

7th

INTERNATIONAL CONFERENCE OF PALAEOGEOGRAPHY

Palaeogeography in
the digital & AI age



ABSTRACT VOLUME

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Introduction

The 7th International Conference of Palaeogeography (ICP 2026) brings together researchers and professionals from around the world in Mendoza, Argentina, from 16 to 19 October 2026. Under the theme *Palaeogeography in the digital & AI age*, the conference offers a welcoming and collaborative setting in which to present recent advances in geoscience, exchange ideas and build connections across disciplines.

ICP is a biennial forum dedicated to international academic exchange and interdisciplinary collaboration in palaeogeography and related fields. It also highlights the strategic role of palaeogeographic research in predicting the distribution of energy and mineral resources and in supporting their exploration worldwide. Since its launch in 2013, the conference has held six editions in China: Beijing (2013 and 2015), Chengdu (2017), Beijing (2019), Wuhan (2022) and Nanjing (2024). This is the first time that the ICP has taken place outside China, marking a new chapter in its international development. Situated at the foot of the Andes, Mendoza provides an inspiring setting for this gathering, combining remarkable geology with internationally renowned vineyards and gastronomy.

About this volume

This volume contains the **180 abstracts** of the conference programme: 11 plenary lectures, 103 oral presentations, 64 posters and two contributions to the Rudolf Zuber commemorative session. Plenary speakers are introduced by short biographical profiles.

Abstracts are grouped by theme and session. Each contribution keeps its volume work number (001–180) and its programme code (PL = plenary lecture; O = oral presentation; P1/P2 = poster sessions). The table of contents lists every abstract, and the author index lists all authors and co-authors with the work number and page of each contribution. In the PDF edition, entries in the contents, the index and the plenary profiles are linked to the corresponding abstract.

Abstracts are published essentially as submitted by the authors. For this edition, the texts were copy-edited for spelling, grammar and consistency of presentation (author names, affiliations, keywords, units and funding statements); the scientific content remains the responsibility of the authors.

The programme also lists Piotr Krzywiec's brief commemorative presentation "Poland and Argentina in the 19th century – a brief overview", for which no abstract was submitted.

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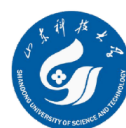
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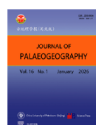


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Santanu Banerjee

Plenary lecture 001 · Palaeogeography and palaeodrainage reconstruction of eastern Gondwanaland recorded in Palaeo-Mesozoic deposits of India

Santanu Banerjee is a distinguished Indian geoscientist, with 164 SCI-indexed publications and more than 8,400 citations. He has taught sedimentology, stratigraphy and related subjects at IIT Bombay since 1999. He currently serves on the editorial boards of leading journals, including Journal of Palaeogeography, Sedimentary Geology, Scientific Reports, Journal of Petroleum Geology, Marine Geosciences and Energy Resources. He has supervised more than 20 PhD students and over 100 master's students. Many of his former students have received prestigious AvH, DFG and MSCA fellowships and now hold academic positions.



Luis Buatois

Plenary lecture 002 · Application of ichnology to reconstruct depositional environments: reviewing the state of the art and assessing knowledge gaps

Luis Buatois specializes in the palaeoenvironmental, stratigraphic and evolutionary applications of ichnology. His research combines field and subsurface studies undertaken worldwide to investigate trace fossils, depositional environments and the history of life. He earned his degree in Geology at the University of Buenos Aires in 1987 and his PhD at the same institution in 1992. In 1994, he completed a degree in Philosophy, focusing on the philosophy of science, at the University of Tucumán. He was a postdoctoral fellow at the Kansas Geological Survey from 1994 to 1998, before returning to Argentina as a researcher with CONICET. He joined the University of Saskatchewan in 2004 and is also a Corresponding Member of CONICET. His publication record includes six books, three edited journal special issues and approximately 400 scientific papers. He has supervised more than 40 graduate students and postdoctoral fellows, contributing to the training of researchers in ichnology, sedimentology and palaeontology. He has served as Vice President of the International Palaeontological Association and President of the International Ichnological Association. He is Co-Editor of Ichnos and Sedimentology Section Editor for the Journal of South American Earth Sciences. His editorial board service includes Ameghiniana, Scientific Reports, Sedimentary Geology, Lethaia and other geoscience journals. He is a member of the international subcommissions on Ediacaran and Cambrian stratigraphy and chairs the Working Group on the Terminal Ediacaran. He received the Raymond C. Moore Medal from the Society for Sedimentary Geology in 2022.



Gabriela Mángano

Plenary lecture 002 · Application of ichnology to reconstruct depositional environments: reviewing the state of the art and assessing knowledge gaps

Gabriela Mángano is an ichnologist working at the intersection of palaeobiology and sedimentology. Her research investigates how animal-sediment interactions have shaped the evolution of the biosphere. She studies marine, marginal marine and continental environments in rocks ranging from the Precambrian to the Holocene. She earned her Geology degree and PhD at the University of Buenos Aires and a degree in Philosophy at the University of Tucumán. From 1994 to

1998, she was a postdoctoral fellow with the Kansas Geological Survey and the University of Kansas. She subsequently became a CONICET researcher in Argentina and moved to Canada in 2004. She holds her current chair in the Department of Geological Sciences at the University of Saskatchewan and is a Corresponding Member of CONICET. Her publication record includes six books and more than 350 papers and book chapters. She has supervised or co-supervised more than 50 graduate students and postdoctoral fellows. She has served as Co-Editor of *PALAIOS* and *Sedimentology* and is currently Co-Editor of *Lethaia*. Her editorial board service includes *Ameghiniana*, *Journal of Paleontology*, *PALAIOS* and other international journals. She previously served on the Scientific Board of the UNESCO International Geoscience Programme and is a voting member of the international subcommissions on Cambrian and Ordovician stratigraphy. Since 2023, she has been a Corresponding Member of Argentina's National Academy of Exact, Physical and Natural Sciences. Her awards include the Outstanding Educator Award of the Association for Women Geoscientists (2018), the Geological Society of America Geobiology and Geomicrobiology Division Distinguished Career Award (2023), the Billings Medal (2023), Honorary Membership of the Society for Sedimentary Geology (2024), and its Raymond C. Moore Medal (2026).



Zhong-Qiang Chen

Plenary lecture 003 · The Rise of the Altaid Plateau (Central Asia): Palaeogeographical Drivers of Late Triassic Earth's Freezing State

Zhong-Qiang Chen studies mass extinctions, ecosystem recovery, stratigraphic correlation and interactions between life and the environment. He is Deputy Director of the State Key Laboratory of Geomicrobiology and Environmental Changes at China University of Geosciences in Wuhan. He received his PhD from Deakin University, Australia, in 2001. His appointments have included Associate Professor at the University of Western Australia and Changjiang Scholar Distinguished Professor, appointed by the Ministry of Education of China. His work has contributed to the international Triassic chronostratigraphic framework and global correlation standards. He proposed a stepwise model of ecosystem recovery following mass extinctions and developed approaches to reconstructing ancient food webs and assessing their stability. These studies identified biodiversity loss preceding ecosystem collapse. His Earth system modelling also examines the disruption of the marine phosphorus cycle after the Permian-Triassic extinction and links between ocean oxygenation and early Ediacaran animal evolution. He chairs the Triassic Subcommission of the International Commission on Stratigraphy and is Vice President of the International Association of Palaeogeography. He previously chaired UNESCO International Geoscience Programme projects IGCP 572 and IGCP 630. He has published 292 SCI papers, including eight highly cited papers, and has an h-index of 60. He has held executive editorial or editorial board roles in four SCI journals and organized 17 special issues. He has repeatedly appeared on lists of Highly Cited Chinese Researchers and the world's top 2% of scientists. His current interests include in situ microanalysis, early life-environment interactions in the Archean and Hadean, biosignatures and planetary habitability.



Xiaomin Fang

Plenary lecture 004 · Uplift of the Himalaya–Tibetan Plateau and its impacts on Asian and global climate and ecology

Xiaomin Fang is a geomorphologist and physical geographer whose research examines the tectonic uplift of the Tibetan Plateau and its effects on landforms, climate, the environment and ecology. He is a Professor at the Institute of Tibetan Plateau Research of the Chinese Academy of Sciences. His work integrates geomorphology, soil science, sedimentology, basin analysis, palaeomagnetism, environmental magnetism, geochemistry and biology. This multidisciplinary approach connects the geological evolution of the Tibetan Plateau with environmental and climatic change, using evidence from sedimentary records and related Earth science disciplines. He is an Academician of the Chinese Academy of Sciences, a Fellow of The World Academy of Sciences and a Fellow of the Geographical Society of China. He also serves as Vice Chairman of the International Association for Trans-Himalaya Earth System Science, the Chinese Society for Sustainable Development and the Chinese Association for Quaternary Research. He has published more than 300 papers in journals including Science, Nature and their related titles, Proceedings of the National Academy of Sciences and other major international journals. These publications have received more than 20,000 citations. He received the Second Class Prize of China's National Natural Science Award twice, in 2007 and 2011. He has been included among Elsevier's Highly Cited Chinese Researchers and the world's top 2% of scientists. Reuters has also recognized him among the world's top 1,000 climate scientists.



