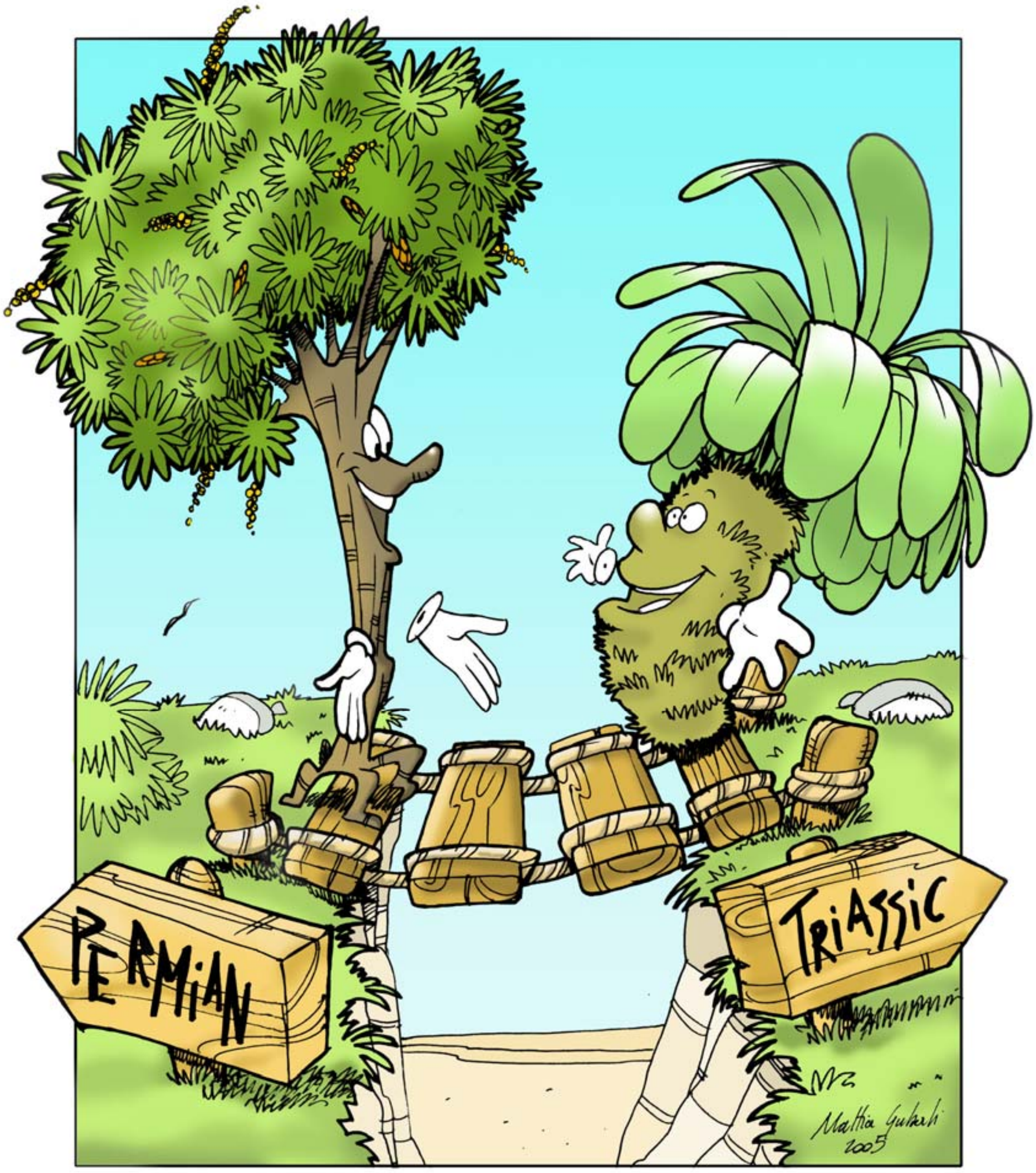
NATURMUSEUM SÜDTIROL
MUSEO SCIENZE NATURALI ALTO ADIGE
MUSEUM NATÖRA SÜDTIROL

Let us meet across the P/T boundary

Workshop on Permian and Triassic Paleobotany and Palynology

ABSTRACT BOOK



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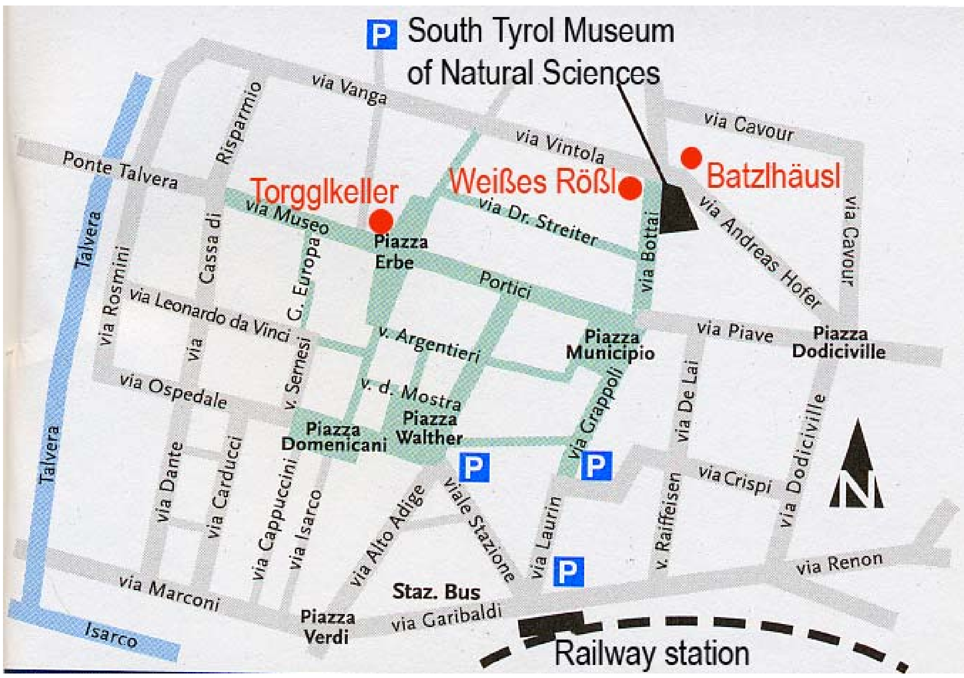
THE MUSEUM

The workshop is held at the South Tyrol Museum of Natural Sciences, in Bozen / Bolzano, Bindergasse / Via Bottai 1.



PROGRAMM

Arrival on Thursday, June 16, 2005

3.00 p.m.	Arrival at the Museum with registration (posters and presentations may be handed in)
4.00 p.m.	Guided visit through the South Tyrol Museum of Natural Sciences
5.00 p.m.	"*What's growing on Permian sediments*?" - Icebreaker-party
6.00 p.m.	Everybody to his hotel
c. 7.30 p.m.	Who is interested, dinner together at a nice Tyrolean restaurant

Workshop, Friday, June 17, 2005

9.00 a.m.	Opening ceremony
9.30 a.m.	**Keynote lecture**: Permian floras: where does it begin, where does it end? – by **Hans Kerp**
10.30 a.m.	Tea and Coffee break
10.30 a.m.- 12.40 Morning session, Chairman: Christoph Hartkopf-Fröder	
11.00 a.m.	Sequence of significative palynological events in the Upper Permian South Alpine successions: potential tool for delineating biochronological units – by **Paola Pittau**
11.25 a.m.	Permian and Triassic wildfires and atmospheric oxygen levels - by **Dieter Uhl**
11.50 a.m.	Vegetation succession through the end-Permian ecologic crisis – by **Johanna H.A. van Konijnenburg-van Cittert, Cindy Looy and Henk Visscher**
12.15	Distribution of sedimentary organic matter in Anisian carbonate series of S Poland: evidence of third-order sea-level fluctuations – by **Annette E. Götz, Joachim Szulc and Susanne Feist-Burkhardt**
12.40	Lunch at the Batzlhäusl
