United Nations
Educational, Scientific and
Cultural Organization

International Geoscience
Programme
Austria

ÖSTERREICHISCHE
AKADEMIE DER
WISSENSCHAFTEN

AUSTRIAN CONTRIBUTIONS TO UNESCO´S INTERNATIONAL GEOSCIENCE PROGRAMME (IGCP)

Summary Report for 2017

Open pit of the Williamson Diamond Mine (Tanzania). Photo: C. Hauzenberger

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1. NATIONAL COMMITTEE ACTIVITIES AND FUNDING:

In 2011 the Austrian Academy of Sciences has started the reorganization of its international research programmes. IGCP is now part of the new reseach structure "Earth System Sciences (ESS)" and responsibilities of IGCP were overtaken by the new "National Committee for Geo/Hydro Sciences".

Personnel structure of the Austrian National Committee for Geo/Hydro Sciences:

Chair: Prof. Dr. Werner E. Piller, University of Graz, Institute for Earth Sciences (Geology and Palaeontology), Heinrichstrasse 26, A-8010 Graz, Austria. Phone: +43-316 380-5582¸ Fax: +43 316 380-9171; werner.piller@uni-graz.at; http://erdwissenschaften.uni-graz.at/mitarbeiter/personal/homepages/piller/index_de.php

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Members of the Austrian Academy of Sciences:	Prof. Dr. Werner Piller
	Prof. Dr. Dieter Gutknecht
	Prof. Dr. Christoph Spötl
The Ministry of Science, Research and Economy:	Dr. Karolina Begusch-Pfefferkorn
The Ministry of European and international Affairs:	Botschafter Mag. Stephan Vavrik
Austrian Commission for UNESCO:	Secretary General Mag. Gabriele Eschig
Austrian Geological Survey:	Mag. Klaus Motschka
Austrian Universities:	Prof. Dr. Ewald Brückl
	Prof. Dr. Steffen Birk
	Prof. Dr. Günter Blöschl
	Prof. Dr. Helmut Habersack
	Prof. Dr. Susanne Muhar
	Prof. Dr. Hans-Peter Nachtnebel
Natural History Museum Vienna:	Dr. Alexander Lukeneder
Other governmental institutions:	Dr. Robert Holnsteiner
	Dr. Christine Jawecki
	Dr. Reinhold Godina
	Oberst Günter Wendner

In 2017 the funding for IGCP, provided by the Austrian Ministry for Science, Research and Economy, was

EURO 80.000,- = US$ 96.003,-[1]

[1] Exchange rate per 02/01/2018

This funding is entirely used for research projects.

2. CURRENT RESEARCH PROJECTS WITHIN THE FRAMEWORK OF IGCP:

In 2017 four research projects were carried out:

IGCP-596 Conodont biostratigraphy and occurrence data of Mid-Paleozoic corals in Mongolia and Europe ("Mid Paleozoic conodonts and corals")
Project manager: E. KIDO, Institute for Earth Sciences (Geology & Paleontology), University of Graz.

IGCP 596 concerns the relation of Mid-Paleozoic biodiversity patterns and climate change. During the Devonian and Carboniferous periods, a series of global crises in the marine ecosystem are documented. One of causes during the Mid-Late Devonian had its origin in the development of rooted landplants. That development led to enhanced weathering and soil production, which resulted in an increased nutrient load and pollution of marine environments. Both, the rapid evolution of terrestrial ecosystems and climate change (like Middle Devonian greenhouse conditions or the Late Devonian/Early Carboniferous cooling event) had a strong influence on biodiversity globally.
Aim of IGCP 596 is to identify the cause of ecological turnover during Devonian extinction events, and see how marine and terrestrial communities responded. Because of the complexity of the investigation of paleoenvironmental conditions, analysis follow a multidisciplinary approach including high-resolution stratigraphy, geochemical and geophysical techniques as well as sedimentological and paleontological study. The reconstruction of biodiversity patterns of Devonian climate sensitive organisms, i.e. the behavior of fossil groups during times of global crises, might give interesting results that can become useful even for our future, as from the fossil record long term biotic response is preserved.
One of the most important climate sensitive fossil groups are corals. Datasets obtained from the Paleobiology Database show that rugose corals for example, experienced a drop in diversity since the late Middle Devonian, from previousely more than 760 species during the Eifelian and Givetian climax, which resulted in about 380 species during the Frasnian, and less than 90 species during the Famennian. The initial recovery fauna after the Kellwasser crisis at the Frasnian/Famennian boundary was a cosmopolitan, low diversity rugose coral fauna, which is called the *Cyathaxonia* fauna. It is represented by small, simple-structured solitary corals that are interpreted as ahermatypic of the cold and aphotic zone. Rebound of colonial rugose corals took even until the late Famennian.

