universität wien

Faculty of Earth Sciences, Geography and Astronomy

Meet the "Faculty for Exploration"


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Exploration as a Scientific Adventure

The Faculty of Earth Sciences, Geography and Astronomy is a highly diverse faculty. It encompasses a broad range of disciplines, from those markedly based in physics such as astrophysics, meteorology and geophysics to geoscientific disciplines such as geochemistry, geodynamics, impact research, mineralogy, palaeontology, palaeobiology, petrology, sedimentology and environmental geosciences; not to forget to mention the disciplines of physical geography and regional, human, economic and social geography, cartography and geoinformation.

Diverse in their scientific approaches and methods, all departments of the Faculty explore nature and contribute to our understanding of the environment at different scales of time and space, from the Big Bang to the Sun; from the Sun to planet Earth; from the Earth to humankind and the impact of humankind on the future of our planet.

It is the wide range of subjects offered at our Faculty, combined with a variety of degree programmes, high academic standards and expertise among our staff as well as state-of-the-art infrastructure supporting them that makes the Faculty one of the leading faculties, hosting more than 3,000 students and publishing about 700 papers every year.

This brochure provides a bird's-eye view on the Faculty of Earth Sciences, Geography and Astronomy. You will find out how the Faculty operates, and you will gain insight into the current research activities performed at our Faculty. This brochure will allow you to enter a world of exploration. No matter if you are a prospective student, invest in scientific ideas or technologies or are just curious about the world around you, do not hesitate to contact us. We are looking forward to meeting you.

Dean and Vice-Deans
Faculty of Earth Sciences, Geography and Astronomy, University of Vienna

Dean Thilo Hofmann (the second from the left) and Vice-Deans Stephan Glatzel, Jürgen Kriwet and João Alves (from left to right)


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Supporting Research and Teaching

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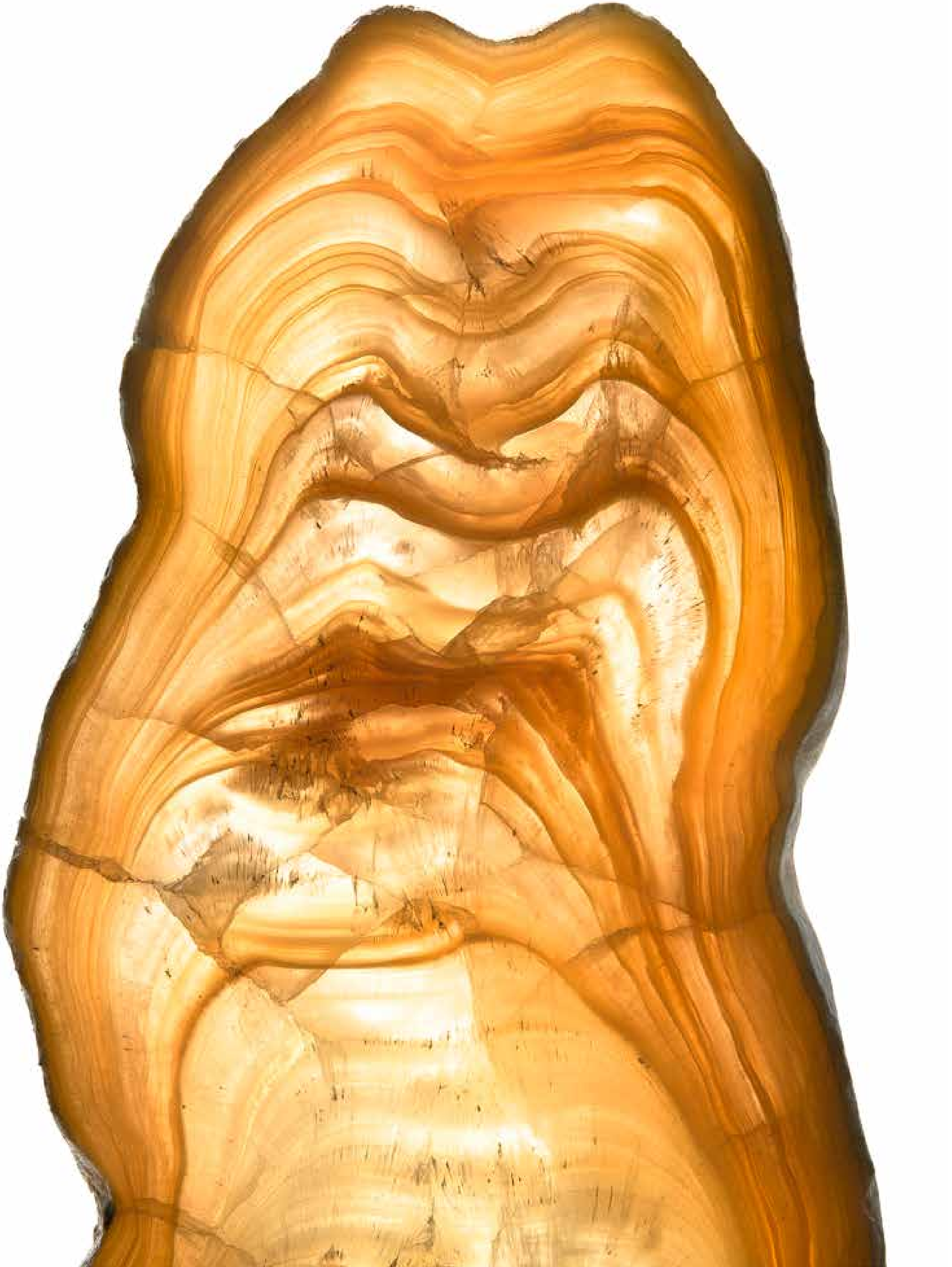
With 24 professorships in eight research departments and altogether about 500 staff members our Faculty ranks among the mid-sized faculties at the University of Vienna. The overall goal of the management of the Faculty as well as of all administrative and technical staff is to provide the best conditions possible for both our researchers and our students. Our academic staff should be able to conduct high-level research in their disciplines. Moreover, and this is equally important to us, we aim at ensuring a high level of teaching for our students. While the Dean and the Vice-Deans are mainly responsible for the strategic development of the Faculty and related decision-making, the Dean's Office oversees and manages day-to-day business activities. In close cooperation with the Dean, the Managing Director handles human resources management, budget planning, monitoring, internal communications, among others, between the Dean, the Vice-Deans and the Heads of the Faculty's departments as well as the management of investment projects. We have, for example, introduced a financial programme to support our departments in funding minor investments. Overall, our Faculty is highly committed to promoting research and excellence in various ways. Along with a financial support programme for research and excellence, we have also successfully established an "Emerging Field Grant" that provides the necessary financial means for a predoc position in a new and high-risk research area for the duration of three years. In addition, we regularly offer a postdoc award to support excellent young researchers in their career. It is a major goal of our Faculty to ensure especially attractive conditions for women and early stage researchers, including a support programme for female scientists returning from parental leave and a programme for the promotion of postdocs and predocs. The team of the Dean's Office would like to encourage you to approach us with any questions or expectations. We are open to new ideas and look forward to helping you whenever you need assistance.

Astrid Heusmann
Managing Director of the Dean's Office

Past Findings, Present Knowledge and Future Endeavours



Introducing the “Faculty for Exploration“

At the Faculty of Earth Sciences, Geography and Astronomy, vast expertise as well as a diversity of methods from many different disciplines are available, enabling excellent disciplinary, interdisciplinary and transdisciplinary research activities and innovative approaches. This allows the description and interpretation of nature at different scales in terms of both time and space, from the universe to planet Earth, including the microstructure of its crystalline components and the manifold interactions between atmosphere, hydrosphere, biosphere, geosphere and anthroposphere. By integrating into its research social processes of spatial and regional development and social and economic geography, the Faculty regards itself as a link between natural sciences on the one hand and social sciences on the other.

The Faculty has defined three thematic areas that focus on basic as well as application-oriented research, responding to current social questions and challenges and that define the research activities of the entire Faculty:

The dynamic cosmos

This area studies the formation and evolution of galaxies, stars and planets, and the underlying physical processes at the different cosmic scales, from large galaxy clusters to the small scale of planetary systems. In the universe, extreme forces and conditions occur, which cannot be replicated in earth-bound laboratories. Insight is obtained through physical models and by observing radiation at all wavelengths.

Dynamics of the geosphere

This thematic area focuses on geological processes with regard to their spatial and temporal interactions and their dynamics. These range from long-term processes that define the conditions on Earth (global geodynamic processes, weathering and sedimentation of rock, etc.) to short-term processes (meteorological extremes such as volcanism and earthquakes). The interactions between geological and biological processes on Earth are taken into account in this thematic area.

Environment, society and risk

In this thematic area, the environment and society as well as their interactions are analysed. Processes occurring in the geosphere and anthroposphere are studied from an angle of basic research. It focuses on the investigation of the influence that societal

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structures and individual action have on spatial development and on systems of geoscience and environmental science. The goal here is to analyse and assess the potential risks involved in environmental change, as well as dangers and risks related to nature, the planning prerequisites, warning systems, short-term and longer-term forecasts, and plans for the sustainable preservation of the natural habitat.

Joint initiatives with methodologies across the different thematic areas are also worth mentioning and are pursued actively as "special focus facilities": high-performance and trace analysis, which may be carried out under clean room conditions, connects lithospheric research and environmental geoscience; scanning electron microscopy and X-ray diffraction link geodynamics and sedimentology, lithospheric research, mineralogy, palaeontology and environmental geoscience. Finally, the joint use of high-performance computers in the Vienna Scientific Cluster links astrophysics with meteorology.

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The Faculty consists of the following eleven subunits:

- Department of Astrophysics
- Department of Environmental Geosciences
- Department of Geodynamics and Sedimentology
- Department of Geography and Regional Research
- Department of Lithospheric Research
- Department of Meteorology and Geophysics
- Department of Mineralogy and Crystallography
- Department of Palaeontology
- Service Unit Earth Sciences
- StudiesServiceCenter
- Dean's Office

Key figures of the Faculty

500 staff members on average in 2015

Academic university staff[1]: 400
Private lecturers: 20
Non-academic university staff: 90
Others[2]: 20

[1] including, among others, full professors, visiting professors, lecturers, university assistants (postdoc and predoc), research assistants, student assistants, academic third-party funded staff
[2] quasi-freelancers and freelancers

3,300 students enrolled in the winter semester of 2015

Students in winter semester of 2015	Bachelor	Master	Teacher education bachelor	Teacher education master
Astronomy	322	48		
Earth Sciences	234	112		
Geography	619	217	616	995
Meteorology & Geophysics	155	19		

This table also includes students enrolled in our three international master's programmes Environmental Sciences, Physics of the Earth and Urban Studies (held in English).

180

doctoral candidates in the
winter semester of 2015

710

publications per year

410

publications in peer-reviewed journals per year

65 %

in Q1 journals

11 monographs per year

EUR **5,634,000**

third-party funding in 2015

Source: reporting system of the University of Vienna, *u:cris*, Accounting and Finance/University of Vienna. Rounded numbers.

Professors of the “Faculty for Exploration“

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Rainer Abart

Professor of Theoretical and Experimental Petrology
Co-Speaker of the DFG Research Unit FOR 471 “Nanoscale Processes and Geomaterials Properties”

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João Alves

Professor of Stellar Astrophysics
Austrian delegate to the ESO Council
Editor-in-Chief of the *Astronomy & Astrophysics*
Corresponding member to the Austrian Academy of Sciences

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Götz Bokelmann

Professor of Geophysics
Member of the “Forschungskollegium Physik des Erdkörpers” (research council concerned with the physics of the earth)

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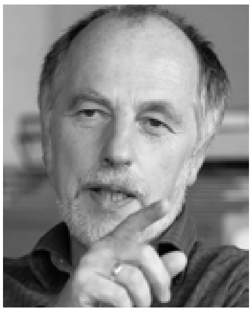
Heinz Fassmann

Professor of Applied Geography, Spatial Research and Spatial Planning
Director of the Institute for Urban and Regional Research of the Austrian Academy of Sciences
Chair of the Commission for Migration and Integration Research of the Austrian Academy of Sciences



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Hans-Heinrich Blotevogel

Professor of Applied Geography, Spatial Research and Spatial Planning (Substitute until Feb 2017)
Member of the Academia Europaea
Corresponding Member of the Austrian Academy of Sciences
Member of the Academy for Spatial Research and Planning (Germany)

Thomas Glade

Professor of Physical Geography
President of the CERG (European Centre on Geomorphological Hazards)
Editor-in-Chief of *Natural Hazards*
Scientific Advisory Board of the Leibniz Institute for Regional Geography (IfL) and the European Academy of Bozen

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Stephan Glatzel

Professor of Geoecology
Advisory Board of the Environmental Sciences Research Network of the University of Vienna
Editor of *Mires and Peat*

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Bernhard Grasemann

Professor of Geodynamics and General Geology
President of the Austrian Geological Society
Associate Editor of *Geological Society of America Bulletin*

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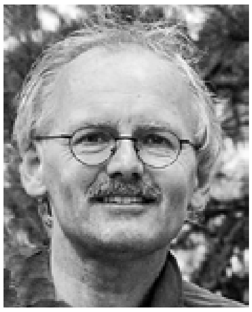
Manuel Güdel

Professor of Astronomy, Satellite and Experimental Astronomy
President of the Austrian Society for Astronomy and Astrophysics
Deputy Head of the Commission for Astronomy of the Austrian Academy of Sciences
Speaker/principal investigator of the National Research Network "Pathways to Habitability"



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Petra Heinz

Professor of Palaeoecosystems

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Thilo Hofmann

Professor of Environmental Geosciences
Head of the Environmental Sciences Research Network of the University of Vienna
Vice-President of the German Water Chemistry Society
Vice-President of the Austrian Association for Management of Contaminated Sites

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Wolfgang Kainz

Professor of Geography and Cartography
Editor-in-Chief of the *ISPRS International Journal of Geo-Information*
Chair of the Austrian Cartographic Commission

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Christian Koeberl

Professor of Impact Research and Planetary Geology
Director-General of the Natural History Museum Vienna
Austrian representative of the Executive Committee of the International Continental Scientific Drilling Program (ICDP)
Member of the Austrian Academy of Sciences

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Stephan Krämer

Professor of Isotope Chemistry and Biogeochemistry
Advisory Board of the Environmental Sciences Research Network of the University of Vienna

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Jürgen Kriwet

Professor of Palaeobiology with Special Emphasis on Vertebrate Palaeontology
Editor of *Paläontologische Zeitschrift* (palaeontological journal)
Review Editor of *Frontiers in Paleontology*
Associate Editor of the *Journal of Vertebrate Paleontology*
Member of the Advisory Board of *Cretaceous Research*
Member of the Editorial Board of *Palaeodiversity*

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Patrick Meister

Professor of Sedimentology
(Substitute until Feb 2018)

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Ronald Miletich

Professor of Mineralogy and Crystallography
Member of the Advisory Board of the ESRF of the Austrian Academy of Sciences
Member of the Advisory Board of the ILL of the Austrian Academy of Sciences
Board Member of the Austrian National Committee for Crystallography

Robert Musil

Professor of Economic Geography
(Substitute until Sept 2016)

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Lutz Nasdala

Professor of Mineralogy and Spectroscopy
Editor-in-Chief of *Mineralogy & Petrology*

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Patrick Sakdalpolrak

Professor of Population Geography and Demography
Member of the Steering Committee of the IGU
Commission on Population Geography

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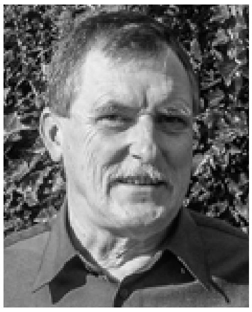
Reinhold Steinacker

Professor of General Meteorology



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Bodo Ziegler

Professor of Galaxy Formation in the Early Universe
Austrian representative in the ESO Users Committee
Member of the Board of Directors of
Astronomy & Astrophysics

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Martin Zuschin

Professor of Palaeontology
Section Editor of *Paläontologische Zeitschrift*
(palaeontological journal)