Zongquan Hu

Plenary lecture 005 · Sedimentary and Distribution Patterns of Black Shale at the Global Ordovician–Silurian Boundary

Zongquan Hu holds a PhD and is a Professor-level Senior Engineer. He serves as Vice President and Chief Geologist of the Petroleum Exploration and Production Research Institute of SINOPEC. His career focuses on oil and gas geology and exploration. His principal areas of expertise are lithofacies palaeogeography and reconstruction, oil and gas reservoir evaluation, and geological assessment of shale gas. He has led two national major oil and gas projects, three associated research topics and more than 20 provincial or ministerial research projects. He has published more than 180 academic papers and six monographs. His research has received a First Class National Science and Technology Progress Award and more than ten provincial or ministerial science and technology progress awards. He is a Council Member of the Chinese Petroleum Society and holds committee roles in oil and gas and natural gas research. His service also includes work on clean energy and carbon strategies, resource palaeogeography, shale oil and gas enrichment mechanisms, and carbonate petroleum systems. He is an academic committee member of the State Key Laboratory of Shale Oil and Gas Enrichment Mechanisms and Efficient Development and Vice Chairman of the Management Committee of the National Energy Key Laboratory of Carbonate Rock Oil and Gas. His editorial responsibilities include senior board roles with Oil & Gas Geology, Experimental Petroleum Geology, Geological Review and Acta Geoscientia Sinica, alongside board membership in Energy Geoscience and other petroleum geology journals. He has received the Silver Hammer Award for young geological scientists, the Sun Yueqi Youth Science and Technology Award, and SINOPEC's Outstanding Contribution Expert distinction.



Piotr Krzywiec

Plenary lecture 006 · International Lithosphere Program Task Force VI on Sedimentary Basins – introduction and invitation to co-operation

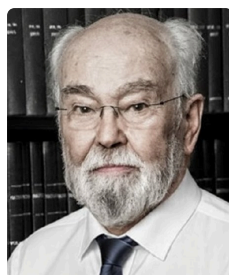
Piotr Krzywiec studied at the Jagiellonian University and the AGH University of Science and Technology, both in Kraków, Poland, and at Imperial College London, UK. He holds an MSc in Geology and an MSc and PhD in Exploration Geophysics. He is a professor at the Institute of Geological Sciences of the Polish Academy of Sciences, Warsaw, and an external lecturer in geophysics and seismic methods at the Jagiellonian University in Kraków and Adam Mickiewicz University in Poznań. He is a past lecturer for the AAPG Visiting Geoscientist Program. His main interests are the integrated analysis of geophysical and geological data, basin analysis, tectonics and the history of geology. He is a member of the Polish Geological Society, Polish Geophysical Society, AAPG, SEG, EGU, International Society of Paleogeography, Petroleum History Institute, International Commission on the History of Geological Sciences (INHIGEO), History of Earth Sciences Society, and the History of Geology Group of the Geological Society of London.



Eduardo B. Olivero

Plenary lecture 007 · Paleobiogeographic and biotic changes in Late Cretaceous marine ecosystems, James Ross Basin, Antarctica

Eduardo Bernardo Olivero is an Argentine geologist and palaeontologist with more than 45 years of research and teaching experience. His work focuses on the stratigraphy, palaeontology and sedimentology of Jurassic-Cretaceous and Cenozoic successions in Antarctica and southern Patagonia. He received his PhD in Geological Sciences from the University of Buenos Aires in 1982. He is Professor Emeritus at the National University of Tierra del Fuego and a retired Senior Researcher of CONICET who remains active through an ad honorem contract. He was a CONICET External Postdoctoral Fellow and Research Associate at Purdue University from 1986 to 1989. His research helped establish the James Ross Basin as an important Southern Hemisphere reference for the Santonian-Maastrichtian. He contributed to stratigraphic correlation and age control of a succession more than three kilometres thick, reconstructed sedimentary palaeoenvironments and transgressive-regressive cycles, and advanced ammonite biostratigraphy and palaeobiogeography. His work includes the first discovery of dinosaur remains in Antarctica and studies of the Weddell Sea shelf and the geological evolution of the Antarctic Peninsula-Fuegian Andes system. He directed CADIC-CONICET in Ushuaia from 1992 to 2004 and developed a multidisciplinary group studying the Fuegian Andes. He served as Regional Coordinator for Antarctica and Tierra del Fuego in IGCP Project 381 and headed the Argentine Antarctic Institute's Biostratigraphy Group. He has published 138 scientific papers and 126 conference abstracts, alongside extensive teaching, thesis supervision and Antarctic fieldwork. His honors include the F. Ameghino Prize (1984), the Argentine Geological Association's Stratigraphy, Sedimentology and Palaeontology Prize (2016), the Paleontological Merit Award (2019), and the Strobel and Consagración prizes (2022). The Antarctic dinosaur *Antarctopelta oliveroi* commemorates his pioneering discovery.



Victor A. Ramos

Plenary lecture 008 · The Andes: A tectonically active system in a changing paleogeography

Victor Alberto Ramos specializes in Andean tectonics and the geological evolution of South America. His research addresses subduction, mountain building, terrane accretion, ridge collision, magmatism and basin evolution, with applications to regional geology and mineral and hydrocarbon systems. He obtained his degree in Geological Sciences at the University of Buenos Aires in 1965, an MSc in Photointerpretation for Geology in Delft in 1968, and his doctorate in Geology at the University of Buenos Aires in 1970. He has been Emeritus Professor at that university since 2011 and Emeritus Researcher of CONICET since 2018. His international appointments include visiting and adjunct positions at Cornell University and a visiting professorship at the University of Texas at Austin. His work has helped explain the tectonic segmentation of the Andes, the influence of slab geometry on deformation and mountain building, and the relationships between magmatism and tectonics. His publications include scientific papers, books and regional syntheses on the Andes, Argentine geology and the crustal evolution of South America. He was Director of the Department of Geological Sciences at the University of Buenos Aires (1991–1993), Vice Dean of its Faculty of Exact and Natural Sciences (1998–2006), and organizing Director of the Instituto de Estudios Andinos Don Pablo Groeber (2011–2013). He served as President of Argentina's National Academy of Exact, Physical and Natural Sciences (2020–2024). His editorial service includes the *Revista de la Asociación Geológica Argentina* and major international geoscience journals. He has supervised numerous theses and trained successive generations of geoscientists. He is a Foreign Member of the US National Academy of Sciences (2010) and a member of TWAS (1998). Selected honors include the Guggenheim Fellowship (1988), Bunge y Born Prize (2009), Mexico Prize for Science and Technology and Konex Platinum Award (2013), TWAS–Lenovo Science Prize (2017), and Leopold von Buch Plaque (2023).



Ron Steel

Plenary lecture 009 · Revisiting Shelf Genesis: Subaqueous Deltas, Strike-Feeding, Mudbelts and Shelf Fans

Ron Steel is a sedimentologist whose research focuses on the construction of continental shelves by deltas, shelf-margin growth and the transfer of sediment to deep-water basins. His work combines sedimentology, sequence stratigraphy and basin analysis to investigate depositional architecture and sediment routing. He obtained a BSc with honors in Geology from the University of Glasgow in 1967 and a PhD from the same university in 1972. He held the Davis Centennial Chair at the University of Texas at Austin from 2003 to 2020 and chaired its Department of Geological Sciences from 2011 to 2015. Earlier positions included Chief Geologist at Norsk Hydro, Professor of Sedimentology and Reservoir Geology at the University of Bergen, and Wold Professor of Energy at the University of Wyoming. He also held the Sixth Century Chair in Sedimentary Geology at the University of Aberdeen and an honorary professorship at Heriot-Watt University. His research examines the timescales and mechanisms of sediment delivery, the partitioning of sediment budgets, and the roles of accommodation, sediment supply and autogenic processes in shelf-margin evolution. Major studies include the palaeo-Orinoco Delta and the Jurassic shelf margin of Argentina's Neuquén Basin. His recent work reassesses compound delta clinoforms and the relationships between subaerial and subaqueous delta components. He has published approximately 260 papers and 11 edited books, and has supervised around 120 MSc and PhD graduates at Bergen, Wyoming and the University of Texas at Austin. His work has received approximately 27,000 citations (Google Scholar h-index of 88 in 2026). He received the AAPG Distinguished Educator Award (2011) and SEPM's Twenhofel Medal for re-

search excellence (2016). He delivered the Geological Society of London's William Smith Lecture in 2014 and has held distinguished lectureships and received multiple best paper and poster awards.