2.00 - 3.15 p.m. Afternoon session, Chairman: Geoffrey Greber	
2.00 p.m.	Triassic plant fossils from N-Italy: a general overview - by **Evelyn Kustatscher, Johanna H.A. van Konijnenburg –van Cittert , Guido Roghi and Luisa Passoni**
2.25 p.m.	Beyond the Permian-Triassic extinction events: The highly diverse Lower Keuper flora (Ladinian, Triassic) of southern Germany – by **Klaus-Peter Kelber**
2.50 p.m.	A Rare Microflora from the Mainhardt Formation (km3o; Upper Triassic) of Southern Germany – by **Carmen Heunisch**
3.15 p.m.	Palaeofloristic patterns across the Triassic - Jurassic transition: catastrophic extinction or long term gradual change? - **Wolfram M. Kürschner, N. R. Bonis and Leopold. Krystyn**

3.40 p.m.	Tea and Coffee break
4.10 p.m.	Poster session
5.40 p.m.	Round table discussion, Discussion-leader **Johanna H.A. van Konijnenburg-van Cittert & Hans Kerp**
6.30 p.m.	Taking posters off / getting CDs back
8.00 p.m.	Dinner at a nice Tyrolean restaurant

Poster session:

Georg Heumann: *Neuropteridium intermedium* Schimper et Mougeot 1844 – a pteridophyte from the upper Buntsandstein of Western Germany.

Michael Hiete, Ulrich Berner, Carmen Heunisch and Heinz-Gerd Röhling: Organic Carbon Isotopic and Palynological Excursions near the PTB in NW-Germany.

Evelyn Kustatscher, Johanna H.A. van Konijnenburg –van Cittert and Michael Wachtler: Seedferns and horsetails from the Anisian plant locality Kühwiesenkopf / Monte Prà della Vacca (Dolomites, N-Italy)

Christian Pott, Hans Kerp and Michael Krings: Cuticular Analysis of Seed Plants from the Upper Triassic of Lunz (Austria): Preliminary Results.

Guido Roghi, Evelyn Kustatscher and Johanna H.A. van Konijnenburg-van Cittert: Late Triassic Plant Fossils from North-Eastern Italy.

