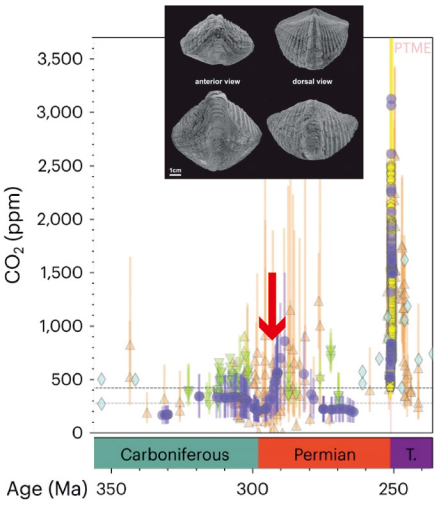
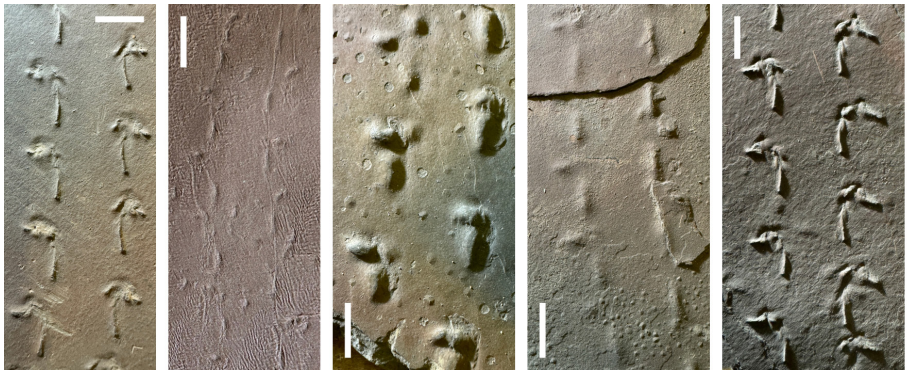
Permophiles

International Commission on Stratigraphy









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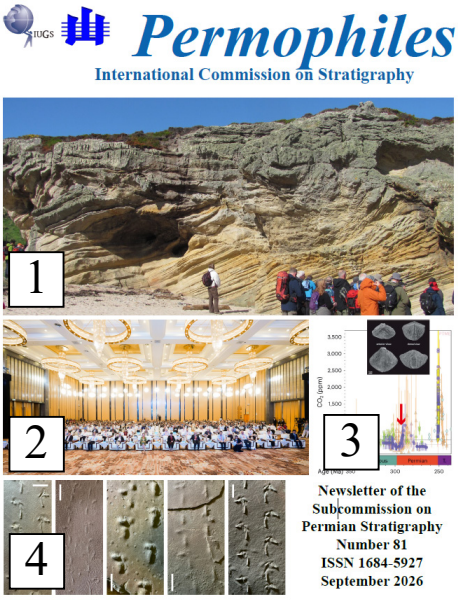


Fig. 1. Hopeman Sandstone, Covesea foreshore. Geoffrey Warrington, this issue.

Fig. 2. Photograph of the STRATI 2026 Opening Ceremony, Suzhou, China. Photo courtesy of the STRATI 2026 Organizing Committee.

Fig. 3. Specimen of *Pachycyrtella omanensis* showing its characteristic morphological features. Specimen of *P. omanensis* contributed to the observation of the spike in atmospheric CO2 corresponding to the end of the deglaciation. Marco Viaretti et al., this issue.

Fig. 4. Possible beetle walking traces assigned to *Lithographus* from the Nierstein lower Permian red-beds. Sebastian Voigt et al., this issue.

Notes from the SPS secretary
Yichun Zhang

Introduction and thanks

I write this note amid a busy period, sandwiched between the Strati2026 meeting in Kunshan, a subsequent one month fieldwork campaign in northern Tibet, and the upcoming Micropalaeontological Congress in Xinjiang, China.

As I have mentioned in many previous notes, I believe our Permian Subcommission is the most enthusiastic group. This is well illustrated in multiple aspects. At the SPS business meeting held on 2 July in Kunshan, lively discussions centred on several key Permian issues, including GSSP related topics and working groups. Especially for early-career researchers, they offered numerous suggestions to strengthen our Permian community. Furthermore, as evidenced in this issue of *Permophiles*, the Wolfcamp Formation remains a subject of vigorous debate. Science thrives on debate. *Permophiles* serves as an excellent forum for comments and discussions on Permian-related issues.

This issue of *Permophiles* contains interesting articles covering the Permian biostratigraphy, paleogeography and geochemistry. Thanks to all contributors to this issue: Charles M. Henderson, Mercedes di Pasquo, Michael Stephenson and co-authors, Sebastian Voigt and co-authors, Rasoul Sorkhabi, Wayne K. Camp, Alessandro P. Carniti and co-authors, Marco Viaretti and co-authors, and Geoffrey Warrington.

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This issue opens with reports from several SPS working groups. Charles M. Henderson presents progress of the base-Kungurian GSSP Working Group and reviews work carried out at the Rockland section in northeastern Nevada, USA. He then reports on activities of the base-Roadian GSSP Working Group, documenting the full stratigraphic succession and fossil assemblages exposed at Stratotype Canyon within Guadalupe Mountains National Park. Mercedes di Pasquo provides the report for the Gondwana to Euramerica Correlations Working Group. Her submission covers fossil comparisons across South America, Russia, India and North America, development of key species for intercontinental correlation, and digital dissemination of knowledge concerning bridge taxa.

Subsequently, Charles M. Henderson presents his seventeenth harangue. He still focuses on GSSP, which is a key issue of SPS and ICS. He suggests that the GSSP is the most effective tool for stratigraphic correlations globally despite some drawbacks –for instance, the FAD of a species can hardly be precisely pinpointed.

Michael Stephenson and co-authors introduce the potential of palynology for the correlation across different continents in Gondwana. The vegetation/palynological assemblage types will change according to the changes of paleogeography and paleoclimate, which will provide a strategy for paleogeographic correlations.

Sebastian Voigt and co-authors introduce the sedimentary features and the age of the Permian strata in the Nierstein area and summarize the key trace fossils in this area. They highlighted the significance of the trace fossils in the Nierstein red beds.

Both Rasoul Sorkhabi and Wayne K. Camp commented on the term Wolfcamp Formation proposed by Lucas (2026) in the last issue of *Permophiles*. Rasoul Sorkhabi suggests that the Woflcamp Formation should also been applied in the subsurface formation. Similarly, Wayne K. Camp does not agree with Lucas (2026) and suggests the usage of Wolfcamp Shale to represent the counterparts of the shallow-water shelfal carbonates in deep-water basinal clastic deposits in the Delaware Basin.

Alessandro P. Carniti and co-authors report on Cisuralian brachiopods from the Bianping section in South China. The presence of some cold-water brachiopod elements in the Cathaysian Province may indicate the upwelling of cold-water currents to bring some Gondwanan taxa to South China.

Marco Viaretti and co authors present the application of the brachiopod species *Pachycyrtella omanensis* in paleoenvironmental and paleoclimatic reconstructions. The shells of this species can be used to reconstruct atmospheric CO_2 levels, biomineralisation changes, and seasonal palaeotemperature variability. Future studies integrating brachiopod shell microstructure with geochemical analyses hold broad potential for wider application.

I have also submitted a short article introducing the application of OvitalMap for managing Permian related references. This tool can directly display the locations and content of Permian focused publications. It enables users to track research progress across all facets of Permian studies and investigate the spatial distribution of key taxa. Most importantly, the global Permian research community can jointly build a large scale visual reference database using this approach.

Geoffrey Warrington introduced the K.W. Glennie Commemorative Event held in Scotland on 8-10th May 2026.

Finally, three congresses were announced, including the 23rd IAGR & ICTSEA Congress, the 3rd Asian Palaeontological Congress and the 38th International Geological Congress.

Future issues of Permophiles

The next issue of *Permophiles* will be the 82nd issue. We welcome contributions related to Permian studies around the world. So, I kindly invite our colleagues to contribute harangues, papers, reports, comments and communications.

The deadline for submission to Issue 83 is 31 December 2026.

Manuscripts and figures can be submitted via email (yczhang@nigpas.ac.cn or ivan.rodriguez.barreiro@uvigo.gal) as an attachment.

To format the manuscript, please follow the TEMPLATE on the SPS website.

Notes from the SPS Chair
Elizabeth A. Weldon

As many of our readers enjoy (or swelter though) their summer, I am hibernating through winter in Melbourne. It is a bit of a contrast to the pleasant temperatures experienced in the

evenings in Suzhou at STRATI 2026. Special thanks go out to our Chinese hosts reading this note who ensured STRATI was a great success, particularly from a Permian perspective. On day three there was an option to visit the Meishan Section to see the GSSP for the base of the Changhsingian stage, followed by several sessions with Permian presentations to attend on Thursday. I co-convened a session on the PT boundary in the morning of day four, before moving rooms to help Iván Rodríguez-Barreiro convene the Subcommission on Permian Stratigraphy (SPS) Session in the afternoon. The SPS Session included presentations on marine and terrestrial environments from the Cisuralian to the Lopingian, from China, Europe, the Middle East, and Australia. It was well attended by Early Career Researchers, some of whom were partly funded by finances received from the IUGS and distributed through the SPS. Simultaneously, Yichun Zhang (SPS Secretary) was busy co-convening a session on the Tethys Ocean Realm that also included several Permian talks. If you missed attending the conference or some of the presentations a link to the abstract volume can be found here.

On day four of STRATI the SPS Business Meeting was also held. At the meeting we received reports from each of our working groups and formally acknowledged the end of term of the "The correlation between marine and continental Carboniferous-Permian transition" working group. This team have been prolific in their publications over many years (80+ published or submitted). In the last issue of *Permophiles* (#80, 2026) Schneider and Voigt published a significant multistratigraphic correlation chart of Euramerican, Eastern European and South African Basins demonstrating the extensive nature of the work undertaken by the working group. In recognition of the many years of leadership Joerg Schneider has dedicated to this group and to the SPS Executive, we announced Joerg's continued involvement in the SPS as an Honorary Member.

ECRs and long-term members of the SPS attending the Business Meeting, were involved in brainstorming some ideas for the SPS to consider. These included: a Permian hackathon, Permian marathon (presentations with open discussion), webinars based on Permian strata from different continents/regions and a variety of continental stratigraphy topics, a workshop on Permian fossil identification, and further work on marine-continental correlation, reconstruction of continental basins, and integrative stratigraphy. I greatly thank everyone who participated, and I look forward to seeing many of the ideas implemented over the coming year.

Also at STRATI 2026, the International Commission on Stratigraphy released the latest International Chronostratigraphic Chart (ICC) (2026/06). In addition to the traditional static document copy International Commission on Stratigraphy, the latest version of the ICC is available in a data format. Of specific note to *Permophiles* readers, is a revision of the numeric age for the base of the Wuchiapingian on the new chart. On the previous ICC (2024/12) the numeric age was 259.51 ± 0.21 Ma, and now on the ICC (2026/06) it is 259.857 ± 0.084 Ma following Wu et al. 2026.

The ICS also announced that preparation for the next edition of the Geologic Time Scale will commence shortly. Every Subcommission will be responsible for writing the chapter corresponding to their system/period including a retranslation of historical work and significant updates from 2020 (The Geologic Timescale 2020, Gradstein, et al. 2020) to 2030. Drafting will be undertaken throughout 2027 and 2028, and submission and proofing will take place in 2029 in preparation for publication in time for STRATI 2030.

Also in ICS news, the Silurian Radotinian Stage (Pridoli Series) GSSP is now formally assigned to the Hvizdalka Section, Prague Synform, Czech Republic, with the golden spike being placed in bed 19, 4.2m above the base of the Pozary Formation. In addition, astrochronozones will be formally 'defined as fundamental building blocks in chronostratigraphy at a smaller scale to that of a stage, and independent of a stage'. And finally, the first circular for The 2028 International Geological Congress | IGC 2028 Calgary was announced. Please place this event in your calendars.

If you have further ideas, comments or feedback for the SPS please don't hesitate to get in touch with myself or the other members of the Executive.

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The base-Kungurian GSSP Working Group Report

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Introduction

The Kungurian Stage is the only stage that has not been ratified with a Global Stratotype Section and Point within the Permian System. In 2012 there was a consensus regarding a GSSP level marked by the FO of *Neostreptognathodus pnevi*. Two sections were proposed including the Mechetlino section in Russia (Chernykh et al., 2012) and the Rockland section in Nevada, USA (Henderson et al., 2012). Additional work was published for the Mechetlino Section (Chernykh et al., 2020b). However, the Mechetlino section is no longer available owing to scientific sanctions by the IUGS because of Russia's continuing invasion of Ukraine. It was announced in *Permophiles* 74 that SPS would move ahead with a GSSP proposal for the Rockland Section in Nevada (Angiolini et al., 2023). A working group was formed (Henderson, 2023, 2024), and recent progress reported at the Geotolosa meeting at Toulouse, France, June 26, 2025.

Background

It is the fourth stage of the Permian but has the distinction to be close to the original base-Permian as defined by Murchison in 1841 for a succession of limestone and gypsum exposed along the Sakmara River. The traditional Kungurian succession in Russia becomes increasingly restricted, poorly fossiliferous, and includes some terrestrial facies. The traditional Kungurian included two sequences that lacked biostratigraphically useful fossils, so the base-Kungurian was later shifted to a lower position within the traditional upper Artinskian. This lower position more closely correlates with the Wolfcampian-Leonardian boundary at the base of the Skinner Ranch and Hess formations in West Texas.

Current base-Kungurian Working Group

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Walter S. Snyder (Boise State University, ID., USA)

Kate Tierney (University of Iowa, USA)

Dongxun Yuan (School of Resources and Geosciences, China University of Mining and Technology, Xuzhou, China)

The working group is charged with preparing and reviewing a GSSP proposal for the Rockland Section base-Kungurian. This will be compiled in the ICS proforma for GSSPs by Charles Henderson with input from all Working Group members (see https://stratigraphy.org/gssps/files/GSSP-proforma.pdf).

Location

Rockland Section, NE Nevada, USA

40.77904°N; 114.60604°W

Base-Bed 11.6 at 26.5 m above base of detailed section; this level is at 1813.5 mab in the overall Rockland section.

Lithofacies and Sequence Stratigraphy

The GSSP interval includes wackestone to packstone with heterozoan-extended assemblages dominated by echinoderms, bryozoans, brachiopods and fusulinids. The section is a thick, uninterrupted marine carbonate succession from early Sakmarian to late Kungurian. Depositional rates are high including 57.35 m/Myrs in the Sakmarian, 57.06 m/Myrs in the Artinskian, and 86.5 m/Myrs in the Kungurian.

Primary Marker (range chart and plate in preparation by Charles Henderson)

The conodont *Neostreptognathodus pnevi* within the lineage from *N. pequopensis* to *N. pnevi* to *N. clinei*. The interpreted FO of this taxon occurs at 1813.5 (26.5 m in detailed section) in the Rockland section and in Bed 9 at the Mechetlino section in Russia. The evolutionary succession and transitional morphotypes are remarkably comparable within both sections, lending confidence for this long-distance correlation. The FO of *N. pnevi* has guided the decision of the chosen point to represent the base-Kungurian. The species will also guide correlation of the base-Kungurian in many other sections, but not everywhere. Other markers are essential for accurate correlation.

Secondary Markers and Correlation

Biostratigraphy; Fusulinaceans (range chart and plate in preparation by Michael Read)

Schwagerina (Chalaroschwagerina) hawkinsi, *Skinnerella diabloensis*, and *Parafusulina communis* occur within a 40 m interval below the GSSP. *Skinnerella diabloensis* is typical of the lower Bone Spring Formation in West Texas and similar taxa are known from the Paleotethyan realm (e.g., *S. quasigruperaensis* = Bolarian-Kubergandinian). *Schwagerina hawkinsi* is common in the lower Leonard and Skinner Ranch formations in West Texas (upper Artinskian). At 28.5 metres above the GSSP level *Parafusulina deltoides* (=middle Hess Formation) and *Pamirina* cf. *darvasica* (Tethyan taxon of the Bolorian) occur. The latter taxon was previously reported by V. Davydov, but it was not duplicated in our recent work.

Biostratigraphy; Brachiopods (list of taxa in preparation by Lucia Angiolini)

Only a few collections have been made but a typical taxon in the interval is the semi-infaunal productid *Peniculauris* aff. *imitata* Cooper and Grant (1975). The Rockland specimens differ slightly from *Peniculauris imitata* Cooper and Grant, 1975 in the Hess Formation by having slightly finer ribs and a deeper sulcus, which is, however, quite variable in the species. The shell substance is thick and well preserved, consisting of a secondary laminar layer with pseudopunctae, suitable for geochemical analyses.

Chemostratigraphy; Strontium Isotopes

Several strontium isotopic studies have been completed at Rockland including by Kate Tierney (2010; whole rock), Luke Bratton (conodonts), and Hana Jurikova (brachiopods). Mark Schmitz determined a $^{87}Sr/^{86}Sr$ isotopic value of 0.70743 for the base-Kungurian based on conodonts at Mechetlino. All results at Rockland for the GSSP interval are more radiogenic than coeval values on the McArthur GTS2020 curve, with the best results (from whole rock and brachiopods) about 0.0001 higher (on average values are about 0.0002 higher), which is significant. Conodont $^{87}Sr/^{86}Sr$ values demonstrate these elevated isotopic trends occur along the entire NW Pangea margin during the Kungurian suggesting that the region may have experienced strong continental influence with limited mixing. The final proposal will evaluate and provide a detailed assessment of these differences. These differences may reflect in part the dataset used by McArthur for this interval; it is important to remember that this curve is a work in progress. However, the results for the base-Sakmarian and base-Artinskian at Rockland (whole rock and conodonts) are nearly identical to those for the GSSP sections in Russia (Chernykh et al., 2020a, 2023) and the McArthur curve (McArthur et al., 2020), but trend more radiogenic near the mid-Artinskian, perhaps coincident with the Artinskian Warming Event (Marchetti et al., 2022). This could have led to high evaporation rates and potentially decreased mixing of ocean waters, but there is no evidence for isolation in the Rockland section with many fully marine organisms throughout the section (Bratton, 2024).

Magnetostratigraphy and Radio-isotopic dating

No magnetostratigraphic work has been completed or planned. There are no ash beds recognized to date at Rockland and those at Mechetlino have only yielded detrital zircons. The geochronologic age is interpolated at 283.3 Ma (see International Chronostratigraphic Chart v2026/06).

Correlation and Plan

The working group will describe the Mechetlino section as a supplementary reference section and consider correlation into other regions including the nearby Carlin Canyon section, various sections in SW USA (e.g., Lucas et al., 2022, 2024), Arctic Canada, and South China. The working group will vote and assuming a 60% majority in favour, the proposal will be sent to SPS for voting. The proposal will appear in the next *Permophiles* #82 for comments from the community. Once SPS and ICS vote in favour (assuming 60% majority) and IUGS ratifies, an article will be prepared for publication in Episodes.