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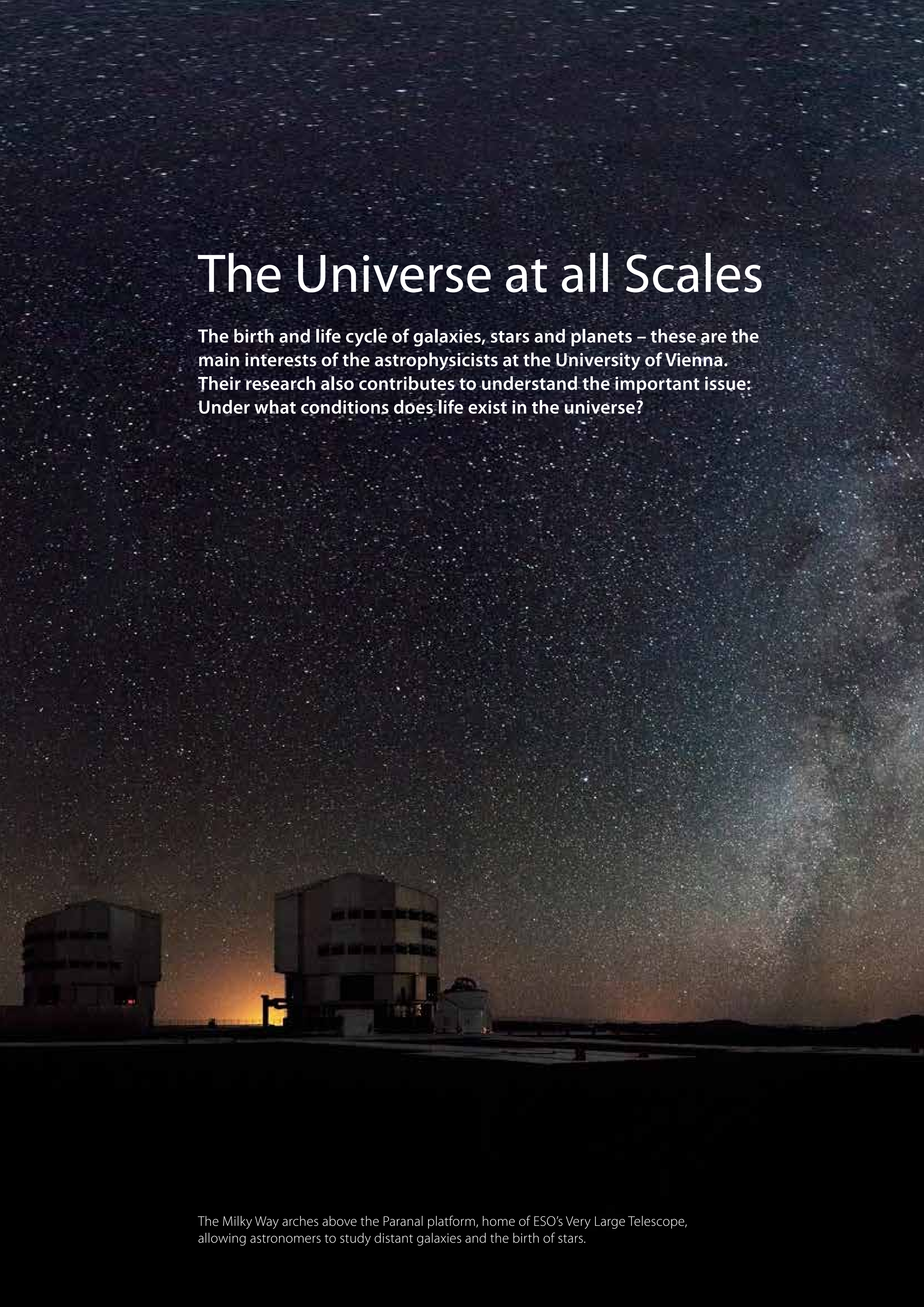
As of July 2016

The Universe at all Scales

The birth and life cycle of galaxies, stars and planets – these are the main interests of the astrophysicists at the University of Vienna. Their research also contributes to understand the important issue: Under what conditions does life exist in the universe?



The Milky Way arches above the Paranal platform, home of ESO's Very Large Telescope, allowing astronomers to study distant galaxies and the birth of stars.

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Magdalena Brunner is running some preparatory checks and calibrations before the 80 cm Vienna Little Telescope (vlt) is used by students in practical observatory courses.

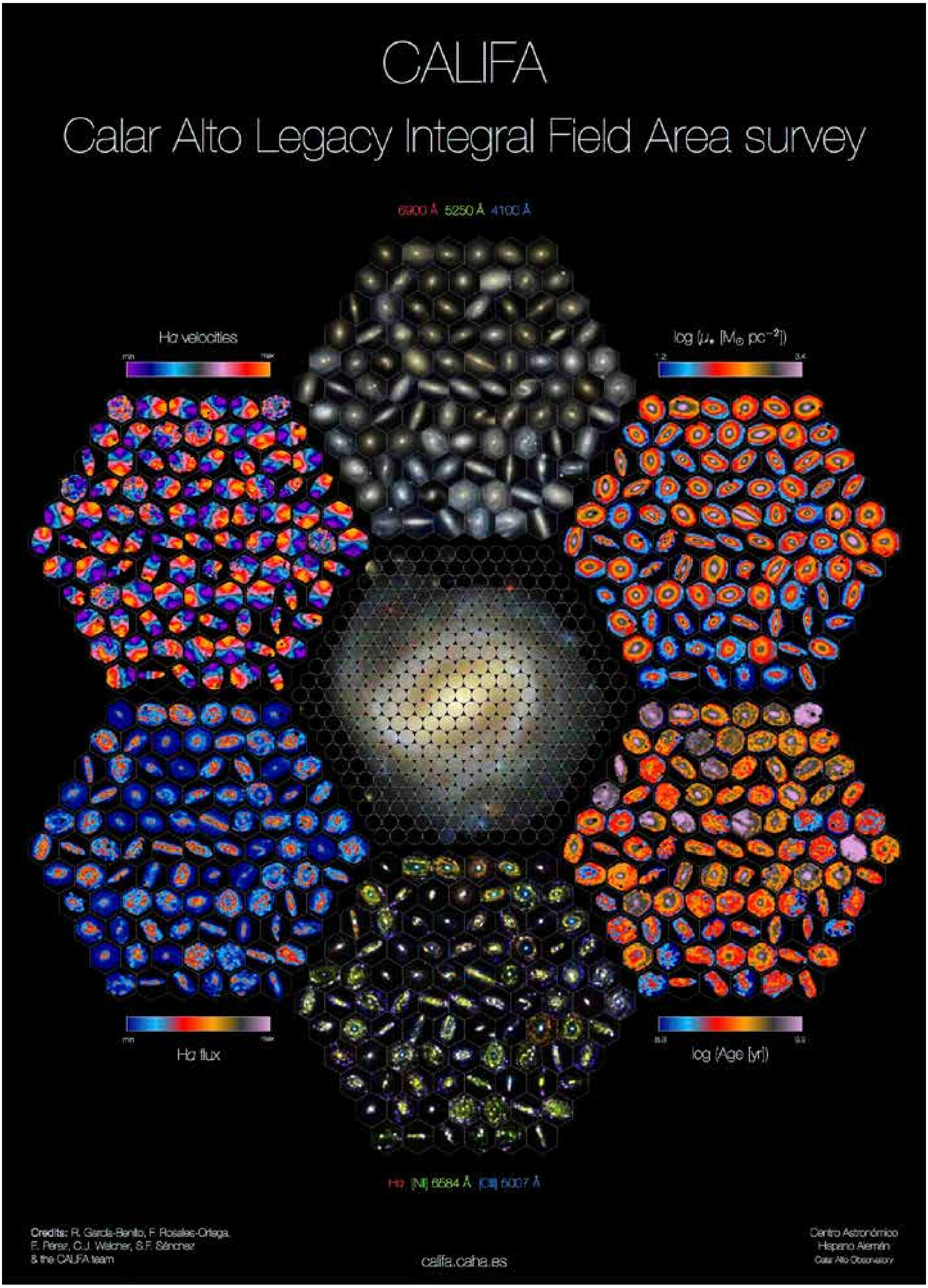
"Even with the largest telescopes available today, the first galaxies of the universe are visible to us as Vienna's city centre would be from the moon," says astrophysicist Bodo Ziegler. So it is fascinating that astronomers can still learn a lot about these early galaxies. Bodo Ziegler, Head of the Research Group Extragalactic Astrophysics, and his colleague Helmut Dannerbauer, for example, have been able to completely record how stars are formed in a galaxy cluster ten billion light years away. They observed the surroundings of the enormous "Spiderweb Galaxy" MRC 1138-262 with the APEX telescope (Atacama Pathfinder Experiment) of the European Southern Observatory (ESO). "The interstellar gas clouds where stars are born absorb light. However, radio telescopes like APEX allow us to observe the cold universe so that we can also survey these cold gas clouds," Ziegler explains. In their study, the astrophysicists found that the creation of stars is not only usually obscured by dust clouds but also occurs in unexpected places. They discovered the secret blueprints of a galactic metropolis.

"To increase our understanding of the evolution of galaxies, we must study galaxies from different cosmological eras – from the first objects to our local neighbourhood."

Bodo Ziegler, Professor of Galaxy Formation in the Early Universe

The first galaxies were formed as early as 500 million years after the Big Bang. In the 13 billion years since then, they have changed their shape and composition repeatedly, but also new galaxies were formed. "In order to advance our understanding of the universe, we must look at its entire development – from our Milky Way all the way back to the first galaxies," says Ziegler. It is not only about how stars are formed, he explains, but about all physical aspects of the evolution of galaxies. In order to study these, "we have to examine galaxies with many different approaches in all wavelength ranges – X-rays, visible light, infrared radiation and radio waves. We call this the multiwavelength approach."

The researchers predominantly use spectroscopic methods to determine the physical properties of galaxies. Bodo Ziegler's team participated in the international project CALIFA (Calar Alto Legacy Integral Field Area) that observed more than 600 very different galaxies in our Galactic neighbourhood at the Calar Alto observatory in southern Spain over three years using a special 3-D spectroscopic method. This new method allowed them to distinguish on spatially resolved scales the physical properties, such as their kinematic characteristics, their chemical composition and their stellar populations more precisely than ever before. In another project, Ziegler and his team observe galaxies that are between 5 and 8 billion light years away. The focus is on potential interactions between galaxies clustered closely together. For their analysis, they combine spectroscopy using the largest telescopes of ESO (of which Austria is a member) stationed in Chile's Atacama Desert and high-quality imaging from the Hubble Space Telescope.



Galaxy properties from the CALIFA 3-D spectroscopic survey of 600 nearby galaxies

"Diffuse interstellar gas clouds become stars, which host earth-like planets and burn out or explode, creating a multitude of elements that eventually end up in other stars, planets and our blood."

João Alves, Professor of Stellar Astrophysics

How stars were born

How do diffuse interstellar gas clouds form, evolve and eventually collapse to form stars and planets? This is the key research question of João Alves and his Research Group Star and Planet Formation. "You could say we make sonograms of pregnant clouds. We develop different methods to study these star-bearing wombs," says the astrophysicist. To see through the interstellar gas clouds, Alves and his Research Group primarily use infrared telescopes such as Herschel and ESO's Very Large Telescope.

One of the Group's key research areas is the 3-D visualisation of data from space. Their 3-D analyses recently uncovered an optical illusion that had not been detected with the previous 2-D analyses: The Gould Belt in the Milky Way is not actually a ring of stars but a projection effect. This puts the existence of the "belt" of stars near our Sun, which was first identified in the 19th century, into question. As part of the international project, the researchers also created the first 3-D map of the regions around our Sun. Their 3-D analysis also revealed the presence of enormous streams of young stars, traced by the massive but short-lived O- and B-stars. The data came from the European Space Agency (ESA) satellite Hipparcos.

Alves' Group is also involved in the Gaia satellite project of ESA and is eager to explore Gaia data with the new 3-D techniques developed for the Hipparcos satellite. "The data will allow us to reconstruct the regions near our Sun in a never before seen resolution and create accurate maps of stars and the interstellar gas between them. We will be able not only to reconstruct our Galactic neighbourhood accurately but, by doing that, understand the origins of sun-like stars and the build-up of galaxies like our Milky Way," says João Alves. The first data will be published for analysis in the late summer of 2016. In the near future, Alves wants to focus more on one of humankind's big questions: Are we alone in the universe? "We have learned in the last few years that one in five stars has an earth-like planet with water. This gives the question new relevance," Alves explains.

Conditions for habitable planets

The question why life is possible on Earth and not on some other planets is the focus of Manuel Güdel and his Research Group Star and Planet Formation. Co-operating with researchers from other groups and departments, Güdel is studying the astrophysical factors that make planets habitable. He heads a

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Theresa Lueftinger reconstructs the distribution of the magnetic fields on the surface of stars with computer programmes from observations.

Observations using the Atacama Large Millimeter Array (ALMA) reveal an unexpected spiral structure in the outflowing material around the star R Sculptoris. A Group around Josef Hron and Franz Kerschbaum focuses on the late stages of stellar evolution with their complex mass loss processes.

national research network, for which the Austrian Science Fund (FWF) recently extended funding until 2020. How do the properties of stars influence planets? Under what conditions do some proto-atmospheres survive on planets, and why do some evaporate? What properties must a planet have to create suitable conditions for life and, in particular, liquid water? And how do all these factors have to interact to finally result in a habitable planet? “Our goal is to gain a comprehensive view of the different factors and their interactions using modelling by 2020,” Güdel explains. His team is initially focusing on our solar system – particularly Earth with its neighbours Mars and Venus – as a field of study. In the case of Earth, its mass, insolation and the astronomical architecture of our solar system made life possible. However, the Group is also studying extrasolar planetary systems with very different properties.

In another project, Güdel’s Group is studying the properties of so-called protoplanetary disks – enormous disks of gas and dust that can later form planets. “It is important to understand protoplanetary disks in order to understand where planets come from, how they form, grow and create their first atmosphere,” the astrophysicist explains. The project is funded by the EU, the FWF and the Austrian Research Promotion Agency (FFG).

At the same time, Güdel’s Group and other researchers at the Department of Astrophysics are involved in a number of space missions. Franz Kerschbaum’s team is, for example, developing research technology, e.g. on-board software for satellites. Because of their activities, Güdel’s and Kerschbaum’s teams are involved in the planned ESA exoplanetary missions PLATO, CHEOPS and ARIEL, the ESA planetary mission SMILE, the James Webb telescope (NASA and ESA) and the ESA X-ray telescope Athena, as well as the future evaluation of the gathered data.

Instruments for ESO’s Extremely Large Telescope

Austrian scientists are also involved in the development of three instruments for the European Extremely Large Telescope (E-ELT), which is currently under construction. The enormous ESO telescope with its 39-metre diameter primary mirror will be the world’s largest telescope for the visible and near-infrared range. Led by the Viennese astrophysicists, the Austrian team is involved in the development of the camera MICADO (Multi-AO Imaging Camera for Deep Observations), which will permit more precise imaging of near-infrared wavelengths. The Mid-Infrared ELT Imager and Spectrograph (METIS) will provide high-resolution data from the mid-infrared spectrum. The third instrument, MOSAIC, will allow spectroscopic analyses of very distant galaxies. One of the tasks of the Austrian team is to develop components for the data reduction software of the instruments.

“The current faces of Venus, Mars and Earth can tell us how the young solar system might have looked. Through them, we can understand our origins. And that shows us new ways of identifying habitable planets in the universe.”

Manuel Güdel, Professor of Astronomy, Satellite and Experimental Astronomy

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Department of Astrophysics

astro.univie.ac.at

The Whole Range of Environmental Processes

Processes in our environment influence the transport of contaminants in water, soil and air and the behaviour of nanoparticles. Two research groups at the Department of Environmental Geosciences are studying these processes with ground-breaking methods.

What is the impact of human activities on the environment? How can we effectively protect and sustainably use our resources? Researchers from the Department of Environmental Geoscience strive to gain a molecular-level understanding of chemical mechanisms and biological pathways of processes that control the exogenous earth system in time and space, and apply fundamental insights to the solution of some of the pressing environmental problems of today and tomorrow.

Sand and gravel are the most commonly used construction materials. However, in an Alpine country like Austria, their supply is limited. Potential extraction sites conflict with other land uses. "For a long time, the excavation of gravel pits was considered problematic because of the supposed negative impact on ground water quality", Thilo Hofmann, who leads one of the two research groups at the Department, explains. However, a country-wide study allowed the environmental geoscientist and his Research Group to demonstrate that gravel pit ponds can have very positive ecological impacts, which can even improve ground water quality. They attract specific animal and plant populations. If water polluted with nitrates or

"Our goal is to understand crucial mechanisms that influence environmental processes and to apply this understanding to the solution of important current and future environmental issues."

Thilo Hofmann, Professor of Environmental Geosciences

pesticides flows into the pond, the resident flora and fauna can degrade the pollutants. "If certain rules are followed, gravel pit ponds can be an efficient water filtration system," says Hofmann. With their study, the researchers contributed to a guideline for the protection of ground water in sand and gravel extraction developed with the Austrian Water and Waste Management Association (ÖWAV). As a result, resource master plans are revised.