Ariana Osman

Plenary lecture 009 · Revisiting Shelf Genesis: Subaqueous Deltas, Strike-Feeding, Mudbelts and Shelf Fans

Ariana Osman is an Assistant Lecturer in the Petroleum Geoscience Unit, Department of Chemical Engineering, at The University of the West Indies, St. Augustine, Trinidad and Tobago. Her research focuses on sediment partitioning, delta evolution and shelf-margin growth, particularly in the late Miocene to Pleistocene palaeo-Orinoco system. She earned a BSc in Geology from Western University, Canada, in 2004, an MSc in Geology from the University of Texas at Austin in 2006, and a PhD in Geoscience from The University of the West Indies in 2024. Her doctoral research, supervised by Ryan Ramsook, examined how mixed deltaic processes and sediment gravity flows built the Trinidad shelf margin during stable and growth-faulted phases. She integrates outcrop stratigraphy, well logs and seismic data to investigate sediment transfer, depositional architecture, and the effects of sea-level change and tectonics. Her current research addresses compound delta clinoforms, subaqueous delta accretion, sediment storage and delivery to deep-water environments, including comparative work on the palaeo-Orinoco and Norway's Cook Formation. Her publications also include research on mixed-process subaqueous delta platforms in the Jurassic Lajas Formation of Argentina's Neuquén Basin. Before joining The University of the West Indies in 2017, she worked as a geologist at BP Trinidad and Tobago from 2006 to 2010, contributing to exploration and development projects in the Columbus Basin through prospect evaluation, seismic mapping, volumetric assessment, risk analysis, well planning and three-dimensional modelling. From 2010 to 2013, she was a Visiting Scientist at Leibniz University Hannover, Germany, researching the sequence stratigraphy of Paleogene coal-bearing deposits and the interaction of salt tectonics and sea-level change. Her teaching includes sedimentology, stratigraphy, petroleum geology, palaeontology and biostratigraphy, research projects and geoscience seminars. She has supervised undergraduate projects, contributed to curriculum development and accreditation activities, and organized field teaching and outreach. Her publications appear in *Sedimentology*, *Journal of Sedimentary Research*, *Basin Research*, *Marine and Petroleum Geology*, *Earth-Science Reviews* and *Sedimentary Geology*, as well as an AAPG memoir. She collaborates with the RioMar Research Consortium at the University of Texas at Austin and contributes to research on reservoir and seal properties for carbon capture and storage. She has delivered professional short courses, invited talks and field trips for academic and industry audiences. Her distinctions include first place in the student poster competition at IMAGE 2022 and a BP Graduate Scholarship. She also serves on the editorial committee of the Geological Society of Trinidad and Tobago and as Co-Editor of its magazine.



Longde Sun

Plenary lecture 010 · Integration of Innovation and Industrial Chains: Exploration and Development of Continental Gulong Shale Oil in Daqing

Longde Sun holds a PhD and is an Academician of the Chinese Academy of Engineering. He specializes in natural gas field development engineering and petroleum geology and currently serves as Deputy Director of the Science and Technology Committee of China National Petroleum Corporation. His career combines oil and gas exploration and development research with engineering practice. He has worked at the Shengli Oilfield in Shandong, the Tarim Oilfield in Xinjiang, the South China Sea oil and gas region, the Daqing Oilfield in Heilongjiang, and the headquarters of China National Petroleum Corporation. His principal contributions concern continental shale oil exploration and development, progressive exploration and development of complex fault-block oilfields, efficient development of deeply buried marine sandstone reservoirs and complex natural gas fields, and integrated engineering systems for oil and gas production. His work connects geological characterization with practical approaches to field development. He organized research and engineering construction for the development of the Tarim gas supply underpinning China's West-to-East Gas Pipeline project, including the Kela 2, Yaha and Yingmaili gas fields. These projects contributed to development theories and technologies for condensate and abnormally high-pressure gas fields, as well as advances in continental shale oil exploration and development. He has published more than 70 academic papers in Chinese and international journals. His honors include two First Class and two Second Class National Science and Technology Progress Awards, the Ho Leung Ho Lee Foundation Science and Technology Award, the Guanghua Engineering Science and Technology Youth Award, and the National May 1st Labor Medal. He also receives the State Council Special Government Allowance.

Portrait: Chinese Academy of Engineering. Institutional source.



Carlos Zavala

Plenary lecture 011 · The delta efficiency: a key concept for understanding deltaic sedimentation in the stratigraphic record

Carlos Zavala is an Argentine geologist who earned his Ph.D. in Geology from the Universidad Nacional del Sur, Argentina, in 1993. He conducted postdoctoral research at the University of Parma, Italy (1994-1996), under the supervision of renowned sedimentologist Professor Emiliano Mutti. He has more than 35 years of experience in scientific research, university teaching, and international geological consulting. He was Professor of Stratigraphy at the Universidad Nacional del Sur and a researcher at CONICET (Argentina). He currently serves as Distinguished Professor (Changjiang Scholar Chair Professor) and Ph.D. supervisor at Shandong University of Science and Technology, Qingdao, China. His expertise includes sedimentology, sequence stratigraphy, and sedimentary basin analysis, with particular emphasis on continental and marine depositional systems, sediment gravity flows, and hyperpycnal processes. He has conducted research and hydrocarbon exploration projects in more than 40 sedimentary basins across 11 countries. He has authored and co-authored numerous international scientific publications and has been an invited speaker at conferences and universities worldwide. His career also includes leading research projects, supervising graduate students, and collaborating with academic institutions and the energy industry.

Plenary lectures

001 PLENARY LECTURE PL-17-1110

Palaeogeography and palaeodrainage reconstruction of eastern Gondwanaland recorded in Palaeo-Mesozoic deposits of India

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The Paleo-Mesozoic sediments in the Pranhita-Godavari, Mahanadi and Damodar basins of south-eastern India provide critical constraints on sediment dispersal, source-terrain evolution, and the paleogeographic reconstruction of eastern Gondwanaland. Provenance analysis of the sedimentary deposits of these basins is essential for reconstructing the paleogeography of eastern Gondwanaland and for constraining the tectonic and sedimentary linkages among India, Antarctica, and Australia. Reconstruction of these drainage patterns is crucial for constraining the timing of India's separation from East Gondwanaland and the subsequent reversal of drainage patterns driven by tectonic processes. Integrated sandstone petrography, heavy-mineral chemistry, and detrital monazite geochronological data indicate that these basins received sediment from both proximal and distal sources. Rutile chemistry of sandstones suggests dominant contributions from metapelitic source rocks, while garnet chemistry indicates significant granulite-facies input in the Pranhita-Godavari Basin and predominant amphibolite- to granitoid-derived detritus in the Mahanadi and Damodar basins. Detrital garnet compositions show strong affinities with the Eastern Ghats Mobile Belt and East Antarctica, whereas additional similarities with the Chhotanagpur Gneissic Complex, Assam-Meghalaya Gneissic Complex, and southwestern Australia are evident in the Mahanadi and Damodar basins. Detrital monazite ages from the Pranhita-Godavari Basin define major populations at 1) 2600–2100 Ma, 2) 1000–700 Ma, and 3) 500–400 Ma, whereas those from the Mahanadi and Damodar basins yield age clusters at 1) 2500–2200 Ma, 2) 1600–1500 Ma, 3) 1100–700 Ma, and 4) 600–400 Ma. Integrated provenance analyses indicate that proximal sediment was supplied from the Indian cratonic uplands, including the Karimnagar, Khammam, and Bhopalpatnam granulite belts for the Pranhita-Godavari Basin, and the Eastern Ghats, Rengali Belt, and Chhotanagpur Gneissic Complex for the Mahanadi and Damodar basins. Distal sediment contributions were delivered through transcontinental drainage systems from East Antarctica to all three basins and from southwestern Australia to the Damodar Basin. Shifts in monazite age spectra, particularly the disappearance and subsequent reappearance of Cambrian populations together with the first appearance of Paleoproterozoic ages in the Mahanadi and Damodar basins, record continental-scale drainage reorganization during the Paleo-Mesozoic transition. These shifts likely reflect tectonic processes associated with East Gondwana rifting, which culminated in Late Mesozoic Gondwana separation and led to paleoslope reversal due to mantle-plume-related domal uplift. Collectively, the provenance data support the interpretation that India, Antarctica, and Australia remained connected through extensive sediment-routing systems until the final stages of Gondwana fragmentation, highlighting the role of Gondwana basins of India in preserving continental-scale tectonic and paleogeographic evolution.