Accessibility, protection and marker

Access to the section involves a non-technical climb from a location that can be reached on gravel roads by a SUV. The site is protected and freely accessible on Bureau of Land Management (BLM) land. A marker will be prepared following ratification.

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The base-Roadian GSSP Working Group Report

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Introduction

The Guadalupian Series (Middle Permian) consists of three stages (Roadian, Wordian and Capitanian in ascending order) that were ratified by IUGS in 2001. All three GSSPs were presented in a single proposal (Glenister et al., 1999), but detailed descriptions of these sections were not published in *Episodes*, as is the norm for ratified GSSPs. A group of researchers led by Shuzhong Shen investigated the three sections in the Guadalupe Mountains in order to provide additional correlation data and publish in *Episodes*. The Capitanian was published in *Episodes* in 2022 (Shen et al., 2022), but the other two boundaries proved to be more problematic. The problems and progress of the Roadian and Wordian can be seen in the presentation by Shuzhong Shen and Charles Henderson on October 24, 2023 (see link provided in the SPS website) and in *Permophiles* 76 (Henderson and Shen, 2024; Henderson, 2024; Lucas, 2024). A SPS voting members meeting on zoom in December 2023 decided that working groups would be established to investigate the Roadian and Wordian. Voting members agreed that the Roadian GSSP section is a good section, but opinions varied regarding the correlation potential of the chosen level, which is marked by the FO of *Jinogondolella nankingensis*.

Background

The ratified base of the Guadalupian Series and Roadian Stage is defined at a point 42.7 metres above base of the Cutoff Formation (13.1 mab of El Centro Member) at Stratotype Canyon in Guadalupe Mountains National Park (GMNP), West Texas, USA. The Cutoff Formation is the original basal unit of the Guadalupian Series (Glenister et al., 1999) and it is generally correlated with the Road Canyon Member, which is the first limestone member of the Word Formation in the Glass Mountains, West Texas. These latter sections are on private land and are no longer accessible, but they were the location for the extensive brachiopod studies of Cooper and Grant (numerous papers and monographs) and for the original recognition of a morphocline from *Mesogondolella idahoensis* to *Jinogondolella nankingensis* (Wardlaw and Grant, 1990).

The base-Roadian was ratified in 2001 (base-Guadalupian or Middle Permian; note Middle is capitalized – see Henderson's Harangue #5 in *Permophiles* 67) and a gold disk was later placed at Stratotype Canyon in the Guadalupe Mountains of West Texas, but an *Episodes* article was not published. A draft of a future *Episodes* article is under review within the working group (produced by Shuzhong Shen and others) based on additional research conducted in the Guadalupes (see Shen et al., 2020). This new research demonstrated that the GSSP was not as perfect as previously thought. Despite this imperfection, geologists have been able to correlate the base-Roadian within an acceptable

level of uncertainty for a quarter century. It turns out that the original lineage of *Mesogondolella lamberti* to *Jinogondolella nankingensis* may involve a third species or subspecies (see Primary Marker below). The question facing the working group is how much this affects correlation. Of course, our evolutionary lineages are interpretations. In my view, it is possible to maintain the GSSP but with greater awareness of the possible limitations and a supermajority vote.

Current base-Roadian Working Group

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Hana Jurikova, (University of St. Andrews, St. Andrews, UK)

Lance Lambert, (Department of Earth and Planetary Sciences, University of Texas at San Antonio, USA)

Lorenzo Marchetti, (Museum fur Naturkunde, Berlin, Germany)

Galina Nestell, (University of Texas at Austin, USA)

Michael Read, (Stephen F. Austin State University, USA)

Ausonio Ronchi, (Universita di Pavia, Italy)

Shuzhong Shen, Vice-Chair (State Key Laboratory of Critical Earth Material Cycling and Mineral Deposits, Nanjing University, Nanjing, China),

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Dongxun Yuan, (School of Resources and Geosciences, China University of Mining and Technology, Xuzhou, China)

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Quanfeng Zheng, (Nanjing Institute of Geology and Palaeontology, Nanjing, China)

WG Task: The working group is charged to consider whether the boundary can remain at its current level or revised a few metres higher or lower. The working group will also consider a Standard Auxiliary Boundary Stratotype section (SABS) at the Maweishan section in south China. Finally, a manuscript will be prepared that either proposes a new level or provides new details regarding the current GSSP level to be published in *Episodes*; the result will be reviewed by the subcommission.

Location

The Cutoff Formation crops out along the western escarpment of GMNP in West Texas and is well exposed at Stratotype Canyon, approximately 1 km southeast of Williams Ranch House and the mouth of Bone Canyon at 31.8767°N, 104.8768°W.

Lithofacies and Sequence Stratigraphy

The Shumard Member forms the basal unit of the Cutoff Formation and is 28.8 m thick. Its base is marked by a 1.2 m-thick debris flow breccia, which is overlain by dark, thick-bedded limestone with chert bands; the uppermost 8 m of the Shumard Member contains several intervals of strongly nodular limestone. The contact with the overlying El Centro Member is sharp and marked by the abrupt appearance of black shale. The El Centro Member is 26.4 m thick and can be subdivided into three informal intervals. The lower 8 m is dominated by black shale interbedded with cherty bands and contains large limestone concretions. The middle interval, between 8.0 and 16.75 m, consists mainly of organic-rich dark limestone with common laminations that yield only rare conodonts. The base of the Roadian GSSP is defined at 13.1 m above the base of the El Centro Member. The upper interval of the El Centro Member, from 16.75 to 26.4 m, is again dominated by black shale with large limestone concretions, from which conodonts have been recovered. The El Centro Member is overlain by the Williams Ranch Member, which is composed predominantly of dark, thin-bedded limestone with cherty nodules and represents the upper unit of the Cutoff Formation. The Williams Ranch Member is overlain by the Pipeline Shale; both units include abundant *Jinogondolella nankingensis*.

Numerous composite sequences and high frequency cycles are recognized in the succession but durations of each are uncertain. Similar high frequency cycles are also known at Penglaitan in South China (Shen et al., 2020), but they do not match up particularly well with those in West Texas. It is likely that the succession from the Shumard to the Williams Ranch (*i.e.*, the Cutoff Formation) represents a third order depositional sequence.

Primary Marker

The primary marker is the first occurrence of *Jinogondolella nankingensis* at 42.7 metres above base of the Cutoff Formation at Stratotype Canyon. *Jinogondolella nankingensis* is distinguished from other gondolellids by the presence of serrations on the anterior upper (ventral inner) margins of the element. The boundary was not based on the first occurrence of serrations, however. The originators of the proposal (Glenister et al., 1999; Lambert et al., 2000) recognized serrations in transitional morphotypes below the designated boundary. Bruce Wardlaw and Lance Lambert (mostly Lance Lambert) provided the detailed descriptions of this morphocline (see Glenister et al., 1992; Lambert et al., 2000) and Lambert (2024) provided clarification. Conodont workers often provide interpretations of the evolutionary process because they look at many specimens from many closely spaced samples. It is important to remember that all of these are interpretations (see my Harangue #17 in this issue). Can we ever be sure that we finally have it right? In this case, the evolution of *Jinogondolella nankingensis* was described as a mosaic paedomorphocline because several characters seemingly evolved at varying rates and exhibited differently at different ontogenetic stages leaving a heterochronic record. In such a case, distinct points in the evolution become blurred and the original boundary was chosen at an arbitrary point in the late stages within this heterochronic record.

Of course, different sampling strategies can affect our interpretations. Wardlaw and Grant (1990) indicated that the transition was sharp in the lower part of the Road Canyon Formation (Glass Mountains) – usually occurring in a single (widely spaced by several metres) sample. In recent more detailed sampling at Stratotype Canyon (Shen et al. 2020) a longer interval with transitional specimens was recovered. A

new species or subspecies with more subtle serration is under consideration. Some of the illustrated specimens above the sharp transition noted by Wardlaw and Grant (1990) would fit this concept as well. The conodont workers on this proposal will develop a consensus before distributing the draft proposal more widely among the working group.

Secondary Markers and Correlation

Biostratigraphy; Ammonoids and Fusulinaceans

The Roadian Stage is characterized by the presence of the index ammonoid species *Perrinites normani* and *Eumedlicottia burckhardti*, along with several others (e.g., *Texoceras texanum, Peritrochia erebus*, and *Paraceltites elegans*), in the Road Canyon Limestone (Lambert et al., 2000). The *Perrinites* Zone in the Road Canyon Formation comprises approximately 20 species belonging to more than 10 genera, notably *Perrinites vidriensis, Paraceltites elegans, Stacheoceras* spp., *Demarezites* sp., *Eumedlicottia burckhardti*, and *Roadoceras roadense* (Lambert et al., 2000). Although *Perrinites* is also characteristic of the Leonardian, it is particularly abundant in the basal Guadalupian. In contrast, *Waagenoceras* is the descendant of *Demarezites* and occurs in the upper Roadian and as an index for the Wordian.

Roadian fusulinaceans are assigned to the *Parafusulina boesei–Skinnerina* sp. Zone (Wilde, 2000) and show clear affinities with those of the overlying Wordian Brushy Canyon and Cherry Canyon formations. This contrasts with the Roadian ammonoid assemblages, which retain stronger affinities with the underlying Leonardian faunas.

Chemostratigraphy; Strontium and Carbon Isotopes

Strontium isotopic values are more radiogenic than expected in the McArthur curve, just as they were for the Kungurian at Rockland (see working group report for Kungurian in this issue of *Permophiles*). Conodont $^{87}Sr/^{86}Sr$ values demonstrate these elevated isotopic trends occur along the entire NW Pangea margin during the Kungurian suggesting that the region may have experienced strong continental influence with limited mixing. The final proposal will evaluate and provide a detailed assessment of these differences. These differences may reflect in part the dataset used by McArthur for this interval; it is important to remember that this curve is a work in progress. There is a significant negative $d^{13}C_{carb}$ isotopic excursion in the Lower Roadian above the GSSP level.

Magnetostratigraphy

There are no magnetostratigraphic data for the section, but the interval should fall in the upper part of the long Kiaman Superchron prior to the Illawarra Reversal.

Radio-isotopic dating

Volcanic ash beds are more common in the Wordian and Capitanian. The closest radioisotopic age (266.525 ± 0.27 Ma) is in the lower Wordian South Wells Member (Shen et al., 2020). In South China an age of 273.01 ± 0.14 Ma occurs at the base of the Kuhfeng Formation (Zhengpanshan section; original location for *J. nankingensis* (Jin, 1960)) in association with well developed *Jinogondolella nankingensis*; this has been used to date the base-Roadian in China, but the age in GTS 2020 (Henderson and Shen, 2020) is 274.4 ± 0.4 Ma. This age is in part derived from occurrences of the ammonoid *Sverdrupites harkeri* in combination with a radioisotopic age of 274.0 ± 0.12 Ma in the Okhotsk Massif of NE Russia (Davydov et al., 2018). *Sverdrupites harkeri* is also recovered in the transgressive lower Assistance Formation in association with *Jinogondolella nankingensis behnkeni* Wardlaw 2015 from the Sverdrup Basin in the Canadian Arctic (updated from Henderson and Mei, 2007). This older age for the base-Roadian may be indirectly supported by the first occurrence of *Jinogondolella nankingensis* at Zhengpanshan if this occurrence coincides with the acme of *Jinogondolella nankingensis* in the upper Williams Ranch or Pipeline Shale members.

Correlation and Plan

It is possible to correlate the base-Roadian in several other regions within a variable degree of uncertainty. Whether this uncertainty is acceptable will be evaluated by the working group prior to producing a draft of an article currently planned for *Episodes*. Correlations with Russia and northern Canada are mentioned above. It is important to note that the Guadalupian in the Sverdrup Basin is well represented but the only level of serrated conodonts occurs at the base in the lower Assistance Formation. *Jinogondolella* is restricted to near equatorial sites above the lower Roadian because of profound provincialism. As a result, correlations are best constrained with South China, but conodont taxonomy and distribution still need to be resolved. Tethyan fusulinaceans in South China are very different from those in the Delaware Basin of Texas. *Demarezites* occurs in the Roadian of West Texas and southeast China, but many taxa are endemic to each location. Such issues seem to be typical of Middle Permian correlations.

Accessibility, protection and marker

Stratotype Canyon Section is normally accessible by four-wheel drive and on foot. It is protected by being in a National Park and is freely accessible for research, but permits are required. The marker is already in place.

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The Gondwana to Euramerica Correlations Working Group Report

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Introduction

The Gondwana-Euramerica Working Group was formed in 2022 due to the paucity of studies and problems on the correlation between these two areas. This report includes recent results from many of the members, which are summarized below in the context of the objectives of this group.

Current Workling Group:

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Elizabeth Weldon, (School of Life and Environmental Sciences, Faculty of Science Engineering & Built Environment, Deakin University, Geelong, VIC 3220).

Yichun Zhang, (State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Nanjing, China).

WG Task:

The work will compare fossils (invertebrates, conodonts, palynology) from the South American Apillapampa Section with various successions in India, the USA, and Russia, including the Sakmarian GSSP. The taxonomy of key species for correlation will be examined as "bridge taxa" occurring in different Permian provinces. The working group will conduct further fieldwork at neighboring sections to complement the work at Apillapampa, providing maximum correlation opportunities with Euramerica and other parts of Gondwana. A first contribution with a summary of the objectives of the WG was published in *Permophiles* 73 (2022), and a second one in *Permophiles* 76 (2024), providing the stratigraphic information of the Copacabana Formation at Apillapampa (Bolivia) and possible paleontologic links with

northern Hemisphere.

Report on Progress

A manuscript on the Apillapampa invertebrates, palynomorphs, conodonts, and other fossils (e.g., fusulinids), which could provide a template for Gondwana correlation, and with the Sakmarian GSSP in Russia, and elsewhere (e.g. India, West Texas), is in progress and will be submitted to the *Journal of South American Earth Sciences* in 2026 by di Pasquo, Cisterna, Henderson, Lopez, Calle Salcedo, and Grader.

Gabriela Cisterna presented an oral contribution at the III Congreso Chileno de Paleontología discussing preliminary results on the brachiopods of the Apillapampa section published as a short paper in a special volume in 2025; she also gave this presentation at a Zoom meeting of the Working Group on December 17th 2024.

Charles Henderson presented a talk at the Geotolosa meeting on June 26, 2025, discussing the Sakmarian correlation on a near-global basis; he repeated this presentation at a working group Zoom meeting on September 4th, 2025. His abstract provides additional information on the Apillapampa section, which is included in contributions that can be consulted in *Permophiles* 76, 77 (2024), and 78 (March 2025), and in Cisterna et al. (2024, 2025).

Paulina Kavali reported a palynological analysis of the Talchir Formation from the MAWP 114 core drilled in the Wardha Basin, central India (Kavali and Mishra 2025), which comprises a rich assemblage of 79 species (38 spore species, 34 pollen species, and 7 algal species). Based on the identification of radiometrically and biostratigraphically constrained key species, such as *Vittatina* spp., *Converrucosisporites confluens*, and *Pseudoreticulatispora pseudoreticulata*, among others, the studied interval is inferred to be no older than the Gzhelian. The inferred Asselian age relates the Talchir deposits to the last episode of the Last Paleozoic Ice Age (LPIA), and its updated palynostratigraphic scheme of India allows correlations across Gondwana.

Mike Stephenson referred to the ongoing work with Evelyn Kustatscher on the possible bridge taxa, *Densipollenites/ Nuskoisporites,* included in *Permophiles* 78 (Stephenson et al., 2025). The *Nuskoisporites dulhuntyi* is considered one of the key biostratigraphic marker species for the Lopingian of Europe. *Densipollenites* is common in the Tethyan Lopingian (e.g. Stephenson and Korngreen, 2021; Stephenson et al., 2024) and is present in the Indian Gondwana succession from where it was first described by Bharadwaj (1962). Michael Stephenson has also shared knowledge of bridge taxa through digital means, in galleries of photographs and taxonomic notes, for example, the BGS Taxonomy online galleries: https://www.bgs.ac.uk/information-hub/data-collections/fossil-taxonomy/) and the gallery of Usolka palynomorphs https://permian.stratigraphy.org/Gallery/Usolka/. A new synthesis (Stephenson et al., 2026) redefines the palynostratigraphy of the Carboniferous–Permian succession across northeastern Gondwana—from Israel and Jordan to Oman, Yemen and Pakistan—one of the world's most important regions for petroleum systems, groundwater resources and future carbonstorage potential. The interval also preserves one of the most complete records of Late Paleozoic Earth history, including Gondwanan glaciation, climate transitions, biotic evolution and large-scale tectonics. Because much of the succession is nonmarine and known mainly from cores and cuttings, biostratigraphy has long relied on palynomorphs. This study expands the original Arabian OSPZ scheme into nine new interval zones spanning the Serpukhovian to the Changhsingian, and traces them along two regional correlation lines. Converting the scheme to interval zones improves consistency and ease of use. The work reveals strong palynological similarities between southern NE Gondwana and western Gondwana during the Serpukhovian and late Carboniferous—times dominated by coldadapted floras producing monosaccate pollen and simple spores. By contrast, Guadalupian–Lopingian assemblages show fewer affinities, especially in northern areas where nontaeniate bisaccate pollen (e.g., *Protohaploxypinus uttingii*, *Falcisporites stabilis*) prevail. Simple paleoclimate modelling helps explain these patterns.

Liz Weldon is working on a quantitative analysis to complement a previous descriptive analysis of the paleobiographic distribution of the Gondwanan-Euroamerican genus *Terrakea* Booker, 1930 (Brachiopoda). It is also a bridging taxon that utilizes transitional provinces in the Permian to migrate between the Gondwanan and Boreal Realms.

Plans

Fieldwork at Apillapampa will include a magnetostratigraphic study, a new collection of fossils from both the marine and the coal members, and geochemical analyses. Additionally, the Copacabana Formation at Ancoraimes and Zudañez in Bolivia will be sampled for invertebrates, palynology, and other fossils. The main fieldwork is scheduled for November 2026. IUGS funding has been allocated by the SPS to MDP (USD 2500) for the field trip.

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Henderson's Harangue #17

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Paralysis by Perfection

As an attempt to stimulate debate or perhaps simply because something smells fishy, I deliver my seventeenth harangue for *Permophiles* #81. In Italian, it would be "L'arringa di Henderson" (the double "r" is important).

I recently received a request in my role as Secretary-General of ICS for a GSSP marker for the base-Cambrian at Fortune Head, Newfoundland – it seems one had not been placed following ratification in 1992. I did some research on this GSSP (base-Fortunian Stage) and discovered that there is valuable information pertinent to both my various harangues regarding the GSSP process as well as the glacial pace of completing the time scale. We can learn by looking at the beginning of the Paleozoic Era for insights to assist some upcoming decisions related to the Permian near the end of the Paleozoic.