Late Devonian phacopid trilobites from the Samnuuruul Formation (Western Mongolia). Photo: T. Suttner

However, the record of Devonian coral species available via the Paleobiology Database is biased (not all literature is entered; mainly localities of non-developing countries are explored of which most of them are located on the southern hemisphere Perigondwana realms).
Within the submitted proposal we focus on Devonian deposits of the Baruunhuurai Terrane in western Mongolia, an area of which nearly nothing is known. Outcrops are located close to the border of China and consist of Eifelian to Famennian deposits of the Baruunhuurai Formation and the Samnuuruul Formation. According to recent advances in tectonic research of the Central Asian Orogenic Belt (CAOB), it turned out that the Baruunhuurai Terrane, as part of an oceanic island arc complex in mid-latitudes of the northern hemisphere, is one of the key areas for biodiversity study of Mid-Late Devonian fossils. Initial field trips resulted in large fossil collections including plants, corals, trilobites, crinoids, brachiopods and bryozoans. However, a Mid-Late Devonian age of marine deposits has been suggested based on identification of macrofossils. No high-resolution microfossil biostratigraphy was applied until now. A proper age determination of the Devonian sedimentary sequence in western Mongolia would provide a good base for further study of macrofossil biodiversity. In Late Devonian sections of the Samnuuruul Formation corals of the *Cyathaxonia* fauna occur abundantly. Application of conodont biostratigraphy could clarify the age of this fauna in Mongolia and would enable to compare Mongolian species with those developed in Europe and elsewhere.

IGCP-*609* **Climate-environmental deteriorations during greenhouse phases: Causes and consequences of short-term Cretaceous sea-level changes**
Project manager: M. WAGREICH, University of Vienna
See also: http://www.univie.ac.at/igcp609/

IGCP-609, a 5 year UNESCO-IUGS project, investigates sea-level changes during extreme greenhouse climates. The recent rise in sea-level in response to increasing levels of atmospheric greenhouse gases and the associated global warming is a primary concern for society. Evidence from Earth's history indicate that ancient sea-level changes occurred at rates an order of magnitude higher than that observed at present. To predict future sea-levels we need a better understanding of the record of past sea-level change. In contrast to glacial eustasy controlled mainly by waxing and waning of continental ice sheets, shorttime sea-level changes during major greenhouse episodes of the earth history are known but still poorly understood. The global versus regional correlation and extend, their causes, and consequences of these sea-level changes are strongly debated.

Cretaceous lateritic paleosoils and cave sediments at a quarry in Eastern Austria denoting large paleokarst systems during the Late Cretaceous. Photo: M. Wagreich

IGCP609 addresses correlation, causes and consequences of significant short-term, i.e. kyr to 100s of kyr, sea-level changes during the last major greenhouse episode of earth history, the Cretaceous (145 Ma – 66 Ma). The long-term sea-level record, i.e. 1st to 2nd order cycles occurring over millions to tens of millions of years, is controlled by the internal dynamic history of the Earth. The changing rates of ocean crust production led first to long-term sea-level rise, high stands, and then decline during Cretaceous times. However, superposed shorter-term, 3rd to 4th order (kyr to 100s of kyr), sea level changes are recorded in Cretaceous sedimentary sequences. The mechanisms for these are highly controversial and include brief glacial episodes, storage and release of groundwater, regional tectonism and mantle-induced processes. Recent refinements of the geological time scale using new radiometric dates and numerical calibration of bio-zonations, carbon and strontium isotope curves, paleomagnetic reversals, and astronomically calibrated time scales have made major advances for the Cretaceous. Major international efforts such as EARTHTIME, EARTHTIME-EU and GTSnext programs are improving the Cretaceous time scale to yield a resolution comparable to that of the Neogene. It is now for the first time possible to correlate and date short-term Cretaceous sea-level records with a resolution appropriate for their detailed analysis.
This project will investigate Cretaceous sea-level cycles in detail in order to differentiate and quantify both short- and long-term records within the new high-resolution absolute time scale based on orbital cyclicity. The time interval for study begins with the first major oceanic anoxic event (OAE 1a) and terminates at the end of the Cretaceous. It includes the time of super-greenhouse conditions, the major oceanic anoxic events, the Cretaceous Thermal Maximum and the subsequent cooling to ordinary greenhouse conditions.
The first major goal is to correlate high-resolution sea-level records from globally distributed sedimentary archives to the new, high-resolution absolute time scale, using sea-water isotope curves and orbital (405, 100 kyr eccentricity) cycles. This will resolve the question whether the observed short-term sea-level changes are regional (tectonic) or global (eustatic) and determine their possible relation to climate cycles.
The second goal will be the calculation of rates of sea-level change during the Cretaceous greenhouse episode. Rates of geologically short-term sea-level change on a warm Earth will help to better evaluate recent global change and to assess the role of feedback mechanisms, i.e. thermal expansion/contraction of seawater, subsidence due to loading by water, changing vegetation of the Earth System.
The third goal will be to investigate the relation of sea-level highs and lows to ocean anoxia and oxidation events, represented by black shales and oceanic red beds, and to evaluate the evidence for ephemeral glacial episodes or other climate events. Multi-record and multi-proxy studies will provide a high-resolution scenario for entire sea-level cycles and allow development of quantitative models for sea-level changes in greenhouse episodes.