Katrin Ruckwied, Annette E. Götz and Joachim Szulc. Palynofacies of the Wielkie Koryciska section (Middle Triassic, Tatra Mts.): tool for reconstruction of the eustatic evolution of the Hronicum Basin.

Birgit Vörding, Abdallah Abu Hamad and Hans Kerp: Cuticular features of *Dicroidium* from the uppermost Permian of Jordan

Excursion to the Bletterbach / Butterloch Canyon, Saturday, June 18, 2005

8.30 a.m.	Departure from the South Tyrol Museum of Natural Sciences. Transfer by bus to Radein / Redagno
9.30 a.m.	Arrival at Radein / Redagno with excursion through the Bletterbach / Butterloch canyon
1.00 p.m.	Visit to the "Besuchszentrum" and/or the Local Museum with drinks
1.45 p.m.	Departure from Radein / Redagno, return to Bolzano via Tesero, Stava
5.30 p.m.	Arrival at Bolzano

Visit to the Archaeological Museum, Sunday, June 19, 2005

9.30 a.m.	Guided visit to the Archaeological Museum where "Ötzi, the iceman" is exposed

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ABSTRACTS

DISTRIBUTION OF SEDIMENTARY ORGANIC MATTER IN ANISIAN CARBONATE SERIES OF S POLAND: EVIDENCE OF THIRD-ORDER SEA-LEVEL FLUCTUATIONS

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During the Anisian Central Europe was part of the NW Tethys shelf area and its N Peri-Tethyan Basin. For reconstruction of the eustatic history and correlation of depositional series of these two palaeogeographic settings, S Poland (Silesia) is a particularly well-suited area since in Middle Triassic times it was situated just between the Tethys Ocean and its northern marginal Germanic Sea (Szulc, 2000).

In the present study sedimentary features, palynofacies patterns and stable isotope signatures recorded in Anisian carbonate series of Silesia are used to detect major eustatic signals at a third-order scale. Palynofacies parameters displaying relative sea-level changes are (1) the ratio of continental to marine particles (CONT/MAR ratio), (2) the ratio of opaque to translucent phytoclasts (OP/TR ratio), and (3) the relative proportion of marine plankton. The most prominent eustatic signal occurs within the Pelsonian with maximum abundance of marine plankton, another plankton peak is documented in the upper Bithynian. Both intervals reflect phases of maximum flooding. Transgressive and highstand deposits are recognized by changes in the terrestrial input of organic particles and the relative percentages and diversity of the plankton group. Transgressive deposits are characterized by increasing values of the OP/TR ratio. The highest amount of opaque particles occurs during stratigraphic intervals of maximum flooding and within early highstand deposits. Carbonates representing the late highstand show decreasing values of the OP/TR ratio. In addition, the size and shape of plant debris, as well as variations in the distribution patterns of land-derived palynomorphs, are used to decipher early and late highstand deposits. Sequence boundary zones are marked by a significant change in the CONT/MAR ratio. Stable isotope curves of both $\delta^{13}C$ and $\delta^{18}O$ indicate two intervals of maximum flooding within the Anisian. These geochemical signatures correlate with the sedimentological and palynological data (Götz *et al*., 2005).

The example from the Middle Triassic of S Poland may serve as a model for an integrated sequence stratigraphical analysis carried out in a peripheral zone of an ocean domain.

References

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NEUROPTERIDIUM INTERMEDIUM SCHIMPER ET MOUGEOT 1844 – A PTERIDOPHYTE FROM THE UPPER BUNTSANDSTEIN OF WESTERN GERMANY

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Within the Buntsandstein sequences of the northern Eifel area (Western Germany) *Neuropteridium* was a characteristic floral element. The Triassic sediments were deposited in the 'Eifeler Nord-Süd-Zone', a primarily variscian tectonic depression. Alluvial fans provided conglomerates at the base of the middle Buntsandstein followed by braided river channel and floodplain sediments, intercalated with aeolian sands. At the transition to the upper Buntsandstein first paleosols occured. Braided rivers draining northwards left coarse channel sediments and sandy to clayey floodplain sediments. The Voltziensandstein of the northernmost Eifel area shows deltaic influences.

Within the vegetation *Neuropteridium*, accompanied by *Crematopteris*, *Anomopteris*, *Schizoneura*, *Thamnopteris*, *Lesangeana*, a. o. preferred moist areas in this lowlands. *Equisetites* and *Pleuromeia* settled on damp fluvial overbanks, oxbows and abandoned ponds whereas conifers (*Albertia*, *Voltzia* and *Pelourdea*) conquered more dryer locations. Characteristic amphibians like *Parotosaurus*, *Chirotherium* and *Eifelosaurus* lived in this fluvial landscape. Analysing palaeontological and sedimentological evidences the climate of the middle and upper Buntsandstein assumedly was semi-arid and seasonal in the Eifel area.

