological advances have opened up exciting new avenues to explore this dynamic epoch in geological history. These groundbreaking, quantitative insights into the processes that operated on the Earth are now fundamental to our understanding of the evolution of terrestrial planets as the formation and evolution of the lithosphere are primary factors controlling the evolution of the Earth.

In this session, we would like to bring together different types of information across various disciplines that can be collected on the evolution of terrestrial planets using the Earth as the most accessible planetary object in our solar system. We are looking forward to contributions covering structural geology, geochemistry, petrology, geobiology and geodynamic modelling.

Topic 3) Dynamics of the Deep Earth: From the Core and Mantle to Continents

3.1 Novel isotopic insights into high-temperature geochemical processes

Martijn Klaver[1], Liam Hoare[2], Sebastian Kommescher[2]
[1]Institut für Mineralogie, WWU Münster, Germany; [2]Experimentelle Petrologie und Geochemie, Institut für Geologie, Mineralogie und Geophysik Ruhr-Universität Bochum, Germany
Keynote: Remco Hin, Bayerisches Geoinstitut

The isotopic compositions of “non-traditional” elements offer an exciting addition to the geochemist’s toolbox and have found a rapidly increasing use in the study of a wide range of high-temperature processes. Subtle yet important variations in the isotopic composition of a range of elements result from equilibrium or kinetic isotope fractionation during chemical reactions. As such, “non-traditional isotopes” have provided valuable new insights into planetary differentiation, mantle sources of oceanic basalts, mass transfer in subduction zones, crust formation through time, mineral-melt reactions, degassing, and many other applications.

This session provides a podium for the exciting vistas offered by these new isotopic systems, and we welcome a wide range in contributions that further the use of stable isotope fractionation in high-temperature processes. This includes new applications of novel isotopic systems to tackle major geochemical problems, both from a theoretical framework and through the study of natural samples, and innovative analytical techniques. In addition, we particularly invite studies that aim to rationalise new high-precision isotope data through the quantification of isotopic fractionation factors between minerals, melts, fluids, etc. Such constraints are in ever-increasing demand to utilise these new isotopic systems to their fullest. Studies that constrain isotopic fractionation factors through *ab initio* modelling, experiments, or measurement of natural samples are keenly invited to this session.

3.2 Composition and evolution of deep planetary interiors

Edgar S. Steenstra[1], Lena Noack[2], Martijn Klaver[1], Ilya Kupenko[1]
[1]Institute of Mineralogy, WWU Münster, Germany; [2]Institute of Geological Sciences, Freie Universität Berlin, Germany
Keynote: Julien Siebert, IPGP

The terrestrial planets and asteroids underwent early and extensive chemical differentiation resulting in the formation of a metallic core and silicate mantle and crust. As the mantle and core make up most of the mass of these bodies, it shapes their long-term evolution and present-day surface compositions. Magma ocean differentiation as well as subsequent mantle convection and tectonics drive major elemental cycles that determine the composition of planetary atmospheres and volcanic activity. Core composition determines the extent of planetary core convection and nature of core crystallization, and therefore planetary magnetism and atmospheric evolution. The study of the deep Earth, including ist core, is restricted to indirect methods such as observational and theoretical geophysics, geodynamics, experimental petrology and mineral physics, in addition to geochemical analyses of samples of the mantle such as xenoliths and diamonds.Recent progress in understanding of the deep Earth and other planets therefore requires interdisciplinary and synergetic efforts across the different Earth Science disciplines.

The purpose of this session is to bring scientists together from different fields including planetary differentiation, core formation, geodynamics, geophysics and mantle petrology in an attempt to further understand the physical and chemical processes that shape the

evolution and present state of planetary interiors including that of the Earth. We thus invite contributions from (isotope) geochemistry, geodynamics and geophysics, as well as experimental petrology and mineral physics.

Topic 4) Plate Tectonics and Orogenic Processes

4.1 Magmas and Fluids in the Crust

Philipp A. Brandl[1], Felix S. Genske[2], Christoph Beier[3]

[1]GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel, Germany; [2]Institut für Mineralogie, Westfälische Wilhelms-Universität Münster, Germany; [3]Department of Geosciences and Geography, University of Helsinki, Finland

Keynote: Prof. Alessio Sanfilippo, Department of Earth and Environmental Science - University of Pavia

Mantle convection drives the geological processes from rifting of the continental crust, to spreading and the continuous formation of oceanic crust along mid-ocean ridges, to plate subduction and finally collision and orogeny. The partial melting of the Earth's upper mantle is a common driver to the magmatic processes operating in both the continental and oceanic crust. Mantle dynamics and magmatism thus shape the Earth's surface and control the long-term geochemical cycles. The heat associated with oceanic and continental magmatism drives hydrothermal activity and the exchange of heat and elements between the Earth's interior, oceans and atmosphere. However, where melts ascend and ultimately erupt or where fluids circulate is strongly controlled by the crustal architecture, i.e., thickness, permeability and porosity, and tectonic environment. Plate tectonic parameters such as the rate of continental rifting and oceanic spreading or mid-ocean ridge segmentation, for example, result in temporal and spatial changes of magma composition. Recent studies have emphasized the important role of crustal controls on magmatism and hydrothermal activity, e.g., in intraplate settings, at transform faults or arc-backarc settings.

This session aims to bring together contributions from different fields including geochemistry, tectonics, geophysics, and hydrothermal research to trace crustal pathways and the initial formation and evolution of magmas and fluids while they travel through the crust. Studies that combine observations on the modern seafloor with crustal analogues exposed on land (e.g., ophiolites) are particularly welcome.

4.5 Advances in Geochronology: From present techniques to future applications

Aratz Beranoaguirre[1,2], Leo J. Millonig[2], Richard Albert[2]

[1]Karlsruher Institut für Technologie, Germany; [2]FIERCE (Frankfurt Isotope & Element Research Center), Goethe Universität, Frankfurt am Main, Germany

Keynote: Marcel Guillong, ETH Zürich

Recent advances in geochronology and the application of non-traditional geochronometers have unlocked a wealth of research opportunities in the earth sciences. These developments provide powerful tools that can constrain the ages, rates and durations of fundamental geological processes and phenomena, which were not well understood (or deciphered?) until a few years ago.