Traces of anthropogenic inputs

In addition to hydrogeology, Thilo Hofmann's team of environmental geoscientists studies pollutants and their behaviour in the environment. The focus is on contaminations and how to combat them. Current projects, for example, study the impact of microplastic particles on the behaviour of other contaminants in water and the use of biochar in the remediation of lightly contaminated soils. In some cases, anthropogenic pollutants can also make natural processes visible: In a project with a large water supplier, the scientists are using gadolinium as an indicator for interactions between river water and ground water. Gadolinium is used as a contrast agent in magnetic resonance imaging. The extremely stable and highly toxic substance is eliminated by the human body very quickly. "If a river contaminated with waste water infiltrates an aquifer, gadolinium is an ideal signal for our analyses," says Thilo Hofmann. It allows the researchers to measure how much river water is entering the ground water, how rapidly the river water is moving and which proportion of contaminants it contains.

The Group's third major area of research is nanogeoscience, i.e. the analysis of environmental processes on the nanoscale (a nanometre is a millionth part of a millimetre). Building on their

Preparation of calibration standards for contaminant analysis

Loading an auto-sampling rack on a gas chromatography/mass spectrometry system to analyse traces of poly-aromatic hydrocarbons (PAH), a widespread organic contaminant in the environment

internationally renowned analysis of natural nanoparticles, the focus of Thilo Hofmann and his colleague Frank von der Kammer is now on engineered nanoparticles. In an ERA-NET project, the researchers are currently studying the use, behaviour and risk of nanopesticides such as copper oxide nanoparticles in soil. In a recently completed study, they examined the behaviour of technical titanium dioxide (TiO2) – a common component of sunscreen – in surface waters such as the Old Danube, a popular bathing spot in Vienna. They developed a special analysis method for this study. The Group is currently also contributing their experience in the development of methods to a number of international working groups, among them the development of OECD guidelines for the testing of nanoparticles.

"A core question of our research for the last decade has been how to distinguish engineered particles from natural particles in the first place," says nanogeoscientist Frank von der Kammer, adding: "We have been able to show that it can be done with cerium dioxide, which is sometimes added to fuels." The researchers found that natural particles often contain impurities. In natural samples, the metal cerium nearly always co-occurs with lanthanum at a 2:1 ratio, while engineered particles have an extremely high purity grade. To prove this, they developed a single-particle multi-element analysis method. The tool required for it, a time-of-flight

"We want to understand processes involving nanoparticles. After all, in terms of surface area, these tiny particles make up a large part of the reactive surface of our planet."

Frank von der Kammer, Deputy Head of the Department of Environmental Geosciences

mass spectrometer, is currently being applied for together with the Department of Analytical Chemistry. Using this method, they are planning to develop a reference database together with ETH Zurich: Natural particles will be analysed to determine their element patterns. This data can then be used as reference material for particles in unknown samples and will help to answer the question whether they are natural or engineered.

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The Tyndall effect proves the presence of particles in the aqueous sample. The effect, which is qualitatively shown here with a simple laser pointer, is used for particle size determination in sophisticated light-scattering photometers.

"Because of their profound understanding of the earth system, geoscientists are ideally suited for analysing the relationship between humans and their environment."

Stephan Krämer, Professor of Isotope Chemistry and Biogeochemistry

Environmental and isotope geochemistry

Environmental geochemistry of nutrients and pollutants is the focus of the second group at the Department led by Stephan Krämer. "The supply of vital micronutrients to bacteria, plants and humans influences our environment in major ways," says Walter Schenkeveld, a scientist focusing on nutrient acquisition. "For example, the iron acquisition of phytoplankton in the ocean and the copper acquisition of methanotrophic bacteria influence the climate." The team investigates factors causing a low supply of micronutrients in aquatic systems and soils, and which biogeochemical processes are used by organisms to increase the supply.

Krämer's Research Group Environmental Geochemistry also analyses processes that can mobilise or immobilise inorganic pollutants such as mercury, uranium or chromium. One research question is: Under which conditions can soil contaminated by depleted uranium ammunition pose a risk for the ground water? Depleted uranium (a by-product of the enrichment of natural uranium) is used in armour-piercing shells deployed in many conflict areas. Another "dangerous mineral" is chrysotile. For decades, it was used to produce asbestos cement. The unregulated disposal of asbestos cement waste and its use as recycling material has caused soil contamination. A current project investigates whether and how quickly the natural weathering of chrysotile contributes to a reduction in contamination and whether the weathering process can be accelerated by plants.

The environmental geochemists also study the stable isotope geochemistry of metals in the environment. Most chemical elements of the periodic table consist of a mix of several stable isotopes. The exact isotopic composition of natural materials, i.e. the relative ratio of isotopes to each other, can vary minutely between environmental samples. "The high-precision measurement of the isotopic fingerprints of an element in an environmental sample can tell us about its geochemical history," Jan Wiederhold, an environmental isotope geochemist in the Krämer Group explains, adding: "The characteristic isotopic signature allows us to distinguish between different contamination sources of heavy metals or different processes in biogeochemical cycles." Current research in the Group focuses on the isotopic signature of mercury (Hg). Together with partners from Germany and Switzerland, the researchers aim to determine the transport pathways and transformation mechanisms of mercury in contaminated locations and advance the understanding of the behaviour of mercury in the environment. This high-precision analysis of isotope ratios of metals has only become possible recently with new methods such as Multicollector-Inductively Coupled Plasma Mass Spectrometry (MC-ICPMS). This method allows the researchers at the University of Vienna to investigate completely new questions in environmental geochemistry.

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Department of Environmental Geosciences

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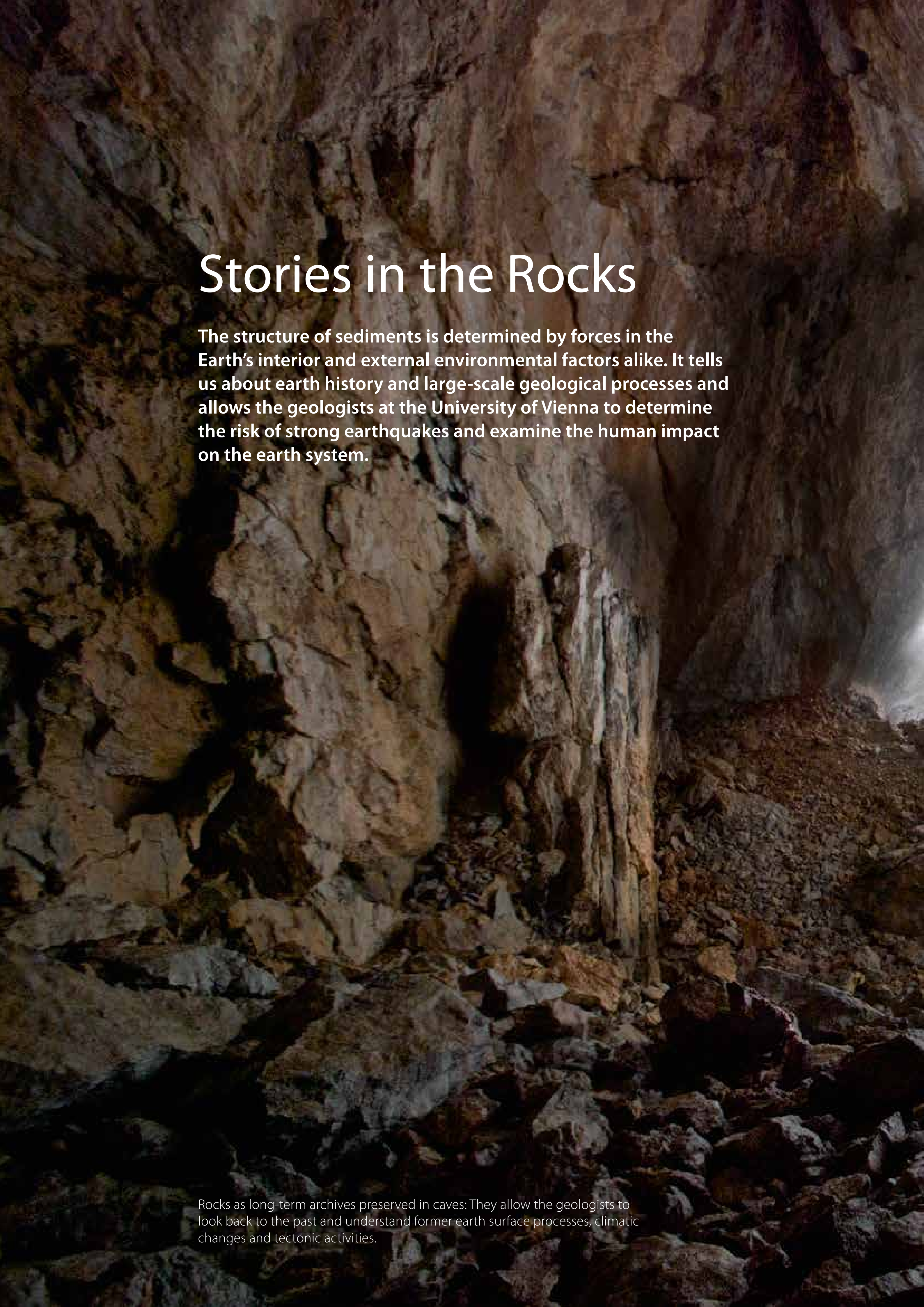
Shining light on environmental geochemistry: Photochemical processes influence pollutant and nutrient cycling.



Stories in the Rocks

The structure of sediments is determined by forces in the Earth's interior and external environmental factors alike. It tells us about earth history and large-scale geological processes and allows the geologists at the University of Vienna to determine the risk of strong earthquakes and examine the human impact on the earth system.

Rocks as long-term archives preserved in caves: They allow the geologists to look back to the past and understand former earth surface processes, climatic changes and tectonic activities.

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Geological forces keep the Alps in motion. Studies show that the Eastern Alps are shifting to the east at a rate of 1.5 mm a year. That does not happen without seismological shocks. Of the approximately 100 annual earthquakes in Austria, only just over a dozen of them are felt by the population. It is not clear whether "strong" earthquakes – quakes with a magnitude of over six on the Richter scale – are possible in the Eastern Alps. Strong earthquakes might also only occur at intervals of a thousand or several thousand years – the existing seismological records do not reach back far enough to tell. In order to collect data on strong earthquakes, the Research Group Structural Processes uses a very special archive of earth history.

Caves as archives

The researchers look for signs of movement in caves: There, often several hundred metres below the surface, scratches in and displacements of the calcareous sinter speak of past quakes. "In the Alps, it is hard to find proof of active tectonics, that's tectonic movement in the last 10,000 years. The last ice age eroded the Alps so heavily that all traces have been obliterated. In caves, however, these signs remain visible," says Bernhard Grasemann, Head of the Group. In cooperation with the Natural History Museum Vienna, geologists are collecting signs of earthquakes from the last 500,000 years in several different caves. They compare their data from the Eastern Alps with data from sinter caves in the southern Aegean, a tectonically very active region. The results do not only serve to complement historical records: "If we know the rate at which earthquakes repeat, we can evaluate probabilities more precisely," Bernhard Grasemann explains. The FWF project "Speleotect" is the first comprehensive study on Quaternary tectonics in the Eastern Alps.

"The reputation of structural geology in Vienna is, among other factors, based on combining geological field data with the numerical modelling of deformation processes."

Bernhard Grasemann, Professor of Geodynamics and General Geology

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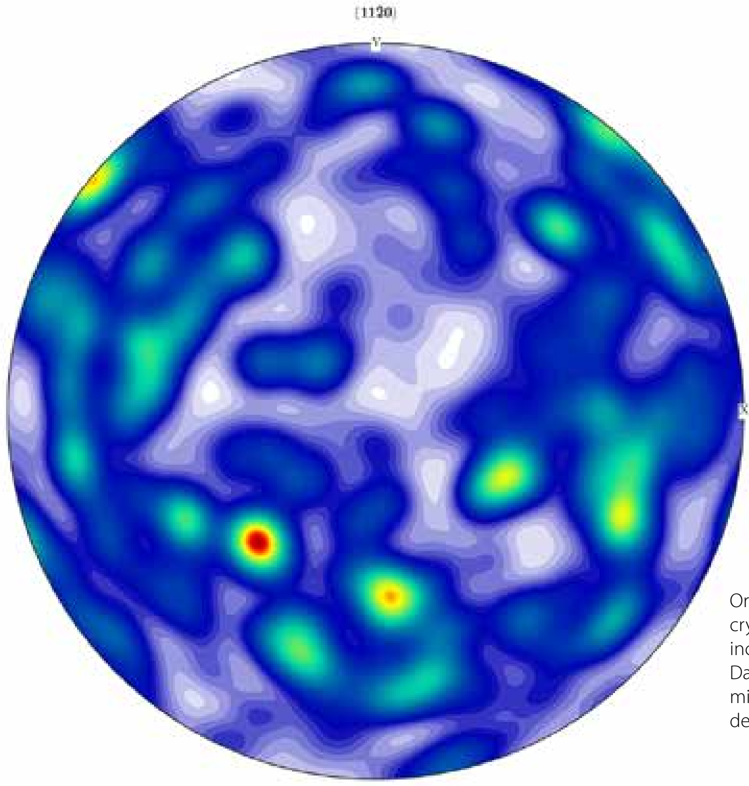
Cut rock sample used for measuring permeability, i.e. the rate of fluids passing the rock

In a different project, geologist Kurt Decker studies active tectonics in the Vienna Basin. In 2015, he was able to demonstrate that there are fault lines and fault systems underneath the Vienna Basin that are serious enough to cause a strong earthquake. At the same time, the structural analyses of the Vienna Basin and other tectonically active regions also provide data that are useful for petroleum geology. Active and inactive faults have a considerable influence on where reservoirs of fluids, such as hydrocarbons (e.g. petroleum), can form in the Earth's crust. The Department cooperates with the oil industry in basic research projects.



Orientation of crystallographic axes of quartz crystals from a shear zone, which arrange with increasing deformation in characteristic patterns. Data were measured with a scanning electron microscope, and orientations are plotted in a density plot.

Rock deformation processes

The analysis of the behaviour of deformed rocks when subjected to natural faults is one of the key research areas of the Research Group Structural Processes. A current doctoral thesis focuses on ductile or plastic deformations of rock. Under surface conditions, glacier ice behaves similarly to ductile rock at a depth of approximately 20 km and temperatures of 400 to 500°C (e.g. marble). The way the ice flows can tell us how rocks behave deep down under the earth where they cannot be observed directly. Therefore, the researchers around Grasemann and his colleague Martin Schöpfer want to use Austria's largest glacier, Pasterze on Großglockner, as an analogous laboratory to model the flow and deformation behaviour of the ice.

Another project, which has started in 2016, will be dedicated to the numerical modelling of calderas – craters of volcanoes whose magma chamber has collapsed. The project, which received the Faculty's Emerging Field Grant 2015, studies how calderas collapse. The objective is to develop state-of-the-art 3-D computer simulations of restless calderas to gain insight into volcanic processes. This will contribute to understanding the potential dangers of the craters. The researchers are collecting data from calderas on the Canary Islands.

Small traces, large impact

How are sediment rocks structured? Which depositional processes can we deduce from the order of the sedimentary layers? How do sedimentation dynamics and environmental conditions influence them? These are questions that the Research Group Sedimentology and Stratigraphy are studying in several projects. Among other things, they are investigating the potential of rocks to store petroleum, studying the climate on our planet 10,000 to 100,000 years ago and investigating fluctuations in sea level under palaeoclimatic conditions to allow us to draw conclusions about changes that can be expected during the current climate change.

In addition to these diverse research questions of sedimentology, there is also a heated debate among geologists concerning a fundamental question: When did or will the influence of humans on the environment become so strong that we influence geological processes in the earth system? Has the so-called Anthropocene already started? And if so, when? "These questions focus on humankind and our environmental, geological and atmospheric footprint," geologist Michael Wagreich explains.

Field work at the so-called Leitha limestone quarry in the south of Vienna, where samples are taken for porosity and permeability measurements

“Everyone is talking about the Anthropocene. There is much evidence of human influence. Now, this new geological epoch should be formally defined.”

Michael Wagreich, Deputy Head of the Department of Geodynamics and Sedimentology

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Students discussing the cutting, polishing and thin section preparation of rock samples together with a technician

Has the Anthropocene started?

The term "Anthropocene" was coined in 2000 by the Nobel Prize laureate in Chemistry, Paul Crutzen. Researchers do not agree whether it has already started or not. Michael Wagreich is a member of a working group of the Subcommission on Quaternary Stratigraphy of the International Commission on Stratigraphy (ICS) together with Paul Crutzen and others. The ICS is in charge of naming geological epochs and is currently considering whether the Anthropocene epoch should be formalised and when its beginning would be. In a 2015 publication, the researchers found that in terms of stratigraphy, it would be ideal to place the beginning of the Anthropocene in 1945. The explosion of the nuclear bombs and the nuclear weapons tests in the following years caused artificial radioactive isotopes to enter the atmosphere, which have since then spread worldwide. "The plutonium isotopes that can be detected in ice cores from the Antarctic are the same as in lakes in Europe or ice cores from Greenland," says Wagreich. In January 2016, Wagreich and international colleagues published an article in the renowned journal *Science* reflecting on issues that can be considered as evidence of an Anthropocene epoch. However, critics point out that the radioactive material is still being spread and depleted and say that a geological epoch cannot be defined based on active processes.