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A RARE MICROFLORA FROM THE MAINHARDT FORMATION (KM3O; UPPER TRIASSIC) OF SOUTHERN GERMANY

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Twenty samples from an Upper Triassic outcrop section in southern Baden-Wuerttemberg, near Sulzbach on the river Murr, were palynologically investigated. Only four samples out of the basal part of the Obere Bunte Mergel (km3o, Mainhardt-Fm) contain a diverse and well preserved microflora. The Obere Bunte Mergel are facially interpreted as playa which spread over the retrograding fluvial sandstones of the Kieselsandstein (Hassberge-Fm).
The most striking microflora taxa belong to the *Corollina* group: *Corollina meyeriana, C. zwolinskai, C.* cf. *torosa* and *Corollina* sp. as well as *Granuloperculatipollis rudis. Spiritisporites spirabilis* is common, also *Enzonalasporites* spp. Among others, *Pseudenzonalasporites summus*, *Froelichsporites* cf. *traversei* and diverse bisaccoid pollen grains, e.g. *Triadispora crassa,* and different spore taxa are present.
Lithostratigraphically and also sedimentologically the investigated section of the km3o can be correlated with the Tuvalian (Upper Carnian). This age determination is supported by investigations on vertebrates from the underlying Kieselsandstein (Seegis, 2005). The microflora is quite different from that of the Gansinger Dolomite section (Lower Tuvalian, Switzerland) investigated by Scheuring (1970: zone G). Here, the *Corollina* group is missing. Following Fijalkowska-Mader (1999) the investigated section can be correlated with the *meyeriana* Zone, Subzone a. She correlated this subzone with the *densus-maljawkinae* phase ((Tuvalian; Brugman, 1982). According to Brugman (1982) and other authors in the Alpine realm *Corollina* starts in the lower part of the Norian.

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ORGANIC CARBON ISOTOPIC AND PALYNOLOGICAL EXCURSIONS NEAR THE PTB IN NW-GERMANY

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The biological crisis across the Permian-Triassic boundary (PTB) is associated with major changes in the global carbon cycle which are reflected in carbon isotopes of carbonate and organic matter. We are presenting a high-resolution profile of $\delta^{13}C_{org}$ (bulk) of arid continental sediments spanning the topmost Zechstein and lower part of Lower Bunter showing a negative shift 40 m below the mutual PTB and also a negative excursion close to the PTB. Both isotopic signals can be attributed to regional effects.

The transition from the Upper Permian Zechstein with its evaporitic and sabkha facies to the Bunter of an Early Triassic age with its playa lake and fluvial facies occurs gradually in the Mid European Basin (MEB). The investigated borehole Wulften-1 is located a few kilometers SW of the Harz mountains near Osterode. In the MEB it took an intermediate position between the facies development of the central and the more marginal basin reflected by its mostly silty to fine sandy lithology. The cored section contains the Calvörde-Fm. (suC; Lower Bunter) and the Zechstein. The „Graubankbereich", containing the mutual PTB, can be easily identified in suC2. 177 m of the Wulften-1 core (Z5 to Z7 and suC1 to suC8) were sampled at 10 cm intervals. In addition to the about 1.800 samples for geochemical investigations, 31 samples were taken for organic petrographical, and another 32 samples of selected grey lithologies were taken for palynological analyses.

Organic petrography revealed that particulate organic material (POM) is dominated by allochthonous black wood and graphite. Presumed autochthonous brown wood and palynomorphs are present in minor amounts. Vitrinite reflectance (VR) allows to distinguish between particles of different maturities. Particles with 0.3 to 0.5 %-VR are supposed to be autochthonous. Higher maturities of 1.2 to 1.5 %-VR are probably allochthonous. The spectrum of palynomorphs in the Lower Bunter is dominated by phytoplankton (30-50 % prasinophyceae, 1-10 % other phytoplankton), whereas pollen (0-30 %) and spores (0-20 %) play a minor part (undeterminable specimens 20-30 %). The first appearance of early Triassic *Densoisporites playfordii* at the base of suC3 marks the correlation with the *papillatus-playfordii*-phase.

BEYOND THE PERMIAN-TRIASSIC EXTINCTION EVENTS: THE HIGHLY DIVERSE LOWER KEUPER FLORA (LADINIAN, TRIASSIC) OF SOUTHERN GERMANY

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Macroplant assemblages from the Lower Keuper of southern Germany („Erfurt Formation", Longobardian, Ladinian, Triassic) have been known from a large number of localities described since the early 19th century. Although favourable outcrop situations in previous decades are reduced to a minimum, intensive sampling has yielded an additional variety of new plant fossil taxa.

The Lower Keuper flora in Germany represent a mixed association of palaeophytic floral elements and of modern mesophytic components that emerged for the first time in the Anisian or Ladinian. Lycopsids are represented by *Isoetites* and *Annalepis* species, the latter occasionally in large quantities. Sphenophytes are very prominent genera appearing ubiquitously and in abundance and diversity. *Equisetites arenaceus* and *Neocalamites merianii* being the most abundant horsetails, followed by *Equisetites conicus, E. macrocoleon, Neocalamites schoenleinii, Schizoneura paradoxa, Echinostachys, Phyllotheca.* The flora yields also a wide array of Filicales and Pteridosperms, e.g. *Danaeopsis arenacea, Bernoullia, Chelepteris, Schizopteris pachyrhachis, Chiropteris digitata, Sphenopteris schoenleiniana, Cladophlebis distans, Scytophyllum bergeri, „Sagenopteris", Linguifolium, Sphenozamites tener* and *Glossopteris*-like leaves. Very rare are pinnules of *Phlebopteris* sp. (Matoniaceae), pointing to a debut of leptosporangiate ferns in the Lower Keuper. Ginkgophytes and conifers are documented by *Sphenobaiera, Swedenborgia, Willsiostrobus, Widdringtonites, „Podozamites", Desmiophyllum imhoffi.* Cycads occur infrequently and include fronds of *Pterophyllum robustum* and leaves of *Taeniopteris angustifolia* and fertile structures named as *Dioonitocarpidium.* The salient evolutionary feature is the first appearance of the Bennettitales, testified by fronds of *Pterophyllum jaegeri.*