We invite contributions that describe new developments in the field of geochronology, such as advances in analytical techniques, novel applications that integrate geological information with geochronological data, and studies that highlight geochronological needs and possible future research directions.

4.6 The role of fluids in metamorphic and metasomatic reactions

Dominik Sorger[1], Phillip Gopon[2], Bastian Joachim-Mrosko[3]

[1]Geoscience Center, Georg-August-University Göttingen, Germany; [2]Lehrstuhl für Geologie und Lagerstättenlehre, Montanuniversität Leoben, Austria; [3]Institute of Mineralogy and Petrography, University of Innsbruck, Austria

Keynote: Simon Schorn, NAWI Graz Geocenter, University of Graz (Austria)

The fundamental role of fluids in metamorphic and metasomatic reactions has only been recognized in the past decades. The abundance and composition of metamorphic/ metasomatic fluids have been shown to control phase stabilities, reaction kinetics, and thus the resultant mineral assemblages and textures of metamorphic/ metasomatic rocks. They are also not only important drivers for metamorphic reactions, but they can also mobilize, transport, and enrich elements in the crust; leading to the formation of hydrothermal ore deposits.

This session aims to highlight new research that is contributing to our understanding of the role of fluids in metamorphic and metasomatic reaction. We especially seek work from laboratory experiments and/or natural samples that illuminate this important topic from a range of different perspectives and a range of different scales (km-nm).

4.7 Deciphering orogenic processes: Combining metamorphism, anatexis, metasomatism and geochronology

Valby van Schijndel, Alessia Borghini

University of Potsdam, Germany

Plate tectonics is an important process responsible for shaping our planet and in particular for the formation of orogenic belts, elements cycling and interaction between the Earth surface and its interior. The formation of mountain chains is the result of plate tectonics plus processes such as metamorphism, anatexis, fluid-rock interaction (i.e., metasomatism) that contributed to crustal differentiation and mantle heterogeneity. Hence the study of these processes combined with geochronology in strategic localities provide insights for the evolution of our planet.

Mineral assemblages and inclusions are important record keepers of chemical reactions in response to changing conditions and can be used to explain a variety of crustal-scale petrologic and tectonic processes as well as the timing of these reactions.

This session will focus on the application and development of state-of-the-art analytical methods and experimental approaches in the combined fields of geochemistry, petrology, tectonics and geochronology by investigating metamorphism, anatexis, metasomatism, geochronology and thermodynamic modelling at mineral-scale.

We invite contributions using multi-disciplinary and innovative studies to investigate metamorphic processes in different rock types, their geochronological constraints, exhumation mechanisms, the nature of melts and metamorphic fluids, fluid-rock interaction at depth, transport and transfer of elements, and trace element behaviour in these settings. We welcome investigations based on but not limited to geochemical, geochronological, petrological and/or modelling techniques on natural rocks, minerals or laboratory and numerical experiments.

4.8 Tectonic Systems (TSK Open Session)

Kathrin Faßmer[1], Thorsten Nagel[2], Michael Stipp[3], Nikolaus Froitzheim[4], Kamil Ustaszewski[5]
[1]Universität Innsbruck; [2]Universität Aarhus; [3]Universität Halle; [4]Universität Bonn; [5]Universität Jena

We invite contributions from the fields of tectonics, structural geology, and crystalline geology. Both regional as well as process-oriented studies from all kinds of active or fossil tectonic settings are welcome – rifting, ocean spreading, subduction, collision, transform, as well as intra-plate deformation. Studies dealing with the development of methods related to the deformation of crust and lithosphere from the micro-scale to plate scale are also invited.

Topic 5) The Earth System and Global Change

5.1 The co-evolution of Earth's atmosphere, oceans, and life from the early Archean until today

Sebastian Viehmann[1], Simon V. Hohl[2], Florian Kurzweil[3], Sümeyya Eroglu[4]
[1]Universität Wien, Austria; [2]Tongji University Shanghai, China; [3]Universität zu Köln, Germany; [4]Westfälische Wilhelms-Universität Münster, Germany

Keynote: Johanna Marin-Carbonne

The evolution of the atmosphere-hydrosphere system through Earth's history repeatedly transformed the environmental conditions on Earth's landmasses and oceans, creating various habitats for life. However, the physico-chemical conditions prevailing in paleo-environments, the timing of environmental changes, and the impact of continental weathering on the chemical composition of the oceans and sediments are still incompletely understood. An important requirement for the reconstruction of paleo-environmental conditions is a holistic understanding of key processes in modern environments such as weathering, hydrothermal alteration of the oceanic crust, bacterial activity, sedimentation or diagenesis.

With this session, we encourage contributions from the interdisciplinary fields of low-temperature geochemistry, oceanography, sedimentology, and geo(micro)biology with the aim to understand modern and ancient aquatic and sedimentary environments. This includes the reconstruction of redox-changes, the cycling of elements and their isotopes in aquatic and sedimentary environments, the evolution of early life habitats, and paleobiology during critical intervals of environmental and climatic changes.

5.2 The imprint of astronomical climate forcing: Geochronometer and paleoclimate archives

Stefanie Kaboth-Bahr[1], Christian Zeeden[2], David De Vleeschouwer[3], Arne Ulfers[2]
[1]University of Potsdam, Potsdam, Germany; [2]Leibniz Institute for Applied Geophysics, Hannover, Germany; [3]University of Münster, Münster, Germany

The pacing of the global climate system by astronomical insolation forcing is clearly demonstrated in the timing and specific patterns recorded in various geoarchives. Examples of astronomically paced climate change include rhythmically-bedded limestone-marl alternations and sapropels, glacial/interglacial cycles, carbon cycle modulations, and many more examples. The imprint of astronomical cycles can be used as high-precision geochronometer, and as paleoclimate information. Extreme events can especially be expected to relate to extremes in insolation. We invite contributions utilizing the imprint of Milankovic cycles as preserved in the geologic record in any way, including the often poorly understood mechanisms that translate this forcing into geoarchives. Submissions exploring orbital time scales, proxy data and/or modelling work are welcome; we aim to bring together studies focused on global and regional climate responses to astronomical forcing at different time scales.