Wagreich and his team want to examine other markers for the beginning of the Anthropocene. This epoch would follow the Holocene, which began 11,700 years ago. The considerable spread of aerosols and deposits of lead particles in the Northern Hemisphere are, for example, connected to the intense mining activities of the late Bronze Age. "Isotope analysis of sediments shows lead from that time period in stratigraphic terms," says Wagreich, who analyses sediments in rivers and lakes, in particular. "We are particularly interested in the history of how these first contaminants caused by humankind spread." The geologist expects to be able to find lead particles in the sediments from approximately 3,000 years ago in Austria as well. However, stratigraphy is also interested in more recent phenomena: Traces of human behaviour, e.g. the use of plastics, can also be found as microscopic plastic particles in younger sedimentary layers, which is being referred to as "plastic stratigraphy".

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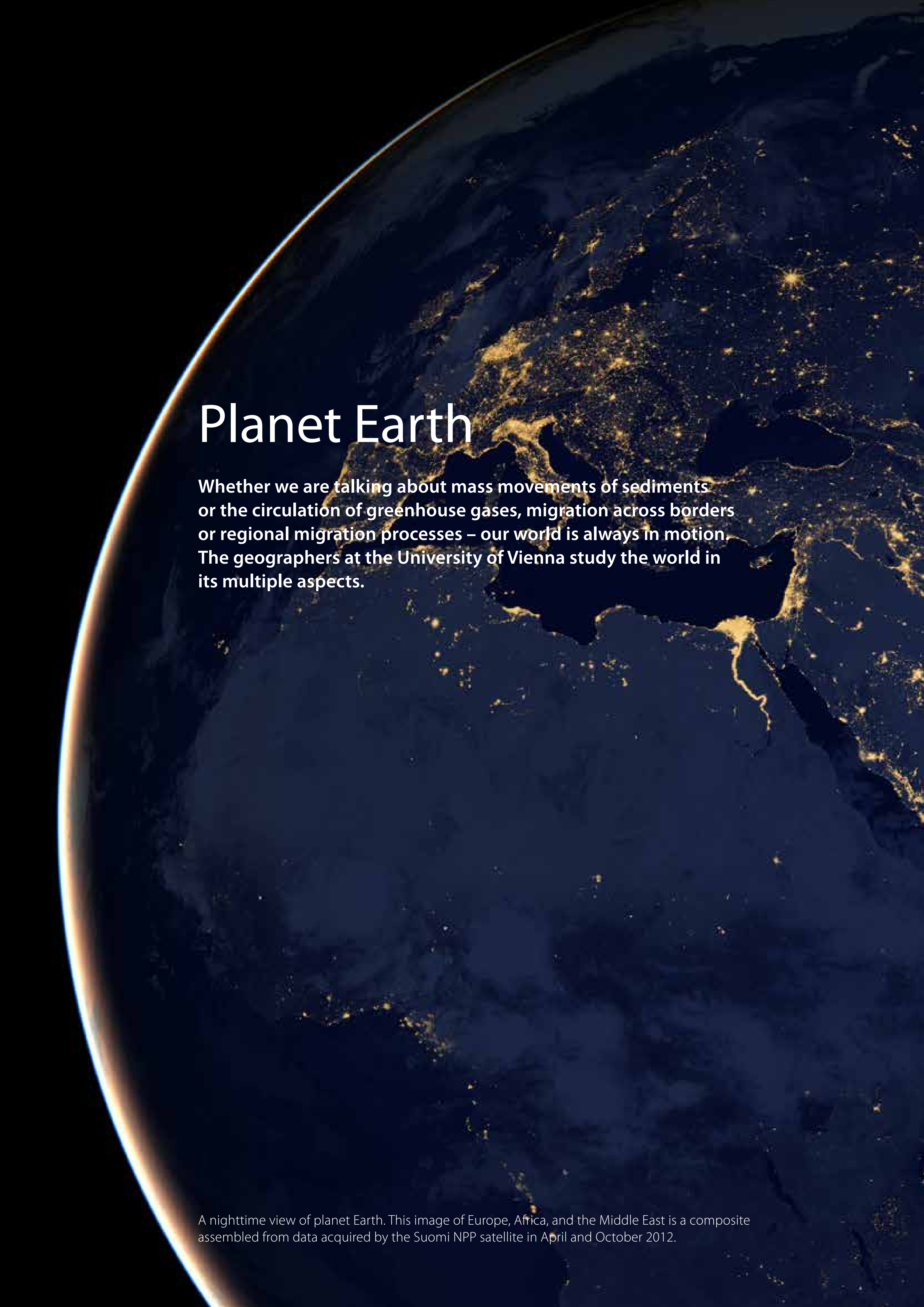

Planet Earth

Whether we are talking about mass movements of sediments or the circulation of greenhouse gases, migration across borders or regional migration processes – our world is always in motion. The geographers at the University of Vienna study the world in its multiple aspects.

A nighttime view of planet Earth. This image of Europe, Africa, and the Middle East is a composite assembled from data acquired by the Suomi NPP satellite in April and October 2012.

© B. Groiss

Field work in Gresten, Lower Austria: Two students use a drill crawler with pneumatic ram; a student marks the so-called inliner, containing the drill core.

Avalanches, earthquakes and landslides can generate tremendous force, which may result in disastrous consequences for humans and the environment. While avalanches and earthquakes have been studied in detail for decades, "there are very few continuous monitoring programmes for landslides such as shallow or rotational slides, mudflows or rockfalls," says Thomas Glade, Head of the Research Group Geomorphological Systems and Risk Research. The key research areas of the Group are earth surface processes, natural hazards and risk assessment.

With their project NoeSLIDE, which was launched in 2014, the geomorphologists are, for example, addressing the lack of long-term studies on landslides. They have established an early warning system for landslides, mudflows and rockfalls in different parts of Lower Austria. The combined use of sensors and laser scanners allows Glade's team to analyse the different flow, fall and slide processes. They also record external factors such as precipitation, solar radiation and temperature. At the same time, they aim to develop fundamental knowledge concerning the following questions: How can the risk associated with landslides and similar events be minimised? What can be done to prevent them? What should be done to handle an emergency situation, including risk communication? With their project BioSLIDE, the researchers investigate whether changes in vegetation or biomass influence the motion dynamics of slopes.

Environmental processes, environmental hazards

The Research Group Geoecology, which is the Department's second group that studies geography from the perspective of natural sciences, also focuses on current environmental processes and problems. One example are greenhouse gases.

How do the exchange processes of greenhouse gases occurring between the soil, plants and the atmosphere look like? How does human influence change them? Stephan Glatzel's Geoecology Group addresses these question on the basis of peatlands – a rather young research area at the Vienna Geography Department. Peatlands are carbon sinks, provided that they remain undisturbed. When peatlands are used or drained, harmful greenhouse gases, such as carbon dioxide, are released.

Stephan Glatzel estimates that up to 3 % of Austria's surface could be considered peatlands, following the international definition (i.e. areas covered by a peat layer of at least 30 cm). However, there is no

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Rotational landslide with deformed agricultural road in Stössing, Lower Austria in June 2009 comprehensive survey on peatlands, and the data are too old to be used as accurate information. The only peatlands that have been exactly charted are found in nature reserves. Additionally, peatlands have not been taken into account as far as Austria´s climate footprint is concerned. "We do not know how it would influence the balance if we included them," says Glatzel. The researchers are investigating the changing impact that peatlands have on the climate, e.g. on the basis of the "Pürgschachen Moor" located in Styria. They have already found that the severe drought in the summer of 2015 promoted the spread of dwarf pines in the peatlands.

Geography of humankind

Whether through construction work, agricultural use or by causing greenhouse gas emissions – the anthropogenic influence on ecosystems and the interaction between nature and society play an important role in physical geography. The second large area of geography in Vienna focuses on the people themselves: Human geography deals with different aspects of demographic change, rural depopulation and with the increasing migration into cities or urban spaces as well as with spatial planning matters.

Life expectancy in Austria is increasing at an average rate of two years per decade. In the following years, there will be a considerable increase in the number of elderly people in comparison with other age groups. We need concepts for integrating elderly people into society as long as possible – for example through employment or volunteer work. Currently, two dissertation projects carried out within Heinz Fassmann's Research Group Applied Geography focus on active ageing. Over the last ten years, the rural peripheral regions of Austria, which are characterised by young people migrating into the cities, have seen an influx of people moving into these rural areas at the end of their working life. This is, for example, true for the southern Burgenland. The question arises whether these elderly people are indeed "new immigrants" and why they move there or where they actually come from. The researchers also want to study the potential that these new residents have for the development of municipalities.

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Geography students analyse soil samples in a laboratory course.

"Demographic change and the depopulation of structurally weak areas are associated with a strong gender bias," says Robert Musil, Interim Head of the Research Group Human Geography. "More women than men leave the rural areas for cities." Researchers from his Group have studied the impact of the gender aspect on regional development: The project genderATlas (genderatlas.at), for example, shows which municipalities in Austria have female mayors (the first female mayor was sworn in in Lower Austria in 1948) and examines in which Austrian regions young women and men have a particularly high level of education. The interactive online map was presented in the autumn of 2015.

Interview with a rice farmer in North-East Thailand

Country life and city life

Further topics studied by the human geographers at the University of Vienna include the integration of ethnic minorities in Vienna, the development of inner-city districts in five major European cities, the development of financial centres in Europe and urban agglomerations. Another research topic comprises spatial planning methods and systems: A team working in the Research Group Applied Geography led by Hans-Heinrich Blotevogel compared the different spatial planning systems of European countries. The researchers were interested in examining how these countries deal with current challenges such as climate or demographic change and whether and how quickly institutions reacted to them.

"Our Department covers the entire range of geography as well as cartography and geo-information sciences. They complement each other in the extensive tasks at the interface of the environment, society and risk."

Wolfgang Kainz, Professor of Geography and Cartography and Head of the Department of Geography and Regional Research

The Research Group Population, Environment and Development also studies changes in spatial structures, regional development dynamics and demographic changes such as ageing processes and their consequences, focusing in particular on South and South-East Asia. In January 2016, Patrick Sakdapolrak took over as Head of the Group, as Helmut Wohlschlägl retired at the end of 2015. The new Professor of Population Geography and Demography recently analysed climate change, migration and social resilience of rural communities in Thailand. In future, Patrick Sakdapolrak's Group will focus on population dynamics at the interface of environmental change and social transitions.

Visualisation of geodata

Geography seeks to gain a comprehensive understanding of our physical and social world and all its interactions. Modelling processes and changes are a key tool in this regard. Vienna has a long tradition of research on the visualisation of geographical information. The Research Group Cartography and Geoinformation has gained international reputation with its work on the so-called hyperglobes. Bands of clouds move around the world in real time, continental drift can be seen in time-lapse, hot spots of greenhouse gas emissions become visible – digital technology has given the traditional globe a new face. By projecting digital geodata onto the globe, "we are able to increase the understanding of many different issues," say Head of the Research Group Cartography and Geoinformation, Wolfgang Kainz, and his colleague Andreas Riedl. In 2005, the University of Vienna was the first European research institution to present a tactile hyperglobe. Today, the globe's "library", developed together with different cooperation partners, includes over 300 geographical topics. At a price of approximately € 100,000 the globes are still too expensive for everyday use, but smaller, more affordable globes, onto which many dynamic phenomena of our planet can be projected, are already being developed.

Teaching Geography and Economics

The Research Group Didactics of Geography and Economics provides theoretical and practical training for the approximately 1,700 students who are studying to become Geography and Economics school teachers. "For us, didactics does not only represent the theoretical basis of successful schooling but also a research area in the field of social sciences," says Christiane Hintermann, who has been coordinating the Group since the spring of 2015. Researchers in this field discuss subject-related ideas as well as insights from didactics of related disciplines, educational science and practical work at school and adapt these insights so that they can be used for the education of future Geography and Economics teachers. The aim is for students to develop the ability to explain the theoretical basis of their decisions concerning teaching methods and content. While emphasis is currently placed on the key research areas of migration and diversity as well as textbook analysis, future research should increasingly focus on questions of political education, the integration of fundamental concepts of geography (such as place and space) into teaching and the implementation of competence-oriented curricula. The Group is also involved in the publication of the journal *GW-Unterricht* (www.gw-unterricht.at). It is very important to maintain national and international contacts and to cooperate with various partner schools.

"Geography is characterised by natural and social sciences. When it comes to solving problems, physical and human geography work hand in hand. This allows us to understand the complicated links and interdependencies that are so important today."

Hans-Heinrich Blotevogel, Professor of Applied Geography, Spatial Research and Spatial Planning

Department of Geography and Regional Research

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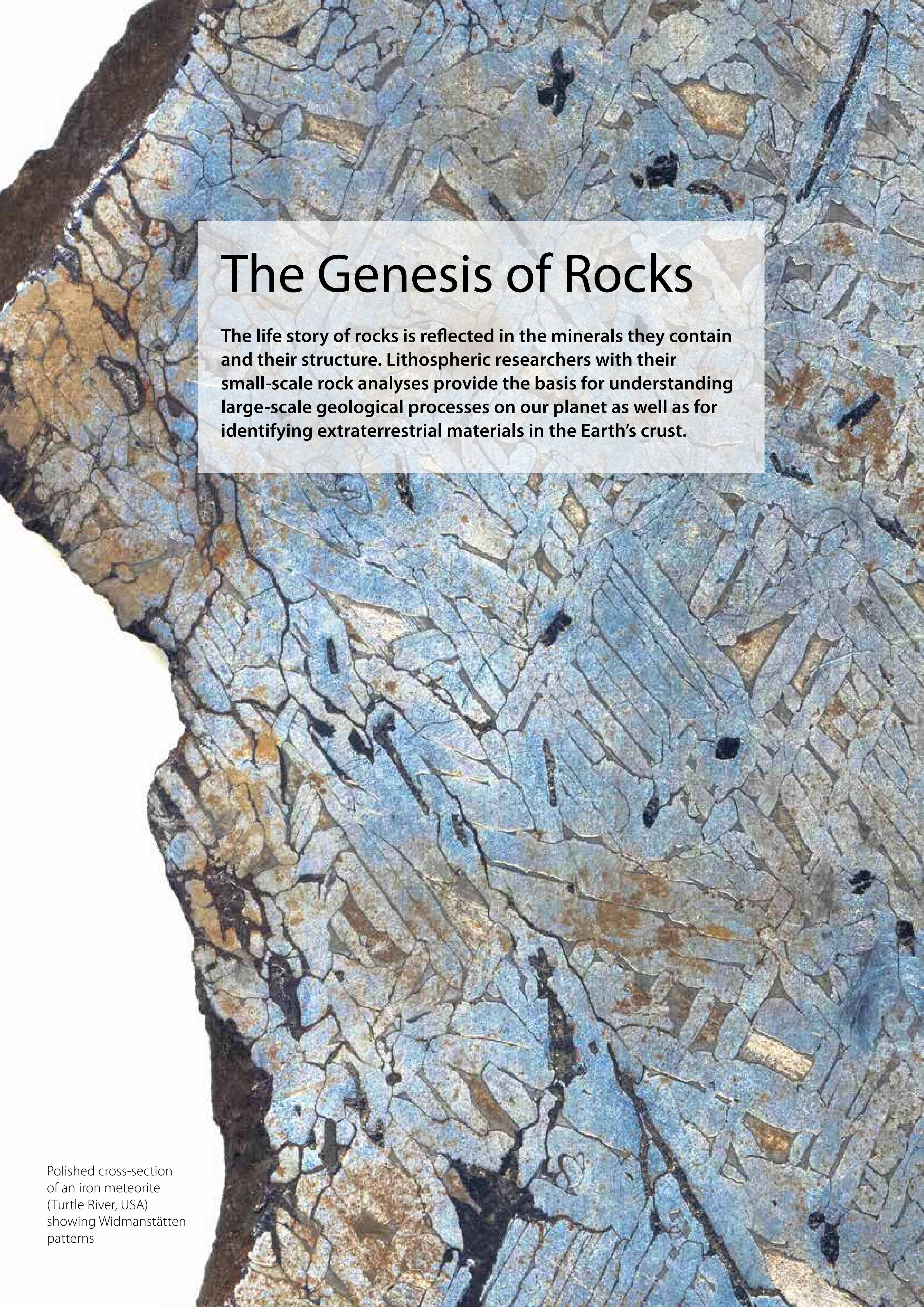
The Genesis of Rocks

The life story of rocks is reflected in the minerals they contain and their structure. Lithospheric researchers with their small-scale rock analyses provide the basis for understanding large-scale geological processes on our planet as well as for identifying extraterrestrial materials in the Earth's crust.



