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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 2019

Lower Cretaceous (Hauterivian to Albian) shallow to marginal marine–non-marine succession at Jebel Chemsi, Gafsa region, central Tunisia, beautifully exposed in this anticline structure. Photo: B. Sames

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1. NATIONAL COMMITTEE ACTIVITIES AND FUNDING:

Since 2011 IGCP-Austria is part of the new research structure "Earth System Sciences (ESS)" and responsibilities of IGCP were overtaken by the new "National Committee for Geo/Hydro Sciences". ESS, an initiative of the Austrian Academy of Sciences (ÖAW), financed by the Federal Ministry of Education, Science and Research (BMBWF), aims at studying the physical, chemical, hydrological, biological, social, technological and economic processes of the Earth System and their interaction. ESS is an interface between Austrian science and international research and is directly integrated in international research programmes and cooperation (e.g. UNESCO´s MAB, IGCP and IHP programmes, WCRP, UNISDR, LTER, ISCAR, Future Earth) through its three National Committees *Global Change*, *Geo/Hydro-Sciences*, and *Man and the Biosphere (MAB)*. These NCs, made up of renowned scientists and representatives of several ministries and federal organizations, monitor the Austrian research scene, analyse its strengths and knowledge gaps and work out targeted new research foci.

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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	Prof. Dr. Christoph Spötl
The Ministry of Education, Science and Research:	Dr. Karolina Begusch-Pfefferkorn
The Ministry for Europe, Integration and Foreign Affairs:	Gesandter Dr. Erst-Peter Brezovsky
Austrian Commission for UNESCO:	Secretary General Mag. Patricia Jankovic
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	Dr. Wolfgang Lenhardt
	Prof. Dr. Bernhard Grasemann
	Prof. Dr. Hannah Pomella
	Prof. Dr. Karl-Heinz Erb
Natural History Museum Vienna:	Dr. Alexander Lukeneder
Other governmental institutions:	Dr. Robert Holnsteiner
	Dr. Christine Jawecki

Dr. Reinhold Godina

In 2019 the funding for IGCP, provided by the Austrian Ministry for Science, Research and Economy, was

EURO 80.000,- = US$ 87.490,-[1]

[1] Exchange rate per 11/02/2020

This funding is entirely used for research projects.

2. CURRENT RESEARCH PROJECTS WITHIN THE FRAMEWORK OF IGCP:

In 2019 three research projects were carried out:

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 6 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.

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.

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

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-632 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.

Cyclic marginal marine succession of the Orbata Formation (latest Barremian to earliest Albian, Jebel Chemsi, central Tunisia) recording short-term sea-level changes of the western Tethys at the northern margin of Gondwana. Photo: B. Sames

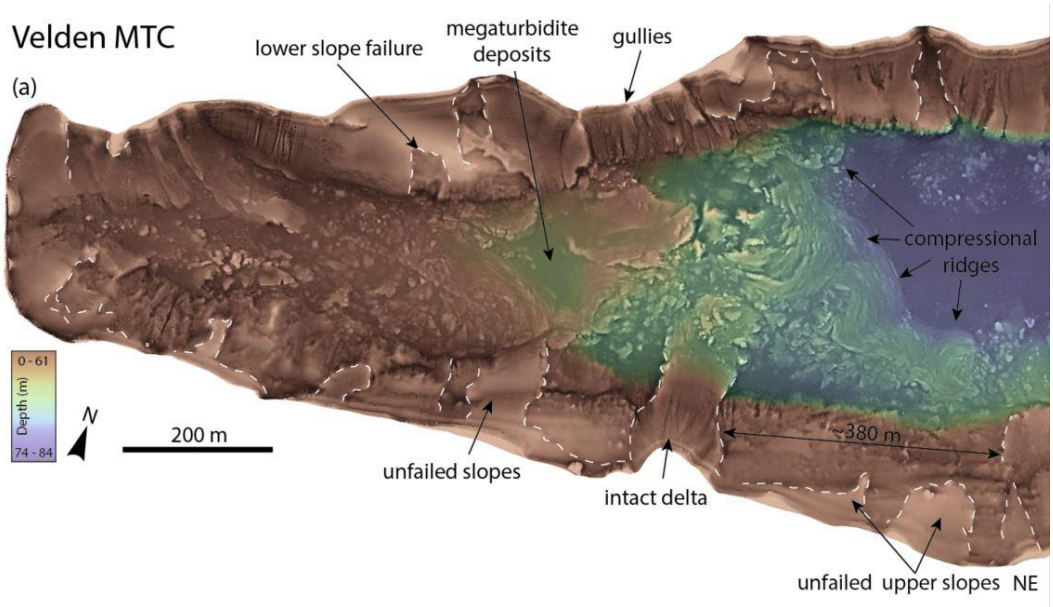
The proposed project aims to solve the following research questions:

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.

IGCP-640 Studying the Significance of Subaquatic Slides in Austrian Lakes ("S4LIDE-Austria")
Project manager: M. STRASSER, Institute of Geology, University of Innsbruck.

Mass movements and avalanches are not just common – potentially hazardous – natural processes on land in steep-relief (snow-covered) mountain regions, but can also occur deep below the water surface in oceans and lakes. There, large water saturated sediment mass can become instable and remobilized, forming one of the main processes to transfer sediment mass from the shallow to the deep sea, or transforming energy to the water and thus initiate tsunami waves threatening coastal communities and infrastructures. In order to asses geohazards, environmental implications and economic significance of subaqueous landslides across the World's continental margins, the IUGS-UNESCO International Geoscience Programme (IGCP) Project 640 - S4LIDE: "Significance of Modern and Ancient Submarine Slope LandSLIDEs" was established as an international and multidisciplinary platform for coordinated research and development dedicated to submarine landslide research.



Spectacular subaquatic landslide morphologies in the westernmost part of Wörthersee (Carinthia, Austria) imaging the Velden mass-transport complex. Photo: M. Strasser

Given that lakes have well-constrained boundary conditions, smaller sizes and offer the possibility to be investigated on a complete basin-wide scale, studying subaquatic mass movements in lacustrine environments offers a series of advantages that make lake studies vital to improve our knowledge on global marine processes (Lake as Model for the Ocean). This ÖAW S4LIDE-Austria project will – for the first time - systematically analyze and investigate limnogeological datasets of Austrian lakes for subaquatic landslide. This aims at compiling consistent morphometric characterization, dating- and process-based interpretation of lacustrine landslides in Austrian lakes, to eventually be integrated with the global datasets to study fundamental and/or compare different subaquatic landslide processes across scales and settings and thus contributing to address the IGCP-640 project objectives.

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 Education, Science and Research. The Austrian IGCP National Committee is currently discussing the structure and personell composition of the Austrian Geoparks Forum.

CURRENT STATUS OF AUSTRIAN GEOPARKS

- *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/

- *Carnic Alps* (approved 2012;)*:*
  Note: The Geopark has been evaluated in 2016 with request to some enhancements. The re-evaluation has been carried out in July 2018. Following the revalidation report and considering this Geoparc received a “yellow” card in 2016, the UGGpC decided in early 2019 to award a ***RED*** *card. The Carnic Alps UGGp did not manage to implement the recommendations received in 2016 after a “yellow” card revalidation and no longer meets criteria (ii), (iii), and (vi) of the Operational Guidelines for UNESCO Global Geoparks, Section 3.*

Vienna, 19/02/2020, G. Köck