5.3 Warm climates in Earth History as a future analogue

Jacek Raddatz[1], Iuliana Vasiliev[2]
[1]Goethe-Universität Frankfurt, Institut für Geowissenschaften, Germany; [2]Senckenberg Biodiversity and Climate Research Centre, Frankfurt am Main, Germany

By the end of this century the atmospheric concentration of CO_2 will reach levels not existent on Earth for millions of years, with severe consequences for humankind. One strategy to improve our understanding of the subsequent changing Earth's system and climate processes is to analyse periods in Earth history that have experienced such high levels of pCO_2. In this session we aim to bring together paleoclimatic and paleoceanographic reconstructions of both prolonged and transient past warm periods. While the short-term records will provide examples of rapid and abrupt environmental changes similarly to the predicted future changes under increasing CO_2, the long-term records may offer answers on how system Earth copes with such changes. In particular, we invite contribution that focus on periods of the last 145 Myr with the target to compare sea vs. land paleoclimatic and paleoenvironmental changes. We also encourage contribution from modelling studies, bridging the gap towards integrating the proxy records from extremely warm settings.

5.4 Palaeomagnetic and rock magnetic approaches applied to sedimentary sequences - dating and environmental reconstructions

Stephanie Scheidt[1], Christian Zeeden[2], Mehrdad Sardar Abadi[2], Christian Laag[3]
[1]University of Cologne, Institute of Geology and Mineralogy, Cologne, Germany; [2]Leibniz Institute for Applied Geophysics, Rock Physics & Borehole Geophysics, Hannover, Germany; [3]Université de Paris, Institut de Physique du Globe de Paris, CNRS, Paris, France

Keynote: Dr. Ramon Egli, ZAMPG Vienna (Austria)

Sediments can record the direction and relative intensity of the Earth's magnetic field. The determination of these magnetic properties therefore makes it possible to correlate sequences with each other and to constrain the age of the deposits. In addition, the presence or absence of magnetic minerals in sediments, as well as their composition, condition and orientation, can provide information about supply areas, depositional processes, and environmental conditions during genesis and diagenesis. This session offers the opportunity for contributions that fall within the broad topic area of palaeomagnetism, rock and environmental magnetism of sedimentary sequences from marine, limnic and terrestrial depositional environments. The session invites case studies, but also studies showcasing new theoretical approaches and measurement techniques, which for example have impacts on the understanding of sediment distribution and deposition processes, remanence acquisition, or the evolution of past climates and environments.

5.5 Deciphering past climates and biogeochemical cycles with geochemical proxy archives

Michael James Henehan[1], David Evans[2,3], Marjorie Dianne Cantine[2,3], Michael Tatzel[4]

[1]Section 3.3 Earth Surface Geochemistry, Deutsches GeoForschungsZentrum GFZ, Potsdam, Germany.; [2]Institut für Geowissenschaften, Goethe-Universität Frankfurt, Frankfurt am Main, Germany; [3]Frankfurt Isotope and Element Research Center (FIERCE), Goethe-Universität Frankfurt, Frankfurt am Main, Germany; [4]Universität Göttingen, Geowissenschaftliches Zentrum, Göttingen, Germany

The geological record offers a wealth of empirical examples of how our planet responds to diverse drivers such as greenhouse gas input, evolutionary innovations, and even extra-terrestrial impact. Our challenge as geoscientists is to extract useful insights from the rock and fossil record of these events. Geochemical proxies applied to the geological record have already allowed us to learn a great deal about our planet, and provide key quantitative constraints needed to ground process-based modelling investigations. New technological and theoretical advances mean that the array and potential of such tools, and range of questions they can be applied to, is growing at a pace. This session aims to bring together those developing and using geochemical tools (e.g. traditional and non-traditional stable isotopes, trace element compositions) to reconstruct the climates, (bio)geochemical cycles, and ecosystems of the past to showcase and discuss new innovations, new applications, new interpretations and, perhaps, new problems. We are keen to foster cross-fertilisation of ideas and techniques across geological timescales and sub-disciplines, and encourage participation across the broad spectrum of geochemistry, from modern proxy calibration to deep-time applications, and from terrestrial and marine realms.

5.6 Natural archives as recorders of past climate and environmental conditions – processes, methods and applications

Raphael Gromig[1], Sonja Berg[2], Niklas Leicher[2]

[1]Simon Fraser University, Canada; [2]University of Cologne, Germany

Keynote: Dr. Alexander Francke, The University of Adelaide, Australia

Studying the climate of the past is crucial to understand the climate of today and to predict the climate of the future. Disentangling naturally occurring variations of past climate and environmental conditions from man-made influences as well as non-climate related geological processes displays a major challenge. Since historical sources about changing climate conditions only reach back several hundred years we have to rely on natural archives, such as sediments from rivers, lakes and oceans, loess deposits, speleothems, corals and tree rings amongst others in order to gain a better understanding of the climate in the past. A key prerequisite for paleoclimate studies on these archives is a reliable age control to allow interpretations in a chronological framework and to integrate the data into a regional and global context.

Archives suitable for paleoclimate reconstructions have in common that they react sensitively towards climate changes such as shifts in temperature and precipitation by adjusting their sedimentation rate and composition, chemical composition or growth patterns or even by ceasing to exist. However, they can differ significantly in their temporal range and resolution and their existence can be bound to certain geological features such as caves or tectonic depressions, limiting their regional occurrence. These limitations make it crucial to investigate records covering all time spans and regions in order to get a comprehensive understanding of past climate and environmental conditions.

We invite speakers from all disciplines to present paleoclimate studies based on all natural archives, including records from high to low latitudes and independent of the time span and temporal resolution.