Polished cross-section of an iron meteorite (Turtle River, USA) showing Widmanstätten patterns

Landsat satellite image of the El'gygytgyn impact structure

"New analysis methods allow us to take the fingerprints of meteorites in impact rocks and draw conclusions about the nature of the impact bodies."

Christian Koeberl, Professor of Impact Research and Planetary Geology

In the far north-east of Russia, on the Siberian peninsula of Chukotka, lies the 18 km-diameter El´gygytgyn crater. The formation, which was created by a meteorite impact 3.6 million years ago, has long been the focus of scientific interest. El'gygytgyn is the only impact crater known on Earth to have formed in acid volcanic rocks. "This gives us the unique opportunity to investigate the shock effects of acid rocks by studying core samples," says Christian Koeberl, impact researcher and geochemist, who also serves as the Director-General of the Natural History Museum Vienna. With his Research Group Impact Research & GeoCosmoChronology at the University of Vienna, he has been involved in the "International Continental Scientific Drilling Program" (ICDP) project at El'gygytgyn since the beginning of the project. In a follow-up project funded by the Austrian Science Fund (FWF), the researchers analysed core samples taken from the crater lake and tried to find ways of distinguishing the volcanic bedrock from rocks influenced by the meteorite impact.

In 2016, another large ICDP and IODP (International Ocean Discovery Program) project will take the Viennese scientists to Yucatán, Mexico, to the famous Chicxulub impact structure. The impact of a particularly large asteroid that occurred there is widely considered the cause of the mass extinction event 65 million years ago that also resulted in the extinction of dinosaurs. The crater has been preserved in good condition, making it an important natural laboratory for impact research. In the new drilling project, the research partners – Christian Koeberl is one of the six principal investigators of the ICDP project – want to study the peak ring form of the crater and the behaviour of the rocks with regard to the impact as well as investigate the environmental changes caused by the impact, which are supposed to have led to global mass extinction.

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Drill rig with supporting installations on frozen Lake El'gygytgyn. The flags of all countries and institutions that supported the drilling project are visible.

From impact to geochemistry and cosmochemistry

In addition to impact research, Koeberl's Group also studies geochemistry and cosmochemistry: "We try to understand not only how impact craters are formed but also the physical, chemical and geological processes that are associated with the impact." To this end, the researchers use isotope analyses as well as geochemical and geochronological methods in dedicated laboratories. Recently, the Department was able to install the equipment for a method that is available only in very few places worldwide: osmium isotope analysis. It can be used to detect traces of extraterrestrial materials in the rocks affected by the impact. "It essentially gives us a kind of fingerprint of the impacting body," he explains.

Large meteorite impacts generally influence the material of the Earth's crust. This creates so-called impact breccias (fragments of various rocks that have subsequently become solidified in one piece) or melt rocks. Isotope analyses allow the researchers to detect the extremely small traces of extraterrestrial material – the majority of the meteorite is vaporised on impact – and distinguish them from the large amount of terrestrial rock. The largest class of meteors – chondrites – contain a considerably higher proportion of siderophile (or "iron-loving") elements than terrestrial rocks. This includes platinum metals such as iridium or osmium, which occur at a rate 50,000 times higher than in crustal rocks. By measuring the enrichment of the platinum metals and the ratio of elements to each other (e.g. the rhenium (Re) – osmium (Os) ratio and the ratio of the isotopes 187Os and 188Os to each other), researchers can show the presence and amount of extraterrestrial components in the impact rock. "This also allows us to draw conclusions about the type of meteorite we are dealing with," says Koeberl.

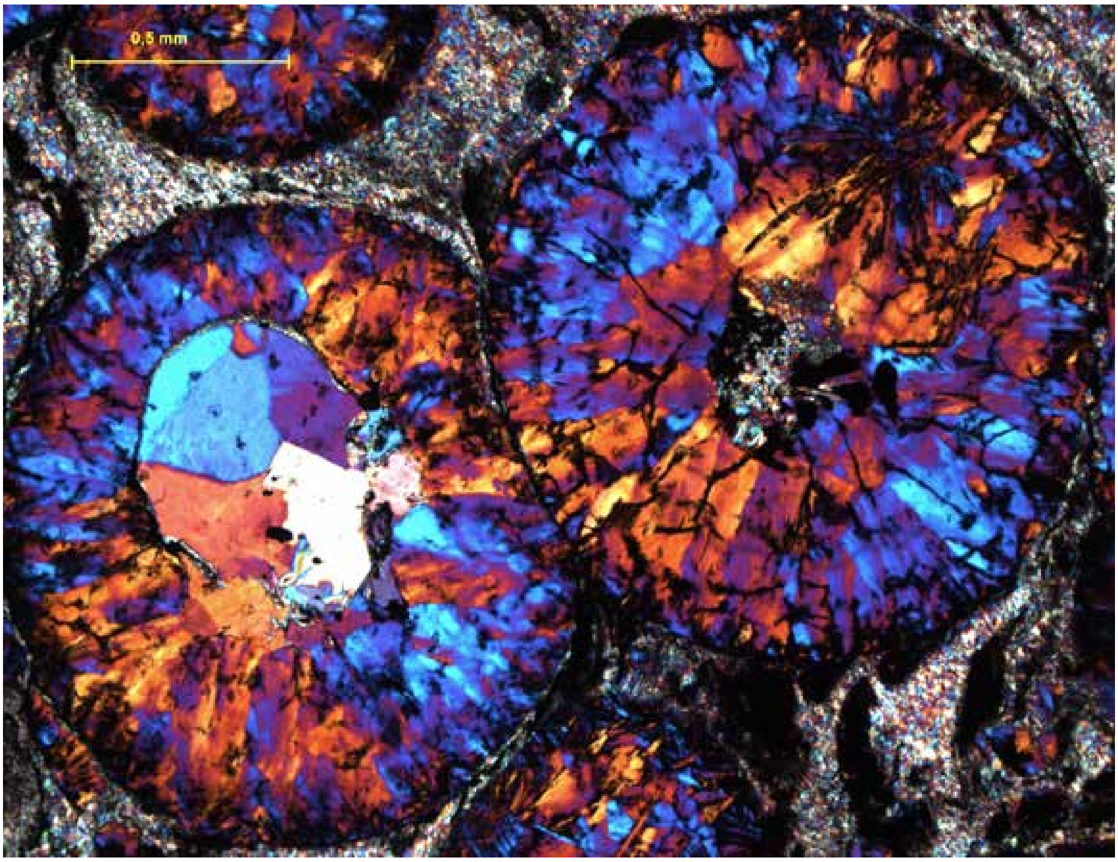
Rock analysis in the lab

The theoretical and experimental analysis of rocks, their properties and their formation history are the focus of the Research Group of the petrologist Rainer Abart: "Whether in terrestrial or lunar rocks, in meteorites, in slags from industrial smelters or in ceramics production: We are interested in all processes of rock formation," says the Head of the Research Group Petrology. Our focus, he says, is on the high temperature range, as found in the Earth's crust and mantle and applied in industrial processes.

In some ways, the work of the petrologist is similar to that of medical diagnostics: "Instead of taking tissue samples for histological analyses, we take thin rock cuttings for petrographic analysis," says Abart. Optical microscopes with a resolution of down to 1 micrometre "already give access to many useful diagnostic indicators on the formation history of the rock", he says. However, many structures in rocks are considerably smaller. Scanning electron microscopy allows the petrologists to access structures in the nanometre range. Electron microprobes and scanning electron microscopes also provide information on the chemical composition of the material as well as on crystal structures and orientations.

"Processes such as magmatic crystallisation, rock metamorphism or deformation happen at the atomic level but have far-reaching implications on all scales: Understanding the microscopic processes underlying rock formation allows us to predict the behaviour of the bulk material," Abart explains. Knowing how different types of rock react to changes in temperature and pressure is a prerequisite for understanding, e.g. tectonic plate movements.

Extraction of aluminium oxide crucible from a high-temperature furnace at 900°C



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Thin section photograph under crossed polarisers showing spherules from impact spherule layers in the Barberton Greenstone Belt, South Africa

Materials science for geomaterials

Abart's team regard their work as materials science focused on geological materials. Transferring concepts from materials science to geological systems was also the objective of the project "Nanoscale Processes and Geomaterials Properties" (2008-2016), which has been funded by the German Research Foundation (DFG) and the FWF. An interdisciplinary team studied how and at what rates substances move through geological material and how information about the formation of rocks is stored in their building blocks.

"We want to understand reaction mechanisms in geomaterials, particularly in the solid state, calibrate them experimentally and ultimately transfer them to natural rocks," says Abart, who directs the project together with Wilhelm Heinrich from the German Research Centre for Geosciences (GFZ) in Potsdam. In 2014, the researchers were able to create crystal orientation maps based on experiments on crystals under directional stress. They show by which mechanisms crystals grow at different pressures.

"For predicting the dynamics of the deep Earth, we need to understand the material it is made of."

Rainer Abart, Professor of Theoretical and Experimental Petrology

In cooperation projects with industry partners, Abart's Group also deals with artificial rocks such as refractories or slags. The focus is often on optimising production processes, e.g. in order to improve the high-temperature properties of ceramics . The principle is the same: The formation processes determine the material properties.

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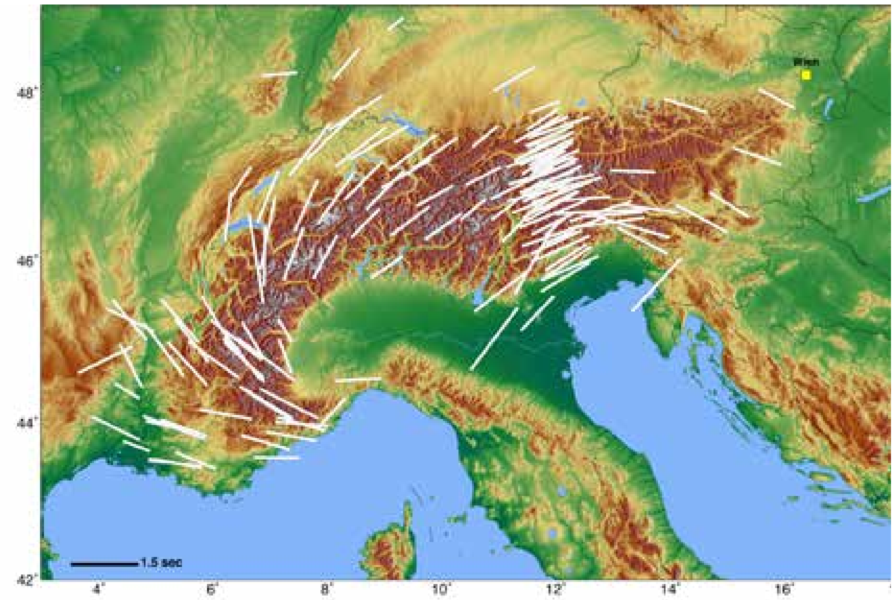
Department of Lithospheric Research

lithosphere.univie.ac.at

From the Sky Above Mountains into their Depths

The Alps are an important field of study for both geophysicists and meteorologists at the University of Vienna. The first group of researchers uses physical methods to analyse hitherto unexplored depths underneath the mountains, while the others record the unique characteristics of mountain weather and phenomena of climatic relevance.

Researchers from the Department of Meteorology and Geophysics apply mathematics and physics to study the solid earth and atmosphere system.



The Alps are a central object of research for the Research Group Geophysics, e.g. for deciphering the internal deformation within the mountain chain.

The geological history of the Alps is relatively well known: Several million years ago, the Earth's crust began rising as the result of a collision of the African and the European continents – and Europe's largest mountain chain is still rising. This sometimes results in earthquakes, which can be registered with highly sensitive seismometers. However, geophysics can also use the seismic waves generated by earthquakes to explore unexplored depths of the Earth's interior. The Research Group Geophysics led by Götz Bokelmann has already successfully used seismic waves to reconstruct large-scale deformation patterns in the subsurface of the Alps.

"Geophysics plays an important role in finding and dealing with natural resources and in understanding environmental and societal hazard issues such as seismic hazards and nuclear safety."

Götz Bokelmann, Professor of Geophysics

The researchers were able to determine these deformations based on what is called "seismic anisotropy": As a result of geodynamic processes and the deformations caused by them, mineral crystals orient themselves in certain direction inside the Earth. Their preferred orientation, in turn, influences physical properties, e.g. the characteristic double refraction of seismic waves. Based on the direction and speed with which the waves spread, "we can deduce the deformation geometry of the material in the Earth's interior," says Götz Bokelmann. He was, for example, able to show that the orientation of the crystals in the subsurface of the Alps is largely aligned with the mountain chain's topography, i.e. mainly the mountain ridges. "This is one of the clearest examples of mountain-chain-parallel anisotropy worldwide," says the geophysicist. The researchers also found systematic deviations that have not yet been explained. The study, which was published in 2014, has raised questions that are currently being studied in the large-scale European project AlpArray.

Seismology and safety

Modern geophysical methods allow researchers to gain insights into Europe's largest mountain chain in a way that has so far never been possible in the two centuries in which the Alps have been studied. AlpArray, which involves 18 countries, aims to use geophysics to survey the subsurface of the Alps more accurately than ever before. The Department of Meteorology and Geophysics is coordinating Austria's contribution to this project. AlpArray Austria is funded by the Austrian Science Fund (FWF). In 2015, a temporary network of mobile seismometers covering all of Austria was set up. Over the next two years, these seismological stations will record even the most minute ground motion data. "The data gathered in this project will also help us understand the earthquake hazard better," says Bokelmann.

Using geophysical methods to answer questions relevant to society is another goal of Bokelmann's Group: Currently, the team is, for example, assessing the seismic hazard in different regions of Austria, particularly in the larger Vienna region. In order to be able to evaluate the risk of future earthquakes, they examine stalagmites, i.e. stone formations that rise from cave floors, in flowstone caves. "If the stalagmites are intact, this means that in the last 10,000 to 20,000 years no earthquake has been strong enough to topple the stalagmites," the researcher explains. Based on the numerical modelling of their results, the team can determine the risk of earthquakes. Other projects include the development of geophysical methods that can be used to prove that nuclear weapon tests have been carried out underground (in cooperation with the Comprehensive Nuclear Test Ban Treaty Organization CTBTO). Furthermore, the team uses geophysical methods to evaluate the potential risks of different kinds of energy extraction, e.g. the recovery of natural gas from shale rock, or fracking.

Atmospheric analyses

The Research Group General Meteorology and Climatology at the Department of Meteorology and Geophysics specialises in weather phenomena in the mountains, particularly the Alpine region. The Group, which is led by Reinhold Steinacker, focuses particularly on diagnostic modelling, i.e. the question of how the current weather can be determined with maximum precision. To this end, the researchers have developed the Vienna Enhanced Resolution Analysis (VERA) method, "a pioneering project for the diagnostic high-resolution modelling in mountainous areas that has gained international recognition," says Steinacker.

Simply put, VERA can be used to analyse the weather in the Alpine region in real time. The

Earthquakes in Austria

system calculates the spatial distribution of air pressure, temperature, wind and precipitation and removes erroneous data automatically. It recognises both systematic errors caused by wrongly calibrated instruments and random errors resulting from transmission problems. VERA is, for example, used by the Austrian aviation weather service. Steinacker's Group is particularly interested in the

"Generally, the objective of meteorology is to improve weather forecasts. We focus on diagnostic modelling, because the better we know the current weather, the better we can predict what it will be like in the future."

Reinhold Steinacker, Professor of General Meteorology

IR thermometry is an important measurement tool in meteorological science to determine, e.g. the radiation temperature of snow-covered or snow-free surfaces as well as cloud base temperatures.

small-scale features of meteorological phenomena. The measuring instruments are installed at short distances, sometimes only 2 km, creating a dense network of surface stations in the areas they are surveying. In contrast, global weather models generally get their data from stations located at intervals of 25 to 30 km. "It has recently been shown that the integration of small-scale regional data sets into global models can have a positive impact on the quality of their forecasts," says Steinacker.