002 PLENARY LECTURE PL-19-1450

Application of ichnology to reconstruct depositional environments: reviewing the state of the art and assessing knowledge gaps

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The recognition that trace-fossil distribution is strongly controlled by environmental factors has led to the success of ichnology as a valuable tool in facies analysis and paleoenvironmental reconstructions. Intense research during the last decades has resulted in more sophisticated trace-fossil models for wave- and tide-dominated shorelines (with detailed zonations from backshore to shelf and from supratidal to subtidal), estuaries, and deltas. However, many other depositional environments have not been explored to the same extent. Although attention has been given to subtidal sandbodies, resulting in the ichnologic delineation of sand sheets, tidal sand ridges, compound dune fields, and isolated dune patches, the trace fossil content of tidal straits has only been explored very recently. End-members with respect to wave and tidal dominance are better understood than mixed systems, but progress has been made in the characterization of tidally modulated shorefaces and wave-dominated tidal flats. Muddy coasts are still poorly known from an ichnologic standpoint, remaining essentially unrecognized in the geologic record. The vast majority of ichnologic studies dealing with marginal-marine environments focus on either estuaries or deltas, and there is an unfortunate lack of models for other transitional settings (e.g. bays). In turn, wave- and river-dominated deltas are much better understood than tide-dominated deltas. Mixed deltaic systems remain to be explored in more detail. In addition, ichnologic studies of deltas are mostly restricted to coastal deltas, with very few analyses performed in shelf-edge deltas and subaqueous deltas. Deep-marine trace fossils have been the focus of detailed systematic work, but further study is needed to finely tune sedimentologic and ichnologic datasets. Recent research, however, is yielding insights into the significance of trace fossils to characterize deposits formed due to a variety of processes, such as hyperpycnal currents, episodic turbidity currents, and bottom currents. The ichnology of carbonate systems remains much less explored than that of siliciclastic systems, with work focused on Bahamian-type carbonates, reefs, rocky shorelines, and chalk. Continental ichnology evolved from an unexplored field to an explosion of research, with detailed studies dealing with lakes, rivers, paleosols, and deserts. On a negative note, invertebrate and vertebrate ichnology have evolved independently, and there is still a pressing need for integrating these two disparate datasets. The role of climatic and latitudinal controls on ichnofaunas is gradually starting to be recognized through studies in tropical and glacially influenced settings. Similarly, the role of macroevolution is helping to calibrate secular changes in ichnofaunal composition for various depositional settings. Appreciation of the role of tectonic context is becoming of paramount importance. Progress has been made regarding the contrasting ichnologic characteristics of passive-margin fine-grained and active-margin coarse-grained turbidite systems, but further research is needed.

003 PLENARY LECTURE PL-19-1515

The Rise of the Altaid Plateau (Central Asia): Palaeogeographical Drivers of Late Triassic Earth's Freezing State

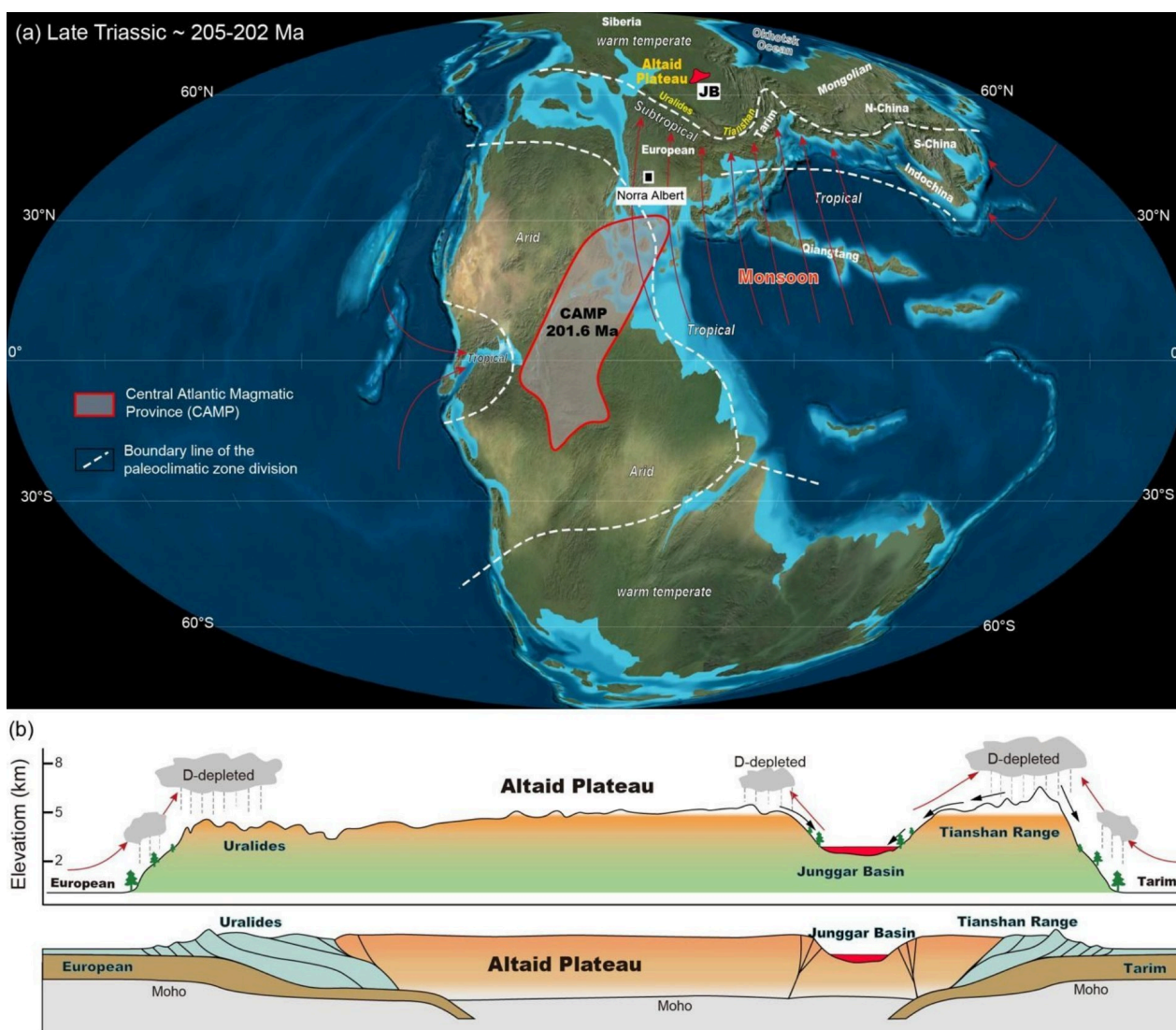
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The Late Triassic (~204.6–201.9 Ma) represents a pivotal interval in Earth's history, characterized by an apparent paradox: the onset of global cooling preceding the emplacement of the Central Atlantic Magmatic Province and the subsequent end-Triassic mass extinction (ETME). While the ultimate extinction trigger is attributed to volcanogenic warming, the mechanisms driving the preceding cooling phase remain unresolved, with hypotheses invoking decreased atmospheric CO₂, sulfur aerosol emissions, or tectonic-scale climate reorganization. Here, we present new quantitative palaeoelevation constraints for the southern Altaids (Central Asian Orogenic Belt) at NW Pangea that offer a tectonic solution to this climatic enigma. Utilizing a dual-proxy approach, combining conventional hydrogen isotope (δD) palaeoaltimetry of *n*-alkanes with an innovative ultraviolet-B (UV-B) proxy derived from pollen grain morphology and ultraviolet-absorbing compounds (UACs), we reconstruct the elevation of the Junggar Basin (NW China) and its surrounding ranges during the Rhaetian. Our results demonstrate that this region sustained palaeoelevations of 3,028–4,050 m, comparable to the modern Tibetan Plateau. This high-altitude orogenic system is evidenced by significant alpine floral stress, including malformed pollen grains and elevated UAC concentrations indicative of enhanced UV-B radiation.

We propose that the amalgamation of the Tarim, European, and Siberian cratons during the final assembly of Pangea established a vast, latitudinally extensive "Altaid Plateau" in the temperate Northern Hemisphere. This orographic feature had profound palaeoclimatic consequences: (1) it catalysed mountain glaciation and regional cooling through orographic effects; (2) it intensified the Pangean monsoon system; and (3) it fostered the development of endemic alpine ecosystems. Critically, we argue that the uplift of this plateau reset regional and potentially global climate states, providing a direct tectonic linkage between the long-term cooling trends observed in the geological record and the extreme climatic disruptions immediately prior to the ETME. These findings underscore the pivotal role of late-stage Pangean orogenesis in driving Mesozoic climate transitions and establishing the environmental backdrop for the rise of modern ecosystems.



004 PLENARY LECTURE PL-17-1045

Uplift of the Himalaya–Tibetan Plateau and its impacts on Asian and global climate and ecology

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The rise of the Himalaya–Tibetan Plateau has profoundly transformed the geomorphological and climatic framework of Asia, with far-reaching consequences for ecological and biological evolution across Asia and Africa, as well as for the global climate system. Nevertheless, the precise co-evolutionary pathways and underlying driving mechanisms remain debated. Drawing on our recent investigations, we show that during the early Cenozoic, the central and southern sectors of the plateau occupied a low-lying area within the tropical monsoon belt, supporting tropical to subtropical evergreen forests. In contrast, the northern plateau and the extensive Asian interior were dominated by the subtropical high, giving rise to desert conditions under a hot, arid climate. By approximately 41 Ma, ongoing convergence between India and Asia had eliminated the Tethys and Para-

Tethys seaways bordering the southern and northern margins of the plateau. This tectonic event triggered rapid uplift of the central and southern plateau, accompanied by the formation of the broad Lunkola lowland valley. Such topographic reorganization likely strengthened the tropical monsoon, allowing it to penetrate northward into the southern subtropics. As a result, the previously hot, arid deserts of Southeast Asia near 26°N were replaced by subtropical monsoon forests. From about 26 Ma onward, the Lunkola valley underwent accelerated uplift, coeval with rapid elevation of the Himalayas and the northern plateau. This phase reconfigured Asian topography from an early 'low west-high east' pattern to a 'high west-low east' configuration. The subtropical monsoon consequently advanced further northwest, reaching the modern temperate monsoon front and establishing a monsoon system similar to today's. These changes collectively transformed the formerly hot, arid northern plateau and East Asia into monsoon forests and forest-grasslands, coinciding with a marked increase in Asian biodiversity. Between 15 and 8 Ma, the northeastern plateau experienced rapid uplift, joining the rest of the plateau. This triggered profound ecological shifts and widespread aridification across the plateau. The central plateau transitioned from forests to shrubs, alpine grasslands, and desert grasslands, while the northeastern plateau and Asian interior shifted from forests to forest-steppes, steppes, and deserts. A teleconnection may have been established, leading to drying in equatorial East Africa, where early forests gave way to savannas. Savanna fauna originating in the northeastern plateau may have migrated to Africa, possibly facilitating the evolution and emergence of hominins. This aridification also enhanced erosion, dust emission, and desert expansion in the plateau and Asian interior, ultimately producing the thick Chinese loess deposits and influencing marine and terrestrial biodiversity and global cooling.