5.7 Applications in 3D Geological Modelling

Rouwen Lehné[1], Jennifer Ziesch[2]

[1]Hessian Agency for Nature Conservation, Environment and Geology - HLNUG/FGI-DGGV, Germany; [2]State Authority for Mining, Energy and Geology - LBEG, Germany

Over the last decades, 3D geological modelling has become a standard in hydrocarbon exploration and production, has been adopted and is developing towards a systematic effort by geological surveys, and is on the verge of being able to properly handle the structurally complex settings in which the mining sector operates. New, exciting possibilities are arising and new application domains are opening up, which challenges geomodellers to integrate data and methods from different domains (e.g. remote-sensed and subsurface data), and to deliver integrated content (e.g. urban underground infrastructure and geology). One of the biggest challenges is the construction of consistent complex 3D models based on the evaluation and processing of input data from structural/geological maps, wells, and geophysical data. In this process, several hurdles must be overcome, i.e., developing standards, harmonization, integration of data, storing and sharing content in a structured manner, and developing services. In the process challenges are manifold, and so are the solutions.

We solicit novel and illuminating abstracts from the wide field of geological 3D-modelling and associated topics such as data modelling & data storage and sharing systems. We especially encourage the younger generation to present.

Topic 6) Earth Surface Processes and Sedimentology

6.1 Earth surface processes in extremely water-limited environments

Benedikt Ritter[1], Janek Walk[2], Christine Heim[1], Jean Braun[3]

[1]Universität zu Köln, Germany; [2]RWTH Aachen Universität, Germany; [3]GFZ Potsdam, Germany

Water is the defining feature of the habitable Earth; it is essential for all life as we know it. Earth surface processes are crucially dependent on the availability of water: the absence of which in any state (solid, liquid, vapour) largely reduces the variety of Earth surface processes to aeolian activity, tectonic and magmatic forcing, and extra-terrestrial impacts. It is evident that transient episodes of increased water availability leave long-lasting traces in extremely water-limited environments by, e.g., fluvial erosion and deposition, pedogenic and microbial crusts, authigenic mineral formation, and weathering. In contrast, some Earth surface processes are still active under hyper-aridity, sourced primarily by fog or dew, e.g., crusts, cementations, or mineral phase transitions. In such environments, abiotic processes will inevitably dominate. With increasing water availability biological processes become increasingly important, eventually dominating soil-forming processes and modulating geomorphic evolution. Investigating geo-biological processes across this transition holds the potential to characterize the mutual dependency of life and Earth surface evolution.

Earth surface process and their interactions in fully arid to hyper-arid environments are poorly understood compared to their semi-arid and temperate counterparts. Key questions of this session therefore encompass the interdisciplinary and broad research on abiotic and biotic processes, the archives they are preserved in, their spatial and temporal variability, modelling over recent to long-term geological timescales, magnitudes, and mutual interactions under extreme water limitation. We welcome contributions from the fields of sedimentology, geochemistry and mineralogy, geobiology, earth-surface processes and modelling.

6.2 Rates and Dates of Earth Surface processes: Methods & Applications

Hella Wittmann[1], Tibor Dunai[2], Tony Reimann[2], Mirjam Schaller[3]

[1]GeoForschungsZentrum GFZ Potsdam, Germany; [2]Universität zu Köln, Germany; [3]Universität Tübingen, Germany

Keynote: Darryl Granger

The processes that shape our Earth´s surface are versatile and dynamic, cover wide-ranging spatio-temporal scales and are often characterized by complex feedbacks between geomorphology, hydrology and biogeochemistry. To address this complexity, the development of geochemical and geochronological methods has seen an exciting growth in the past two decades. Amongst them, cosmogenic nuclides have become an indispensable tool in geomorphology for the reconstructing of “dates”, but also in deciphering the feedbacks between e.g. tectonics and climate by constraining “rates” of erosion, sediment transport, and weathering. Even more so, they allow wide ranging applications from archeology to paleoseismology, to study the evolution of the Earth´s surface. A similarly exciting growth has been seen in the development of other geochronological methods such as luminescence and thermochronology techniques, whose capabilities to decipher Earth surface changes are currently pioneered (e.g. OSL thermochronology, OSL rock surface dating) and potential applications in geoscience and archaeology will undoubtedly continue to grow in the future.

To address these fundamental developments, we invite contributions from a wide range in techniques across disciplines, such as, but not limited to: i) (multiple, in-situ, meteoric) cosmogenic nuclides, ii) geochronology (e.g. luminescence, (U-Th)/He), radiocarbon), iii) thermochronology and iv) geochemistry, that quantify dates and rates of landscape change over any temporal or spatial scale. Observational, laboratory- and/or modeling-based studies are welcome from any stage of the career, but early-career contributions are explicitly welcomed.

6.3 Fractionation of metal(loid) stable isotopes during low-temperature Earth surface processes

David Uhlig[1], Maria Chapela Lara[2]

[1]Forschungszentrum Jülich GmbH, Germany; [2]GFZ German Research Centre for Geosciences, Germany

Keynote: Prof. Dr. Philip Pogge, Johannes Gutenberg-Universität Mainz, Institut für Geowissenschaften, AG Sedimentgeochemie

The thin, dynamic, and habitable skin of Earth's surface is shaped by the interaction of gas, water, rock, and biota. Chemical weathering is at the core of these interactions. It drives soil formation by transforming rock into soil, and transfers metal(loid) elements from solids into solutes. Before being exported by streams into the oceans, these solutes are cycled through biological and/or geochemical processes. Biological processes include not only the uptake, within-plant translocation, and recycling of mineral nutrients, but also biological weathering, induced either by roots or microorganisms. Geochemical processes include mineral dissolution, secondary mineral formation, mineralogical transformations, and adsorption-desorption. Beyond that, inorganic and microbially mediated redox reactions also determine the fate of metal(loid)s at Earth’s surface. During all these complex biological and geochemical interactions, metal(loid) elements are re-distributed between the compartments of the Earth’s surface, leaving behind isotopic fingerprints that represent powerful tools for tracing and quantifying (bio)geochemical processes and transport pathways.

For this session, we invite field, experimental, modelling, and conceptual studies that use metal(loid) stable isotopes to trace and quantify (bio)geochemical processes at the Earth’s surface and across different spatial (laboratory, weathering profile, catchment, landscape, ecosystem) and temporal scales (neo and paleo records). We also welcome contributions that broaden our understanding of the underlying mechanisms and extent of isotope fractionation during low-temperature Earth surface processes.