IGCP-630 Sedimentological and Paleontological response of Microbialites reefs to pH changes in the aftermath of the Permian-Triassic mass extinction ("PTB Microbialites and pH")
Project manager: S. RICHOZ, Institute of Earth Sciences (Geology and Palaeontology), University of Graz.

The greatest mass extinction of Earth life, the end-Permian extinction (EPE) resulted in dramatic elimination of >90% marine species and >70% of land life. The giant carbonate platform present all around Pangea during the Permian suffered dramatically and the prolific skeletal carbonate factory was abruptly replaced by a non-skeletal carbonate factory. After the mass extinction, microbial communities recolonized the normal marine realm of the oceans margin in a great variety of forms and settings, containing a microfauna, not very diversified but sometimes abundant. The Early Triassic displays at least four main events of carbonate deposition in form of microbial communities or microbial by-products (e.g. oolites or wrinkle structures). The full recovery of complex metazoan reefs was largely delayed until Middle Triassic time. The aftermath of the end-Permian mass extinction not only witnesses a major crisis in carbonate systems but also experienced large-scale perturbations of the global carbon cycle as shown

by important variations in carbon, calcium and boron isotopes records. These microbial deposits consequently developed under complex and changing environmental conditions.

Giant Microbialite (see hammer for scale) at Vedi section, Armenia. Photo: S. Richoz

Although the presence of Permian-Triassic Boundary Interval (PTBI) microbialites is well-known, a continuing problem is the precise determination of the conditions of growth and the processes leading to a non-obligatory calcification. It is unclear by which peculiar environmental conditions microbialites growth was favoured. It has been shown than the microbialites grew in stable oxic conditions and thus changes should originate from other parameters.

Oceanic water acidification is often cited, beside anoxia, as cause for the EPE. A new study, where boron isotopes, a proxy for paleo-pH variations, were measured on samples of the United Arab Emirates shows, however, that no oceanic acidification occurs at the end-Permian extinction as awaited. But it happened later, around the base of the Isarcicella isarcica conodont Zone, the third conodont zone after the extinction. An alkalinisation occurs as well before the extinction interval and stays more or less constant through it. This acidification level at the base of the I. isarcica Zone could correspond to the end of the first microbialites event of the Lower Triassic. But this is still a working hypothesis and one of the objectives of this project is to date more precisely, by conodonts and carbon isotopic stratigraphy, the end of this first microbialites in several sections in Turkey, Iran and Armenia.

A sedimentological and micropalaeontological survey of these sections will be made with a peculiar focus on the upper part of the interval. Before the finding of this acidification event in the I. isarcica Zone, we did not pay much attention at eventual changes occurring in the upper part of the microbialitic interval which could announce it and at its overlying non-microbialitic sediments. Field observations and focused resampling of the upper part of the microbialites complexes will be necessary for most sections (Turkey, Armenia and Iran). Normative counting of microfossils in thin sections will be operated.