KEYWORDS Himalaya-Tibetan Plateau; Asian monsoon; Cenozoic uplift; Climate change; Biodiversity evolution

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005 PLENARY LECTURE PL-19-1425

Sedimentary and Distribution Patterns of Black Shale at the Global Ordovician-Silurian Boundary

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A set of globally correlative dark shales were deposited across the Ordovician-Silurian transition, serving as a global sweet spot interval for shale oil and gas. Large-scale development of shale oil and gas in this interval has been realized in the United States and China. This study presents a comprehensive global review, regional correlation and case analysis of the shales formed during this interval, explores their global distribution pattern, basin-scale sedimentary evolution and lithofacies distribution, and identifies future exploration directions for shale oil and gas. The main findings of the study are as follows: (1) On a global scale, the world during the Late Ordovician to Early Silurian was characterized by a pattern of two supercontinents flanking one superocean. Dark shales were mainly developed on the marginal sides of the Gondwana and Laurussia continents facing the Paleo-Tethys Ocean. The opening and closing sequence of the Paleo-Tethys Ocean basin controlled the timing and duration of transgression-regression events between the supercontinents. The transgression-regression periods of the northern Laurussia Continent occurred earlier than those of the southern Gondwana Continent. Within the same continent, North Africa, located in the low-lying marginal areas, experienced earlier and longer-lasting transgressions compared with the

Middle East in the relatively higher terrain. (2) Based on factors such as ocean-continent configuration, tectonic stress regime, paleoclimate, paleoecology, paleo-ocean currents and lithofacies, the sedimentary models of shales in major global continental blocks during this period have been established. Sedimentary centers are mainly divided into two types: those located at continental margins and intra-platform depressions. The former is associated with transgression caused by the expansion of the Paleo-Tethys Ocean, featuring high-quality shale with large thickness and extensive continuous distribution, presenting a wide zonal pattern parallel to the continental block margins. The latter is related to low-lying paleogeomorphology formed by tectonic compression or glaciation, mostly distributed as elongate belts perpendicular to plate margins with relatively small continuous areas. The stability of continental blocks and sediment supply conditions control the base-shale-top structure of shale sequences and the internal lithofacies evolution characteristics of shales. Large plates with abundant terrigenous sediment supply such as North Africa and the Middle East generally have a clastic rock-shale-clastic rock structure, with linearly gradational lithofacies within the shale sequences. Small plates like South China usually possess a carbonate rock-shale-clastic rock structure, accompanied by relatively complex lithofacies variations inside the shale sequences. (3) Taking the Upper Ordovician Wufeng Formation-Lower Silurian Longmaxi Formation in South China as an example, this paper discusses the theoretical and methodological system of sequence stratigraphy and lithofacies for fine-grained sediments. The multi-parameter comprehensive sequence division method and geological-geophysical correlation method are adopted to solve the division problem of thin-bed sequences. The three-end-member diagram is used to determine inorganic facies types, and TOC is applied to define organic facies grades for comprehensive lithofacies division. The multi-parameter comprehensive quantitative mapping of sedimentary microfacies and lithofacies is utilized to address the prediction problem of fine-grained lithofacies. (4) This paper discusses the characteristics and genesis of three major types of inorganic minerals in the Wufeng Formation-Longmaxi Formation, as well as their interaction relationships with organic matter. Terrigenous quartz grains are relatively large with poor roundness, and the long axes of the grains form a certain angle with laminae, which is related to bottom current activity to a certain extent. Biogenic silica is mainly derived from siliceous organisms such as radiolarians, showing coexistence of different particle sizes and good preservation. The diameter of the radiolarian tests exceeds the upper grain size limit of fine-grained sediments, indicating that they settled into a quiet bottom-water environment after the death of plankton in the surface water layer, and they have genetic connections and a positive correlation in content with organic matter. The grain size of carbonate minerals in coarse laminae is generally larger than that in fine laminae, and multiple small particles aggregate into larger ones, suggesting that both chemical precipitation and mechanical sedimentation occurred. Carbonate minerals have a dilution effect on organic matter. Clay minerals are suspended in flake form in the upper layer of sedimentary water bodies and settle slowly; they adsorb each other to form floccules in the middle and lower water layers, and further aggregate into flocculent particles through diagenesis. Clay minerals show a negative correlation with organic matter.

KEYWORDS Black shale; sedimentary model; Late Ordovician-Early Silurian; shale oil and gas; China; global

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006 PLENARY LECTURE PL-19-1540

International Lithosphere Program Task Force VI on Sedimentary Basins – introduction and invitation to co-operation

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The International Lithosphere Program (ILP; <https://ilp.nju.edu.cn>) is a global scientific initiative that promotes multidisciplinary research on the nature, dynamics, origin, and evolution of the Earth's lithosphere. It was created in 1980 by the International Council of Scientific Unions at the request of the International Union of Geological Sciences (IUGS) and the International Union of Geodesy and Geophysics. It bridges geology, geophysics, and geotechnology through an integrated solid Earth perspective, linking deep Earth processes to the surface. ILP seeks to elucidate the nature, dynamics, origin and evolution of the lithosphere through international, multidisciplinary geoscience research projects and coordinating committees. The ILP is charged with promoting multidisciplinary research projects of interest to both the geological and geophysical communities. The ILP's main goals are: to strengthen the connection between solid-earth and non-solid-earth aspects relevant to the lithosphere and vice-versa; and to strengthen the profile and the impact of lithosphere research and topics of societal relevance, i.e. energy and environment. In order to respond to these goals, several Task Forces have been established, including TF VI on Sedimentary Basins. Its mission focuses on understanding the formation and evolution of sedimentary basins, from regional to nano-scale, from the deep Earth to near-surface processes. Topics covered by the ILP Task Force VI are at many levels relevant to broadly understood paleogeographic studies, and may be of interest to the wider paleogeography community. This link will be illustrated by two examples of ongoing research projects: one devoted to inversion tectonics and associated syn-tectonic depositional systems (Fig. 1A), and one focused on the transform margin of East Africa and source-to-sink regional onshore-offshore analysis of its Jurassic to recent development (funded by NCN grant 2025/59/D/ST10/00783).

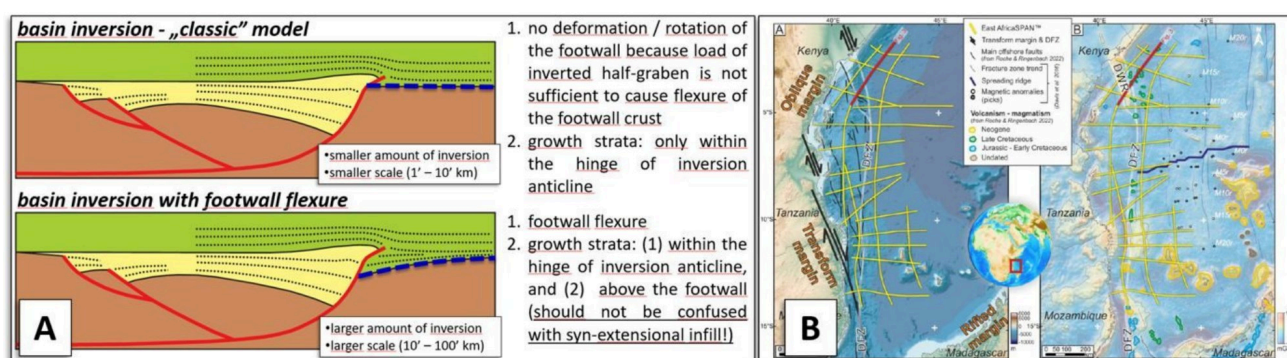


Fig. 1. A: conceptual model of inversion tectonics associated with footwall flexure (lower panel); B: Regional maps of the East Africa margin showing basin configuration and the location of East AfricaSPAN™ seismic profiles (cf. Stachowska et al., Late Cretaceous post-breakup magmatism along the East African margin, Gondwana Research, submitted).