6.4 Landslides – detecting, monitoring, modeling, assessing hazards, and coping with risks

Jewgenij Torizin, Thomas Lege, Dirk Balzer, Nick Schüßler

Bundesanstalt für Geowissenschaften und Rohstoffe, Germany

Ongoing climate change affects existing weather patterns by influencing the intensity, frequency, and timing of weather extremes and bringing them to regions where those conditions were exceptionally rare or even unknown. Consequently, such unprecedented weather extremes and associated geohazards seriously threaten infrastructure and human lives. In particular, near-surface processes such as gravitational mass movements (landslides) are inevitably associated with extreme rainfalls, among other triggering factors. The need for practical approaches for landslide hazard and risk assessment under changing climatic conditions is higher than ever.

This session should cover essential areas of landslide hazard and risk assessment such as detection and monitoring by innovative remote sensing techniques, modeling of landslide processes at different scales, and provide an outlook on the practical implementation of hazard and risk assessment in spatial planning.

Therefore, we highly encourage contributions to the following topics:

- Earth observation (EO) for landslide detection and monitoring (applications of EO in combination with machine learning are highly appreciated);

- Reports on landslides triggered by exceptionally high rainfall;

- Case studies and tools dealing with heuristic, data-driven, and physically-based methods for landslide susceptibility and hazard assessment and, in particular, considering uncertainties in those assessments;

- Bridging the gap between fundamental research and practical applications (e.g., early warning systems, implementation of research outcomes in spatial planning, etc.).

Topic 7) Keys to Biosphere Dynamics: Geobiology and Paleontology

7.1 Geo-Biosphere interactions through space and time: new analytical and experimental approaches to the fossil record

Fabian Gäb[1], Moritz Liesegang[2]
[1]Universität Bonn, Germany; [2]Freie Universität Berlin, Germany

Interdisciplinary investigations on the limits of the fossil record have filled knowledge gaps over the last years. Yet, the characteristics and impact of silica, carbonate and phosphate authigenesis overprinting the primary biological signals remains mostly unclear, which fundamentally limits our understanding of the history of life on earth. Additionally, the impact of diagenetic fluids, precursor compositions and the microbial fauna and activity on mineralization in marine and terrestrial environments remains enigmatic. Highly resolving analytical methods, such as NanoSIMS, MALDI-ToF-MS, µ-Raman Spectroscopy, FTIR, and synchrotron-based imaging offer new insights about the temporal and spatial variability of mineral replacement reactions and mineral-organic matter interaction. These analytical methods provide evidence for the fundamental importance of micro- and nanoscale processes in fossilization pathways. Bringing together these different and novel approaches should lead to synergetic effects that will further our understanding of fossilization processes as a whole.

For this session we welcome process-oriented studies that investigate the interplay between the biological and mineralogical world either experimentally or analytically. This session intends to provide a platform for researchers from all relevant fields, e.g., microbiology, paleontology, mineralogy and geochemistry.

7.2 Living Earth – geobiological and paleontological perspectives on an evolving planet

Jan-Peter Duda[1], Christine Heim[2], Helge Mißbach-Karmrodt[2], Manuel Reinhardt[3]
[1]University of Tuebingen, Germany; [2]University of Cologne, Germany; [3]University of Goettingen, Germany

Keynote: Prof. Karim Benzerara, CNRS Paris, France

Ever since life emerged, the Earth has been shaped by continuous interactions between the biosphere and geosphere. Fascinated by the intimate relationship between living and non-living matter on our planet, and seeking to understand how our modern world came into being, we invite contributions that explore (micro)organisms and their habitats through deep time and space. Attempting to understand the past and looking into the future, we also encourage presentations that elucidate complex bio-geo interactions at play in modern environments. We welcome geobiological studies that employ approaches from various disciplines (e.g., sedimentology, paleontology, geomicrobiology, geochemistry), including innovative state-of-the-art analytical techniques, experimental work or modelling.

Die Session ist mit dem DFG SPP 1833 "Building a Habitable Earth" verknüpft.

7.3 Assessment of the Earth System through Micropaleontology

Patrick Grunert[1], Jassin Petersen[1], Martin Langer[2]
[1]University of Cologne, Germany; [2]University of Bonn, Germany

Keynote: Nicolaas Glock, University of Hamburg, Institute of Geology

The study of microfossils has a fundamental role in a wide range of fields of research by addressing key-aspects of the Earth System. Traditionally applied for stratigraphic correlation, microfossils serve as primary markers in bio- and sequence stratigraphy and as archives for isotope stratigraphy. Recent decades have seen a rapidly growing understanding of the diversity and biology of the microfossil-producing organismic groups throughout Earth's history. In parallel, the pivotal roles of their diverse metabolic and biomineralization pathways for biogeochemical cycling as well as for the determination of a shell's geochemical signature have been recognized. Most recent developments show an expansion of applied micropaleontology to the assessment of sea-level change and ecological quality. Micropaleontology has thus established itself as a vital contributor of studies on paleoecology, paleoclimatology, paleoceanography, micro- and macroevolution, and transformations of the Earth System in the Anthropocene.

With this session, we provide a platform for the interdisciplinary exchange amongst researchers working on timely microfossil-based research topics. Contributions from all fields of micropaleontology are welcome, including (but not limited to!) proxy-based studies of the Earth System, paleobiodiversity, phylogeny, evolutionary processes, biomineralization, actualistic fieldwork, and innovative method development. We particularly encourage young researchers to present their work in this session.

Topic 8) The Human Footprint: Applied and Environmental Geosciences & Archeometry

8.1 Geosciences and Waste Management

Daniel Vollprecht[1], Guido Deissmann[2]
[1]Montanuniversität Leoben, Austria; [2]Forschungszentrum Jülich GmbH, Germany

Keynote: Prof. Sieger van der Laan, Eindhoven University of Technology

Geosciences and waste management get in touch when end-of-life materials interact with the environment during their treatment, recycling or disposal. Mineral wastes & by-products (e.g. slags, ashes, C&D wastes, excavated materials) represent the largest stream of secondary raw materials and their interaction with aqueous solutions determines their recyclability, which might be enhanced by tailoring their mineralogical properties during production. Furthermore, the utilisation of these materials for the production of geopolymers might allow to produce CO_2-saving inorganic binders.