The new boron isotope study shows a relative higher alkalinity during the extinction and its direct aftermath. This can have a clear impact on the microbialites which are non-obligatory calcificiers. Some preliminary tests on microbial microfacies have shown that in some cases the different components (filling micrite, filaments, biomicrite, etc.) can have a difference in _13C of up to 1‰, meanwhile other cases show no difference at all. A more systematic carbon isotopic analysis of the different types of microbialites is clearly required. Calcium (_44/40Ca) and Magnesium (_26Mg) isotopes will help us to further better constrain the carbon cycle. So we will attempt to describe and understand the different geochemical patterns of the different microbialite types. In combination with a high resolution sedimentological and paleontological approach, it should help to decipher processes in microbialites formation and in water

chemistry changes, especially in the carbon cycle, on shallow shelves in the aftermath of a major mass extinction and during the post-extinction oceanic acidification.

IGCP-630 Continental Crises of the Jurassic: Major Extinction Events and Environmental Changes within Lacustrine Ecosystems. Subproject Late Mesozoic lacustrine systems in Tunisia and their global correlation (IGCP 632 Lacustrine Systems)

Project manager: B. SAMES, Department of Geodynamics and Sedimentology*, University of Vienna.*

IGCP 632 focuses on the interactions between major events and climate, and the correlations between the evolution of ancient lacustrine ecosystems and the marine realm during the Jurassic Period. Particularly poorly understood is the role of zonal climate belts in the greenhouse world and how the major events of that period are expressed along meridional climate gradients. The project offers new insights into the timing and causes of major perturbations in the evolution of life on Earth, covering the entire Jurassic to the development of Early Cretaceous lake systems.
Jurassic to Lower Cretaceous lacustrine sedimentary archives provide a major tool to reconstruct palaeoclimate evolution during changing Mesozoic greenhouse climate. Relative to the widely known marine record the continental high-resolution palaeoclimate evolution is poorly known and a target of recent international geoscience programs and projects.
Mesozoic continental to marine transitions and their stratal equivalents are known from Tunisia, where transgressions and regressions onto the essentially stable Saharan Platform and coeval tectonics produced a complex pattern of basins and islands that where inhabited by tetrapod dinosaurs and other vertebrates, and provide ample lacustrine and fluviatile facies.

Panoramic view of Jebel Chemsi (Gafsa region, sounthern Central Tunisian Atlas) from the south with Hauterivian to Albian, successions. Photo: B. Sames

The proposed project aims to solve the following research questions:

1) What precise stratigraphic age have lacustrine limestone strata of the late Mesozoic in Tunisia?
2) What facies and biota characterize the lacustrine limestones?
3) What is the source of lacustrine fine-grained material?
4) Are these lacustrine systems controlled by regional tectonics or by global palaeoclimate and sea level changes?

The following methods will be applied: To unravel stratigraphic ages we combine biostratigraphy of continental lacustrine carbonates using mainly ostracods and charophytes, in combination with strontium isotope stratigraphy of (frequent) marine intercalations using marine fossil shell material. Detailed microfacies investigations on fine-grained lacustrine limestones will be applied using thin sections. The source of the lacustrine fresh-water fine-grained material remains enigmatic up to now. This project will look into the micro- and nanofacies of these fine-grained limestones by using thin sections and smear slides under light microscope and broken fresh rock surfaces and slides in electron microscopy (REM). This will give indications of whether the fine-grained matrix is of inorganic origin or organic origin. In addition, analyses of stable isotopes of carbon and oxygen will be used to characterized the limestone matrix and to give hints to the origin of the calcite. Using refined stratigraphy and ages of lacustrine limestone intervals and marine interlayers, and the stratal evidence of large and small transgression-regression cycles, we will reconstruct the development of deep-lake facies in time and their relation to global eustatic sea-level changes, thus contributing to the debate on possible ice during greenhouse times of the Mesozoic and the aquifer or limno-eustasy hypothesis of continental groundwater storage fluctuations, bridging a gap in knowledge on today's global change and sea-level rise.

3. SELECTED IGCP-RELATED PUBLICATIONS

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4. GEOPARKS

The National Committee decided to take the responsibilities for the Geopark Program in Austria. This decision is supported by the Austrian UNESCO Commission and by the Austrian Ministry of Science and Research. The Austrian IGCP National Committee is currently discussing the structure and personell composition of the Austrian Geoparks Forum as well as its collaboration with the National Committee.