KEYWORDS International Lithosphere Program, Task Force VI Sedimentary Basins; paleogeography, flexural inversion, transform margin. East Africa

007 PLENARY LECTURE PL-17-0950**Paleobiogeographic and biotic changes in Late Cretaceous marine ecosystems, James Ross Basin, Antarctica****E.B. Olivero^{1,2*}, M.I. Lopez Cabrera¹**¹ Centro Austral de Investigaciones Científicas (CADIC)–Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), B.A. Houssay 200, V9410CAB Ushuaia, Tierra del Fuego, ARGENTINA² Universidad Nacional de Tierra del Fuego (UNTdF-ICPA), 9410 Ushuaia, Tierra del Fuego, ARGENTINA

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During the Late Cretaceous, the Arctic and Antarctic both occupied polar positions and experienced months-long day-night cycles and relatively warm temperatures, yet their environments differed fundamentally: the Arctic was an ocean surrounded by continents, whereas Antarctica was a continent surrounded by oceans. In the absence of glacial albedo, high summer solar radiation in Antarctica—partly absorbed by land vegetation—likely drove alternating summer and winter cyclonic and anticyclonic centers, producing atmospheric and oceanic circulation patterns unlike those of today. As a result, Cretaceous Antarctic polar ecosystems, both marine and continental, were distinctive and lacked modern analogues. Our research in the James Ross Basin reconstructs a sequence of major ecological events and changes over a 20-million-year period—between 86 and 66 Ma—before the global extinction event at the K/Pg boundary. From 86 to 80 Ma, the Weddell shelf formed and expanded under very warm-water conditions. The marine biota was dominated by cosmopolitan and Indo-Pacific mollusks, the trace fossils by cosmopolitan elements of the Cruziana ichnofacies, and the terrestrial vegetation by ferns and gymnosperms. A key feature of this interval was the progressive exclusion from Antarctica of warm-water faunas, among them mollusk groups that persisted into the Maastrichtian elsewhere in the world. Between 80 and 66 Ma, the marine biota became endemic to the Weddellian Province and adapted to markedly colder waters, while the terrestrial vegetation shifted to angiosperm dominance. This interval is characterized by the dominance of Austral kossmaticeratid ammonites in Antarctica and by the appearance of endemic trace fossils produced by trophic generalists (detritivores, deposit feeders, and bacterial farmers), such as *Euflabella*, *Paradiptyodora*, and *Tasselia*. The transition to endemic, cold-adapted biotas under strongly seasonal primary productivity occurred relatively abruptly, around 80 Ma. It marked the onset of ecosystems structurally similar to those of the modern ocean, and likely preceded the global Maastrichtian cooling event.

008 PLENARY LECTURE PL-17-1135**The Andes: A tectonically active system in a changing paleogeography****Victor A. Ramos**

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From very early on, with Charles Darwin's first observations in 1835, it was recognized that the Andes were an active mountain range, characterized by earthquakes, erupting volcanoes, and ongoing orogenic uplift. Over the last two hundred years of research, a series of processes has been identified that allows us to understand the significant differences between the various Andean segments. First, the Andes are the result of different modes of subduction along the Pacific margin of the South American Plate, which is bounded to the north and south by the Antilles Arc and the Scotia Arc. The absolute displacement of the overriding plate to the northwest results in a transpressional contact with the Antillean Arc, while the southern contact is dominated by transtension. Its northern sector is characterized by the Cenozoic accretion of a series of oceanic arcs that have

imprinted on its geology different terranes delimited by ultrabasic belts and zones of strong dynamic metamorphism. This basement controls the mafic and poorly evolved characteristics of the active volcanic arc of the Northern Andes. The central Andes to the south have segments with their own unique characteristics. The northern sector of Peru has no active volcanism, exhibits the highest elevations in the Cordillera Blanca, shows horizontal subduction since the Miocene, and is strongly subjected to compression. The sector south of the Abancay deflection, although it has an active volcanic arc, has experienced conspicuous crustal delamination and records an extensional regime during the Late Cenozoic. This has been caused by slab rollback towards the trench, conditioned by the steepening of the subducted slab from the Late Oligocene onwards. It is the only segment of the Andes where a complete Dickinson orogenic cycle has been recorded during the Cenozoic. The northern sector of Chile, along with the adjacent Bolivian sector, constitutes the most central segment of the Andes, exhibiting the most pronounced paleogeographic expression of its various elements. These include a compressive forearc, a magmatic arc with highly evolved products resulting from its thick continental crust, a unique Altiplano (high plateau) resulting from thermal uplift of a couple of kilometers, and tangential tectonics with extensive fold and thrust belts and horizontal shortening exceeding 250 km. This tectonic stacking created extensive foreland basins several kilometers thick. The central Chilean and adjacent Argentinian sector is subject to horizontal subduction, has no active volcanism, and exhibits a strong compressive regime. This segment, characterized by the Pampean flat-slab, presents the best-developed broken foreland in the Andes. Its structure and paleogeography are conditioned by previous Paleozoic sutures, whose reactivation generated the Sierras Pampeanas, basement blocks bounded by reverse faults, many of them active, which caused their orographic uplift during the Late Cenozoic. The southernmost sector of the Central Andes, corresponding to south-central Chile and Argentina, is characterized by a moderately evolved volcanic arc, a narrow fold and thrust belt, and a unique back-arc from a paleogeographic perspective within the entire Andean chain. This back-arc is characterized by more than 800 Quaternary basaltic volcanic centers derived directly from the mantle, which developed under an extensional regime and whose continental crust was not thick enough to give rise to crustal delamination processes. The southernmost Andes record the collision of an active mid-ocean ridge, which leads to adakitic magmatism with small percentages of oceanic crust melting, a characteristic exclusive to this segment. The development of slab windows has produced an abnormally ductile continental crust and mantle due to the subduction of the active mid-ocean ridge. This mantle accounts for notable isostatic uplift, due not only to late Cenozoic deglaciation but also to the heating of the lithosphere, which increased its buoyancy. The Andes transition into the Fuegian Andes, where subduction leads to a transform contact with the Scotia Plate. The characterization of these processes along the margin has allowed the identification of new mechanisms of interaction between the subducted oceanic plate and the upper continental plate that include crustal erosion by subduction, crustal delamination and mantle removal, thermal uplift of the plateaus, and the development of slab windows, among others. These processes are currently being re-evaluated with new information on the mantle obtained through modern technologies, which have given rise to a new revolution in knowledge: **Mantle Tectonics**.

009 PLENARY LECTURE PL-17-0925**Revisiting Shelf Genesis: Subaqueous Deltas, Strike-Feeding, Mudbelts and Shelf Fans****Ronald J. Steel^{1*}, Ariana Osman², Valentina M. Rossi³, Cornel Olariu¹**¹ Jackson School of Geoscience, The University of Texas at Austin, University Station, C1100, Austin, TX 78712, USA² Petroleum Studies Unit, The University of the West Indies, St. Augustine, TRINIDAD AND TOBAGO³ National Research Council of Italy, Institute of Geosciences and Earth Resources, Via Ferrata 1, 27100 Pavia, ITALY

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It has long been recognized that rivers and deltas are a main contributor to the shelf-building process. This does not happen by simple cross-shelf migration of a deltaic clinoform set, because most modern, wave- and tide-influenced deltas are known to develop a double clinothem set, complicating the shelf architecture. The thinner (5–20 m), coarse-grained shoreline clinothem is usually coupled outboard with a thicker (30–200 m), finer-grained subaqueous-delta clinothem. Linkage between the two results in near-continuous sediment bypass across an active subaqueous platform, tens to hundreds of kilometres wide, greatly aided by energetic marine conditions as well as fluid mud on the seabed. This suggests that the subaqueous delta is critical for shelf building. Its muddy and heterolithic gravity flows are a characteristic feature of the subaqueous-delta slope. Further, changes of relative sea-level and their effect on cross-shelf regression during repeated depositional sequence development add another layer of complexity. It is likely that maximum separation of the two clinothem sets occurs during highstand periods (as seen in most modern deltas), but the two merge, with zero platform width, at least when the delta system reaches the shelf break. However, during forced regression the shoreline clinothems can over-ride and merge with the subaqueous delta on the platform long before the delta system reaches a shelf break. This is seen on the Rhone Delta during Late Pleistocene alternation of glacial and interglacial deltaic phases. During such over-rides coarser sediment can bypass onto the subaqueous-delta slope, forming bottomset sandy gravity-flow fans on the shelf, as documented on the Miocene New Jersey shelf. Recognition of the shelf break may sometimes be problematic, but it is necessary that the shelf be seen to terminate, and that there is a bathyal water deepening, often from 350 m to several kilometres. Another complicating element is that the finer-grained subaqueous delta is commonly re-routed offshore along strike by shelf currents, as on the Mekong, Yellow or Atchafalaya deltas. At times this leads to the generation of prograding coast-parallel, shelf mudbelts, as off the Han, Yangtze or Amazon deltas. Together, the subaqueous delta, strike-feeding, mudbelts and shelf fans demonstrate the need to re-visit the process of shelf building.