Peat-forming plants have produced considerable quantities of biomass, proved by sporadically appearing lenticular coal seams. Thus, Lower Keuper coals („Lettenkohle") belonging to the first coals beyond an early Triassic global coal gap. The macrofloral remains are also a storehouse of varied animal-plant-interaction information, documented by settlements of serpulid dwelling tubes, ovoposition scars and feeding traces caused by arthropods. A separate palaeoecological dimension is currently given by new finds of fractured cubic charcoal chunks (fusain). These occurrences suggest that wildfire was also an important environmental factor.

The composition of the Lower Keuper flora seem to be similar to the flora of the germanotype Schilfsandstein floral complex („Stuttgart Formation", Carnian). In synonymising Lower Keuper plant genera, a global trend towards uniformisation of Ladinian-Carnian phytocommunities can be tentatively implied. Approx. 20 Ma after the end-Permian terrestrial ecosystem devastation and subsequent periods characterised by monotypic *Pleuromeia*- and *Voltzia*-floras, the Lower Keuper flora can be deemed as a reliable touchstone to ascertain biotic recovery and long term generic transition through early Triassic time.

PERMIAN FLORAS: WHERE DOES IT BEGIN, WHERE DOES IT END?

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In several respects Permian floras are of particular interest. They are intermediate between the typical Palaeozoic coal-forming floras and the Mesozoic floras, and the Permian characterized by the disappearance of many pteridophytes taxa and the gradually increasing dominance of gymnosperms. During the Permian global climatic changes resulted in the transition from an icehouse to a greenhouse world. The Permian is often seen as a period of major evolutionary innovation, notably within the gymnosperms, but this time interval is also characterized by a marked floral provincialism, probably primarily representing a climatic differentiation rather than geographical isolation. Although the Permian seems to be a period of particular interest, our knowledge is at best fragmentary, because of the incompleteness of the fossil record.

The definition of the Carboniferous-Permian boundary in the terrestrial realm still appears to be highly problematic. According to radiometric datings, much of what is conventionally considered to be Lower Permian ("Lower Rotliegend" / "Autunian") is of latest Carboniferous age. The most dramatic floral change took place at the end of the Westphalian when most arborescent lycopsids became extinct in Euramerica. Conifers and peltaspermaceous seedferns which would become dominant during the Permian were already present during the latest Carboniferous. Floras that can be dated as Early Permian are rare and cover only relatively short time interval. Middle Permian floras are extremely rare in Europe and North America. Classical Upper Permian floras such as the Zechstein floras but also the floras from the Southern Alps again represent only a relatively short time interval. The end of the Permian is marked by the largest extinction event in Earth history. However, our information on the flora relies exclusively on the palynological record, because there are hardly terrestrial fossiliferous boundary sequences. Moreover, the climatic change which seems to have occurred at the Permian-Triassic transition may lead to a biased view.

During this presentation I will focus on two gymnosperm groups of which the record is, though fragmentary, relatively well known, viz. conifers and pteridosperms. These groups are rather difficult to assess because they primarily grew in extrabasinal environments where the preservation potential was low. Walchiaceous conifers first appeared during the Pennsylvanian, had their optimum during the Early Permian and persisted until the end of the Permian. More modern (voltzialean-type) conifers probably appeared during the Early Permian. Among the pteridosperms, the peltasperms appeared in the late Pennsylvanian; they diversified and became more prominent during the Permian. They are intermediate between the typical Palaeozoic pteridosperms and typical Mesozoic pteridosperms. Corystosperms are generally considered to be a group of typical Mesozoic pteridosperms, but they now have been recorded from the uppermost Permian. Both peltasperms and corystosperms, two groups of pteridosperms occurring in palaeotropical, extrabasinal lowland areas, were not affected by the mass extinction at the end of the Permian. During the Early Triassic several groups of plants which first appeared in the palaeotropics during the Permian, migrated north- or southward to settle and expand at lower latitudes.

PALAEOFLORISTIC PATTERNS ACROSS THE TRIASSIC - JURASSIC TRANSITION: CATASTROPHIC EXTINCTION OR LONG TERM GRADUAL CHANGE?