Radioactive wastes are highly challenging with respect to their safe and sustainable treatment and disposal, and the search for appropriate sites for deep geological repositories requires comprehensive knowledge from geosciences and material sciences. The long-term behaviour of waste forms in the repository environment and the interaction of radionuclides with (geo)materials in the multibarrier system play key roles in the evaluation of corresponding disposal concepts and are associated with fundamental geochemical challenges.

Landfilled wastes may have contaminated soil and water, but can also be considered as secondary resources for material and energy recovery. Geophysics provide powerful tools in this context, e.g. for the risk assessment of contaminated sites and the estimation of the resource potential in landfill mining but also for the exploration of suitable sites for geological disposal facilities for radioactive wastes.

This session addresses geoscientific contributions related to mineral & radioactive wastes, ranging from environmental studies and resource-oriented approaches to waste form performance, migration of contaminants (incl. reactive transport modelling and risk assessment/performance assessment) to site characterization for nuclear waste repositories.

8.2 Engineering Geology Challenges in the 21st Century

Christoph Butscher[1], Kathrin Menberg[2]
[1]TU Bergakademie Freiberg, Germany; [2]Karlsruhe Institute of Technology (KIT), Germany
Keynote: Florian Wellmann, RWTH Aachen

Engineering geology is an important discipline in the geosciences, for example when it comes to geotechnical construction projects and the assessment of geohazards, such as landslides. Engineering geologists carry out exploratory work, determine geotechnical parameters and their distribution in the subsurface, and use the findings to assess the geological situation for construction projects or other applications. They document subsoil conditions, create subsoil models and advise engineers on construction planning and execution. Social, legal, technical and climatic developments confront engineering geologists with new challenges, but also bring up new fields of application. Engineering geology research and development is responding to this with new, innovative investigation and evaluation methods as well as digital techniques.

This session invites contributions from all areas of engineering geology that present new, innovative methods and/or areas of application. Presentations may include basic research, applications, and case studies. Contributions that address recent trends and developments and their application to current 21st century challenges are especially welcome. These may include structures and technologies that respond to climate change, such as in flood control or geothermal energy, or digital approaches for documentation and design, such as Building Information Modeling (BIM) in geotechnical engineering. By bringing together research results and practical examples from different fields of engineering geology, this session aims to stimulate scientific exchange and innovation in engineering geology to bring our knowledge up to the very latest level.

8.3 Archaeometry - tracing the past human footprint with geosciences

Andreas Kronz[1], Katrin Julia Westner[2], Sabine Klein[3]
[1]Universität Göttingen; [2]ENS de Lyon; [3]Deutsches Bergbau-Museum Bochum

Keynote: Thilo Rehren, The Cyprus Institute

Archaeometry is a multi-disciplinary science-based approach to the study of the human past. Within this discipline, earth sciences play a key role addressing research questions representing the full thematic range of the subject. Methods initially applied for research in geochemistry and biogeology such as radiogenic and stable isotope systems and trace element patterns now are essential tools for numerous questions in archaeometry and material-based archaeology. Close thematic links to geosciences exist for several aspects, e.g. the provenance of raw materials, development of the global climate, and man-made materials, like glass, ceramics and metals and their impact on human activities. The specific questions in archaeometric research and requirements of the precious and often unique material studied stimulates innovation in sampling and analytical techniques. On-site microsampling and in-situ and (ultra) trace methods are more and more widely used, but may generate novel challenges, concerning both analytical aspects and the sampling policies for cultural heritage material. As in all natural and human science disciplines, open-source data repositories meeting modern criteria become increasingly important. The enormous amount of sampled and stored material from previous studies, and the huge number of acquired research data and results produced to date, has to be made FAIR (findable, accessible, reusable, interoperable). Due to the interdisciplinary nature of archaeometry, this will certainly be one of the most pressing and challenging tasks in the years and decades to come. We would like to encourage all scientists who contribute with their research to the mentioned topics to participate in this session.

8.4 Post-mining: Opportunities and challenges

Dennis Quandt[1], Tobias Rudolph[2], Christoph Hilgers[1]
[1]Karlsruhe Institute of Technology, Germany; [2]Technische Hochschule Georg Agricola, Germany

The closure of mines and the cease of production of raw materials in Germany influences entire regions from a technical as well as societal perspective. These technical and geoscientific changes require an integrated geomonitoring. This concerns in particular the mine water management in the former hard coal mines as pumping of mine water in the abandoned mines is technically not necessary anymore. As a result of the controlled mine water rebound, fluid pore pressures in subsurface rocks increase and may alter the stress state of the subsurface rocks. The increased pore pressures may result in geomechanical changes in the deeper subsurface below the mine. This may result in ground movements and micro-seismic events, which may be measured on the surface. Post-mining also provides an opportunity for post-usage, such as new natural (geo)heritage sites or geothermal energy. Thus, centuries-long active mining produced a wealth of geological, geodetic, geophysical, and geomechanical data. Based on such multidisciplinary data, interdisciplinary geological models and technical solutions can be developed and applied to different mining areas worldwide where active mining has been closed. This session invites contributions from different scientific disciplines that study the processes that undergo in post-mining areas in Germany and globally. Among others, this may include geology investigating sediment or rock properties and structures on different scales, geophysics detecting fluid-induced micro-seismic events and studying stress fields, and geomonitoring of ground movements or gas emissions. Studies may address strategies to optimize reservoir management and/or to improve land rehabilitation above and below ground.