Charles Darwin, in determining the origin of species by natural selection, was concerned with both the past and the present; he was both a geologist and naturalist who collected observations, especially during his voyage on the HMS Beagle. He read Sir Charles Lyell's grand work on the Principles of Geology during that voyage. Darwin (1859; 1st edition) wrote "*if my theory be true, it is indisputable that before the lowest Silurian* stratum was deposited, long periods elapsed as long as, or probably far longer than, the whole interval from the Silurian age to the present day; and that during these vast, yet quite unknown, periods of time, the world swarmed with living creatures*". His concern was that the first levels of abundant fossils known at the time were of complex organisms like trilobites. When and where were all the predicted intermediate links? His explanation was "*the extreme imperfection of the geological record*". His reference to Silurian* may be confusing now, but at the time of publishing his great book, the Ordovician had not yet been named, and a dispute between Adam Sedgwick and his Cambrian and Sir Roderick Murchison and his Silurian had not yet been resolved. In an original 6th edition of Darwin's book from my bookshelf at home (Darwin, 1880) the word Silurian has been replaced with Cambrian*. But it turns out he was not really talking about the lowest Cambrian stratum, as the appearance of trilobites is now attributed to the undefined Cambrian Series 2 (Stage 3). The base-Cambrian, base-Fortunian Stage is marked by an evolutionary innovation attributed to the trace fossil *Treptichnus pedum*, that of a sophisticated feeding process probing into the seafloor (see Buatois, 2018), representing a burrowing style unknown in Ediacaran strata. Lesson 1: A GSSP can be marked by more than the first occurrence of a body fossil. It should be marked by the best indicator in the selected section, and the choice will vary depending on facies and the interval of time under study.

The development of the GSSP was led by the detailed research of Guy Narbonne (Narbonne et al., 1987). Brasier et al. (1994) indicate in Episodes that the "*GSSP is a point in rock that defines a moment in time and was selected with guidance from the level marked by the lowest occurrence of Phycodes* pedum (a trace fossil)*" which "*lies 2.4 m above the base of Member 2 in the Chapel Island Formation*" (*Phycodes** is now referred to *Treptichnus* and sometimes *Trichophycus*). It has come to light that a few specimens of *Treptichnus pedum* appear a metre or two below the GSSP point; this led to considerable discussion (ongoing in some circles) regarding the merit of the GSSP (Landing et al., 2013; Babcock et al., 2014; Geyer and Landing, 2017, Gougeon et al., 2025). In addition to a detailed analysis of the ichnology of the Chapel Island Formation, Gougeon et al. (2025) provide a compelling case in support of the base-Fortunian GSSP. The GSSP has not been changed and is in accordance with GSSP recommendations by ICS. In my view, at this point in time, there is no correlation value in changing it but the discussion is certainly interesting and of value to workers studying rocks of any age. Lesson 2: We need to be careful how we word our GSSP definitions. It is a point in rock – it is not defined by the FO of *T. pedum*; the point was selected with **guidance** from the apparent FO of *T. pedum* at this section. The presence of this trace fossil at other sections around the world will guide (not define) correlation of the Ediacaran-Cambrian boundary. Accurate and precise global correlation will require additional tools ranging from other fossils

to isotopic studies. What level of precision do we expect?

I recommend looking at a copy of "The Origin of Species" and reading (at least) chapter 9 "On the Imperfection of the Geological Record". Darwin talks about migration of taxa, of FOs and FADs, of gaps in the rock record, and on sequence stratigraphy – although not normally using those terms. His insights are truly remarkable for the time. He suggests that the natural geological record is a "*history of the world imperfectly kept*" and recognizes it is "*written in a changing dialect*". He seems to be optimistic that new chapters will be written when he concludes his chapter by saying "*on this view, the difficulties above discussed are greatly diminished or even disappear*". Lesson 3: None of our chosen sections and points will be perfect. In addition, perfection does not mean we must use all known correlation tools to develop our GSSPs; furthermore, new tools will likely be discovered. We should not become paralyzed looking for perfection but rather accept our best efforts and complete the time scale.

In their book "Stratigraphic Paleobiology" (Patzkowsky and Holland, 2012), Steven Holland and Mark Patzkowsky (named by ICS as Digby McLaren Medalists at STRATI 2026) discuss the concept of range offset. Range offset is the discrepancy between first and last occurrences of taxa in a stratigraphic section (FO, LO) and the corresponding time of origination or extinction (FAD, LAD), either regionally or globally. There are many variables, of course, but their models (see their Fig. 5.4) suggest that median values of range offset could be typically in the range of hundreds of thousands to a couple of million years. Some taxa will be less susceptible to these effects, and correlation methods can minimize them, but it is probable that the correlation of a given point determined at a GSSP will still be within the range of +/- 100 Kyrs at best. Should we keep this in mind as we define GSSPs?

In this issue of *Permophiles* I also provide short reports on the Kungurian and Roadian working groups. The Kungurian is one of those intervals of time that is not so well understood. Although there are flooding surfaces, it is a time of general lowstand in many regions. It is a time of aridity and heat on the land – sort of like the "dog days of summer" we are enduring in the northern hemisphere right now. Marine fossils are starting to exhibit provincialism that affects correlation within the Middle Permian. There are few fossils to choose from, but the FO of *Neostreptognathodus pnevi* at Rockland Section in Nevada will guide correlation over a wide region (but not everywhere). Other documented fossils will help. The demonstrated lineage at Rockland of *N. pequopensis* to *N. pnevi* suggests that the chosen FO is likely close to the FAD of the descendant *N. pnevi*, but it is fair to say that we cannot be certain it is the true FAD. Even if it is the true FAD, how would we know that it is? Fortunately, we don't have to. The FO of the species marks or guides the chosen GSSP point – it does not define the boundary. The FO of the same species in other sections only guides our correlations to recognize proximity to the boundary. Other tools will help refine our correlation. Strontium isotopes at Rockland demonstrate the same trend but are offset from the so-called strontium curve of McArthur (GTS 2020). However, this portion of the curve is compiled from results from only a couple of sections that are not particularly well correlated in time; we need to be aware how the curve has been generated, if we choose to use it. Like the time scale, it is a work in progress.

The base-Roadian was ratified in 2001 (base-Guadalupian or Middle Permian; note Middle is capitalized – see Henderson's Harangue #5 in *Permophiles* 67); in contrast with the base-Cambrian, an *Episodes* article was not published, but a gold disk was later placed at Stratotype Canyon in the Guadalupe Mountains of West Texas. A draft of the future *Episodes* article is under review within the working group, but additional research conducted in the Guadalupes (see Shen et al., 2020) has demonstrated that the GSSP was not as perfect as previously thought. Despite this imperfection, geologists have been able to correlate the base-Roadian within an acceptable level of uncertainty for a quarter century. It turns out that the original lineage of *Mesogondolella lamberti* to *Jinogondolella nankingensis* may involve a third species. The question facing the working group is how much this affects correlation. Of course, our evolutionary lineages are interpretations. Can we ever be sure that we finally have it right? In my view, it is possible to maintain the GSSP considering this new data, but with greater awareness of the possible limitations. Who knows, maybe these difficulties will diminish or even disappear as new correlation tools are developed.

Acknowledgements

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Challenges in palynological correlation across Gondwana in the Carboniferous–Permian

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Introduction

In the Carboniferous–Permian, Gondwana covered ~100 million km² — about onefifth of Earth's surface — and it profoundly influenced atmospheric and oceanic circulation including monsoonal megacycles driven by the seasonal heating of a supercontinent (Peyser and Poulsen, 2008); extreme aridity in interior basins during the Permian (Zouicha et al., 2025); and climate transitions from glacial (Carboniferous) to greenhouse (latest Permian) (Stephenson et al., 2007). These shifts are recorded in sedimentary successions, including in aeolian dune systems, evaporites, and postglacial transgressive sequences.

The Carboniferous and Permian rocks of these cratonic basins contain commercial deposits of coal (e.g., in India, Australia, southern Africa and South America), and oil and gas (in Australia, South America and the Middle East), and thus are amongst the most intensely studied Permian and Carboniferous sequences in the world (Stephenson, 2026a). The need in exploration to access stratigraphic sequences through borehole material (cuttings, core and sidewall core) has meant that palynology is also, by far, the most important biostratigraphic tool used in locally correlating sequences in the Gondwana Carboniferous–Permian (Stephenson, 2016). Thus, palynostratigraphic schemes tend to be locally focused, although attempts have been made to correlate more widely across Gondwana, and from Gondwana to the international Permian scale (see Stephenson, 2008, 2016, for summaries). The local focus is also due to the difficulties of correlation relating to palaeoclimate and palaeogeography across a large continent.

Palaeoclimate, palaeogeography and palynology

This preliminary study considers the Carboniferous and Permian palaeogeography and palaeoclimate of Gondwana in the context of correlation, offering explanations for the difficulties in correlation at three time periods: 320 Ma (mid to late Bashkirian), 300 Ma (approximately the Carboniferous-Permian boundary), and 280 Ma (mid Kungurian) (Fig. 1). Maps were constructed based on PaleoDEM and points/polyline/polygon (rotation and

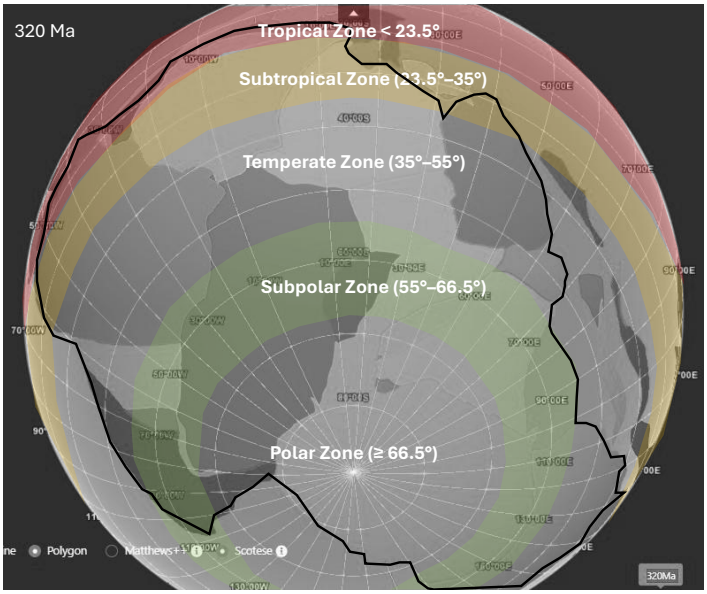


Fig. 1. The climate span of Gondwana (outlined) at 320 Ma with reference to modern climate belts, from the tropical zone (latitude < 23.5°) to the polar zone (≥ 66.5°). Palaeogeography after Scotese and Wright (2018) via the DDE Platform.

geometry files) of Scotese and Wright (2018) and Matthews et al. (2016) for 320, 300 and 280 Ma.

Two trends are of importance in relation to the conditions of palynology that might allow for correlation. The first is the very wide geographical spread of the Gondwana continent in the 320–280 Ma period from 10°S in the extreme northern parts of Gondwana (north Africa and northern South America) to the south pole situated for the 320–280 Ma period over present day Antarctica. In modern terms this would span the tropical zone (latitude < 23.5°) to the polar zone (≥ 66.5°) (Fig. 1) potentially allowing for an enormous natural range in vegetation and therefore palynological assemblage types, with implications for the ability to correlate.

The second is the movement of Gondwana between 320 Ma and 280 Ma. For the bulk of the Gondwana continent, the movement is northward into lower latitudes (Fig. 2) with 'central Gondwana' (for example present day eastern Africa) moving from 70°S to around 55°S between 320 Ma and 280 Ma in the Scotese and Wright (2018) reconstruction (Fig. 2A). The temperature increase due to movement northward would also be modified by temperature decrease relating to the descent into the Carboniferous–Permian glacial maximum in the Gzhelian/Asselian and then subsequent increases due to the ascent out of the glacial period (e.g., Montañez, 2022)

These two trends happening together (see Stephenson et al., 2026b, 2026c) are responsible for some of the very abrupt changes in vegetation/palynological assemblage types through the 320–280 Ma period especially noticeable in the present-day Middle East (northeast Gondwana) which moved around 750 km northward between 300 and 280 Ma, accompanied by postglacial climate warming (see Stephenson et al., 2026a). Very sharp gradients in palaeoclimate with latitude may also have resulted (Stephenson et al., 2026a). Perhaps more challenging are those parts of Gondwana such as modern-day Antarctica and Australia that may have moved *southward* (i.e., toward the south pole) during the period 320–280 Ma (Fig. 2A, B) according to the reconstructions of Scotese and Wright (2018) and Matthews et al. (2016). In these regions, potential temperature changes due to global cooling then warming would be modified by an overall cooling caused by movement toward the pole. So, climate warming due to the demise of glaciation would potentially be counteracted by temperature decrease due to increase in latitude (see Stephenson et al., 2026c).

Implications for correlation

These two trends have implications for the similarities of plant assemblages across the continent of Gondwana, the consequent similarities of palynological assemblages, and the potential for correlation. For example, it is very unlikely that assemblages will be similar enough in the extreme north of northern Gondwana (e.g., modern-day Moroccan or Libyan basins) and in subpolar or polar zones (for example, modern day South African basins)

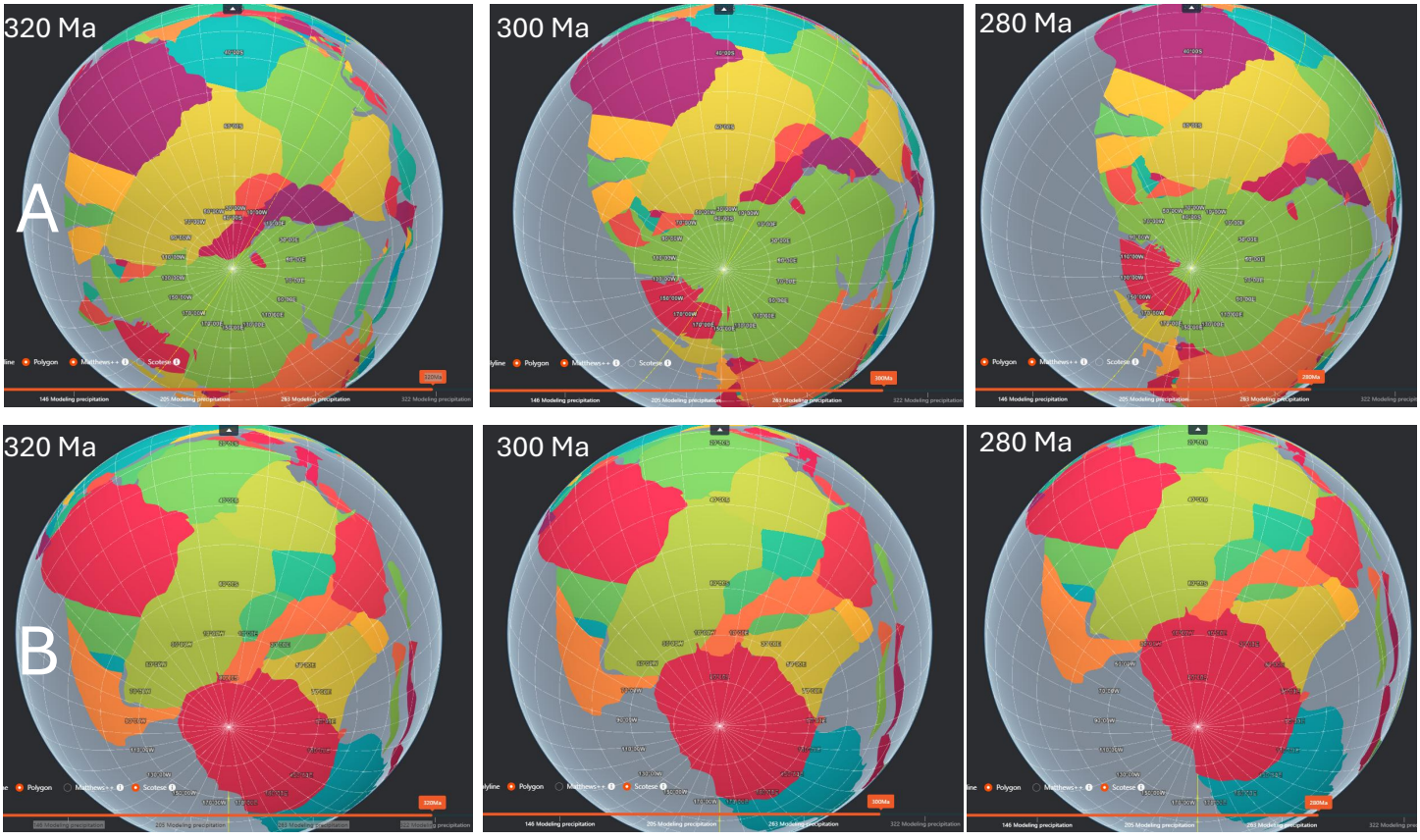


Fig. 2. Movement of Gondwana between 320 Ma and 280 Ma. A, Palaeogeography after Scotese and Wright (2018), and B, after Matthews et al. (2016) for 320, 300 and 280 Ma.

to allow easy correlation. A quick comparison of Carboniferous–Permian palynological assemblages from Libya (e.g., Loboziak and Clayton, 1988) and in the Karoo Basin (e.g., Anderson, 1977) shows very marked quantitative and qualitative differences.

A potential correlation strategy which will be explored in a forthcoming paper will assess the possibilities of correlation zones across Gondwana broadly following palaeolatitude or palaeoclimate belts where palynological assemblages might be similar enough to allow correlation.

Examples that could be pursued include correlating the Amazonas and Solimões basins (Fig. 3) with Morocco and NE Libya basins (~subtropical/tropical); the Arabian basins with the Paraná and Chaco-Paraná basins (~temperate); and southern Africa basins with the Satpura, Son-Mahanadi, Koel-Damodar, and Godavari basins in India (~polar).

A similar observation for correlation includes identifying parts of Gondwana on a similar drift track, for example those parts moving northward into lower latitudes (with an implied resultant warming) and those moving south into higher latitudes. Those with the same drift track, for example some South American basins and Arabia are most likely to display similar development of assemblages through time. Those areas that have the opposite drift track - for example Arabia (generally northward moving) and Australia (generally southward moving, or stationary, with respect to palaeolatitude), may have very different plant/palynological development through the 320 to 280 Ma period.