010 PLENARY LECTURE PL-17-0900**Integration of Innovation and Industrial Chains: Exploration and Development of Continental Gulong Shale Oil in Daqing****Longde Sun**

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This report, themed "Deep Integration of Innovation Chain and Industrial Chain," systematically summarizes the exploration and development practices of continental shale oil in the Gulong Formation, Daqing. The report highlights that China's understanding of shale oil has spanned nearly a century: beginning in the 1980s with oil and gas exploration in the Gulong area of the Songliao Basin using mudstone and shale, and reaching a major strategic turning point in May 2020, when Gulong Oilfield Well 1 achieved high-yield oil and gas flow and was selected for the

"Republic of China Mark". Since then, guided by important directives from General Secretary Xi Jinping, the state has successively established the Daqing Gulong Continental Shale Oil National Demonstration Zone and the National Key Laboratory of Green Extraction of Continental Shale Oil with Multiple Resources, thereby constructing a "government-industry-academia-research-application" scientific research collaboration model and a "three-in-one" joint development framework. By the end of 2025, a cumulative total of 361 horizontal wells had been drilled, with an established production capacity exceeding 1.6 million tons, an annual oil production of 1.085 million tons, and proven geological reserves of 303 million tons. In April 2026, the demonstration zone passed the acceptance inspection by the National Energy Administration, establishing the replicable and scalable "Daqing Model".

KEYWORDS Lacustrine shale oil; exploration history; development performance; Daqing Model; Songliao Basin

011 PLENARY LECTURE PL-19-1400

The delta efficiency: a key concept for understanding deltaic sedimentation in the stratigraphic record

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Deltas have traditionally been regarded as coastal geomorphic elements formed where rivers enter standing bodies of water. This view, largely inherited from modern littoral settings, has strongly influenced the interpretation of ancient deltaic successions and the construction of sequence-stratigraphic models. However, most clastic sediment supplied from continents to marine and lacustrine basins is ultimately river-related, and a significant proportion of this sediment may bypass the shoreline and be transferred far basinward. Therefore, the delta should not be understood only as a shoreline protuberance, but as a depositional system generated by the direct discharge of fluvial flows into a standing body of water, including both littoral and subaqueous components.

This contribution introduces the concept of delta efficiency, defined as the capacity of a land-generated flow to transport and accumulate sediment progressively farther basinward. Delta efficiency depends on the magnitude, duration, sediment concentration, and rheology of fluvial discharges, as well as on the density structure of the receiving basin. In this framework, classical marine littoral deltas represent relatively inefficient systems, where hypopycnal river plumes mainly feed coastal and shallow prodelta environments. By contrast, hyperpycnal littoral deltas represent moderately efficient systems, in which sustained, sediment-laden river floods generate low-gradient prograding ramps that may extend tens to hundreds of kilometres into the basin. The highest efficiency is reached in hyperpycnal subaqueous deltas, where dense river-derived gravity flows bypass the littoral zone and directly feed channels, lobes, and basin-floor fans.

The concept of delta efficiency provides a process-based alternative to conventional classifications that emphasize delta-front morphology, shoreline geometry, or the relative influence of waves, tides, and rivers. Although such classifications are useful for describing modern coastal deltas, they tend to underestimate the stratigraphic relevance of the subaqueous delta, which is commonly the most extensive and volumetrically important part of the system. In ancient successions, this bias may lead to the misinterpretation of basinward sandstone bodies as purely marine, shelfal, or deep-water deposits unrelated to river input, when they may instead represent different efficiency levels of the same deltaic system.

Recognizing variations in delta efficiency has important implications for stratigraphy, sediment routing, and reservoir prediction. Poorly efficient stages are expected to generate relatively restricted littoral delta deposits, commonly expressed as coarsening-upward successions with prodelta, delta-front, and delta-plain elements. Moderately efficient stages can construct extensive hyperpycnal littoral ramps, producing shallow-marine or lacustrine sandstone-prone parasequences with abundant plant debris, wave or tide reworking, and evidence of sustained fluvial supply. Highly efficient stages may transfer sediment directly to inner-basin areas, forming extrabasinal turbidites, subaqueous channels, lobes, and basin-floor fan complexes. Thus, deltaic deposition operates across a continuum from coastal accumulation to deep-water sediment delivery.

This perspective also challenges the exclusive use of eustasy-driven models to explain deltaic and basin-floor sedimentation. Changes in delta efficiency can produce major shifts in depositional scale and sediment distribution without requiring external sea-level change as the primary control. Flood magnitude, discharge duration, sediment concentration, basin-water density, and climate-driven hydrological variability may all regulate whether sediment is trapped near the shoreline or exported to the basin centre. Consequently, delta efficiency offers a unifying concept for interpreting littoral, shelfal, lacustrine, and deep-water deposits as genetically linked components of fluvially supplied depositional systems.

By integrating density-driven flow behaviour, sediment concentration, and basin physiography, the concept of delta efficiency helps to reframe deltaic sedimentation in the stratigraphic record. It emphasizes that deltas are not merely coastal landforms, but large-scale sediment-routing systems capable of connecting continental source areas with distal basin-floor environments. This approach is particularly relevant for the interpretation of ancient marine and lacustrine successions, where the subaqueous expression of deltas may preserve the most complete record of sediment supply, climate forcing, and basin evolution.

KEYWORDS Delta systems; Delta efficiency; Hyperpycnal flows

Rudolf Zuber commemorative session

012 COMMEMORATIVE SESSION ZUBER-02

Professor Rudolf Zuber (1858–1920) – pioneer of petroleum geology in the Carpathians and in the Andes

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Rudolf Zuber (Fig. 1A) was born in 1858, and spent most of his life in Lwów (present-day Lviv in Ukraine). He obtained his PhD from the local university and spent one year in Vienna working at the Imperial Royal Geological Survey. In 1883–1884 Zuber worked at the Jagiellonian University in Kraków where he commenced systematic studies of the Carpathians, contributed to several sheets of the Geological Atlas of Galicia and investigated oil occurrences.

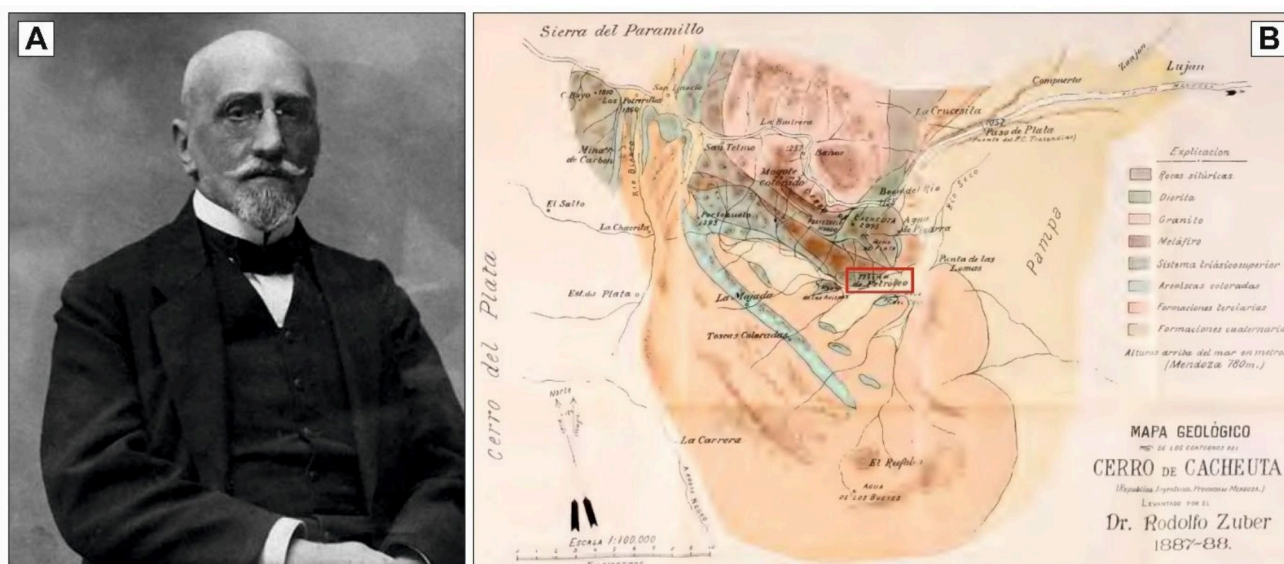


Fig. 1. A: Prof. Rudolf Zuber (1858–1920) (from Miecznik, 2021); **B:** geological map of Cerro de Cacheuta, W-SW from Mendoza, Argentina (Zuber, 1888). Red rectangle: oil mine (Mina de Petróleo), whose location was based on the results of Zuber's geological survey.

In 1886 Rudolf Zuber was employed by *Compañía Mendocina de Petróleo* to study the geology in the vicinity of Mendoza. He prepared a geological map that was used to locate the very first oil mine in Argentina (Zuber, 1888; Fig. 1B). He also worked near San Rafael and in Salta (NW Argentina). According to Prof. Víctor Ramos, Rudolf Zuber “was undoubtedly the most prominent petroleum geologist who worked in our country before the discovery of oil in Comodoro Rivadavia in 1907” (Ramos, 2025).