Topic 9) Energy, Materials, Resources

9.1 Dynamics of ore-forming processes: constraining mechanisms of metal enrichment

Maximilian Korges[1], Julie Michaud[2], Jia Chang[3], Philipp Weis[4]
[1]University of Potsdam, Germany; [2]University of Hannover, Germany; [3]University of Bayreuth, Germany; [4]Helmholtz Centre Potsdam (GFZ), Germany

Keynote: Zoltan Zajacz, University of Geneva

Metals and metalloids are essential ingredients for the technological transition to a green-energy, low-carbon-based society in the future. The rising global demand for these elements cannot be met by recycling alone and requires discoveries of economic ore bodies. Successful exploration for hidden deposits depends fundamentally on the understanding of ore-forming processes in which economically

valuable elements have been enriched by orders of magnitude from trace element concentrations in normal crustal or mantle rocks to ore grades. The controlling mechanisms of element mobilization, transport, deposition, and re-distribution in a variety of geological environments (e.g., magmatic, hydrothermal, supergene) depend on favorable conjunction of many geological, hydrological, chemical, and physical factors. Field-based studies, laboratory experiments, and computer simulations can provide invaluable insights into the mineralizing processes on a variety of scales, both in time and space. This session aims to bring researchers from various disciplines together to present recent progress made towards deciphering the inherent complexity of ore formation. We also invite contributions that use a multidisciplinary approach and/or present novel and advanced experimental, analytical, or numerical methods.

9.2 Energy and technology critical raw materials: from genesis to processing

Jochen Kolb[1], Mathias Burisch[2], Torsten Graupner[3]

[1]Karlsruher Institut für Technologie, Germany; [2]TU Bergakademie Freiberg, Germany; [3]Bundesanstalt für Geowissenschaften und Rohstoffe, Germany

Keynote: Jens Gutzmer

In the light of the global population growth, the global progression in living-standards and the transition from fossil fuels towards more climate and environmentally friendly technologies, the supply of raw materials is expected to be one of the key challenges of our society. This is particularly relevant for commodities such as Cu, Li, Ni, Mn, Co, Cr, Mo, Zn, Ge, In, Ta, REE, PGE and graphite, which are often referred to as energy and technology critical raw materials (ETCR). Although some metals are efficiently recycled from scrap, our economy will continue to depend on primary resources, since the increasing demand for raw materials will not allow to fully rely on secondary resources in the future.

For many of the ETCRs, the mineralogy and distribution in primary ore materials as well as the processes that result in their localized enrichment on the deposit, district and crustal scale are often still insufficiently constrained. This represents a major gap of knowledge for the development of mineral exploration strategies to secure the supply of raw materials in the future. Furthermore, efficient extraction of ECTRs is notoriously challenging as those often occur in complex ore material (i.e., mineralogy, small grain-size and/or low concentration) and hence require innovative processing technologies.

In this session, we invite contributions that use analysis of natural rocks, experiments and/or numerical models in order to improve our geological understanding of ETCRs - ranging from the genesis of ore deposits to the development of processing technologies.

9.3 European Raw Materials / P³ - potential, prosperity, and participation - for responsible sourcing in Europe

Antje Wittenberg, Henrike Sievers

BGR, Germany

Raw Materials are crucial components of a resilient and sustainable economy and society. A sustainable supply of primary raw materials needs accessible mineral deposits and efficiently productive mines. Competing land-use issues, social and environmental challenges, declining ore grades, resource nationalism are just a few aspects, which seems to make it increasingly challenging to secure supplies. The realisation of a low-carbon society and new technologies – especially in the light of the EU's "Green Deal" – change future raw material needs and set a focus in so-called critical raw materials.

Although Europe has a long history in mining, it is still widely underexplored in particular with modern exploration methods. A good understanding of mineral systems, mining sites and remaining resources of historical sites will stay of utmost importance.

This session thus invites contributions focussing on European mineral deposits and exploration and mining activities that indicate a socio-economic importance to the German / European society in particular.

9.4 Chemical sediments and mineral deposits in basins: archives of paleoclimatic, hydrogenetic, biogenic, hydrothermal, and diagenetic, processes throughout Earth's history

Thomas Angerer[1], Grit Steinhöfel[2], Phillip Rieger[3], Leanne Schmitt[4], Thomas Kirnbauer[4]

[1]University of Bonn; [2]Alfred-Wegener-Institut; [3]iCrag-Centre; [4]Technische Hochschule Georg Agricola

Keynote: Dr. Joe Magnall, GFZ

Sedimentary basins record processes in Earth's atmosphere, hydrosphere, and lithosphere, in both time and space, and they host important mineral deposits providing a significant amount of steel, base, precious, and critical metals, as well as industrial minerals. Therefore, studying sedimentary basins has significant societal benefit, both in understanding past and present changes in the Earth system, and in refining ore formation models that support mineral exploration. Chemical sediments and ores (e.g., chert, BIF, Fe-Mn (hydr-) oxides, base metal sulfides, sulfates, phosphates, etc.) preserve mineralogical and geochemical signatures of climatic, biogenic, hydrogenetic, hydrothermal, seafloor alteration, and diagenetic processes. However, full appreciation of this complexity is often limited by restricted research objectives. This session will bring together researchers working on marine (bio-)geochemical cycles, paleo-reconstructions, mineral deposits, and diagenetic processes to inspire interdisciplinary research. A holistic view will improve our understanding of processes, controls, fluxes and preservation of paleo-signatures across spatial scales (mineral to basin) and temporal scales associated with the formation of chemical sediments and mineral deposits in sedimentary basins. For this session, we invite presentations considering geological, mineralogical and/or biogeochemical aspects to decipher the formation of modern and ancient chemical sediments and ore deposits and their potential to serve as paleo-archives. Contributions may base on, but are not limited to, field settings, laboratory experiments, modeling approaches and analytical frontiers in geochemistry.

Topic 10) Outreach, Education, and Geosciences in Society

10.1 Geoscience Communication and Education

Malte Junge[1,2], Sylke Hlawatsch[3], Melanie Kaliwoda[1,2], Simon Schneider[2]

[1]Mineralogical State Collection Munich (SNSB-MSM), Germany; [2]Ludwig-Maximilians-University, Munich, Germany; [3]Richard-Hallmann-Schule, Germany

Keynote: Dr. Anette Regelous (Erlangen)

Geoscientific questions are increasingly relevant in our daily life. However, the public awareness of geoscientific topics is very limited. Therefore, it is important to inverse the visibility of geoscientific challenges and solutions in our society. Communicating geosciences to

a broader audience implies the use of innovative strategies for public outreach. We have to encourage kids to become enthusiastic about geoscientific topics already in schools and leisure activities. Besides public outreach and school education, we also need to motivate geosciences students to address geoscientific challenges to the public. The current situation with the worldwide digital teaching atmosphere brings varies challenges but also opportunities in optimizing e-learning methods in the higher education teaching including digital field trips, microscopy inspire other digital lectures. The aim of this session is to discuss and report on existing and future initiatives as well as connecting people with similar motivation.