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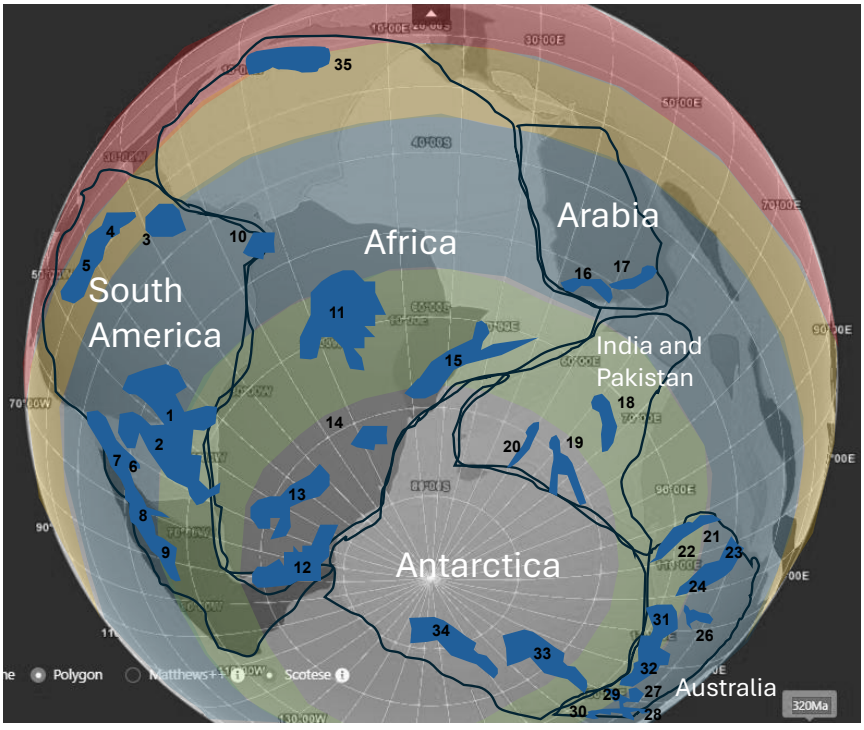


Fig. 3. Palaeolatitude and palaeoclimate belts, and chief basins in the Carboniferous-Permian of Gondwana. 1 Paraná, 2 Chaco-Paraná, 3 Parnaíba, 4 Amazonas, 5 Solimões , 6 Paganzo, 7 Calingasta, Uspallata , 8 San Rafael, 9 Tepuel, 10 Gabon, 11 Congo, 12 Karoo, 13 Kalahari, 14 Zambesi, 15 Tanzanian-Malagasy, 16 Yemen, 17 Oman, 18 Himalayan zone, 19 Satpura, Son-Mahanadi, Koel-Damodar, 20 Godavari, 21 Carnarvon, 22 Collie-Perth, 23 Canning, 24 Officer, 25 Bonaparte, 26 Pedirka, 27 Galilee, 28 Bowen-Gunnedah, 29 Cooper, 30 Sydney, 31 Arckaringa, 32 Murray, 33 Victoria Land, 34 Central Transantarctic Mountains, 35 Morocco, NE Libya.

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Nierstein, Germany – a world-class early Permian trace fossil site celebrates 100 years of discovery

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Introduction

On Sunday, June 13, 1926, Ernst Staiger, a high school graduate from the small wine-growing town of Nierstein in southwestern Germany, discovered fossilized tetrapod tracks in red fluvial clastic rocks of a local quarry. Detailed investigations of the site by the Natural History Museum Mainz followed and yielded hundreds of slabs, mainly bearing fossil arthropod and tetrapod tracks (Schmidtgen, 1927a, b, 1928a-c, 1934). In the 1970s, the private Nierstein Paleontological Museum (PMN) recovered numerous high-quality tracks and traces during land consolidation work in the vineyards between Nierstein and Nackenheim (Fichter, 1984; Haubold and Stapf, 1998; Minter et al., 2007). Since 2021, the Rhineland-Palatinate Geological Heritage Service (GDKE), the Mainz Natural History Museum/State Collection of Natural History (NHMMZ) and the GEOSKOP Prehistoric Museum near Kusel/ Rhineland-Palatinate (UGKU) have been carrying out systematic geological and paleontological excavations in the Rhine riverbed between Nierstein and Nackenheim during low water levels and digitally catalogue the now more than 5,000 specimens with Nierstein trace fossils held in public and private collections (Voigt, 2021, 2022; Voigt and Kehl, 2022; Voigt et al., 2022; Kehl et al., 2025).

In terms of both quantity and quality, the Nierstein deposit meets all the criteria for a trace fossil Lagerstätte (Kimmig and Schiffbauer, 2024). However, the extensive fossil record appears to be both a blessing and a curse: to date, there are only a few scientific publications on this significant collection, and almost all of them are in German. The aim of this article is to summarize the key facts and findings regarding the trace fossils from Nierstein, to raise awareness of their existence, and to encourage further research.

Geographic position and geologic framework

Nierstein is a small town on the left bank of the river Rhine, situated approximately 12 km south of Mainz, the capital of the federal state of Rhineland-Palatinate (Fig. 1). In Nierstein, and particularly in its northern margin towards the village of Nackenheim, Permian continental red-beds are exposed across an area of approximately 4.5 km^2 within a local tectonic uplift (= Nierstein Horst). This is the north-easternmost outcrop of the 40 x 100 km large Variscan intermontane Saar–Nahe Basin and it exposes very young parts of the up to 8,000 m thick succession of upper Carboniferous to lower Permian volcano-sedimentary rocks of this basin (Schäfer, 2005; Boy et al., 2012). The Permian red-beds of the Nierstein Horst correspond to the upper half of the up to 1,500 m thick Standenbühl Formation, which is subdivided in the study area into the Schwabsburg (190 m), Rehbach (460 m) and Nackenheim (130 m) subformations, from base to top.

Chronostratigraphy

No radioisotopic ages are currently available for the Standenbühl Formation. However, Sakmarian to Wordian ages (ca. 294–264 Ma) have been proposed based on lithofacial and biostratigraphic correlations—the latter relying mainly on conchostracans, insects and tetrapod tracks (Haubold and Stapf, 1998; Martens, 2012, 2020; Schneider et al., 2004, 2020; Menning et al., 2022). Most recently, Marchetti et al. (2026: fig. 9)

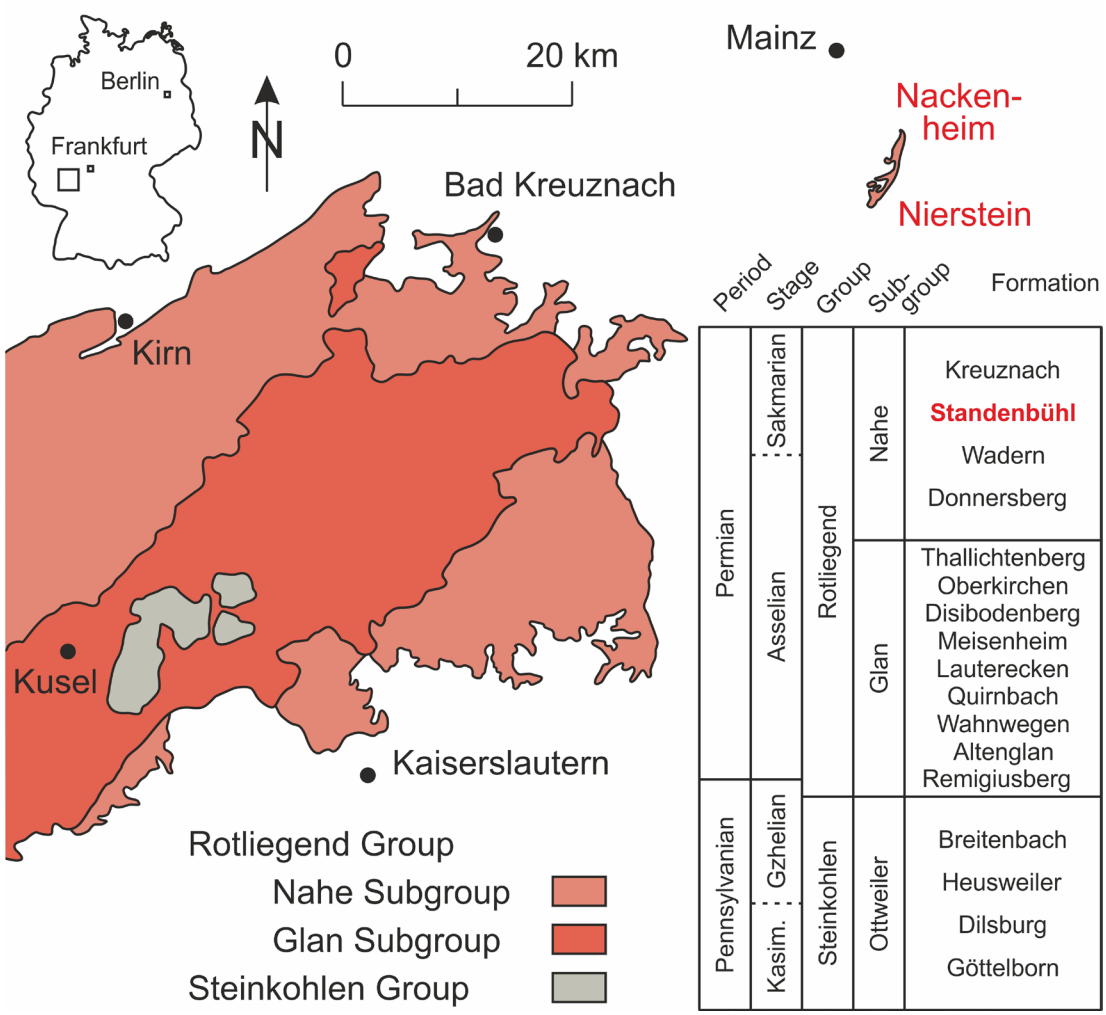


Fig. 1. Geographic and stratigraphic position of the Nierstein lower Permian red-beds at the northeasternmost extension of the late Carboniferous to early Permian Saar-Nahe Basin.

suggested a late Asselian to Sakmarian age (ca. 295–290 Ma) for the Standenbühl Formation based on new radioisotopic ages from the Thuringian Forest Basin of central Germany into account.

Paleoenvironment and sedimentary facies

The Standenbühl Formation consists of playa sediments that probably formed in a closed basin under semi-arid conditions (Boy et al., 2012; Fig. 2). The sand-dominated sequences of the Schwabsburg and Nackenheim subformations of the Nierstein Horst are interpreted as distal-most alluvial-fan deposits ("sandflats"). The Rehbach Subformation consists of thick mudstones and minor fine-grained sandstones interpreted as deposits of meandering channels within a very extensive floodplain ("mudflats"). Lithofacies and biofacies suggest that discharge rates varied significantly seasonally, though channels most likely did not dry up completely, as the vertebrate trace and body fossil record is remarkably rich in amphibian remains (Haubold and Stapf, 1998; Boy et al., 2012). The sedimentary structures observed are primarily those typical of ephemeral streams in areas with sparse vegetation and significant fluctuations in day-night temperatures (Picard and High, 1973): chevrons, ice crystals, contour marks, raindrop and hailstone imprints, load casts, microbially induced sedimentary structures, ripples, foam marks, tool marks, mud-cracks, and rill marks (Fig. 3).

Fossil remains

Most of the discussed fossils come from the middle section of the Standenbühl Formation in the Nierstein Horst, i.e. the Rehbach Subformation. The site is dominated by trace fossils (rhizoliths, invertebrate ichnia, and tetrapod tracks) (Fig. 4). Root traces have not been studied yet. To date, 16 genera of invertebrate trace fossils have been identified: *Acripes*, *Augerinoichnus*, *Avolatichnium*, *Circulichnus*, *Cruziana*, *Diplichnites*, *Diplopodichnus*, *Heterotripodichnus*, *Lithographus*, *Paleohelcura*, *Rusophycus*, *Stiaria*, *Striatichnium*, *Tambia*, *Tonganoxichnus*, and *Treptichnus* (Boy, 1976; Minter et al., 2007; Voigt et al., 2022). These include resting, locomotion, feeding, and dwelling traces of various aquatic and terrestrial arthropods (including Euthycarcinoidea, Conchostraca, Notostraca, Myriapoda, Arachnida, Coleoptera, Monura, and Diptera). Only four genera of tetrapod tracks have been confirmed to date: *Amphisauropus*, *Batrachichnus*, *Dimetropus*, and *Dromopus*, which have been attributed to amphibian, reptile-like amphibian,

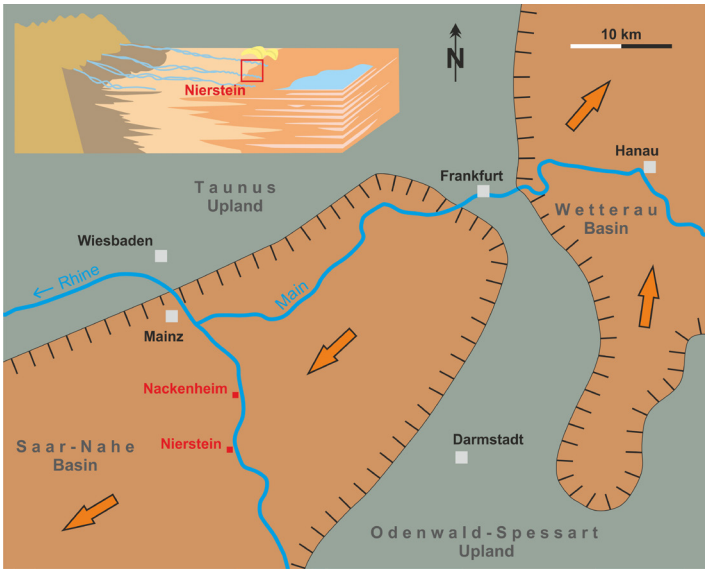


Fig. 2. Generalized paleogeography and depositional environment in the northeastern part of the Saar-Nahe Basin during deposition of the Standenbühl Formation (based on Marell, 1989: fig. 53). The Nierstein lower Permian red-beds are interpreted to be playa deposits that originated in a sandflat-mudflat transitional environment. Depocenter of the internally drained basin was located approximately 100 km southwest of Nierstein. Orange arrows indicate mean current direction. Modern river system and cities are shown for orientation.

pelycosaurian-grade tetrapod, and true reptilian producers (Fichter, 1984; Haubold and Stapf, 1998; Voigt, 2007, 2012). The relatively sparse record of body fossils includes plant remains, hydromedusae, conchostracans, ostracods, and vertebrate remains (Reineck, 1966; Boy, 1976; Schindler, 2007; Boy et al., 2012; Kehl et al., 2025) (Fig. 5).

Most of the fossils occur in or in close association with channel deposits of the Rehbach Subformation. The majority of invertebrate ichnia appear to have been produced in the water-saturated mud of the shallow inner bank of meandering channels. It is the same area where most of the excellently preserved hydromedusae were stranded and embedded. Further research is needed to determine the role of floodplain ponds for the preservation of arthropod tracks and tetrapod bones.

Significance of the occurrence and perspectives

The red-beds of the Nierstein Horst are a unique window into the ecology and evolution of early Permian terrestrial and aquatic arthropods. Stratigraphically, the fossil-bearings beds parallel the early radiation of beetles (Beutel et al., 2024). Representatives of this significant insect group might be well and abundantly documented in the Nierstein red-beds by larval burrow traces (e.g., *Tambia*) and trackways of fully developed insects (e.g., *Lithographus*). Quality and quantity of the Nierstein



Fig. 3. Characteristic sedimentary structures from the Nierstein lower Permian red-beds. From upper left to lower right (length of scale; repository): Interference ripple marks (10 cm; field specimen), oscillation ripple marks (3 cm; Oliver Weber), contour marks (2 cm; NHMMZ), microbially induced sedimentary structures (2 cm; NHMMZ), ice crystal marks (1 cm; NHMMZ), foam marks (5 mm; NHMMZ).

trace fossils are a key to understand extramorphological (= non-anatomically controlled) features and are, therefore, of fundamental importance for the development of a consolidated and reproducible ichnotaxonomy (Minter et al., 2007; Fig. 6). If the late Asselian to Sakmarian age of the most recent correlation of the Standenbühl Formation is correct (Marchetti et al., 2026), Nierstein can serve as a potential ecological reference for the dramatic transition from the peak of the Late Paleozoic Ice Age to the Artinskian Warming Event in the Pangean paleo-equatorial mountain basins (Marchetti et al., 2022).

The scientific potential of the Nierstein red-beds and its outstanding trace fossils is enormous. However, in order to fully realize its potential, the site needs intensified and coordinated research. Digital cataloging of the Nierstein fossils and sedimentary structures held in public and private collections is just a first step in this direction (www.nina.rotliegend.de). And, of course, research collaboration as well as excavation participation by professional geologists and likewise scientifically interested volunteers are always welcome!

Acknowledgments

We would like to thank Hannes Lerp, Kai Nungesser, Harald Stapf (HS) and Oliver Weber for granting access to their collections or collections they care. HS also provided valuable information on the history of the discovery. Ralf Werneburg is thanked for his expert assessment on discosauriscid remains and Georg Sommer for preparing some of the fossil tetrapod remains from the Rhine riverbed. Peter Budeus supports the digitization of the Nierstein trace fossil collection at NHMMZ. We would also like to thank Wolfgang Conrath, Hans-Rieder Matzenbacher, Helen Rapin and Norbert Strumpf for assisting fieldwork in the Rhine riverbed, and the Upper Rhine Waterways and Shipping Authority for granting the excavation permit. Jens Tauchert supported the research by providing information on potential fossil sites and drone imagery, and Jörg Schneider through stimulating discussions on fossils and facies.