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The end – Triassic is characterized by enhanced rates of biotic turnover in both the marine and terrestrial realms. Carbon isotope anomalies have been reported worldwide that may indicate coeval global disturbances in the biogeochemical cycles. Here we present the results of an integrated study of the palynological and the carbon isotope composition of organic matter in the Tiefenbachgraben and Eiberg sections in the Northern Calcareous Alps (Austria). Carbon isotope values from bulk organic matter show significant fluctuations throughout the Triassic – Jurassic boundary with two prominent negative $\delta^{13}C$ excursions. An increase in the spore abundance together with the decline or even temporary disappearance of Late Triassic pollen types indicate concomitant vegetation changes on land. The changes in the pollen and spore record are of quantitative nature rather than a major extinction among Triassic sporomorph taxa. The established carbon isotope curve as well as palyno – and biostratigraphic events can be correlated with other T/J boundary key sections, such as St. Audrie's Bay (England) and New York Canyon (Nevada, USA). The present results, are in marked contrast to the microfloral record reported from the Triassic – Jurassic transition in the Newark basin (USA). A distinct floral turnover and fern spike occurs just a few meters below the Jacksonwald basalt, but the exact stratigraphic age of this microfloral event is uncertain. The different solutions that may explain the contrary results will be discussed.

TRIASSIC PLANT FOSSILS FROM N-ITALY: A GENERAL OVERVIEW

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Fossil plants from the Triassic of Northern Italy have been known since the 19th century, but only in the last 10–15 years a higher amount of taxonomical studies have been published.
Almost no indications on structured macrofossils are known from the Lower and the uppermost Triassic; plant remains come generally from the Anisian, Ladinian and Carnian.
The historically important plant locality Recoaro (e.g. Gümbel, 1879 with ref.) is of Anisian age. Few plant remains have been collected also in Vallarsa (Trento; Selli, 1938) and Monte Pore (Belluno; Accordi, 1952), whereas, more recently, important plant localities have been found in the Northern Dolomites (e.g. Broglio Loriga *et al*., 2002).
Ladinian plant remains have been found so far only in the Dolomites. However, from some localities in the Northern Dolomites a higher amount of macrofossils has been collected (e.g. Wachtler & Van Konijnenburg-Van Cittert, 2000; Kustatscher *et al*., 2004, with ref.).
On the other hand, Carnian macrofossils are well known mostly outside the Dolomites, for example from Raibl (Cave di Predil, e.g. Schenk, 1966-7). More recenty, however, also in the Bergamasc Alps (e.g. Passoni & Van Konijnenburg – van Cittert, 2003) and in the Carnian Alps (e.g. Roghi *et al.,* 2002a, b) rich plant collections have been found.

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SEEDFERNS AND HORSETAILS FROM THE ANISIAN PLANT LOCALITY KÜHWIESENKOPF / MONTE PRÀ DELLA VACCA (DOLOMITES, N-ITALY)

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The Anisian Flora from Kühwiesenkopf is rather rich in specimens and contains a number of landplant taxa belonging to the Lycophyta, Sphenophyta, Pteridophyta, Pteridospermae, Cycadophyta and Coniferophyta (e.g. Broglio Loriga *et al*., 2002).
The sphenophytes are represented by stem fragments with internodes and occasional nodes of *Equisetites mougeotii* (Brongniart) Wills and probably also from *Neocalamites* sp. Moreover, a strobilus and dispersed sporophylls of *Equisetites* with immature *in situ* spores were found, as well as few samples of strobili attributed to *Echinostachys* sp.
The most important seedfern is *Scytophyllum bergeri* Bornemann, characterised by heterophyll leaves and pinnae, in relation to their exposure to the sun. Sun-leaves have opposite, lanceolate pinnae with a rounded apex and entire margin. The shade-leaves, on the other hand, have broader pinnae with an undulated to incised margin attached alternatively. Leaves similar to our sun-leaves have been already described in literature as *Scytophyllum apoldense* (Compter) Linnell, shade-leaves a *S. bergeri* Bornemann (Linnell, 1933).
Some reproductive organs attributed to the genus *Peltaspermum* Harris, probably also belong to *Scytophyllum*. Similar macrofossils have already been described from e.g. the Permian of the Dolomites (Poort & Kerp, 1990) and from the German Keuper (Kelber & Hansch, 1995).
Less abbundant are two additional types of Pteridosperms: The first resembles *Sagenopteris* leaflets, although similar material has been described as *Neoglossopteris* from the Scythian-Anisian of China (Wang, 1996). The second form resembles *Ptilozamites* Nathorst, characteristic for the Rhaetian of Sweden (Nathorst, 1878), but recently also described from the Ladinian of the Dolomites (e.g. Wachtler & Van Konijnenburg – Van Cittert, 2000).

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SEQUENCE OF SIGNIFICATIVE PALYNOLOGICAL EVENTS IN THE UPPER PERMIAN SOUTH ALPINE SUCCESSIONS: POTENTIAL TOOL FOR DELINEATING BIOCHRONOLOGICAL UNITS

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Precise understanding of the depositional history of Permian sedimentation throughout western Europe is frequently hindered by the lack of detailed biostratigraphy, the lateral changing of the lithostratigraphic units, the variety of the terrestrial habitats, and the affection of land plants to climate constraints. Moreover, the development of a zonal system, palynologically defined, is often difficult to obtain by the paucity of suitable intervals for investigation and by the absence of independent biostratigraphical controls against which to calibrate the sporomorphs recorded. Unfortunately, also the incorrect use of taxa impedes the development of zonal schemes. Despite that, palynology is an invaluable biostratigraphic tool in basins dominated by terrestrial successions,