One of the special characteristics of mountain weather are so-called cold air pools. They can form temporarily in Alpine valleys and basins but particularly in dolines – characteristic sink-holes in limestone. Cold pools in such dolines are known for their extremely low minimum temperatures. A doline in the Ybbstal Alps at approx. 1,300 m is known for its historical record of -52.6°C, which is the coldest temperature ever measured in Central Europe. In a current project, the researchers have been able to determine that winter temperatures in the doline have not come close to the temperature in the record year 1932 over the last 10 to 15 years. One suspected reason for this – in addition to global warming – is a feedback loop between biosphere and atmosphere. Extremely low temperatures and a deep snowpack of up to 3.5 m are specific challenges for every measurement system. Dorninger, a member of the Group, developed the so-called MetLift system. It adapts the height of the sensors according to the snow depth automatically. This avoids snow-covering of the sensors. A prototype of the energy self-sufficient system is operated at the Trafelberg in Lower Austria since a couple of years.

Data read-out from temperature loggers during snow-rich winter time (approx. 2.5 m height of snowpack) in a sink-hole: The data are used to study the behaviour of cold air pools.

Discussion of scientific results and weather processes between students and professors

Numerical models and climate research

The Research Group Theoretical Meteorology focuses particularly on the observation and numerical modelling of how air flows over and around mountains. The meteorologists in this Research Group have investigated diverse phenomena such as island wakes, valley breezes and the waves generated by airflow over mountains.

Another research topic is the diagnostic measurement of climate changes and climate anomalies. In several FWF projects and the large-scale EU project ERA-CLIM2, meteorologist Leopold Haimberger is working on correcting data of the global radiosonde network in order to make it better suited for creating global atmospheric climate analyses over several decades. Climate analyses is used to measure global and regional energy transports between the atmosphere and the oceans. An understanding of these processes is fundamental for understanding changes in the climate system. Significant contributions have been made to relevant climate reports such as the IPCC report and the Austrian APCC report.

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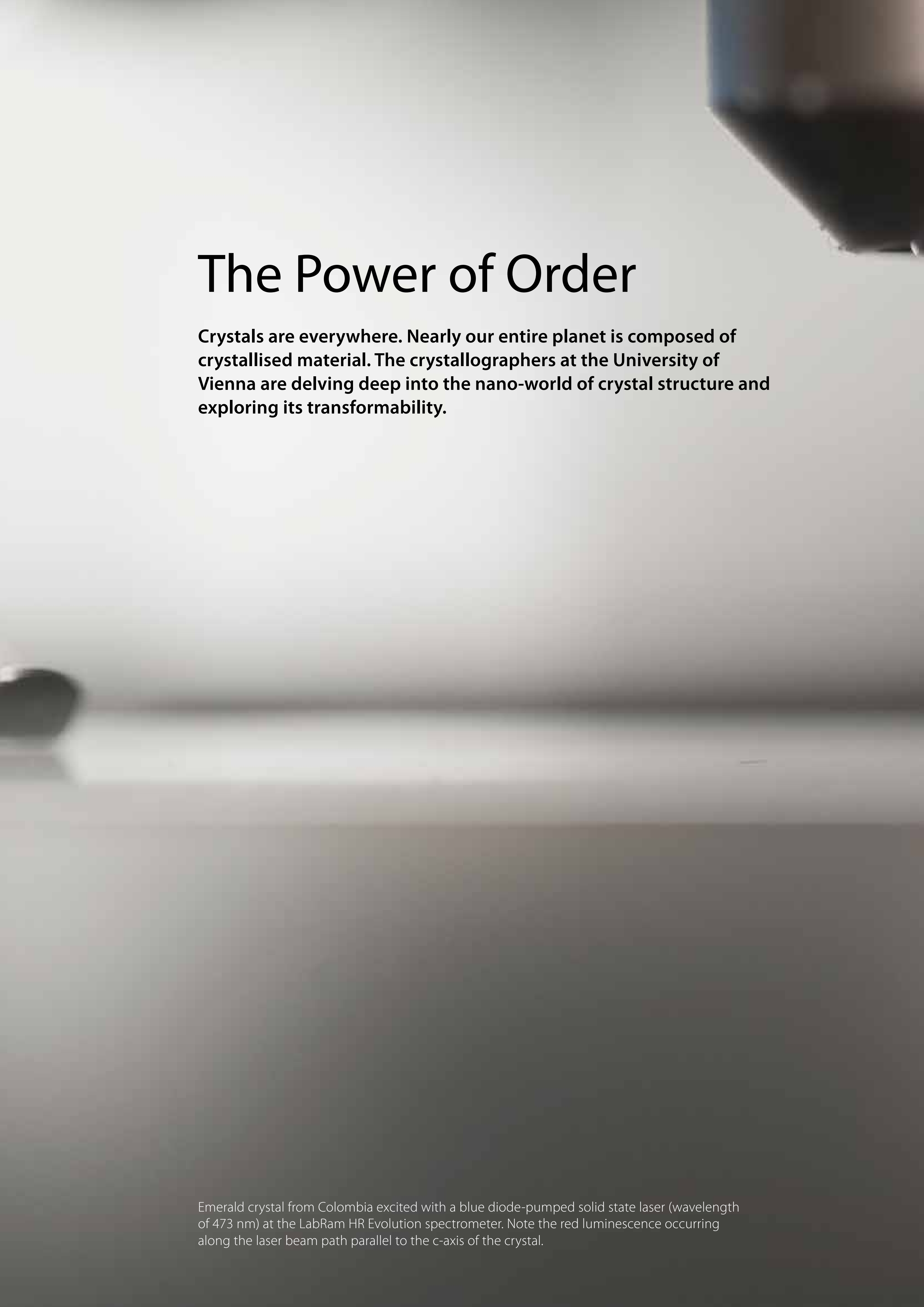
Department of Meteorology and Geophysics

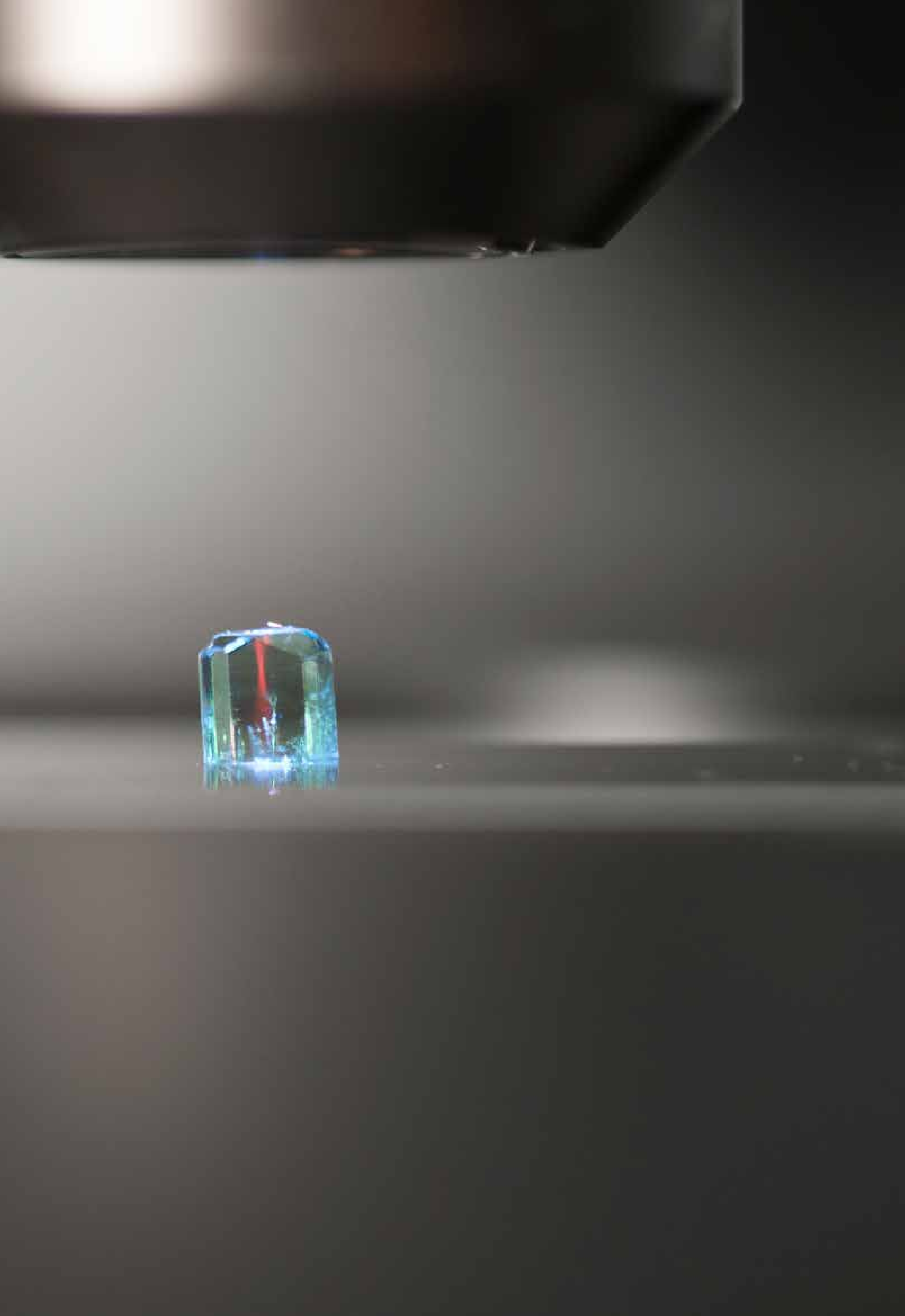
img.univie.ac.at

The Power of Order

Crystals are everywhere. Nearly our entire planet is composed of crystallised material. The crystallographers at the University of Vienna are delving deep into the nano-world of crystal structure and exploring its transformability.



Emerald crystal from Colombia excited with a blue diode-pumped solid state laser (wavelength of 473 nm) at the LabRam HR Evolution spectrometer. Note the red luminescence occurring along the laser beam path parallel to the c-axis of the crystal.



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Postdoc Martin Ende adjusts a diamond-anvil cell for an in-situ experiment collecting high-pressure Raman spectra at a Raman microspectrometer.

What makes car paint glitter and paper appear extra white, and why do glass ceramic hobs not break at high temperatures? The answer is crystals, or more precisely, their regular crystal structure with its atomic configuration. "The crystalline state has a number of specific properties that are often very useful, making it increasingly relevant for humankind," says Ronald Miletich, Head of the Department of Mineralogy and Crystallography. One of the key research areas of his Department comprise the analysis of the stability of crystals, their phase transitions and how the transition processes work.

Extreme conditions can change the crystal structure, i.e. the arrangement of atoms in a crystal. Even under "normal" conditions, crystals can be unstable, at times even fragile: Sometimes, even minute changes in ambient temperature or pressure can cause a transition in the crystal structure. This "phase transition", as researchers call it, changes the physical behaviour of the material.

In one project, the crystallographers at the University of Vienna are studying the behaviour of potentially toxic heavy metal hydrates, which are sometimes brought to the surface by pit water in mining areas. The results will allow researchers to better determine their potential danger for humans and the environment. Another group will study transition mechanisms of sulphate hydrates in exceptional conditions, like those on Mars, in a project granted by the Austrian Science Fund (FWF). The spectroscopic data of certain sulphate hydrates on our neighbouring planet still hold some mysteries for astrophysicists.

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Performing single-crystal X-ray diffraction under low-temperature conditions

Crystalline paths

About a century ago, Max von Laue discovered the diffraction of X-rays by crystals. This discovery gained him the Nobel Prize in Physics and started the era of modern crystallography. Since his discovery, X-ray structure analysis has been used to infer the arrangement of atoms in crystals and changes to this atomic configuration.

"Today, we are interested in the structure property relationships in crystals. With our experimental tools and computer simulations, we are now able to determine when crystal structures change," says Ronald Miletich, adding: "We understand the structure at the starting point and at the end, but we are not always clear on the details of the process between them." Miletich's Research Group Crystallography is increasingly focusing on the transition states of the crystal structure and their role in the phase transition. A focus has been placed on carbonates such as calcium carbonate, CaCO3, the mineral that forms the Limestone Alps – the mountain ranges of the Alps that stretch across Austria.

One of the highlights for the crystallographers at the University of Vienna in 2015 was the discovery of the probable stability range of a new high-pressure form of $CaCO_3$ – an important intermediary step in $CaCO_3$ transition in temperatures below 40°C and at pressure of geological relevance. The researchers discovered the significance of this phase in their laboratory experiments, shedding new light on the transitions of the calcite. In higher temperature ranges, the phase does not play a role under hydrostatic pressure, so the structural changes of the calcite and their processes remain a mystery.

"Over the last 20 years, we have started to investigate structure property relationships in crystals, as we want to know: Can you predict when which of the crystalline structures react, in what form and in which direction they change?"

Ronald Miletich, Professor of Mineralogy and Crystallography

“We make use of spectroscopy in order to analyse minerals. In simple terms, we illuminate them and analyse the reflection spectrum. With this method, we receive manifold information about minerals in the micrometer range.”

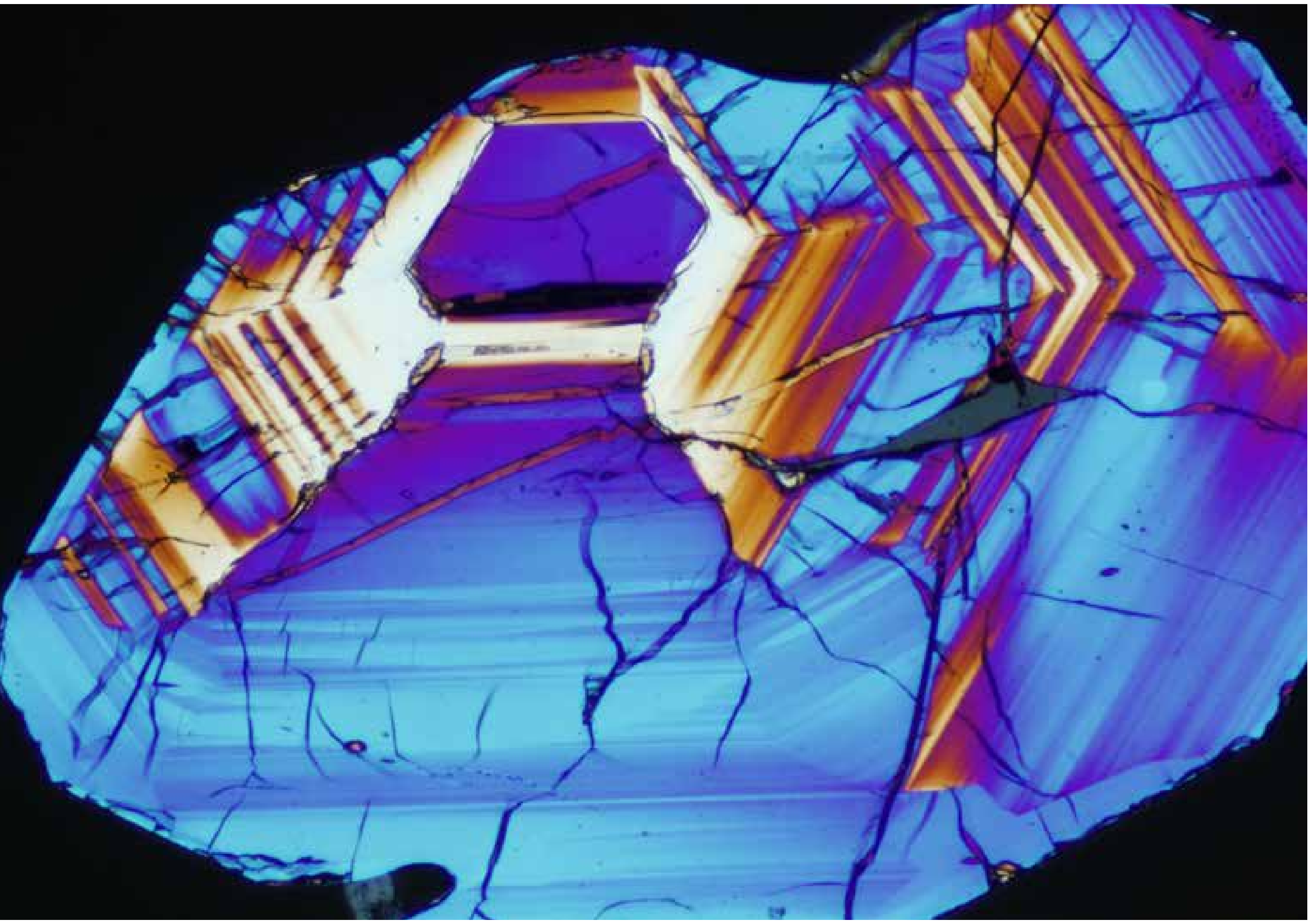
Lutz Nasdala, Professor of Mineralogy and Spectroscopy

Radiation damage & inclusions

How does the irradiation of minerals influence their structural composition? Which mechanisms underlie the colour changes of diamonds exposed to radioactive radiation, an effect that has long been used by the gem industry?