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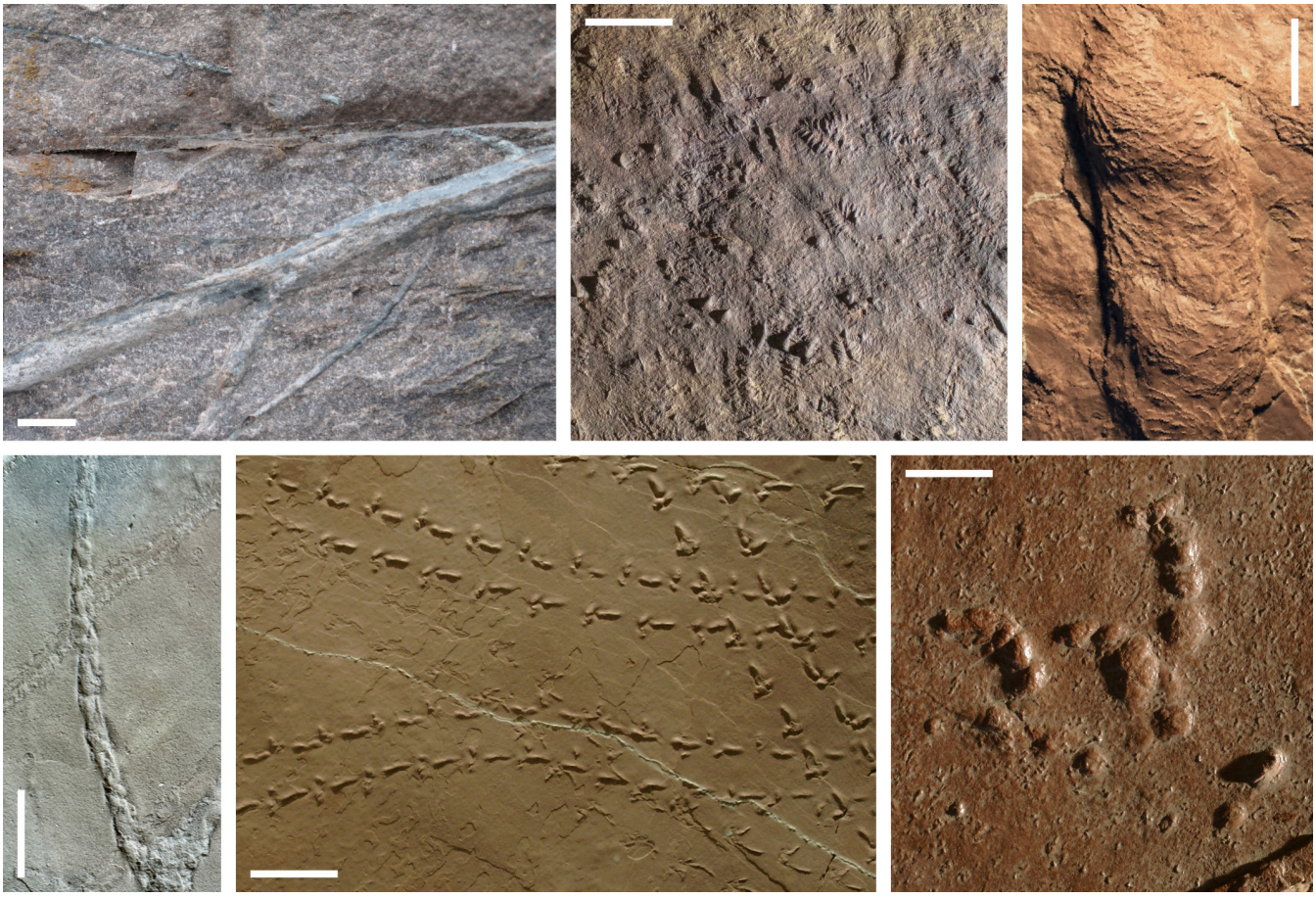


Fig. 4. Trace fossils from the Nierstein lower Permian red-beds. From upper left to lower right (length of scale; repository): Rhizolith of unknown plant (1 cm; NHMMZ), notostracan locomotion and resting traces *Cruziana-Rusophycus* (2 cm; NHMMZ), beetle larva burrow *Tambia* (2 cm; NHMMZ), dipteran larva burrow *Treptichnus* crossing faint milliped walking trace *Diplichnites* (2 cm; NHMMZ), beetle walking traces *Lithographus* (2 cm; NHMMZ), reptilian pes-manus imprint couple *Dromopus* (1 cm; PMN).

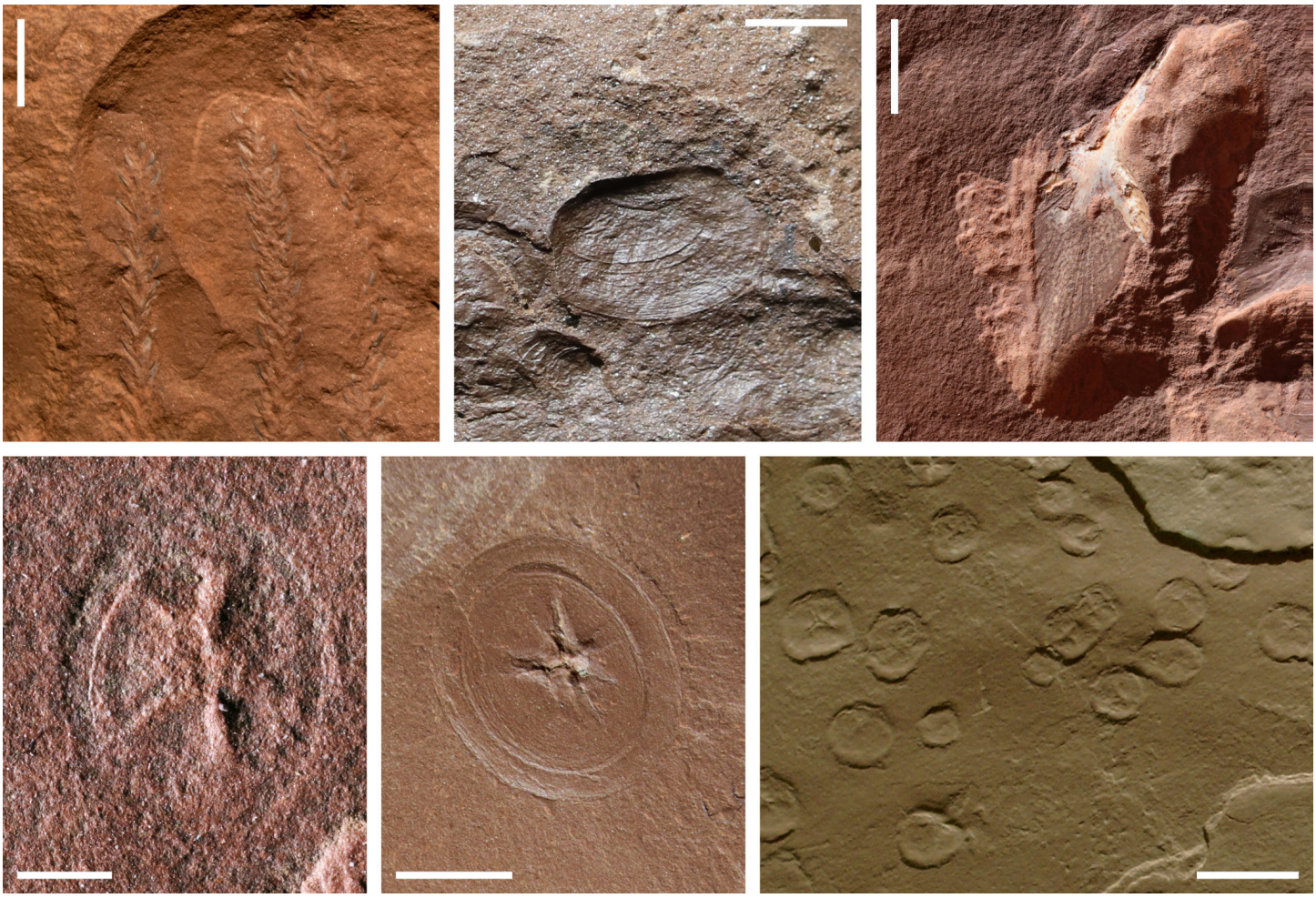


Fig. 5. Bodyfossil remains from the Nierstein lower Permian red-beds. From upper left to lower right (length of scale): Walchian conifer remain (1 cm), conchostracans (2 mm), discosauriscid pterygoid bone (5 mm), *Medusina atava* (2 mm), *Medusina limnica* (2 mm), mass occurrence of *M. limnica* (mm). All specimens are from NHMMZ



Fig. 6. Possible beetle walking traces assigned to *Lithographus* from the Nierstein lower Permian red-beds. The morphology of tracks and trackway patterns varies depending on substrate, gait, and the specific surface of splitting. Given the large number of traces, the interactions among the morphologically active factors can be examined in detail. Scale bars equal 1 cm. All specimens are from NHMMZ.

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In Defense of Wolfcamp Formation in the Permian Superbasin

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I read with interest Stephen Lucas's article on the "use and misuse of the terms Wolfcamp and Wolfcampian in Permian lithostratigraphy and chronostratigraphy" in the USA (Lucas, 2026). Lucas (2026) presented an informative history of the terms Wolfcamp Formation and Wolfcampian Series (corresponding to Asselian to lower Artinskian stages according to the 2024 stratigraphic chart of the International Commission on Stratigraphy). However, I was not convinced by his argument that the term Wolfcamp Formation, currently used (widely and unofficially) for the subsurface "Wolfcamp formation" in the Permian Delaware basin in Texas, should not be formalized.

Lucas's paper is apparently a reaction to Wayne Camp's paper published in the July 2025 issue of the AAPG Bulletin, in which Camp (2025) proposed to formalize the term Wolfcamp Formation as a lithostratigraphic unit for the subsurface formation in the Permian Delaware basin.

I do not want to repeat the historical information presented in both Camp (2025) and Lucas (2026). However, for the sake of this correspondence, I would like to draw attention to the following points.

Lucas (2026) mentions that the name Wolfcamp Formation was originally given by J. A. Udden in 1917 for the shale-dominated Lower Permian formation exposed in the Glass Mountain in southwest Texas. This formation was renamed as two formations – the lower Neal Ranch Formation and the upper Lenox Hills Formation – by C. A. Ross in 1959 and 1963. These two new formations have been formally accepted by the US Geological Survey, and the term Wolfcamp Formation was thus discarded. Lucas regrets this and writes: "In my view, it would have been better to consider the Neal Ranch and Lenox Hills as members of the Wolfcamp Formation or formations in a Wolfcamp Group." So, Lucas (2026) has no problem retaining the term Wolfcamp Formation or Group for the outcropped formation studied by Udden and Ross. However, this has not happened and as Lucas (2026) mentions, Wolfcamp Formation is no longer used for the outcrop formation on the Glass Mountain.

Lucas (2026) then reviews the time-equivalent shale-rich formation extensively drilled in the Delaware and Midland basins. Petroleum geologists, for decades, have referred to it as the Wolfcamp formation or Wolfcamp shale. However, Lucas (2026) disagrees with this nomenclature and points out some lithological and facies differences between the outcrop and subsurface formations (the latter being deep marine, for example) and suggests that, not Wolfcamp Formation, but "new lithostratigraphic names" should instead be used (although he does not offer any alternate formation names).

If Wolfcamp Formation is no longer used for the outcrop formation studied by Udden and Ross and it is thus available, and if petroleum geologists and even U.S. Geological Survey (Gaswirth et al., 2018) have used Wolfcamp for the time-equivalent, shale-dominated subsurface formation, why not simply keep Wolfcamp Formation for the subsurface formation as it is already an established term. Introducing new terms would simply complicate the situation.

Wolfcamp shale in the Permian Superbasin is the second most petroleum producing oil reservoir in the world (second only to Saudi Arabia's Ghawar field), and Wolfcamp shale in the Permian Delaware basin is the best shale play in the USA in terms of production performance (Sorkhabi et al., 2026). It deserves an official lithostratigraphic name.

I found Lucas (2026) very informative, but I do not agree with his conclusion and instead support Camp (2025) that the term Wolfcamp Formation should be formalized for the time-equivalent subsurface formation, especially that it is an available and de facto an established term. Petroleum geologists (and even the U.S. Geological Survey) will continue to use Wolfcamp Formation – whether formalized or unofficially. Let's keep it simple.

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Use and misuse of the terms Wolfcamp and Wolfcampian in Permian lithostratigraphy and chronostratigraphy: Discussion

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I thank Lucas (2026) for bringing up the issue of the use of Wolfcamp as an informal subsurface lithostratigraphic name in

the Delaware and Midland basins of Texas and New Mexico. Presently there is no formal recognition of the Wolfcamp Formation since the formation was subdivided and renamed the Neal Ranch Formation and Lenox Hills Formation by Ross (1959) for exposures in the Glass Mountains (US Geological Survey, 2025). This has left the correlative basinal deposits in the subsurface Delaware and Midland basins with no formal definition.

Camp (2025) proposed reinstating the name Wolfcamp Formation following the guidelines of the North American Stratigraphic Code (NASC) (North American Commission on Stratigraphic Nomenclature, 2021). Camp (2025) defined the proposed Wolfcamp Formation as the interval between the base of the Bone Spring Formation and the top of the Strawn Formation/ Group following historical usage defining the RKI Exploration and Production (Florida Gas Exploration) Ross Draw 7 well (API 30015228100000) in Eddy County, New Mexico as the reference section. This well was chosen because of its centralized location, availability of well logs and drill cuttings, and prior use of borehole logs from this well by the U.S. Geological Survey as a stratigraphic type log for their regional study in the Delaware Basin (Gaswirth, 2020).

Lucas (2026, p.17) objects to using the name 'Wolfcamp', suggesting that a subsurface lithostratigraphic unit should rather be named for the borehole used as the proposed stratotype (Ross Draw 7) following NASC Article 16. Camp (2025, p. 866) referred to this guideline but argued against introducing a new formation name that likely would never be widely accepted because of the long historical use of the Wolfcamp as an informal subsurface lithostratigraphic unit, and proposed reinstating the abandoned Wolfcamp Formation name following the rule of priority and to preserve well established (although informal subsurface) names according to NASC Article 7c. NASC Article 20c provides for using an obsolete formation name for another unit, providing "its reintroduction will cause no confusion" (North American Commission on Stratigraphic Nomenclature, 2021, p. 173). It is the author's opinion that introducing a different formation name for the proposed Wolfcamp Formation would create confusion.

It is worth noting that many other formal subsurface formations are not named from type wells but rather have been named by extending outcrop nomenclature into the subsurface, such as the Bone Spring Formation in the Delaware Basin, named after Bone Spring Canyon, Culbertson County, Texas (US Geological Survey, 2026). Although this practice occurred prior to the establishment of the NASC in 1983, I am unaware of any formal proposals to rename the subsurface Bone Spring Formation after a wellbore or field, presumably because of historical precedence.

Furthermore, the proposed Wolfcamp Formation of Camp (2025) is restricted to the subsurface Delaware Basin, and thus does not conflict with, or is it intended to replace the established outcrop nomenclature (Neal Ranch and Lenox Hills). It is anticipated that the name Wolfcamp Formation could be extended to the equivalent lithostratigraphic interval in the subsurface Midland Basin.

Lucas (2026, p. 17) notes that such reinstatement of the name Wolfcamp Formation as proposed by Camp (2025) is not explicitly addressed by the current NASC guidelines (except perhaps other than by Article 7c and Article 20c) and recommends that alternate nomenclature should be used without offering a reasonable and practicable alternative.

Lucas (2026, p. 16) offers a potential solution by reinstating the name Wolfcamp Formation for the Glass Mountain exposures and demoting the Neal Ranch Formation and Lenox Hills Formation to member status. Alternatively, the Wolfcamp Formation could be elevated to group status, retaining the formation status of the Neal Ranch and Lenox Hills, which would limit confusion with existing nomenclature. I agree with Lucas (2026) who recommends retaining the existing nomenclature of Ross (1959) at the Glass Mountains because of its longstanding use and to avoid further confusion.

If the proposed reinstatement of the name "Wolfcamp Formation" for the subsurface Delaware Basin is the main objection, then perhaps redefining, rather than reinstating, the proposed Wolfcamp Formation of Camp (2025) to the "Wolfcamp Shale" would be more acceptable. Using the name "Wolfcamp Shale" would also address the facies change from shallow-water shelfal carbonates and clastics at the outcrop (the obsolete Wolfcamp Formation) to the deep-water basinal clastic deposits in the Delaware Basin as recommended by NASC Article 18a. A change to include a lithic designation preserves the formation boundary definitions and rank as originally proposed by Camp (2025).

An opportunity remains to formally define the other informal designated "Wolfcamp" subsurface units in the greater Permian Basin (Fig. 1). Accepting the formal definition and use of the formation name "Wolfcamp" in the Delaware Basin would be a good starting point to the greater endeavor of formalizing the Lower Permian stratigraphic units in the Permian Basin. Perhaps an AAPG Hedberg Conference or similar meeting should be convened to address this issue.

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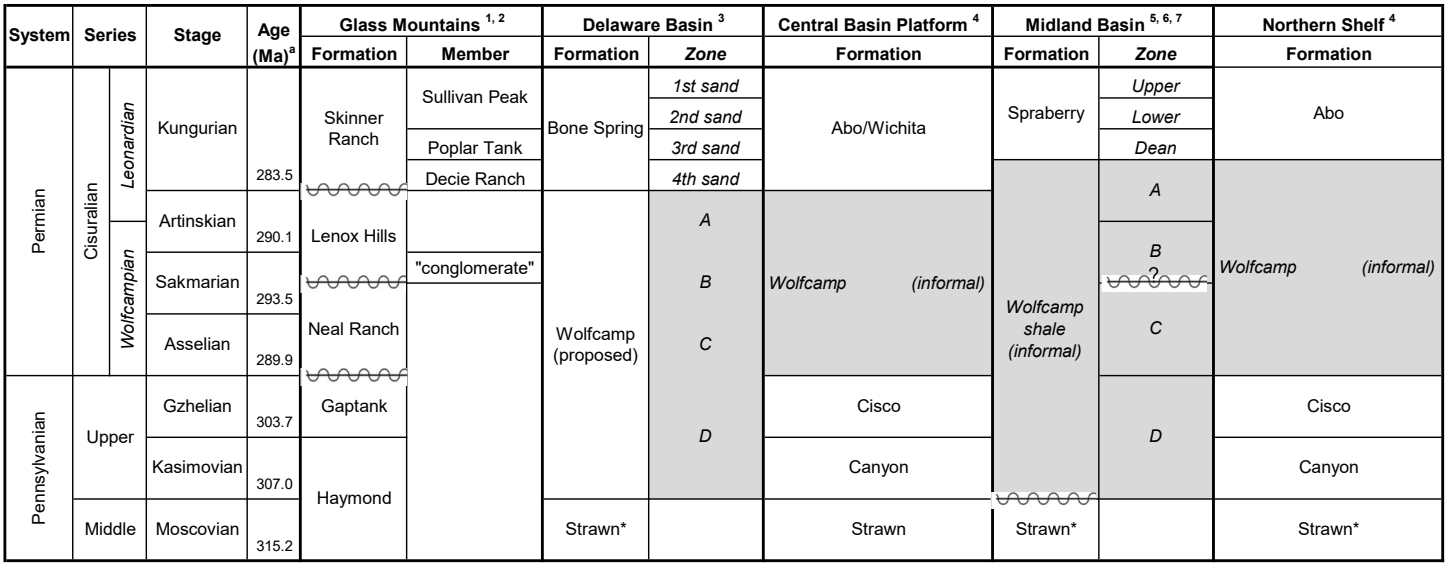


Fig. 1. Regional stratigraphic correlation chart of the Permian Basin showing the proposed Wolfcamp Formation of Camp (2025) and Wolfcamp units that have not been formally defined shaded gray. The Strawn Formation has group status in Texas (US Geological Survey, 2025). [a]Cohen et al. (2013, updated), [1]Ross (1959), [2]Wahlman (2019), [3]Camp (2025), [4]Ruppel (2019), [5]Fu et al. (2020), [6]Barrick and Wahlman (2019), [7]Tian et al. (2022).

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The Bianping brachiopod fauna from the Cisuralian of South China: solving the enigma?