In so far palynology of the Upper Permian sediments, correlations with the ICS chronostratigraphic scale is made difficult by the absence of palynological data from the type area of the Guadalupian Series and by the difficulty of comparing European sporomorph associations with those of the Lopingian Series of South China. Correlations with the CIS-Ural stages are instead possible by the great affiliation of the taxa associations, if not by the quantitative sporomorph compositions, making possible the correlations at Series level. This study focuses on the detailed analysis of the great mass of sporomorph data recorded in the Tregiovo Formation, the Valgardena Sandstones, the Bellerophon and the Tesero Formations, widespread throughout the central and eastern South Alpine arch. It is developed a chronological sequence of significative palynological events that may be useful in delineating biochronological units from the Lower - Upper Permian to the Permian - Triassic boundaries. The bio-events, the proposed biochronological scheme and their potential correlability are discussed; the necessary revision of key taxa is also included. This scheme derives from recently concluded and on-going palynological investigations.

CUTICULAR ANALYSIS OF SEED PLANTS FROM THE UPPER TRIASSIC OF LUNZ (AUSTRIA): PRELIMINARY RESULTS

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Lunz is the most famous and most important Triassic fossil plant locality in the Alps. Based on marine invertebrates occurring in strata directly under- and overlying the "Lunzer Sandstein", the flora was dated as Carnian. Many paleobotanists studied plant fossils from this locality; the fertile remains of cycadoidean plants received particular interest. However, little attention was given to sterile foliage; only a few taxa have been studied in detail. Within the framework of a reinvestigation of the seed plants from Lunz, we currently prepare detailed descriptions of the taxa, based on macromorphology and epidermal anatomy; the fossils often yield excellently preserved cuticles. Our first data indicate that the majority of form taxa established by STUR and KRASSER in the early 20th century are in need of a revision. Our data on the epidermal anatomy of the individual taxa will also provide a basis for reconstructing whole-plant taxa by correlating reproductive structures with sterile foliage. Moreover, we expect that information on the epidermal anatomy will contribute towards a better understanding of the paleobiology of early Mesozoic gymnosperms and the paleoecological characterization of the Lunz ecosystem.

LATE TRIASSIC PLANT FOSSILS FROM NORTH-EASTERN ITALY

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Upper Triassic marcofossils assemblages from Northern Italy are quite rare and not well-known (Kustatscher et al., this volume, p. 8).

In 2000 Dr. Fabio Dalla Vecchia provided us with information of macroremains collected in the Dogna area. This area is located in the Carnian Alps, where also the famouse Raibl flora originated from (Dobruskina, 2001).

The Dogna macroflora comes from a thick succession of subtidal clays, marls and bioturbated to nodular wackestone-packstones belong to the Rio del Lago Formation (Preto *et al*., 2005). Ammonoids and palynomorphs found and studied from this formation are typical of the Aonoides Subzone (Trachyceras Zone), which belongs to the lower Carnian (Preto *et al*., 2005; Roghi, 2004).

The association includes mainly well-preserved conifers and pteridosperms, but also rare fern and horsetail remains have been found.

The conifer remains are represented both by shoots and less abundant fructifications. Some of the leaves have yielded well-preserved cuticles, which show the characteristic morphology of cheirolepidiaceous cuticles.

Pteridosperms are represented by leaf-fragments attributed preliminarily to the genus *Ptilozamites* Nathorst.

Additional elements of the flora are leaf fragments of *Marantoidea* and stem fragments belonging to the genus *Equisetites*.

Associated with this macroflora small drops of amber have been found. The discovery, however, of some amber still attached to conifer shoots with typical cheirolepidiaceous cuticles, indicates for the first time unequivocally the connection between this type of amber and its "motherplant".

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PALYNOFACIES OF THE WIELKIE KORYCISKA SECTION (MIDDLE TRIASSIC, TATRA MTS.): TOOL FOR RECONSTRUCTION OF THE EUSTATIC EVOLUTION OF THE HRONICUM BASIN

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Palynofacies of late Anisian-Ladinian carbonates from the Wielkie Koryciska section was analysed with respect to relative sea-level changes. Sedimentary organic matter of the samples studied is composed of a continental fraction including wood remains of higher land plants, pollen grains and spores, and a marine fraction with acritarchs, prasinophytes, and foraminiferal test linings. The main factors influencing the stratigraphic variation of land-derived and marine organic particles are the proximity of land, the organic productivity, the degree of biodegradation, and the hydrodynamic conditions of the depositional system.

Anisian Reifling and Partnach beds are dated by the marker species *Stellapollenites thiergartii* (Mädler 1964) Clement-Westerhof *et al*. 1974. Palynofacies is clearly dominated by continental particles. Phytoclasts are quite abundant, bisaccate pollen grains are the main constituent of the palynomorph group. Numerous spores and single specimens of the multicellular freshwater alga *Plaesiodictyon mosellanum* Wille 1970 may point to highly proximal conditions. Marine plankton is represented by prasinophytes of the genus *Cymatiosphaera* and rare specimens of acritarchs (*Micrhystridium* spp., *Veryhachium* spp.). A major eustatic signal is recognised by maximum abundance of marine acritarchs and foraminiferal test linings in the uppermost Anisian.