These are questions that the Research Group Mineralogy, led by Lutz Nasdala, seeks to answer. To find answers to these questions, the researchers are subjecting natural minerals and their synthetic analogues to ion beams to intentionally cause structural alterations. Their main tool is a Focused Ion Beam, or FIB, available at the Department. It is also used to prepare samples: The ion beam with extremely high energy can be used like a scalpel to cut minerals without influencing the material too much. The resulting cross-sections (“foils”) are used for irradiation experiments. This research is funded by the FWF via a project and is carried out in close cooperation with the Institute of Ion Beam Physics and Materials Research at the German Helmholtz-Zentrum Dresden-Rossendorf.

The researchers are also investigating the relationship between light and matter. The spectroscopic analysis of a diamond formed 600 km under the Earth’s surface that was found in Brazil caused a scientific sensation in 2014: An international team



Transmitted light image of a zoned zircon crystal from Plešovice, Czech Republic. The different degrees of self-irradiation of the individual growth areas over geological time have led to intense cracking.

Sigrid Reiter, working on her master's thesis at the Department of Mineralogy and Crystallography, changes the sample in the Paar HTK1200 high-temperature camera, preparing a temperature-resolved XRD measurement under controlled atmospheres of up to 1,200°C.

of researchers, including Lutz Nasdala, was able to prove that there is water in the Earth's interior, disproving an over thirty-year-old hypothesis. An inclusion of just 1/30 mm in the diamond contained the rare high-pressure mineral ringwoodite. The Department's Raman spectrometer helped provide the first direct evidence of the terrestrial occurrence of this mineral phase. The water in the crystal lattice of the ringwoodite was found by colleagues from Bavaria. The results were published in the scientific journal *Nature*.

Gems can also be used in research: Zircons are used as reference material for geochronology, i.e. for determining the age of rocks. "Zircon is extremely resistant and, at the same time, it occurs in small quantities in nearly all rocks," Lutz Nasdala explains. Due to its special properties, zircon can be used for the uranium-lead dating method, which analyses the isotope ratio of the two materials. Currently, the researchers are analysing two high-quality zircons in cooperation with globally leading laboratories with the goal of providing new reference material for dating.

Modern mineralogy

For their analyses, the mineralogists and crystallographers use state-of-the-art equipment: Ion beam probes, highly sensitive detectors and strong X-ray sources are just three examples. Mineralogy and crystallography not only make use of modern technology – they are themselves part of the technological progress.

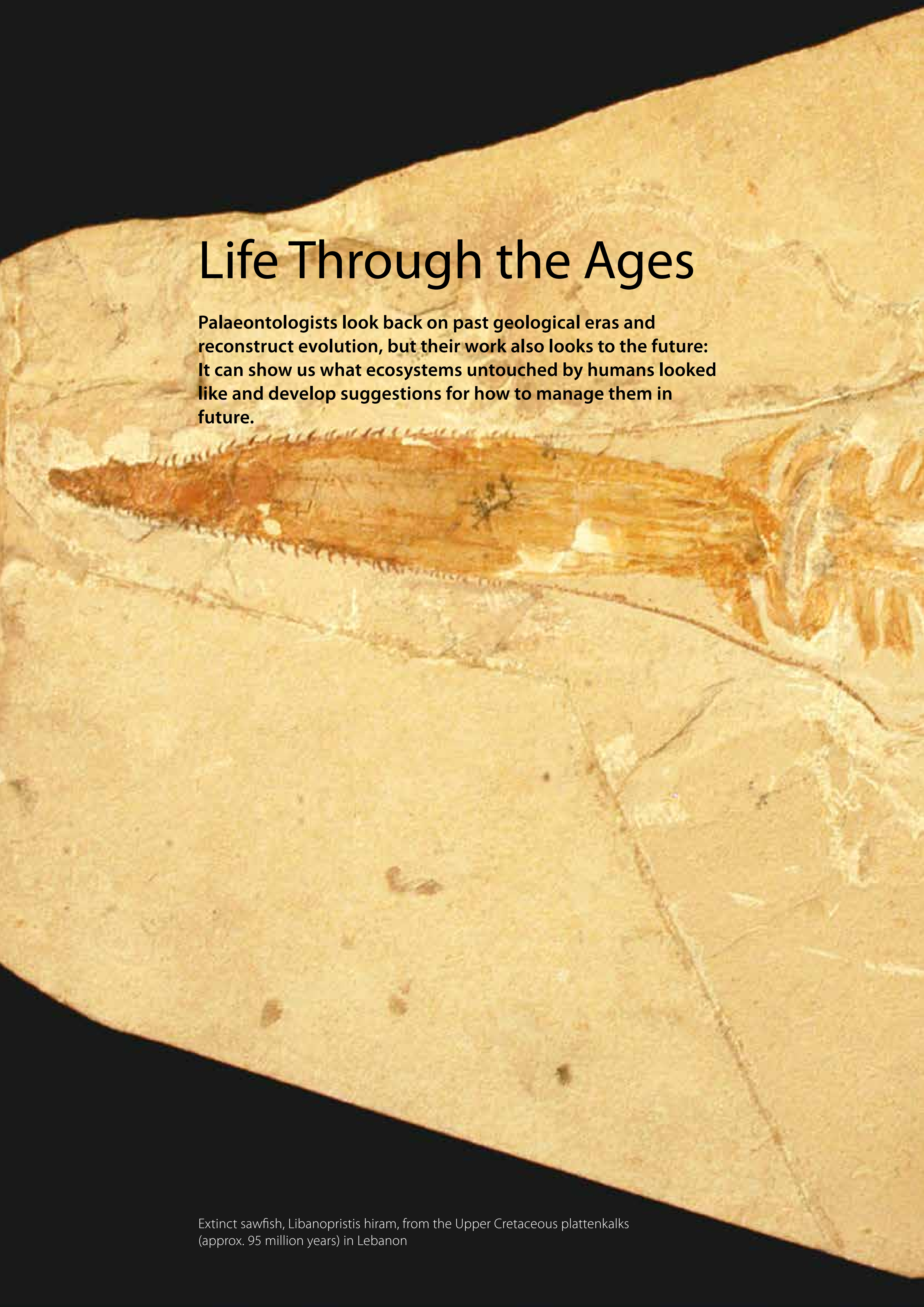
For a German version, go to fgga.univie.ac.at

Department of Mineralogy and Crystallography

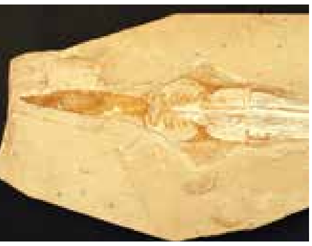
univie.ac.at/Mineralogie

Life Through the Ages

Palaeontologists look back on past geological eras and reconstruct evolution, but their work also looks to the future: It can show us what ecosystems untouched by humans looked like and develop suggestions for how to manage them in future.



Extinct sawfish, Libanopristis hiram, from the Upper Cretaceous plattenkalks (approx. 95 million years) in Lebanon



How did the form of animals evolve? How did their skeletal structures and adaptations emerge? How can the development of vertebrates be reconstructed? These are some of the questions that Jürgen Kriwet and his Evolutionary Morphology Research Group study. The researchers move back and forth between the present day and the past millions of years. In order to understand the evolution of life and the different adaptations of species, they also have to study organisms living today.

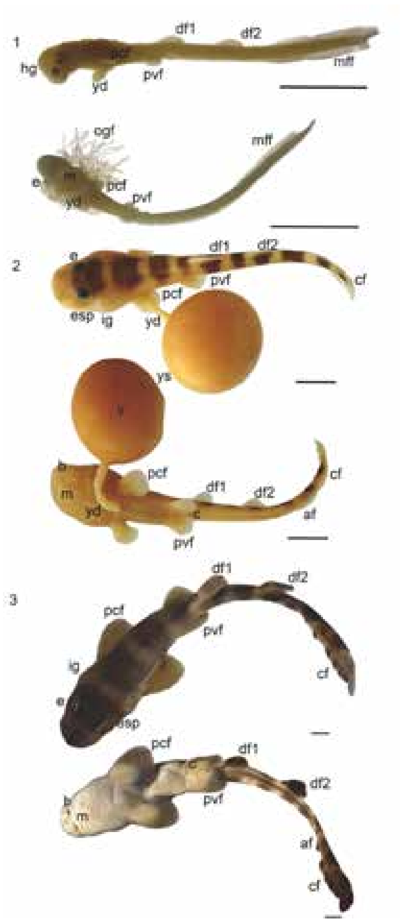
"How does evolution work? What causes functional traits to develop? What causes genetically and epigenetically determined adaptations? Our research on the inner ear has shown that this is an organ where we can make distinctions."

Jürgen Kriwet, Professor of Palaeobiology with Special Emphasis on Vertebrate Palaeontology

Hear, hear!

The inner ear allows us to hear – but it also contains the organ responsible for balance. Its anatomy varies between species depending on how they move. Cathrin Pfaff from Kriwet's Group was able to demonstrate this in a study on squirrels in 2015. Gliding species have thinner semicircular canals than ground-dwelling species. The researchers are now planning to examine whether marsupials, birds and cartilaginous fish also exhibit a correlation between anatomy and locomotion mode. Pfaff explains that the goal is "to compare data from modern species with those from fossils". This will allow them to determine how long-extinct species moved. According to Jürgen Kriwet, the reconstruction of

Rare fossil material (e.g. the oldest known cat, *Proailurus lemanensis*, from Quercy, France) can be investigated non-invasively with high-resolution micro-CT scanning (Bruker/Scyscan 1173).



Various embryonic (1-2) and juvenile (3) stages of bamboo shark *Chiloscyllium punctatum*. The scale corresponds to 1 cm.

the inner ear over millions of years has already been successfully completed for cats. The starting point was a Pseudaelurus fossil – one of the oldest cats in the world.

A micro-CT at the Department and modern image analysis methods give researchers insights that would have been impossible to gain only a few years ago. Additionally, they can now make 3-D images and reconstruct the morphology of different body parts at an extremely high resolution without physically damaging the samples. Using special staining methods, even muscles, soft tissue and the nerve cells can be made visible. The micro-CT is also useful for the second key research area of the palaeobiologists: understanding processes of developmental biology in an evolutionary context.

Evolution and individual development

"Ontogeny recapitulates phylogeny." In 1866, Ernst Haeckel postulated this biogenetic rule, according to which the prenatal development of an individual repeats the evolutionary history of its species in a very short time. This was long a controversial position. "Today we know that there is a clear connection," says Jürgen Kriwet. His team studies these connections, entering uncharted waters: Kriwet's Group is currently studying the individual development of shark embryos. For example, they want to understand how their jaws develop and compare them to fossil records.

Very little is known about the evolution and adaptation of teeth or the differences between species. "Cartilaginous fish are the oldest jaw-bearing vertebrates still living today. Based on them, we can try to find out what things look like at the base of the vertebrate family tree," says Jürgen Kriwet. He and his team are cooperating with international institutions, including the Natural History Museum in London, the Okinawa Churaumi Aquarium and British and Japanese researchers. In 2015, Kriwet and Pfaff were able to show from the analysis of fossilised rays and sharks that their jaw teeth are not directly evolved from their external skin denticles – disproving an earlier hypothesis.

"The fascinating thing about palaeobiology is the connection between life on Earth today and life on Earth in past ages. And sometimes it can even help us think about the life that will come."

Petra Heinz, Professor of Palaeoecosystems

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PhD student Julia Wöger with images of foraminifera from the image analysis

"By using palaeontological methods, we can gain insight into environmental conditions decades or centuries ago. That allows us to better assess the current situation and make predictions for future changes."

Martin Zuschin, Professor of Palaeontology

The state of the environment then and now

Essentially, the Viennese palaeobiologists have already succeeded in describing part of the evolutionary history of vertebrates. The Research Group Palaeoecosystems, led by the Head of the Department, Petra Heinz, on the other hand, focuses on reconstructing marine ecosystems from past eras. Marine habitats are also one of the areas of research of Martin Zuschin's Research Group Environmental Palaeontology: The researchers use palaeontological methods to study environmental changes in marine ecosystems in order to evaluate the current state. Their research is centred on the Persian Gulf and the Northern Adriatic. Environmental palaeontologist Zuschin specialises in shell-bearing invertebrates such as bivalves (mussels) and gastropods (snails), whose dead shells are dated with radiometric and other methods.

"By comparing living and dated dead fauna, e.g. in terms of size, distribution and diversity, we can draw conclusions on environmental conditions and their change over long periods of time," says Zuschin. In 2015, postdoc Paolo Albano studied the impact of oil rigs on the environment in the Persian Gulf (Arabian Gulf) by analysing molluscs and their remains on the sea bed. He was able to show that oil rigs have considerably less impact on the marine environment during normal operation than is usually assumed.

In the Northern Adriatic

In the Northern Adriatic, the researchers went even deeper to understand the condition of the ecosystem and its changes. In addition to analysing the top layer of the sea bed, they also took core samples. In areas with very little sedimentation, a 1.5-metre core sample was enough to depict the entire Holocene – the last approx. 10,000 years. In contrast, core samples taken in areas with a very high degree of sedimentation, such as the Po Delta, cover just about 100 years.

During their dives and underwater expeditions, the researchers studied sedimentation and pollution in seven different locations and compared the current biodiversity with the faunal development of subfossil mussels, snails, etc. One of their findings was that the communities of species are different now than they used to be. Many changes occurred as a result of rising sea levels during the Holocene, but researchers also identified anthropogenic changes in environmental conditions as causes. Their research forms the basis for potential rehabilitation measures: We now have indications of what a "healthy" Northern Adriatic looked like. An important finding of their studies is that fishing by pulling dragnets across the ocean floor, as has been done in the Northern Adriatic for decades, is currently the largest danger for the ecosystem. Without trawling, there would be the potential for self-regulation.

Migration on the ocean floor

In another study, doctoral candidate Rafal Nawrot was able to show how the migration of fauna from the Red Sea via the Suez Canal to the Mediterranean works and why large bivalves are particularly successful. "This study shows what has been happening in the last decades and allows us to predict how the fauna will develop in future," says Zuschin. Although palaeobiology often looks to the past, it can also help develop plans for the future.

For a German version, go to fgga.univie.ac.at

Department of Palaeontology

univie.ac.at/Palaeontologie

A diver collects sediment samples to assess the impact of oil platforms on the environment in the Persian (Arabian) Gulf.

Studying at the “Faculty for Exploration“

The Faculty of Earth Sciences, Geography and Astronomy is one of the most diverse faculties, covering not only all aspects of space and geosciences but also all aspects of interactions between our Earth’s environment and humans. The Faculty currently hosts more than 3,000 students. If you are interested in our research areas and want to benefit from our wide range of degree programmes, you should definitely join us.

Our degrees encompass five bachelor’s and ten master’s programmes (three of which are held in English) as well as a couple of doctoral programmes. The Faculty’s courses range from studies for future Geography and Economics teachers to master’s programmes in natural sciences such as Astrophysics, creating opportunities for explorers of the cities on Earth to the cities of stars beyond our galaxy. This exciting mélange creates an atmosphere that lifts the spirits and enhances intellectual perspectives. The curricula are inspired by our research. Direct contact with top researchers is a characteristic feature of most of our programmes.

As a student at the Faculty for Exploration you will be mapping gender equality or migration patterns in Geography, tackling environmental pollution in Environmental Sciences, measuring climate change in Meteorology, assessing seismic activities and the probability of earthquakes in Geosciences, and, in Astrophysics, study the formation and evolution of stars, planets and galaxies. A favourite among students are excursions, which are an important component of all courses in the FGGA. Excursions take teaching staff and students to remote mountains and exotic cities as well as to more familiar places closer to Vienna, which are about to be (re-) discovered from a scientific perspective. Furthermore, our programmes distinguish themselves by research-driven teaching and an international atmosphere. State-of-the-art research and teaching facilities will make you deal with frontline issues from day one. As our alumni/ae have impressively shown, graduates from our Faculty work around the world, taking decisions in executive positions, or they have become successful entrepreneurs.

Studying at our Faculty also offers you the unique opportunity to join an inspiring academic community, as Vienna is the largest German-speaking university city with 180,000 students, half of which study at the University of Vienna. As a vibrant, young and growing city at the crossroads of the east and the west as well as the north and the south, Vienna has a long tradition of culture and cultural exchange. The city boasts a fabulous climate with warm, sunny summers and beaches along the river Danube or the Danube channel crossing the city centre. There are plentiful opportunities for outdoor activities in Vienna and the Danube valley, along the shores of the nearby Lake Neusiedl or the Alps.