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Introduction

The Permian Period is characterised by its strong marine faunal provincialism due to the formation of the supercontinent Pangea and the development of a semi-sealed Palaeotethys. In particular, three major palaeobiogeographic realms were distinguished based on brachiopods in the Cisuralian: the Boreal Realm in the Arctic Region, the Palaeoequatorial Realm, centred around the Palaeotethys, and the Gondwana Realm in the Southern Hemisphere, comprising modern Oceania, Antarctica and South America (Shi and Grunt, 2000; Shen et al., 2013). Brachiopod faunas from the Cisuralian of South China (e.g., Guanxi, Li et al., 1986), North China and Tarim Basin (e.g., Chen and Shi, 2006a, 2006b) are characterised by their high diversity and dominated by typical warm water taxa, defining a broad Cathaysian Province (Shen et al., 2013). In contrast, tectonic blocks in Xizang (Tibet) and Yunnan, south-western China, are

characterised by cold-water Gondwanan elements mixed with sparse to rare Cathaysian elements, documenting the progressive shift northwards of the Cimmerian blocks during the Cisuralian (e.g., Shi and Shen, 2001; Shen et al., 2013).

This common understanding of Cisuralian brachiopod palaeobiogeography from China is challenged by the Bianping fauna, a Cisuralian brachiopod fauna recorded in Ziyun County, Guizhou, South China (Fig. 1). According to Feng (1998) the Bianping fauna is characterised by 21 cold-water genera that can be correlated with those of western Australia and Timor, in the Gondwana Realm. However, the contribution by Feng (1998) did not provide a complete assessment of the composition, biostratigraphic and palaeobiogeographc significance of the fauna, also challenged by traditional viewpoints, pushing to its re-study.

Composition, age and palaeobiogeographic affinity of the fauna

The Bianping section succession is dominated by the Houzigan Limestone consisting of thick-bedded bioclastic grainstone and packstone, which was accumulated near shore in agitated, shallow-marine carbonate platform environment (Fig. 1). A novel collection of brachiopods from the Bianping Section comprises around 500 well-preserved specimens. The collection spans the interval previously recognised by Xiao et al. (1986) as the Asselian to Sakmarian, based on fusuline zonation (from the base of the *Pseudoschwagerina uddeni* Zone to the base of the *Parmirina davasica* Zone).

Systematic study of the new collection from the Bianping section provided a faunal list of 105 species belonging to 76 genera and seven orders (Productida, Orthotetida, Orthida, Rhynchonellida, Athyridida, Spiriferida, Terebratulida). Overall, the fauna is mainly composed by the spiriferides (39.4%) and the productides (33.6%). The fauna is dominated by classical Cathaysian warm-water elements, such as the productides *Transennatia* sp., *Reticulatia uralica*, *Echinaria* sp., *Linoproductus dorothevi*, costate spiriferides as aff. *Choristites pavlovi* and *Ziyunospirifer triplicata*, and lamellose spiriferides such as *Neophricadothyris asiatica* (Fig. 2). Plicate orthides such as *Enteletes lamarckii*, *Enteletes andrewsi* and *Enteletina* sp. are also common. These elements make the Bianping fauna quite similar to the Asselian–Sakmarian *Protoanidanthus enaagardi – Buxtonia – Linoproductus* Association reported from the Maping Limestone by Li et al. (1986) in Guanxi, the neighbouring province of Guizhou.

Cold-water elements have also been recognised in the Bianping brachiopod collection, but are limited to only six species belonging to five genera, representing just 5.2% of the fauna in terms of specimen number. Gondwanan elements in the Bianping fauna are represented by the linoproductid *Cimmeriella* sp., the productid aff. *Callytharrella* sp. and the spiriferides *Spirelytha* sp. and *Hunzina bisnaini* (e.g., Archbold and Barkham, 1989; Archbold et al., 1995; Shen et al., 2000; Xu et al., 2024) (Fig. 3). Thus, among the Gondwanan genera reported by Feng (1998)

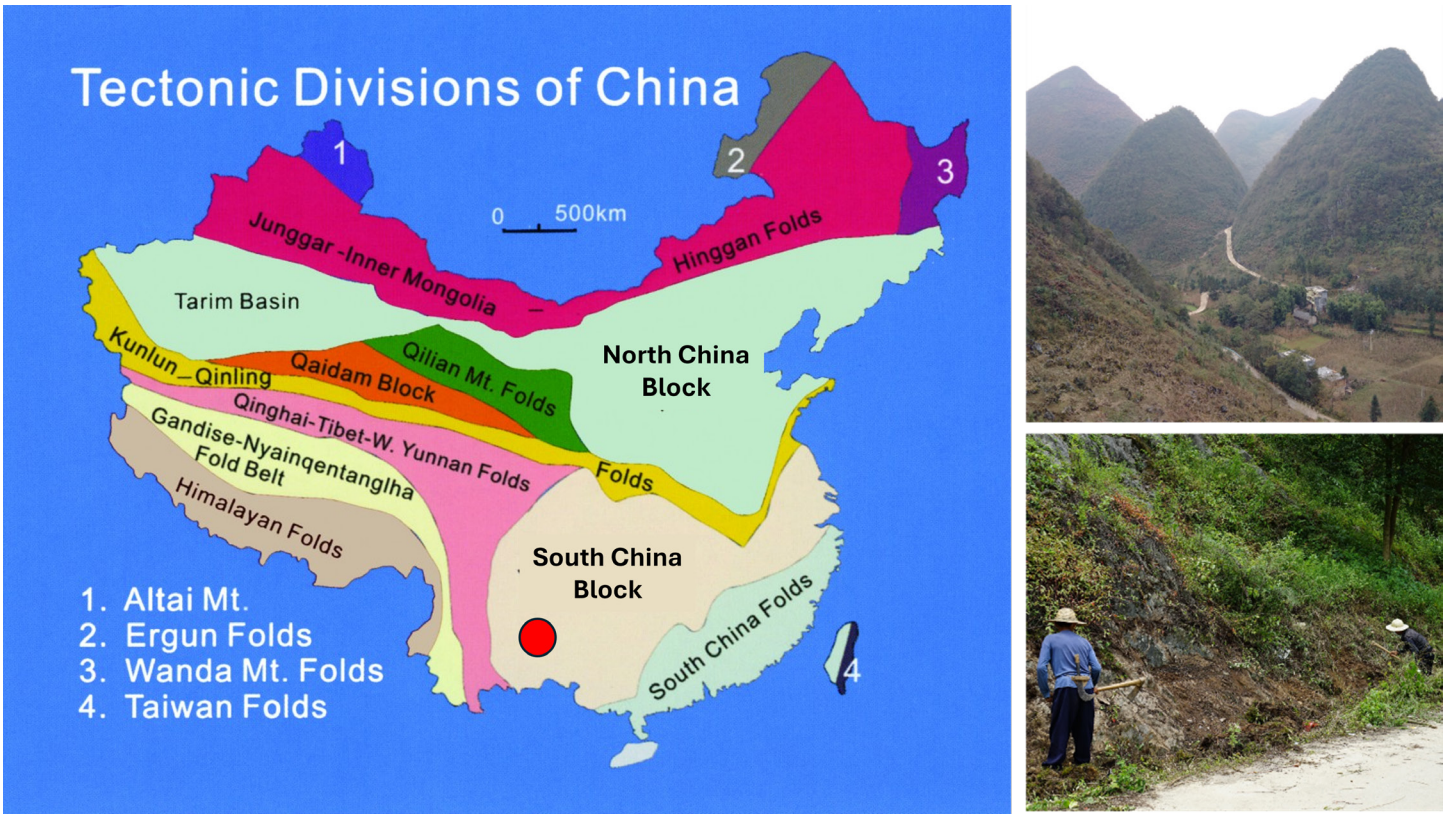


Fig. 1. Location of the Bianping section in Guizhou, in the western part of the South China Block. Adapted after Liu (2013). On the right, photographs of the Bianping section.

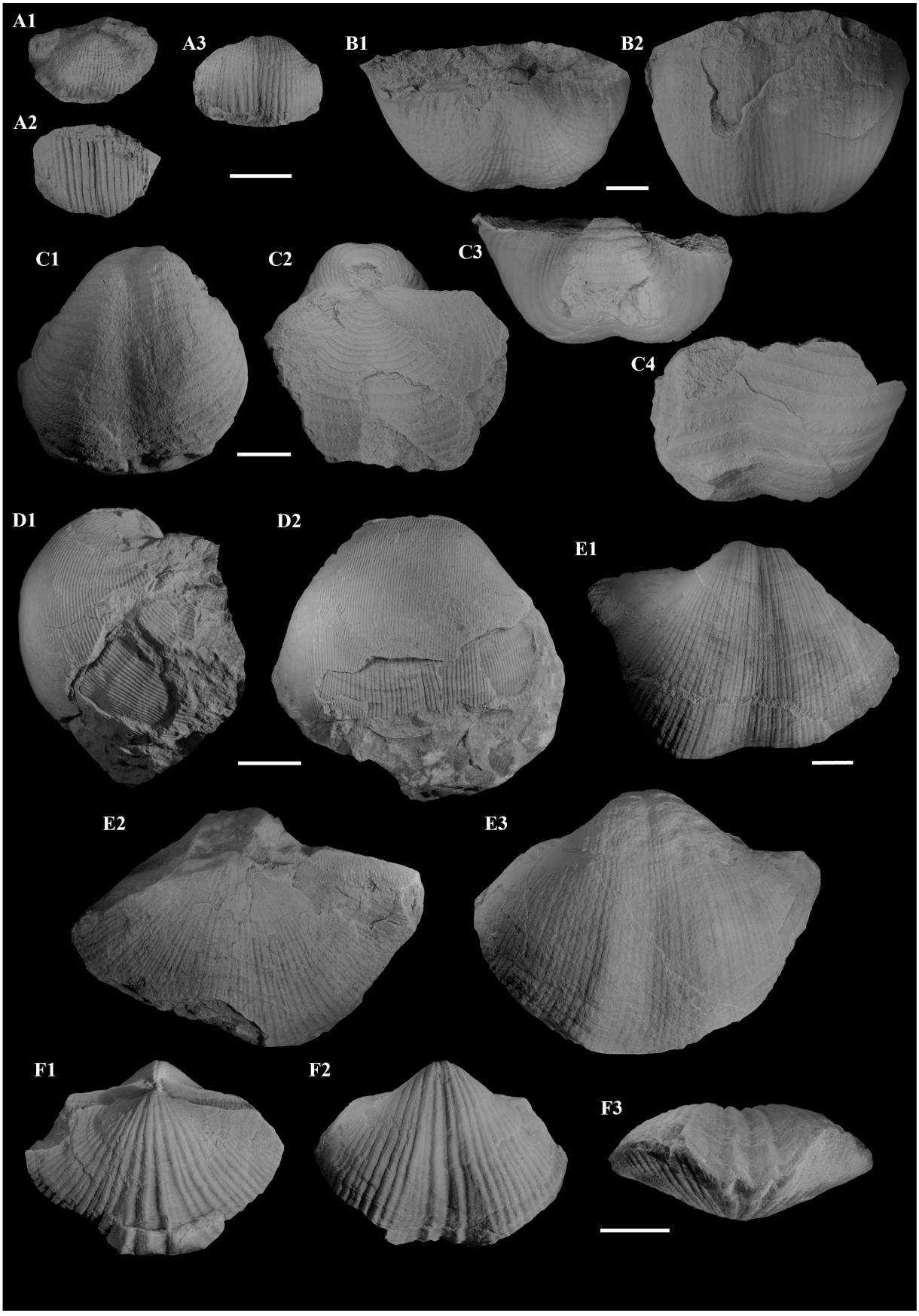


Fig. 2. Photographic plate showing main warm-water elements of the Bianping fauna, of Cathaysian affinity. A: *Transennatia* sp. B: *Reticulatia uralica*. C: *Echinaria* sp. D: *Linoproductus dorothevi*. E: aff. *Choristites pavlovi*. F: *Ziyunospirifer triplicata*. Scale bars are 10 mm for all specimens.

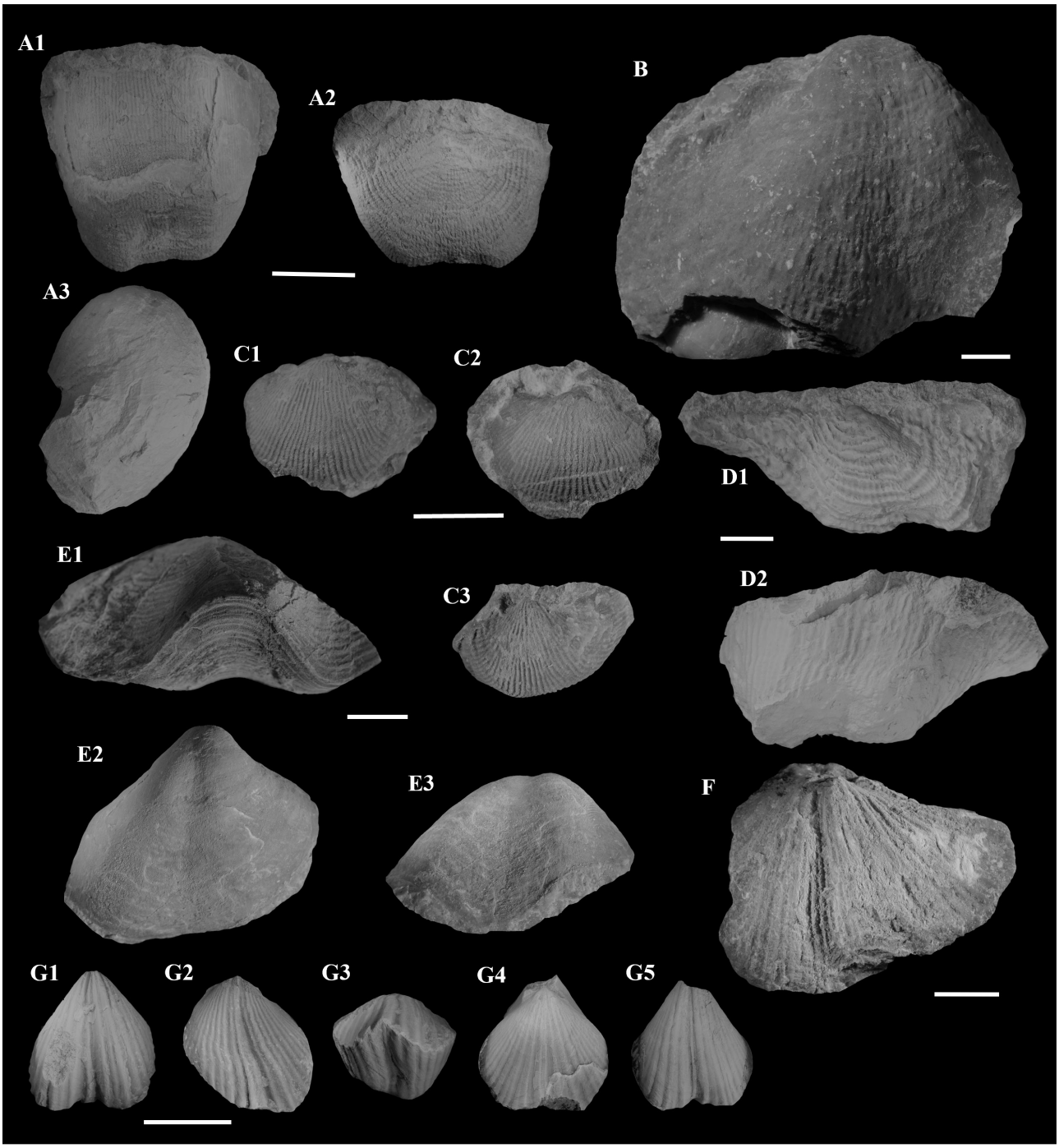


Fig. 3. Photographic plate showing the main cold-water elements of the Bianping fauna. A: *Yakovlevia* sp. B: *Kochiproductus* sp. C: *Cimmeriella* sp. D: aff. *Callytharrella* sp. E: *Spirelytha* sp. F: *Neospirifer* sp. G: *Hunzina bisnaini*. Scale bars are 10 mm for all specimens.

from Bianping, only the occurrence of *Spirelytha* and *Hunzina bisnaini* can be confirmed. Most other identifications have been revised into more common Cathaysian elements. The only exception is *Trigonotreta* cf. *stokesi*, a species which has not been found in the new collection from Bianping, but the identification is confirmed by a re-evaluation of the illustrations by Feng (1998). A few undetermined species of genera commonly occurring in the Boreal Realm, *Yakovlevia* sp. and *Kochiproductus* sp. (e.g., Manankov, 2012; Muir-Wood and Cooper, 1960), also occur in the fauna.

In conclusion, based on the systematic study of the new material, the Bianping fauna can be considered as clearly of Cathaysian affinity, in accordance with its palaeogeographic position within the South China block. However, the minor presence of cold-water elements in the fauna is notable.

Implications

These findings might support previous hypotheses that cold upwelling currents may have intermittently influenced parts of South China during the Cisuralian, which was then

located at palaeoequatorial latitudes. This would have allowed cold-water Gondwanan taxa to temporarily settle among the indigenous warm-water Cathaysian fauna. Other indices of cold-water influence in the Cisuralian of South China are the absence of prominent reef development and the presence of rosettes of calcite prisms in many limestone successions, a diagenetic indication of cold water influence (Shi, 2001). An alternative or complementary explanation is that the presence of these cold-water elements requires a re-evaluation of the palaeogeographical position of South China during the Early Permian, or at least a reconsideration of the thermal structure of the eastern Palaeotethys (Shi, 2001; Marks et al., 2025).

Further steps in the study of the Bianping Fauna include a redefinition of the Asselian to Sakmarian brachiopod biozonation, two stages which are undistinguished in previous brachiopod biozonation schemes for South China (Li et al., 1986; Shen et al., 2017), and further analysis on its palaeobiogeographic significance.

Acknowledgements

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Pachycyrtella omanensis: a key brachiopod taxon after the LPIA demise

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The brachiopod species *Pachycyrtella omanensis* Angiolini, 2001 (Fig. 1) was erected from the upper Sakmarian Saiwan Formation of Oman (Angiolini et al., 1997, 2003; Angiolini, 2001). This syringothyridid brachiopod is characterized by a thick shell and a very characteristic morphology, consisting of a massively protruding ventral umbo, a deep ventral sulcus and a well-developed dorsal fold (Angiolini, 2001). This shell morphology was demonstrated to be an adaptation to the hydrodynamic conditions of the depositional environment (Shiino and Angiolini, 2014), which was characterized by a sandy substrate with high-energy water flow, substrate mobility and high nutrient influx (Angiolini, 2007).