Ladinian Partnach-Wetterstein beds are identified by the marker species *Kuglerina meieri* Scheuring 1978. Palynofacies is still dominated by land-derived particles. The highest amount of opaque phytoclasts and spores occurs within the basal Wetterstein dolomites. Transgressive-regressive trends at a third-order scale are detected by significant proximity changes within the depositional series. Ternary diagrams are used to illustrate this eustatic evolution.

Generally, palynofacies data imply a shallow marine depositional environment with a high terrigenous input of plant debris and pollen grains from adjacent landmasses or islands. The lack of amorphous organic matter points to oxic depositional conditions during the entire Middle Triassic. Previous works postulated a tectonically driven basin evolution, related to the opening of the Meliata ocean (e.g., Masaryk et al., 1993; Haas et al., 1995; Wieczorek, 2000). The new palynological data clearly reveal eustatic signals. Therefore, ongoing studies focus on a more detailed analysis of the depositional system, integrating organic and sedimentary facies.

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PERMIAN AND TRIASSIC WILDFIRES AND ATMOSPHERIC OXYGEN LEVELS

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Over the last few years it has repeatedly been predicted that in several regions worldwide the frequencies of wildfires will increase parallel to future climate change. Due to the climatic transition from a global icehouse into a global greenhouse, which took place during the Permian, knowledge about the development of fire-frequencies during this period and the subsequent Triassic is therefore of special interest, not only from an ecological, but also from an economical and political point of view.
Several authors have speculated that fire frequencies have decreased during the Latest Carboniferous and Permian, parallel to a reconstructed drop in atmospheric O_2-concentrations (e.g. Scott, 2000). These assumptions are based on data from experiments, which have led to the conclusion that the burning of biomass may only be sustained with an atmospheric oxygen concentration of at least 13%. However, recent results from geochemical modelling, extended the duration of a high O_2 peak forward to the end of the Permian and a critical threshold of ~13% atmospheric oxygen may not have been reached before the Triassic (Berner, 2002).
In the last years new evidence for Permian and Triassic wildfires (e.g. charcoal) has been discovered and there is no doubt that during the Permian many ecosystems, on different continents, experienced more or less regular wildfires. In contrast evidence for Triassic wildfires is still rather scarce, but increasing. Especially for the Late Triassic, one of the periods for which the lowest oxygen concentrations have been modelled, we have unambiguous evidence for wildfires, not only from N-America, but also from several Central-European localities.

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VEGETATION SUCCESSION THROUGH THE END-PERMIAN ECOLOGIC CRISIS

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At the end-Permian extinction c. 90% of the marine species became extinct but the crisis also had a large impact on terrestrial life. We will discuss this impact on terrestrial life with a focus on plant life using palynology, as plant macrofossils are too rare for a high resolution analysis.
The data are derived from pollen diagrams from three regions in Europe: northern Italy (Butterloch/Bletterbach), east Greenland (for the crisis and direct aftermath) and Hungary (for the final recovery).
The end-Permian vegetation was dominated by conifer and seed fern woodland. This woodland disappeared during the ecosystem collapse. During the early survival phase lycopods, such as quillworts and clubmosses, played an important role; during the late survival phase *Pleuromeia*-dominated vegetations were important.
The final recovery, the re-establishment of plant communities equivalent (but not identical) to pre-extinction ecosystems, occurred only after 4-5 million years in Europe.

CUTICULAR FEATURES OF *DICROIDIUM* FROM THE UPPERMOST PERMIAN OF JORDAN

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At least four new *Dicroidium* species have been found in the Um Irna Formation (uppermost Permian) from Jordan. These are the earliest and most northern unequivocal occurrences of the typical Triassic Gondwana element *Dicroidium*.
The plant remains are not fragmented and even delicate fronds are very well preserved, which indicates little or no transport.
Cuticles have been prepared from larger specimens and were obtained by bulk maceration. The plants have relative thin cuticles and abundant stomata. Cuticles are extremely well preserved, and the often very thin guard cells are still present. The stomata are not sunken and only relatively few specimens show papillae. Because of the abundance of the material, it is possible to determine the infraspecific variability in the epidermal anatomy. This poster shows a selection of cuticular features of the *Dicroidium* species from the Um Irna Formation. Cuticular features indicate that plants which grow under relatively humid conditions.
Dicroidium apparently evolved in the palaeotropics. With the climatic amelioration in the Early Triassic (see Kidder & Worsley, 2004) the genus migrated southward and finally colonized the entire Gondwana region, where in the Middle and Late Triassic, it became one of the dominating floral elements. The genus *Dicroidium* was apparently not affected by the Permian-Triassic mass extinction event.
The range of *Dicroidium* can now be extended into the Permian. This is the first unequivocal record of the Corystospermales. Because several *Dicroidium* species are known from Late Permian sediments, it may be assumed that the Corystospermales have developed earlier.

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Kidder, D.L. & Worsley, T.R., 2004. Causes and consequences of extreme Permo-Triassic warming to globally equable climate and relation to the Permo-Triassic extinction and recovery. – *Palaeogeogr., Palaeoclimat., Palaeoecol.*, 203: 207-237.