CURRENT STATUS OF AUSTRIAN GEOPARKS

Approved by the Global Geoparks Network:

- *Carnic Alps* (approved 2012)*:*
  The Geopark Carnic Alps is situated in the south of Austria and borders Italy. It includes two west-east orientated mountain ranges of 140 kilometers length, the Carnic Alps and the Gailtal Alps. They are

separated from each other by the Lesach Valley and its eastern continuation the Gailtal Valley. In total the Geopark covers an area of approx. 830 km^2 and is inhabited by 19.600 people.
The Carnic Alps represent one of the very few places in the world in which an almost continuous sequence of Ordovician to end-Permian age has been preserved. In the Gailtal Alps the largest plant fossils of Austria, the petrified trees of Laas, have been preserved.
On more than 80 Geosites, along 5 Geotrails and in the visitor center in Dellach the geological heritage of the region can be explored.

Link: http://www.geopark-karnische-alpen.at/

- *Nature Park Steirische Eisenwurzen* (approved 2002)*:*
  The Nature Park Eisenwurzen, located in the Austrian province of Styria, is part of the Northern Calcareous Alps. Geotourism has a long tradition in the area. As early as 1892 the Kraus Cave of Gams, one of the most splendid gypsum-bearing caves of Europe and the first one in the world with electric light, was opened to the public. In recent times, the adventure of experiencing 250 million years of Alpine history has given new impulses to tourism in the region, which has suffered from extreme depopulation in the past decades.
  Scientists have been aware of the magnificent geology of the region since the early 19th century. It might be mentioned that one geological time interval (about 235 to 230 million years ago) of the Triassic period has been named the Anisian stage after a section of rocks close to the Enns River, which was called Anisius fluvius in Roman times. These comprise two permanent exhibitions: the museum of the Second Vienna Water Supply Line, which benefits from karstic springs in the area, and the GeoCentre of Gams, which provides an overview of the regional geology.
  In November 2015 the Global Geoparks Bureau has reconfirmed Eisenwurzen Global Geopark's continuing membership of the Global Geoparks Network for a further four-year period.

  Link: http://www.geoline.at/

- *Karawanken-Karavanke* (approved 2013):
  This trans-boundary geopark connected and divided by the mountain range with the same name includes several Austrian and Slovenian municipalities. The Geopark is located between two Alpine mountains that exceed 2,000 metres: the Peca and the Košuta. It is marked by the rich, geological variety between the Alps and Dinarides. The area covers 977 km² and is inhabitated by approx. 50.400 people. The Geopark area includes thirteen municipalities (8 in Austria, 5 in Slovenia): Feistritz ob Bleiburg/Bistrica nad Pliberkom, Črna na Koroškem, Dravograd, Gallizien, Globasnitz/Globasnica, Mežica, Bleiburg/Pliberk, Prevalje, Ravne na Koroškem, Zell/Sele, Neuhaus/Suha, Bad Eisenkappel/Železna Kapla, Sittersdorf/Žitara vas.

  Link: http://www.geopark.si

- *Ore of the Alps* (approved 2014):
  The Geopark „Ore of the Alps“ in the district of Pongau near Salzburg is mainly situated in the Graywacke Zone (Palaeozoic clastic rocks rich in mineral deposits) of Austria. The northern fringe of the Geopark belongs to the Northern Calcareous Alps, the southern one to the Central Alps. The most important rocks of the three geological units are slates, graywackes, phyllites, limestones and dolomites. These rocks are often covered by quaternary sediments (till, silt, gravel) of the Salzach glacier. The morphological inventory is manifold. Carbonate cliffs, waterfalls, gorges, springs, rock falls, earth pillars, terraces, cirque lakes, roche mountonées etc. are detectable. But most important for the Geopark are the ore deposits. Copper ore, but also iron and gold forms the basis of former mining, which starts at prehistoric time. The history of copper began in the Bronze Age at the “Arthur-Stollen” (Arthurs mine). Today mining is history – but the memory of this long-lasting mining tradition in the

core of the Geopark is still alive in public mines, mineral museums and traces in the nature. However it comes hand in hand with the responsibility, to secure the former mining activities as a common heritage of man for the future. Furthermore, this region is famous for the skiing area “Hochkönigs-Winterreich”, the annual ski jumping competition in Bischofshofen at epiphany and the wonderful recreation area of the “sun-terrace” of St. Veit/Goldegg, where in ancient times miners were busy, to prospect minerals. The Geopark offers a diversity of GEO, nature, culture, wellness, culinary and adventure.

Link: http://en.geopark-erzderalpen.at/

Vienna, 17/01/2018, G. Köck