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Bachelor's programmes:

- Astronomy
- Earth Sciences
- Geography
- Meteorology
- Teacher education programme in Geography and Economics

Master's programmes:

- Astronomy
- Environmental Sciences (interdisciplinary programme held in English)
- Earth Sciences
- Geography
- Cartography and Geoinformation
- Meteorology
- Physics of the Earth (Geophysics) (international joint master's programme held in English)
- Regional Research and Regional Planning
- Urban Studies (in cooperation with international educational institutions, held in English)
- Teacher education programme in Geography and Economics

Doctoral programmes:

- Astronomy
- Earth Sciences
- Environmental Sciences
- Geography
- Geophysics
- Meteorology

Further information:
StudiesServiceCenter Earth Sciences, Geography and Astronomy
ssc-geo-astronomie.univie.ac.at

International Programmes in English

Joint master's programme in Physics of the Earth (Geophysics)

This new programme started in the winter semester of 2015. It is jointly hosted by the University of Vienna and the Comenius University in Bratislava. The degree programme focuses on mathematical and physical methods and on quantitative methods relevant to the physics of the Earth. Students learn to observe phenomena in the physical environment and to describe them using mathematics.
imgw.univie.ac.at

Master's programme in Environmental Sciences

Environmental Sciences takes an interdisciplinary approach to the investigation of processes that control the earth environment. Chemical, physical, biological, and geoscientific concepts and methods are applied to experimental work and field observations to arrive at a molecular scale mechanistic understanding and quantitative modeling of these processes.
envsc.univie.ac.at

Joint master's programme in Urban Studies (4CITIES)

As an immersive, two-year, interdisciplinary Erasmus Mundus Master Course in urban studies, 4CITIES takes students to six universities in four capital cities: Brussels, Vienna, Copenhagen, and Madrid. The programme incorporates geography, sociology, cultural studies, and additional fields covering the complexity of cities and urbanity. 4CITIES is organised within the Network of Universities from the Capitals of Europe and co-funded by the EU's Erasmus+ Programme.
raumforschung.univie.ac.at/en/lectures-study/master-urban-studies-4cities
4cities.eu

Master's and training programme "OeRISK – Risk Prevention and Disaster Management"

Since the winter semester of 2015, the University of Vienna has been offering a new master's programme (MSc) in Risk Prevention and Disaster Management in close cooperation with a subunit of the Austrian Ministry of the Interior that is concerned with National Crisis and Disaster Protection Management (SKKM – Staatliches Krisen- und Katastrophenschutzmanagement). Shorter certificate courses focusing on selected modules of the master's programme are also available. Its overall aim is to offer practitioners a training programme concentrating on the overarching topics in the general field of risk prevention and disaster management.
oerisk.at

Research Infrastructure

Cutting-edge research and in-depth exploration of different phenomena on Earth and in space demand state-of-the-art research infrastructure. At our Faculty, you find a broad range of research equipment and technology combined with high expertise.

How does the transportation of organic or inorganic elements take place in diverse media and at different scales? How do minerals react to impacting factors like stress or high temperature? What are the key features of different geomaterials and geological processes? Where do chemical elements come from? How are stars born? Our research groups often focus on elementary questions and utilise diverse instruments, methods as well as modelling and simulation techniques. The Faculty's equipment portfolio encompasses devices from various fields of scientific analysis, from microscopy, spectrometry, chromatography and diffraction to soil property analysis and sample preparation. It comprises field devices such as terrestrial 3-D laser scanners and seismometers and instruments for observational astronomy, e.g. CCD cameras. Recently, the Faculty has launched a new dedicated web page to give more visibility to the equipment of the eight departments.

Large-scale research facilities

Our five **special focus facilities** of the Faculty cover the following fields:

- Electron probe microanalytics
- Environmental pollutant and nanogeoscientific analytics
- Geochronology/isotope geochemistry
- X-ray diffraction analytics
- Environmental biogeochemistry of stable isotopes

Furthermore, the Faculty owns a 1.5 m and a 0.8 m telescope.

You can find more information on the large-scale facilities and on the Faculty's research equipment portfolio on our website: fgga.univie.ac.at

There is also a number of large-scale facilities at the Faculty, such as electron microscopes, ion beam applications, mass spectrometers, a multitude of X-ray diffractometers, and a state-of-the-art Multi Collector-Inductively Coupled Plasma Mass Spectrometer (MC-ICP-MS). These have been pooled in five special focus facilities and are accessible for all faculty members. At the same time, the special focus facilities as well as a 1.5 m and a 0.8 m telescope owned by the Faculty are open for cooperation and utilisation outside the Faculty.

Furthermore, high-performance computing is possible through access to computer clusters, including the Vienna Scientific Cluster VSC-3 of a consortium of Austrian universities.

The high standard of research infrastructure and related expertise at the Faculty for Exploration is also characterised by top-level international cooperation and participation in large international programmes. For instance, our researchers participate in and lead research projects in the context of the European Southern Observatory (ESO), the European Space Agency (ESA), the Copernicus European Earth Observation Programme and the International Continental Scientific Drilling Program.

Apart from international cooperation, the Faculty attaches great importance to cooperation within Austria, particularly in and around Vienna, and within the University of Vienna. In this way, synergies can be used to align high-cost infrastructure. Overall, the Faculty aims at providing its researchers and students with the best possible infrastructure so that research and study conditions can be competitive at an international level.

Clean lab facilities of the geo-/cosmochronology section at the Department of Lithospheric Research

© ESO/L. Calçada

Artist's impression of the European Extremely Large Telescope (E-ELT) in its enclosure on Cerro Armazones in Chile's Atacama Desert. Astronomers of the Faculty coordinate and work on the development of three instruments for the E-ELT.

Financial Support

Our Faculty has established various financial support programmes and initiatives focusing on the **promotion of research and excellence**, the promotion of young researchers and the advancement of women in science. The promotion of research and excellence is based on financial support granted for topics or projects that explicitly serve the purpose of promoting third-party funded activities, visibility, publication efforts or excellence. The aim of our **support programme for those returning from parental leave** is to enable women in a postdoc position to resume their research activities quickly after having received a child and to minimise any disadvantages women might face in their academic career. The programme for the **promotion of early stage researchers** supports postdocs and predocs primarily through partial or full coverage of travel expenses for conferences, workshops and international events. The underlying goal is to give young researchers the possibility to build and expand their individual networks and increase their chances of employability. With its financial support programme for **women in science**, the Faculty aims at advancing the career of female postdoctoral researchers.

Public Outreach

In the past, the eight departments of the Faculty of Earth Sciences, Geography and Astronomy have undertaken various efforts to strengthen their public outreach increasingly encouraging the general public to take an interest in science. The Department of Astrophysics, for example, regularly offers guided tours to the University of Vienna Observatory (Universitätssternwarte) and the Great Grubb Refractor (Austria's largest lens telescope) as well as the public lecture series *Nachts auf der Sternwarte ...* (at the University of Vienna Observatory at night …). The Department of Geography and Regional Research offers presentations of the Hyperglobe to interested parties all around the year, organised by the Head of the Hyperglobe Research Group Andreas Riedl. Further activities encompass the Departments' engagement in public events such as *Die lange Nacht der Forschung* (the long night of research) and media activities. To further strengthen the public outreach of the entire Faculty and to provide insight into ongoing research activities to interested people, such as potential students and young scholars, the Faculty has launched the *Faculty for Exploration initiative*. This includes a complete redesign of the Faculty's website and the development of a research portal to make information on research activities and projects available to the general public.

© Fabrizio De Rossi

Reconstruction of the Austrian dinosaur, Struthiosaurus austriacus, which was discovered 1855 at Muthmannsdorf, Austria

© T. Exel

Joint Initiatives

The Environmental Sciences Research Network

The careful use of our planet's resources and the responsible stewardship of the environment form the basis for sustainable development. Environmental sciences provide the scientific background for responsible decision-making by politicians and society. Emphasis is placed on how to protect the environment, how to restore ecosystems and how to manage life on Earth. There is a broad range of different research groups at the University of Vienna that deal with environmental research questions: We have excellent basic research in various departments and institutes related to this field, from research carried out in the humanities and social sciences to research activities in physics, chemistry, life sciences and geosciences. To respond to the growing complexity of environmental issues and to connect the various research groups, the Environmental Sciences Research Network (ESRN) that is led by Thilo Hofmann (Deputy Head: Gerhard Herndl) was established in 2014. The founding faculties were the Faculty of Earth Sciences, Geography and Astronomy, the Faculty of Life Sciences, the Faculty of Chemistry and the Faculty of Physics. The Environmental Sciences Research Network (*Forschungsverbund Umwelt*) brings together researchers from a variety of disciplines, ranging from isotope research to geography, from hydrology to law, and it is open to all researchers dedicated to environmental sciences at the University of

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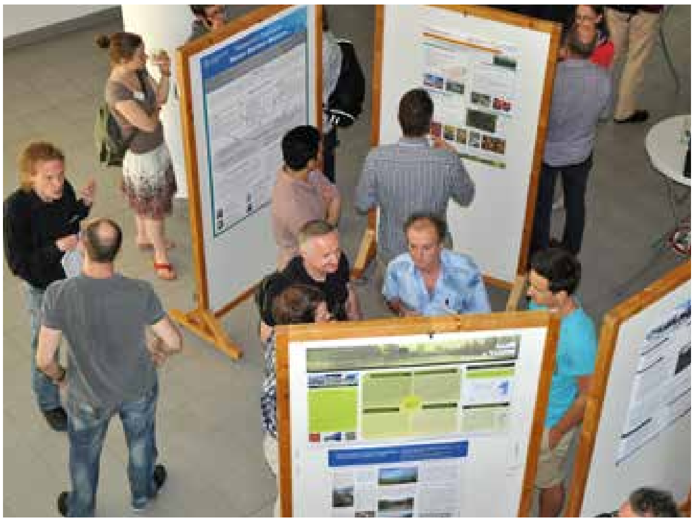


Getting together and discussing with scientists from other fields: In 2015 the Environmental Sciences Research Network organised an internal as well as an external kick-off meeting and two flash talk workshops.

© R. Brünjes

Only eight minutes per talk: Almost 20 research groups of the University of Vienna presented their environmental studies and scientific activities in flash talks in the course of two workshops held in 2015.

Around 100 scientists from 11 out of 15 faculties of the University of Vienna joined the Environmental Sciences Research Network by December 2015. More than 40 research groups are represented.

Vienna. The ESRN promotes networking between researchers in different faculties, supports cooperation through joint scientific activities and research projects, and coordinates teaching activities. Its overall goal is to stimulate cutting-edge research and to increase the internal and external visibility of environmental sciences at the University of Vienna, being one of the leading universities in this field.

umwelt.univie.ac.at

Research Platforms and Centres

Cooperation across borders and joint activities are the focus of various research platforms and centres at the University of Vienna. Researchers from our Faculty are also involved in these platforms and centres.

The **Vienna Metabolomics Center** represents a multidisciplinary platform for comprehensive experimental and theoretical metabolomics analysis. The VIME research consortium comprises internationally renowned laboratories at the University of Vienna that are located at various faculties such as the Faculty of Life Sciences, the Faculty of Chemistry and the Faculty of Earth Sciences, Geography and Astronomy.

metabolomics.univie.ac.at

The **Research Platform Nano-Norms-Nature** brings together scientists from geosciences, ethics and law in order to explore recent developments in nanoscience using an interdisciplinary approach. Its work is based on interdisciplinary standards and focuses on the nano-nature interface.

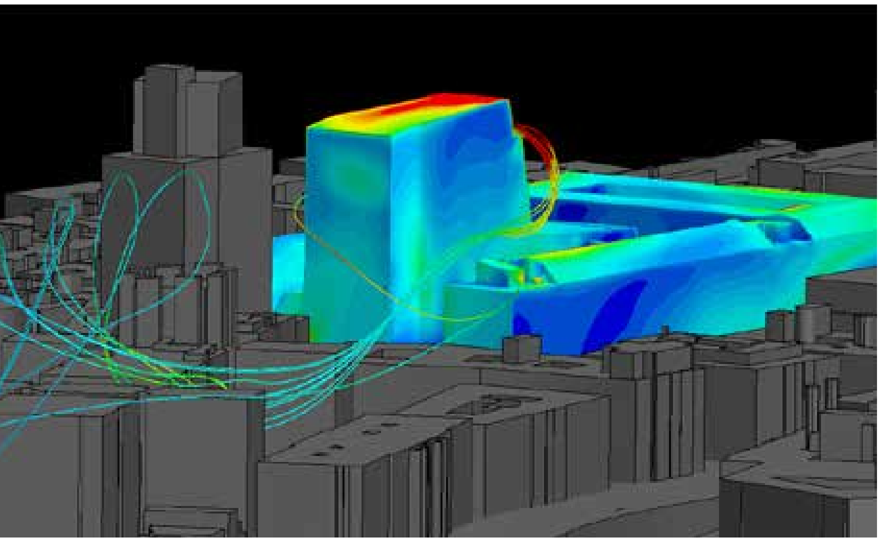
nano-norms-nature.univie.ac.at

CIRDIS, the university-funded **"Center for Interdisciplinary Research and Documentation of Inner and South Asian Cultural History"**, has been crucial in facilitating cooperation among a variety of disciplines, in particular Tibetan studies, Buddhist studies, South Asian studies, social and cultural anthropology, history of art, numismatics, philosophy, archaeology, Iranian studies, Chinese studies and geography. It aims at continuing and expanding CIRDIS by building on and improving the existing high-quality infrastructure of documentation and archiving, and by carrying out innovative research projects focused on the wider Himalayan region.

univie.ac.at/cirdis

University Spin-offs & Start-ups

How do research results find their way into practice? How can innovations, driven by science, enter the market? Spin-off and start-up companies play an important role in generating economic value on the basis of scientific knowledge. Here, we present three successful companies founded by meteorologists of our Faculty.



© Weatherpark

Wind fields around a building

Weatherpark

The three meteorologists Simon Tschannett, Matthias Ratheiser and Wolfgang Gepp met during their studies at the Department of Meteorology and Geophysics. For more than 11 years, they have now been successfully running Weatherpark, Austria's leading company for urban climatology and wind research. Weatherpark offers developers, architects, urban planners and individual apartment or house owners various services comprising consulting, compilation of studies and action planning in the fields of wind comfort, human comfort and micro-climate while also dealing with specific meteorological questions. Weatherpark has, for example, carried out a wind comfort study for the new main railway station in Vienna.
weatherpark.com

MetGIS

MetGIS is a spin-off company of the University of Vienna founded by the meteorologists Gerald Spreitzhofer and Stefan Sperka. The company delivers highly specialised innovative meteorological services, focusing on the worldwide prediction of mountain weather. It operates a powerful, automated forecast system. Based on some of the most advanced technologies, this allows highly detailed real-time predictions for the world's most important mountain ranges in horizontal resolutions of less than 100 m. The predictions are available in graphically excellent representation via www.metgis.com but also via a set of recently developed application programming interfaces (APIs). These allow the easy inclusion of MetGIS forecast data into external information systems (websites, apps, etc.).
metgis.com

© Stefan Sperka/MetGIS GmbH

MetGIS focuses on the worldwide prediction of mountain weather.

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Lightning Detection Sensor (Copyright: UBIMET/nowcast)

UBIMET

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Retirements

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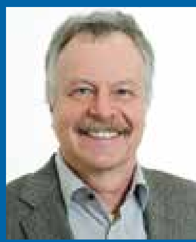

Gerhard Hensler was Full Professor at the University of Kiel in Germany until he joined the University of Vienna in 2003 as Full Professor of Theoretical Astronomy at the Department of Astrophysics (formerly Department of Astronomy) – a position he held until 2015. He led the Research Group Galactic Chemodynamics, which numerically investigates different aspects of the chemical and dynamical evolution of galaxies by means of numerical simulations. Gerhard Hensler was Dean and Vice-Dean of the Faculty of Earth Sciences, Geography and Astronomy and also led the Department of Astrophysics. Currently retired, he still works for the University as scientific advisor and is still a member of several international commissions.

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From 1991 to 2014, **Helmut Wohlschlägl** was Professor at the Department of Geography and Regional Research (since 1999 Full Professor). Until recently, he led the Research Groups Regional Geography and Didactics of Geography. He conducted research on socio-demographic transformation processes and population change in South-East and East Asia, on megacity development as well as on migration and globalisation in South-East Asia. From 1992 to 2010, he was Head of the Department of Geography and Regional Research (formerly Department of Geography) and from 2000 to 2004 Director of Studies and Vice-Dean of the former Faculty of Human and Social Sciences. In 2015, he was elected President of the Austrian Geographical Society.

Professors Leaving

Vanda Grubišić, Director of the NCAR Earth Observing Laboratory in Boulder (CO, USA), was Professor of Theoretical Meteorology at the Faculty's Department of Meteorology and Geophysics until the end of June 2016.

Until mid-July 2015, **Jörn Peckmann** was Professor of Sedimentology and Stratigraphy at the Faculty's Department of Geodynamics and Sedimentology, before he joined the Institute for Geology at the University of Hamburg (Germany).


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