Given the palaeolatitude at which the Saiwan Formation was deposited, i.e. the northeastern margin of Gondwana, around 40°S, this stratigraphic succession and its fossils record represent an excellent source of data to explore the post-glacial conditions after the Late Palaeozoic Ice Age (LPIA). The Saiwan Formation, in fact, recorded a major transgressive event related to a major tectono-eustatic change linked to end of the deglaciation and the concomitant opening of the Neo-Tethys (Angiolini et al., 2003). In this context, *P. omanensis* thrived as a pioneer opportunist taxon, dominating the palaeocommunities with its fast growth and large biovolume (Angiolini, 2007). The palaeoecology of *P. omanensis* translates to a large number of specimens occurring in the fossil record, which, thanks to their often optimal preservation, represent a major source of material to be analysed for palaeoenvironmental and palaeoclimatic reconstructions of this key time-interval.

Shells of *P. omanensis* were part of the material used by Jurikova et al. (2025) to reconstruct atmospheric CO_2 changes during the Late Palaeozoic through $\delta^{11}B$ measurements from brachiopod shells. *P. omanensis* shells in particular recorded the spike signalling the rapid decrease in seawater pH, and an increase in atmospheric CO_2, which marked the end of the major phase of LPIA glaciations (Fig. 1). While the global-scale results obtained from the geochemical analyses of these shells are extremely relevant for our understanding of the late Palaeozoic climatic evolution, *P. omanensis* shells also offer the possibility to study in depth how the end of LPIA affected the benthic communities and how they adapted to life in this highly dynamic time-interval. In this regard, we are conducting two research projects involving the study of *P. omanensis*, from a microstructural and morphometric point of view as well as from a sclerochronological and geochemical one. With this communication we report the preliminary results and the new perspectives that have emerged.

Starting with the microstructural and morphometric examination of *P. omanensis* shells, we took as a reference the work of Ye et al. (2018, 2019). The authors showed that fibres of the secondary layer of modern brachiopod species have peculiar ontogenetic trends observed in the fibre size and shape. We applied the same method to calculate morphometric features

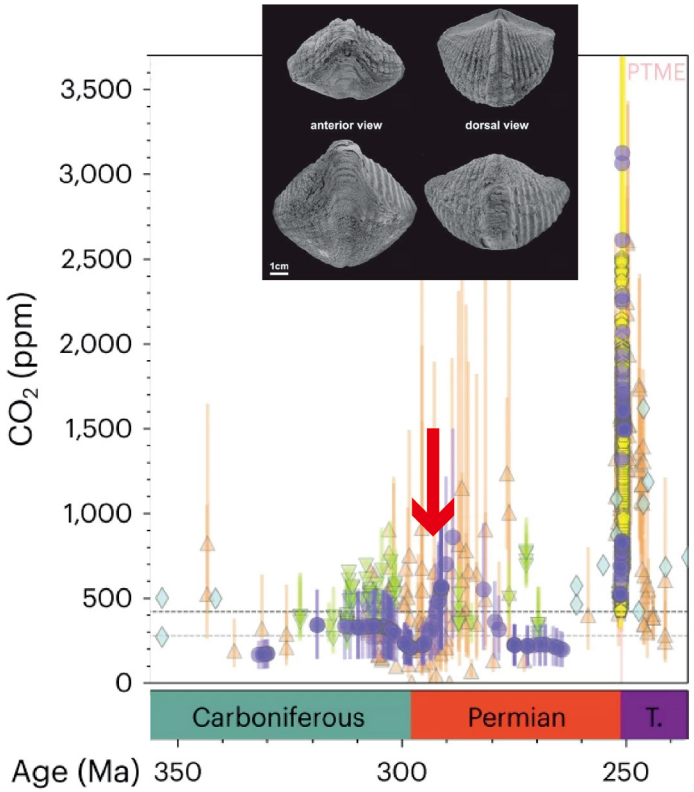


Fig. 1. Specimen of *Pachycyrtella omanensis* showing its characteristic morphological features (modified from Shiino and Angiolini, 2014). Specimen of *P. omanensis* contributed to the observation of the spike in atmospheric CO2 corresponding to the end of the deglaciation (modified from Jurikova et al., 2025).

in fibres of well-preserved shells (Fig. 2), observed by SEM in three regions: umbonal, median and anterior. The preliminary results indicate that *P. omanensis* has a different ontogenetic trend in fibre size and shape compared to modern rhynchonellate brachiopods (Viaretti et al., in prep.). In particular, the largest fibres are found in the median region of the shell, while in the anterior portion the fibres are the smallest. On the contrary, in modern brachiopods, fibre size increases toward the anterior margin. In both Palaeozoic and modern shells, however, fibres become less round with age, suggesting that this may be a common feature of rhynchonellate brachiopods.

These preliminary results indicate that it is possible that the high microstructural diversity of rhynchonelliformean brachiopods prior to the end-Permian mass extinction was lost in the subsequent bottleneck, including different ontogenetic trends within the same microstructural fabric. To explore this further, more brachiopod species should be analysed using microstructural and morphometric approaches. This would also be important for tracking any climate-induced changes in microstructural development, particularly in long-ranging species or genera, that may have recorded size changes in response to environmental stresses. A thorough mapping of brachiopod microstructural diversity is therefore much needed.

A more direct palaeoclimatic and palaeoenvironmental perspective is given by the preliminary data resulting from the sclerochemical analysis of *P. omanensis* shells. As increasingly

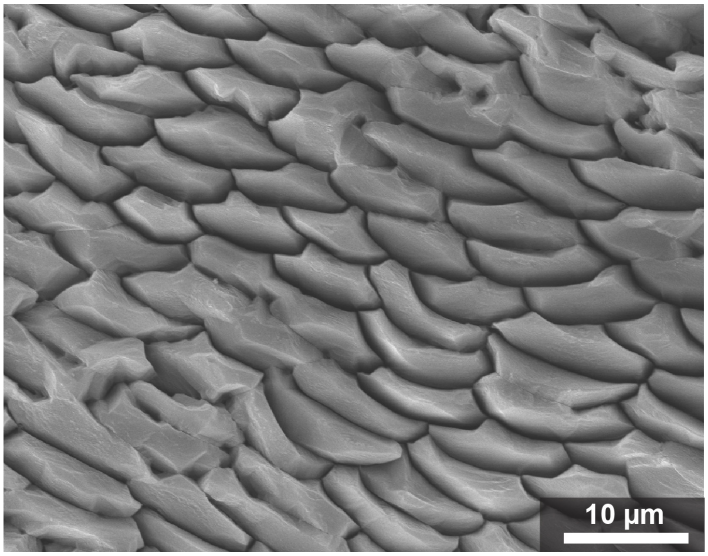


Fig. 2. SEM image showing fibres of the secondary layer of Pachycyrtella omanensis. The microstructure is generally well-preserved, showing only traces of fibres dissolution. Symmetric transversal section of fibres showing the keel and saddle shape, fundamental for morphometric examination, are observed.

shown by recent literature, brachiopod sclerochemistry enables the study of environmental and climatic variability at an approximately annual scale, both in the deep geological past and the present (e.g., Crippa et al., 2025; Garbelli et al., 2025; Viaretti et al., 2025; Angiolini et al., 2026). Obtaining these records provides a unique window into seasonal changes in the environment in which brachiopods, in this case *P. omanensis*, lived offering insights into both local and global environmental and climatic conditions at the time, as seasonality is modulated by regional climate zones and the underlying background climate state.

We measured the $\delta^{13}C$, $\delta^{18}O$ and $\delta^{11}B$ of *P. omanensis* across the growth axis of well-preserved shells, obtaining interesting results. The combination of high-resolution $\delta^{11}B$ and $\delta^{13}C$ measurements allows us to track biomineralisation changes, while $\delta^{18}O$ provides insights into environmental variability. The results reveal three main growth cycles, which provide first insights into seasonal variability during the Early Permian at the height of the demise of the LPIA. The average $\delta^{11}B$ value closely matches the bulk shell compositions reported in Jurikova et al. (2025) demonstrating that the values record mean seawater pH, upon which internal biomineralisation cycles are superimposed, enabling the interpretation of seasonal trends from the shells of *P. omanensis* (Viaretti et al., in prep.).

The amplitude of seasonal $\delta^{18}O$ change ($\Delta\delta^{18}O$) is 3.2‰, which translates into a seasonal palaeotemperature change of approx. 15°C using the calibration of Brand et al. (2019). Such pronounced seasonality is characteristic of temperate climate regimes today; for instance, in Norway, seawater temperatures can drop as low as ~2°C in winter due to strong polar cooling, while summer temperatures may reach highs of 18°C, influenced in part by the Gulf Stream. This suggests that *P. omanensis* lived in a temperate environment characterised by high seasonal variability and that latitudinal gradients must have been relatively strong, at least comparable to those observed today, to drive such pronounced seasonality. The reconstructed amplitude of change should, however, be considered as approximate as it is possible that some of it might be driven by changes in $\delta^{18}O$ composition of seawater ($\delta^{18}O_{sw}$) from seasonal freshwater input resulting from riverine discharge, an environmental component already observed in the Saiwan Formation (Angiolini, 2007). Nonetheless, seasonal changes in freshwater input are also characteristic of environments with strong seasonality, meaning that, pronounced seasonality must have been present in Saiwan Formation during the Early Permian.

While these are only preliminary data and our research is still ongoing, they demonstrate how detailed investigation combining microstructure and geochemistry in *P. omanensis* can provide valuable insights into the demise of the LPIA along the northeastern margin of Pangaea. This, in turn, highlights the potential of other brachiopod species to be used in a similar way to further explore the Permian environmental and climatic evolution.

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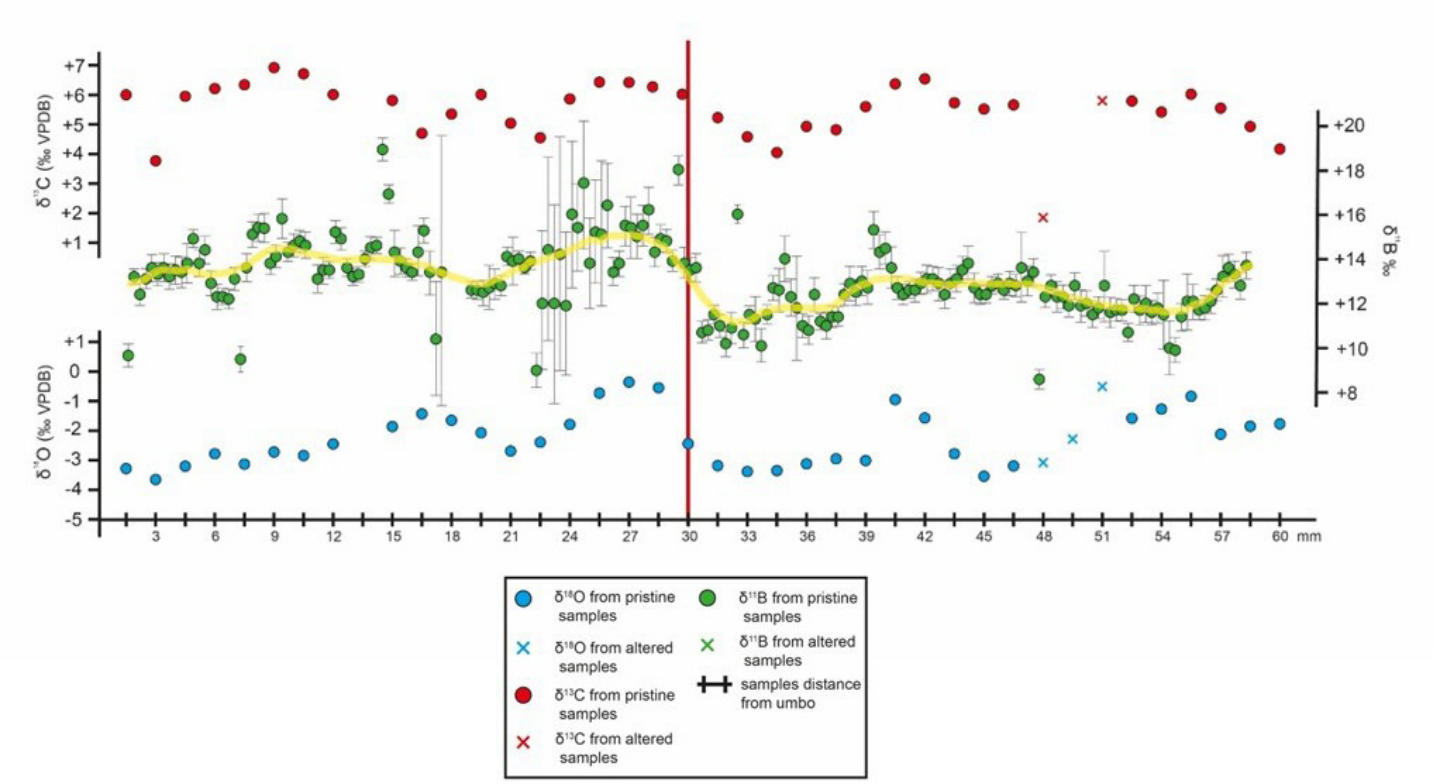


Fig. 3: Preliminary results from the sclerochemical analysis of $\delta^{13}C$, $\delta^{18}O$ and $\delta^{11}B$ values from a *Pachycyrtella omanensis* shell.

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Visualizing Permian studies

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Introduction

The Permian period represents a significant interval in geological history, marked by pronounced climatic change from icehouse to greenhouse conditions during the late Cisuralian (Montañez et al., 2007; Fielding et al., 2008), rifting of the Cimmerian continent from Gondwana during the Cisuralian (Zhang et al., 2013; Shen et al., 2024), a decrease in $^{87}Sr/^{86}Sr$ seawater to a minimum value at the end of the Guadalupian (Korte et al., 2006), and severe mass extinctions at the end of the

Permian (Shen et al., 2011; Fan et al., 2020). Numerous papers have been published but interdisciplinary links remain weak in numerous cases. In this paper, I introduce a new method for organizing Permian literature to facilitate comprehension and communication.

Application of map software in Permian studies

Several software platforms and applications support global mapping, such as Google Earth or OvitalMap. These software applications allow users to add georeferenced tags or points. These tags can be applied for literature management.

Here, I use OvitalMap as an example. In the tags of OvitalMap, the first step is to locate the study area. Coordinates can be entered into the tag. Second, the contents can be added in the tag. These contents may include the bibliographic source of the article, and the abstract or key points of the article. In some cases, the species or genus names can be added to facilitate retrieval. Third, the figures can be attached in the tag. For online figures with persistent URLs (e.g., ScienceDirect), their links can be embedded within the tag. For figures with volatile or insecure URLs, however, it is preferable to link to locally stored files instead. After these steps, the visible literature is displayed geographically on the map.

Benefits of adding literature tags in OvitalMap

The literature tags in OvitalMap help in Permian studies in many ways.

1) Making Permian studies visible

The tags in OvitalMap exhibit directly the Permian studies around the world. For example, eight Permian GSSPs have been established in the last years which are easy to display in OvitalMap (Fig. 1A). Also, clicking tags will show the contents of the literature (Fig. 1B). For different disciplines of Permian studies, various icons are available. At the same time, for the same disciplines/tags, different colors can be applied to indicate different ages (e.g., Cisuralian, Guadalupian, Lopingian). So, numerous tags in OvitalMap directly show the geographical distribution of different types of Permian studies around the world.

2) Studying the same scientific problem from different disciplinary perspectives

Numerous scientific problems can be addressed through interdisciplinary approaches. Nevertheless, communication across disciplines generally remains limited. Tags within OvitalMap offer an opportunity to examine contributions from diverse disciplines toward solving identical scientific questions.

For example, in the reconstruction of the closing process between Indochina-North Qiangtang and South China blocks, numerous models have been proposed. When plotting tags of different disciplines from the Indochina, North Qiangtang and South China blocks, it is interesting to find that the amalgamation of the Indochina and South China blocks may have occurred before the Lopingian as evidenced by the tetrapod similarities between Laos and South China (Liu et al., 2020), the unconformity between Lopingian strata and underlying strata in the North Qiangtang Block due to compression force resulted possibly from the collision of Indochina-North Qiantang with South China (Qiao et al., 2021). The latest magnesium isotope study also suggests that the anoxia event in the Paleotethys Ocean was much more severe than in the Neotethys Ocean (Hu et al., 2026). This most likely resulted from the limited circulation in Paleotethys Ocean due to the collision event between South China and Indochina-North Qiangtang blocks.

Therefore, insights from different disciplines contribute to addressing the same scientific problem based on the tags from OvitalMap.

3) Checking available studies during fieldwork

Tags within OvitalMap can be exported as .kml or .kmz files. These files can be loaded as overlays within OruxMaps or other applications to support fieldwork navigation (Fig. 2). So, during fieldwork, users can easily find previous geological studies conducted nearby. Conversely, once fieldwork is completed, the field tracks can also be imported into OvitalMap to check easily the routes and pictures from the fieldwork.

4) Querying data within the system to identify paleogeographic patterns

OvitalMap tags provide a search function, allowing users to query information via the task field of tags. It provides a possible way to explore the distribution of any species or genus.

For example, the foraminiferal genus *Shanita* is a significant paleobiogeographic genus that has attracted attention in the last few years (Jin and Yang, 2004). When querying the genus *Shanita* in the tags, the distribution of this genus is clearly shown in OvitalMap (Fig. 3). Based on the distribution of this genus, it can be concluded that it was distributed across the Cimmerian continent as well as the Gondwanan margin in lower latitudes.



Fig. 1. A. Locations of Permian established GSSPs. B. Clicking any tag will show the contents of the literature.



Fig. 2. Application of OvitalMap tags for fieldwork navigation.

So, conclusions can be reached about the oceanic currents in the Neotethys Ocean and the distribution of this genus (Ju et al., 2021).

5) A good platform for scientific communications

For Permian studies, a large number of regional journals are available in different languages, such as German, French, Chinese, Japanese, Hindi, and others. Often, those local journals tend to be neglected by non-native-language researchers. OvitalMap offers a useful platform for communication among scientists from different countries. In addition, scientists of different disciplines can also use such platform for communication.

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Fig. 3. OvitalMap allows users to search for tag contents. Here, the result of searching the foraminiferal genus *Shanita*, as an example.

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The K.W.Glennie Commemorative Event, Aberdeen and Hopeman, Scotland, UK. 8-10th May 2026

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Introduction

The name 'Glennie' will forever be connected with hydrocarbon exploration in the UK North Sea and with desert sedimentation and the Permian deposits in that region. Kenneth William ('Ken') Glennie (1926–2019) was born in Yeovil, Somerset, to Aberdonnian parents. He served in the Army in Libya and Egypt from shortly after WWII until 1949 and then studied geology at the University of Edinburgh, after which he had an MSc funded by Shell in 1953 and joined that company in 1954. After being sent to look for potential hydrocarbon source rocks in parts of the UK and Europe he worked in New Zealand and Canada until 1963. Then, after the extent of the gas field discovered in Early Permian Rotliegend deposits of desert origin at Groningen in the Netherlands in 1959 was appreciated, he was dispatched to Libya, India, the Trucial coast (now the UAE), and Oman to study deposits of modern desert environments. He was appointed Team Leader Southern North Sea in 1972 and worked largely on that area until his retirement from Shell in 1985. He then became an Honorary Professor at the University of Aberdeen where he lectured on North Sea petroleum geology to MSc classes and supervised PhD students. He published a seminal work on desert sediments in 1970 and continued working on that subject and its relevance to Permian successions in the UK part of the Southern Permian Basin into his 80's; the topic of a DSc awarded by Edinburgh University in 1984 was 'Desert Sediments, Present and Past'. A selection of his publications is appended. In his later years Ken lived in Ballater, a village on the River Dee, west of Aberdeen, and near Balmoral Castle, the summer retreat of the British Royal Family. Ken died on 23 November 2019, after a short illness; his funeral was on 11 December 2019. Among many notices of his passing was one in the Muscat Daily on 25 November 2019 in which he was 'Fondly remembered as the father of Omani geology'.