10.2 Geoethics – fostering ethical perspectives in Geosciences

Dominic Hildebrandt[1], Simon Schneider[2], Martin Bohle[3]

[1]Swiss Federal Institute of Technology Zurich, Switzerland; [2]Ludwig Maximilian University Munich, Germany; [3]Ronin Institute for Independent Scholarship, Montclair, USA

Keynote: Nussaïbah B. Raja, FAU Erlangen

Geoethics is a dynamically evolving concept framing various kinds of ethical aspects of Geoscience activities. As an expression of critical thinking and taking responsibility, Geoethics is fundamental to all kinds of Geoscience subdisciplines, however raising different types of questions and problems depending on the specific context. Many of these are intimately linked to specialties of our discipline, e.g. its historically male-dominated character as well as a strong focus on field work. With this session we aim to provide a platform for current works featuring critical analysis of 1) geoscience history and its implications, 2) intra-scientific issues such as gender inequalities or racism, 3) working methods and their implications for the environment, research objects and local communities, 4) geoscientists' work at the interface to society, politics and other stakeholders including geocommunication and geoeducation. We encourage you to submit your work to our session even if your specific topic is not covered above, but has a geoethical dimension.

10.3 Geoscientific museums and collections in the area of responsibility between science and public relations

Dorothée Kleinschrot[1], Christin Kehrer[2], Birgit Kreher-Hartmann[3]

[1]Julius-Maximilians Universität Würzburg, Germany; [2]TU Bergakademie Freiberg, Germany; [3]Friedrich Schiller Universität Jena, Germany

Keynote: Dr. Ilja Kogan, TU Bergakademie Freiberg, Institut für Geologie

There is no geoscience communication without museums. Curators of geoscientific collections have not only the original material in their archives, sample storages and showcases but also as hands-on for teaching purposes or workshops. Because curators are in close dialogue with other scientists they educate on the cutting edge. One duty is to convey current research to a wide audience for example by curating special exhibitions that sharpen the visitor's gaze as by offering public lectures or student labs. Museums offer the opportunity to get people excited about science at an early age. Besides that, digital presentation options become more up-to-date when access to exhibitions and teaching collections is limited. This session aims to bring together curators and other scientists who deal in any way with public relations and the mediation of geoscientific issues.

Topic 11) Open Sessions

11.1 Shaping the future of geoscientific data: The path to FAIR data

Thomas Rose[1,2,3,4], Dominik C. Hezel[1], Sabine Klein[3,5,6], Horst R. Marschall[1,6]

[1]Institut für Geowissenschaften, Goethe Universität, Frankfurt am Main, Germany & NFDI4Earth; [2]Department of Antiquity, Sapienza University of Rome, Rome, Italy; [3]Forschungsbereich Archäometallurgie, Leibniz-Forschungsmuseum für Georessourcen/Deutsches Bergbau-Museum Bochum, Bochum, Germany; [4]Department of Archaeology, Ben-Gurion University of the Negev, Be'er Sheva, Israel, [5]Institut für Archäologische Wissenschaften, Ruhr-Universität Bochum, Bochum, Germany; [6]FIERCE, Frankfurt Isotope & Element Research Centre, Goethe Universität, Frankfurt am Main, Germany

Keynote: Kirsten Elger, GFZ Potsdam Library and Information Services

Geosciences are a data driven science. The exponential increase of data, the large range of sub-domains in Earth System Sciences (ESS), as well as the lack of commonly applied meta-data, vocabularies and ontologies urgently requires solutions how to store, access and manage ESS data. Additional challenges are legacy data, long-term storage options, as well as the often long-tail nature of specialised sub-domains. Presently, data are stored highly non-systematically, ranging from personal databases on local computers up to established, curated repositories and databases. Recent years saw a plethora of large-scale and international initiatives (e.g., IGSN, COPDESS, NFDI4Earth, OneGeochemistry) to transform this heterogeneous status of data storage and curation into a sustainable solution that follows the FAIR principles: findability, accessibility, interoperability, and reusability, and includes publishers as well as funding agencies. In particular, the NFDI (National Research Data Infrastructure), and within this the NFDI4Earth consortium for the ESS aims to develop a framework to easily access, and work with all geoscientific data, as well as document their FAIR data schemata, vocabularies, ontologies, etc.

We invite everyone working with geoscientific data, repositories, databases, etc. to contribute to this session. The session aims at discussing the current state, challenges and future directions to make geoscientific data FAIR. We welcome to this session presentations of individual projects, data-driven initiatives, large infrastructure projects, as well as results from data science projects.

11.2 Latest Achievements in Scientific Ocean and Continental Drilling

Christoph Böttner[1], André Bornemann[2], Simona Pierdominici[3]

[1]Christian-Albrechts-Universität zu Kiel, Kiel, Germany; [2]Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Hannover, Germany; [3]Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum - GFZ, Potsdam, Germany

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.

11.3 Young Scientist Session

Iris Arndt[1,4], Joshua Sawall[2,4], Fiene Matthies[3,4]
[1]Goethe Universität Frankfurt, Germany; [2]Technische Universität Berlin, Germany; [3]Gottfried Wilhelm-Leibniz-Universität Hannover, Germany; [4]Junge DGGV

If you are a young scientist, this session will give you the opportunity to present your work among peers. We will consider everybody without PhD or with a recently finished PhD project a young scientist. You can present your latest project, your BSc or MSc thesis or your PhD progress; submissions from all fields in geoscience are welcome. We especially welcome all young scientists who will be presenting at a conference for the first time or who are not sure if their topic fits into another session. The primary focus of this session is to provide a platform for young scientists to display and discuss their work in a conference environment with a diverse audience.

If large enough, the session will be subdivided according to discipline as identified by the submitted abstracts.

11.4 Open Session: Mineralogy

11.5 Open Session: Geology