I met Ken when we were working on, respectively, the Permian and Triassic chapters of the Petroleum Geological Atlas of the Southern Permian Basin Area (Fig. 1, 2). Despite his professional reputation, and being the recipient of many awards, including the Geological Society of London's William Smith Medal and the AAPG's Sidney Powers Memorial Award, Ken was modest, quietly spoken, and patient in discussions. He was someone that it is my good fortune to have known and the Commemorative Event I attended was a fitting tribute to a remarkable man.

The Commemorative Event

This began with a series of lectures and poster presentations held in the Sir Duncan Rice Library at the University of Aberdeen. Topics covered included the exploration history of the North Sea Basin from Ken's perspective and his contribution to the understanding and significance of the Anglo-Polish Basin. Others covered aspects of the palaeogeography and facies variations in the Late Permian Hopeman Sandstone Formation and the contemporary fauna as reflected in the diversity and taphonomy of vertebrate tracks from that formation. An overview of the sedimentology of reservoir-scale aeolian and fluvial deposits in the northern Wahiba Sand Sea in northeastern Oman was pertinent as that was an area with which Ken had been familiar in his studies of sediments in modern desert environments. After the talks delegates travelled to Elgin where vertebrate remains and tracks from the Late Permian Hopeman Sandstone and from Late Triassic deposits in the same area were seen in the Elgin Museum. Delegates then travelled to Lossiemouth which was the base for excursions to exposures of the Hopeman Sandstone in the most northerly onshore outcrop of Permian rocks in eastern Scotland, on the south coast of the Moray Firth.



Fig. 1. Ken Glennie (left) and the writer in action at a Southern Permian Basin Atlas project meeting in Edinburgh, 25 January 2007. Photographer unknown.



Fig. 2. Ken Glennie (centre) and the editors (J.C. Doornenbal (left) and A.G. Stevenson (right)) with the Petroleum Geological Atlas of the Southern Permian Basin Area at the launch of that mighty (12.7 kg) volume in Brussels, 25 June 2010.



Fig. 3. Deformed aeolian dune bedded Hopeman Sandstone, Hopeman foreshore; the outcrop face is c. 3 m high.

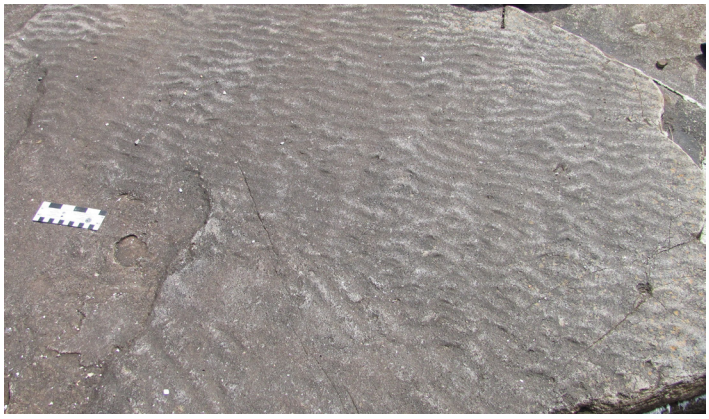


Fig. 4. Ripple marked surface in a fluvio-lacustrine unit, Hopeman foreshore.

The Field Excursions

Day 1 – Hopeman foreshore and Clashach quarries. The Hopeman Sandstone Formation is c. 60 m thick, with large scale aeolian dune bedding and minor fluvial and lacustrine units. From west to east features demonstrated in the formation were (i) dune-bedded sandstone hosting barite, fluorite and pyrite mineralization associated with faults; (ii) large-scale deformation (Fig. 3) of aeolian dune sands resulting from sand fluidization and injection and reflected in large-scale folded, contorted and overturned dune bedding, bowl-shaped subsidence depressions and extrusion structures including large fluid escape features up to 20 m high (see Glennie and Hurst, 2007; Hurst and Glennie, 2008); (iii) fluvio-lacustrine interbeds (Fig. 4) which had yielded reptile tracks; (iv) undeformed fluvio-lacustrine and aeolian deposits overlain by strongly deformed aeolian dune deposits with recumbent folds, (v) the Clashach Fault (Fig. 5), a normal fault in aeolian sandstone and with a downthrow of c. 50 m to the south; (vi) Clashach Quarry (active), aeolian sandstone with tracks of Permian vertebrates (Fig. 6, 7); (vii) Old Clashach Quarry, with aeolian dune bedding.

A dinner held after this excursion was opened appropriately by a piper. It was attended by members of Ken's family who heard tributes about him and ended the proceedings with a contribution of their own.

Day 2 – Covesea foreshore. Aeolian dune sandstone in the Hopeman Sandstone Formation below a very uneven erosion surface above which an intensely deformed sandstone unit includes detached blocks from the underlying dune set (Fig. 8). Farther west, lateral facies changes seen from east to west in a lengthy continuous exposure of the formation were (i) dune cross-stratified sandstones at the western edge of a large composite dune body (Fig. 9); (ii) a more sheet-like and thinly bedded deposit with small dune sets and sheetflood deposits interpreted as formed in a corridor between large, possibly linear, dunes; (iii) farther west there is a transition into large low angle sandstone sets interpreted as deposits of a large draa bedform. The excursion terminated at this point and delegates returned to Aberdeen.

The Commemorative Event was very well organized, and lunches each day and the transport for the excursions were sponsored by Shell. The field excursions benefited from excellent weather, close attention to Health and Safety on the rugged coastal outcrops, and knowledgeable leaders who had compiled a comprehensive guide on which the above account is based; in addition to descriptions this included drone views and other illustrations of each site. The writer renewed acquaintances and made new ones, and, by participating in the excursions, was able to gain first-hand experience of the Hopeman Sandstone which is



Fig. 5. The Clashach Fault and dune bedded Hopeman Sandstone, looking east.

included in his revision, for the Geological Society of London, of that society's Special Report 5 (Smith et al., 1974. A Correlation of Permian Rocks in the British Isles).

Some of K.W. Glennie's publications

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Fig. 6. Part of the active Clashach Quarry in the Hopeman Sandstone (photo courtesy of David Longstaff). Stone from this quarry is being supplied for the completion of Catalan architect Antoni Gaudi's famous Basilica de la Sagrada Familia in Barcelona.



Fig. 7. Vertebrate tracks from the Hopeman Sandstone, Clashach Quarry (photo courtesy of David Longstaff).

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Fig. 8. Hopeman Sandstone, Covesea foreshore. Intensely deformed unit overlying dune bedded sandstone, looking west.

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ANNOUNCEMENT:

The 23rd International Conference on Gondwana to Asia & the International Conference on Tectonics of Southeast Asia (IAGR 2026 & ICTSEA 2026) | November 11–15 2026 (Chiang Mai, Thailand)

The Organizing Committee invites you to IAGR 2026 & ICTSEA 2026, the 2026 Annual Convention of the International Association for Gondwana Research, hosted by the Department of Geological Sciences, Chiang Mai University. The scientific program (November 12-13) features 11 keynote lectures, along with oral and poster presentations spanning tectonics, structural geology, sedimentology, paleontology, economic geology, and natural hazards. A two-day post-conference excursion (November 14-15) visits Paleo-Tethys suture-zone geology near Chiang Dao and Mae Tang, then the high-grade metamorphic Doi Inthanon Complex.

Important dates:
Early-bird registration and excursion deadline: September 25, 2026
Regular registration deadline: October 10, 2026

Conference website: https://www.iagr2026.science.cmu.ac.th/index.php
Conference contact email: iagr.ictsea.2026@gmail.com

ANNOUNCEMENT:

The 3rd Asian Palaeontological Congress (APC3) – Palaeontology for ALL, Learning from the Past, Looking to the Future | March 2–5 2027 (Bangkok, Thailand)

The Organizing Committee warmly invite all Permian colleagues to the next edition of the 3rd Asian Palaeontological Congress (APC3), to be held in Bangkok, Thailand, from 2nd to 5th March 2027, under the auspices of the Asian Palaeontological Association.

The Asian palaeontological record has played a fundamental role in the increase of our collective knowledge on Permian times, and the biotic, environmental and climatic shifts that occurred during this time-interval. Underscoring the importance of the Asian record for this matter, many Permian GSSPs are located in Asian countries and many esteemed colleagues (including past chairs, secretariats and voting members as well as current ones), started, ended or are still pursuing their careers in Asian institutions.

This conference will be a good occasion to meet in person among us Permian workers and discuss the new developments in the study of Asian geological and palaeontological record and the progress in the knowledge, calibration and correlation of Permian localities in Asia.

Of particular interest for the Permian communities are the following thematic sessions:

- TS2: Palaeozoic marine communities and geochemistry as a tool for palaeoenvironment and palaeoclimate interpretation
- TS3: Evolutionary dynamics of reef ecosystems from past to present
- TS4: Marine microfossils and their implications
- TS5: Key innovations in Palaeozoic vertebrates: new evidence from Lagerstätte fossils, scanning technologies, evo–devo, and big data



Some of the localities which will be visited during the pre-conference fieldtrip in southern Thailand, Krabi Province. Top left: Guadalupian limestone. Top right: Miocene gastropod beds. Below left and center: late Cisuralian brachiopods and bryozoans. Below right: Jurassic succession with abundant plant material.

- TS6: Biota and environments under the background of volcanism during the Palaeozoic–Mesozoic transition
- TS13: Non–marine fossil–bearing formations in Asia and their correlations
- TS16: Recent progress of fossil plant study

A pre-conference fieldtrip in the southern part of Thailand (Satun, Trang and Krabi provinces) is planned (Fig. 1). Highlights of the trip will be fossil-bearing localities from the Cambrian to the Guadalupian showcasing the Sibumasu Terrane record of the southern part of the country. The succession from Cisuralian glacial–marine diamictites, representing cool to temperate conditions, to overlying brachiopod–bryozoan-bearing siliciclastic deposits, and finally to fully tropical Guadalupian limestones, will be observed. Additionally, Mesozoic and Cenozoic non-marine deposits will also be visited, including Jurassic red beds rich in fossil wood and dinosaur bones, as well as a Miocene shell bed containing clusters of fossil gastropods. The excursion will also visit a present-day intertidal site, where a variety of living organisms, including corals, sea cucumbers, and chitons, can be observed against the breathtaking coastal scenery of Krabi Province.

The post-conference fieldtrip to Phetchabun and Nakhon Ratchsima (Khorat), a few hours north of Bangkok, will include the visit to fossiliferous sections of the Cisuralian shelf and slope facies and the Guadalupian platform facies, part of the Indochina Terrane. Mesozoic to Neogene fossils including dinosaur, mammal and fossil woods will be observed both from the site and museum part of the Khorat UNESCO Geopark.

Abstract submissions deadline: September 30, 2026
Regular registration: August 1 to November 30, 2026
The webpage of the meeting: https://www.apc3.org/

We look forward to welcoming you all in Bangkok! More information about the conference can be found at the official website as well as in the third circular, soon to be released.

ANNOUNCEMENT:

The 38th International Geological Congress (IGC 2028) | August 12–20 2028 (Calgary, Canada)

The 38th International Geological Congress (IGC) will be held in Calgary, Alberta, Canada on August 12-20, 2028. Calgary is only one-hour drive to the spectacular Front Ranges of the Southern Canadian Rocky Mountains, but the city of 1.6 million also offers many cultural activities. There are many direct international flights to Calgary's YYC which is Canada's third busiest airport. Check our website for more information about attending IGC 2028 - https://www.igc2028canada.org/welcome. This meeting will have a strong community of stratigraphers and paleontologists and will be of interest to many readers of *Permophiles* (see Category 2 at https://www.igc2028canada.org/theme-groups-themes).

The first circular was distributed on March 31st and can be read online at https://www.igc2028canada.org/igc-2028-circulars. There is a call for sessions, workshops, short courses, and field excursions from the home page https://www.igc2028canada.org/. **Submission deadline is March 2027** – you can click on the home page and create an account now. The second circular is planned for January 2027. **Abstract submission and early registration will open in June 2027**. Add these dates to your calendar and please distribute this information within your communities. Start your plans now!

SUBMISSION GUIDELINES FOR ISSUE 82

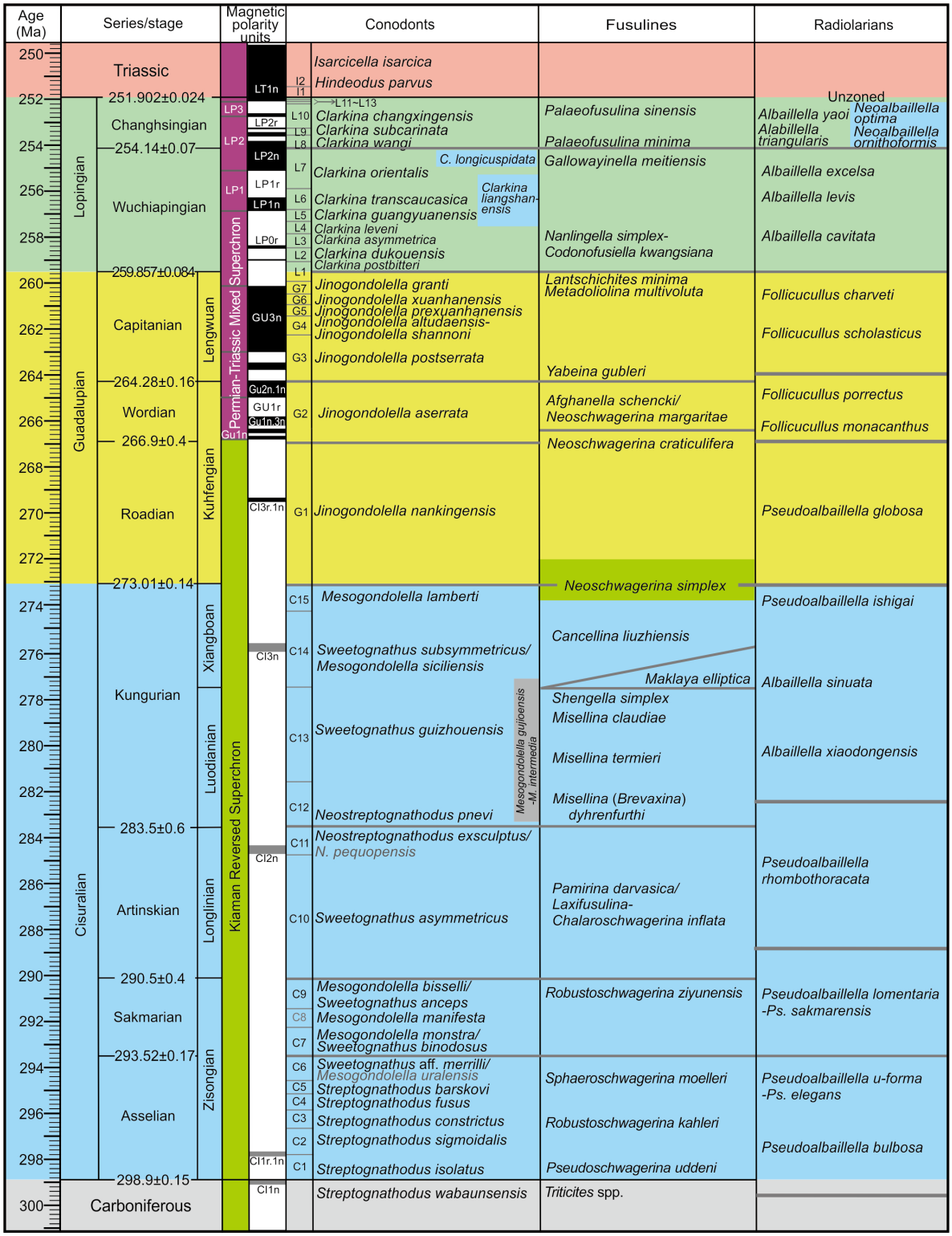
It is best to submit manuscripts as attachments to E-mail messages. Please send messages and manuscripts to Iván R. Barreiro's E-mail address. Hard copies by regular mail do not need to be sent unless requested. To format the manuscript, please follow the TEMPLATE that you can find on the SPS webpage at http://permian.stratigraphy.org/.

Please submit figures files at high resolution (600dpi) separately from text one. Please provide your E-mail addresses in your affiliation. All manuscripts will be edited for consistent use of English only.

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The deadline for submission to Issue 82 is December 31, 2026



High-resolution integrative Permian stratigraphic framework (after Shen et al., 2019. Permian integrative stratigraphy and timescale of China. Science China Earth Sciences 62(1): 154–188. Guadalupian ages modified after (1) Shen et al., 2020. Progress, problems and prospects: An overview of the Guadalupian Series of South China and North America. Earth-Science Reviews, 211: 103412 and (2) Wu et al., 2020, High-precision U-Pb zircon age constraints on the Guadalupian in West Texas, USA. Palaeogeography, Palaeoclimatology, Palaeoecology, 548: 109668. Lopingian ages modified after Yang et al., 2018, Early Wuchiapingian cooling linked to Emeishan basaltic weathering? Earth and Planetary Science Letters, 492: 102–111. Base-Artinskian age modified after Henderson and Shen, 2020. Chapter 24-The Permian Period. In Gradstein F.M., Ogg, J.G., Schmitz M.D., and Ogg, G.M. (eds.), The Geologic Time Scale 2020, Elsevier, v. 2, p. 875–902. The position of the beginning of the Illawarra Reversal is not indicated in the table because it is still controversial, having been placed in the earliest Wordian (Hounslow and Balabanov, 2018), in the middle Wordian (Jin et al., 1999; Steiner, 2006; Henderson et al., 2012; Lanci et al., 2013; Shen et al., 2013a, 2019b; Henderson and Shen, 2020), slightly below the base of the Capitanian (Shen et al. 2022) or in the earliest Capitanian (Menning, 2000; Isozaki, 2009). For references see Shen et al., 2020. Progress, problems and prospects: An overview of the Guadalupian Series of South China and North America. Earth-Science Reviews, 211: 103412; Shen et al., 2022. The Global Stratotype Section and Point (GSSP) for the base of the Capitanian Stage (Guadalupian, Middle Permian). Episodes, 45, 3: 309–331.