In 1901 Zuber was appointed full professor at the university in Lwów, and served as Dean of the Faculty of Philosophy and as a Senate member. Between 1900 and 1913 he continued his consultancy appointments in the Caucasus, Romania, Spain, Mexico, Canada, the United States, Trinidad and Venezuela, in the British colonies in Africa, as well as in India and Indonesia. Zuber was a member of the Polish Academy of Arts and Sciences, the National Academy of Sciences in Argentina, and of geological societies in Germany, France, Austria, and Hungary. Following the First World War, he served as a petroleum geology expert for the Polish delegation to the Peace

Conference in Paris. His magnum opus is the book “Flisz i nafta” [“Flysch and Petroleum”] (1918), in which he presented his pioneering ideas on the formation of source and reservoir rocks, various types of hydrocarbon traps, and also on paleogeographic reconstructions of sedimentary basins.

Rudolf Zuber died in 1920 as one of the many victims of the Spanish influenza pandemic, and is buried in his native Lwów.

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013 COMMEMORATIVE SESSION ZUBER-03

Rudolf Zuber, the Petroleum Pioneer of Argentina

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Dr. Rodolfo (Rudolff) Zuber (1858–1920) arrived in Mendoza from Europe in 1886 and worked in Argentina for six years. He carried out the first geological studies of the oil seeps at Cacheuta, Mendoza, accompanied in the early stages by Brackebusch. He discovered the first Triassic floras, including the classic *Zuberia zuberi*, as it is known today, which allowed him to assign the oil-bearing formation to the Rhaetian, and he produced the first detailed geological map of the area. He successfully led the exploration campaign for the Compañía Mendocina de Petróleo, founded in 1886, during which he drilled some 30 wells and produced about 8,000 cubic meters of oil. This success prompted the Compañía Mendocina to send him to explore from the Sub-Andean Ranges of Jujuy and San Rafael in southern Mendoza to the Brunswick Peninsula at Seno Skyring in the Strait of Magellan. His work in our country did not go unnoticed, and he was appointed Member of the National Academy of Sciences of Córdoba in 1890.

T1

Palaeogeography and major evolutionary events of life

T1-1 Palaeobiogeography and major biotic transitions · 10 abstracts · p. 35

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T1-1 Palaeobiogeography and major biotic transitions

014 POSTER P1-01

Typical Cambrian Storm Deposits: Sedimentary Characteristics, Depositional Sequences, and Depositional Model

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Cambrian strata exposed in the Dabaiwang area of Xuzhou, Jiangsu Province, preserve diverse storm-generated deposits with distinctive lithological and sedimentary characteristics. Based on detailed field measurements of outcrop sections and petrographic observations of thin sections, this study identifies the principal features of the storm deposits, reconstructs their sedimentary sequences, and establishes a regional depositional model. The storm-related successions are mainly composed of thick-bedded dolomitic limestone, oolitic limestone, and calcirudite. Among them, the calcirudite commonly exhibits bamboo-leaf-shaped intraclasts and occurs in several characteristic distribution patterns. Scour surfaces, hummocky cross-stratification, and other storm-related sedimentary structures are widely developed, indicating repeated reworking and redeposition by high-energy storm processes. Considering the transport distance of the gravel-bearing layers relative to the storm center, together with their depositional settings, six types of storm sedimentary sequences are recognized: allochthonous proximal lagoon-facies storm deposits, allochthonous distal oolitic-shoal-facies storm deposits, autochthonous supratidal-facies storm deposits, allochthonous distal intershoal marine storm deposits, semi-allochthonous tidal-zone-facies storm deposits, and autochthonous tidal-zone-facies storm deposits. On this basis, an integrated Cambrian storm depositional model is proposed for the Dabaiwang area. The results further clarify the spatial distribution and sedimentary differentiation of Cambrian tempestites in the Xuzhou region and provide geological evidence for the reconstruction of regional lithofacies paleogeography.

KEYWORDS Cambrian tempestites; Storm sedimentary sequence; Sedimentary facies; Depositional model; Xuzhou area

015 ORAL O-17-4-1435

Palynological flora of the Upper Cretaceous Yaojia and Nenjiang formations in the northern Songliao Basin

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Palynomorphs from the Yaojia and Nenjiang formations in well HLD1 in the northern subsidence area of the Songliao Basin were analyzed. In total, 86 species of fossil spores and pollen belonging to 69 genera were identified, and three sub-assemblages were recognized according to variations in the content of characteristic taxa: *Cyathidites*-*Classopollis*-*Beaupreaidites*; *Osmundacidites*-*Alisporites*-*Callistopollenites*; and *Cyathidites*-*Alisporites*-*Aquilapollenites*. Quantitative paleoclimate analysis based on the Eco-Plant model and SEG reveals distinct phase-characterized paleoclimatic evolution in the study area. During the sedimentary period of the Yaojia Formation, the climate exhibited subtropical warm-humid characteristics with pronounced aridity under this macroclimatic framework, corresponding to a lacustrine contraction phase. During the highstand phase of the Nenjiang Formation lake transgression, rising lake levels occurred concurrently with a pronounced climatic regime shift. This dynamic coupling process between semi-humid to humid climate fluctuations and regional cooling events may reveal the critical transition mechanism of the Late Cretaceous greenhouse climate system: the positive feedback loop formed by lake expansion and climate cooling, as well as the response dynamics of Mesozoic greenhouse climate evolution and paleovegetational development driven by Oceanic Anoxic Event 3 (OAE3).

KEYWORDS Northern Songliao Basin; Late Cretaceous; Yaojia Formation; Nenjiang Formation; Palynological flora

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016 ORAL O-17-4-1450

New discovery of fossil woods from the Early Cretaceous Laiyang Group in the Jiaolai Basin, Shandong Province, and their paleoclimatic implications

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Plants constitute a fundamental component of terrestrial ecosystems. As a major category of plant fossils, fossil wood plays a crucial role in reconstructing floral composition, elucidating plant evolutionary history, and investigating continental paleoenvironments and paleoclimates across geological periods. The Mesozoic represents a critical interval for the diversification and radiation of fossil wood in China. Fossil woods from the Early Cretaceous exhibit remarkable diversity across both the northern and southern phytoprovinces. In the Jiaolai Basin, the Laiyang Group is fossil-rich, preserving plants, palynomorphs, conchostracans, insects, fish, bivalves, gastropods, ostracods, as well as dinosaurs and their footprints. This basin marks the southernmost margin of the northern

Jehol biota and constitutes a significant convergence zone between the northern and southern floras. Recent studies on fossil wood from the North China Block have advanced our understanding of Cretaceous plant community evolution. However, compared to other regions, knowledge of the floristic composition in transitional areas such as the Jiaolai Basin remains very limited. In this study, we report for the first time several fossil wood taxa from the Early Cretaceous Laiyang Group in the Jiaolai Basin, Shandong Province, including *Keteleerioxylon*, *Xenoxylon*, *Pinuxylon*, and *Sahnioxylon*. Examination of these specimens enhances our understanding of the floral landscape in the transitional zone between the northern and southern floras. A multi-proxy approach was employed to analyze the fossil wood, incorporating growth-ring width index, mean sensitivity, latewood percentage, percentage diminution, ring markedness index, and the CSDM curve, all established proxies for reconstructing temperature, moisture, and growth conditions. Based on these analytical results, the paleoclimatic characteristics of the Jiaolai Basin during the Early Cretaceous are discussed.

KEYWORDS Early Cretaceous; fossil wood; growth rings; paleoenvironments

017 POSTER P2-01

Mechanics: The Theoretical Foundation for Quantitative Reconstruction in Paleontology

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Traditional paleontology, constrained by qualitative descriptions and modern analogies, often struggles with preservation bias and missing data. This study highlights mechanics as a rigorous framework for quantitative reconstruction. Through specific case studies, we demonstrate that integrating mechanical principles shifts the research paradigm from observational inference to precise analysis. Inverse mechanics resolves deformation during fossilization, distinguishing artifacts from original structures. Dynamic modeling corrects functional misinterpretations, offering new insights into locomotion and feeding strategies. Furthermore, the application of physical field theory allows sensory and communication systems to be reconstructed, decoding morphological adaptations to acoustics and electromagnetics. Ultimately, this interdisciplinary approach bridges physical laws and biological history. By deriving function from form, mechanics acts as the engineering cornerstone, elevating the discipline from descriptive natural history to a predictive science.

018 ORAL O-17-4-1505

Diachronic paleobiogeography of Gondwana fragmentation: how did plate tectonics structure current biodiversity?

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The current distribution of species results from ancient interactions between the history of Life and that of the Earth. In biogeography, the breakup of Gondwana is one of the major events associated with the emergence of endemism and the diversification of modern flora and fauna. While the relationships between current biogeographical provinces have been widely studied, the contribution of fossil organisms to this history remains limited. In particular, areas of endemism have rarely been formalized by explicitly integrating the temporal dimension inherent in paleontological data. This study aims to integrate the temporal dimension by developing a diachronic approach to the biogeographical analysis of vicariance, in order to study the paleobiogeographical structuring of terrestrial fauna and flora associated with the fragmentation of Gondwana. Fossil records of Gondwanan terrestrial taxa, from the Triassic to the Neogene, were extracted from the Paleobiology Database (PBDB), then aggregated, standardized, and cleaned. Using these occurrence data and associated ranges, several methods of endemism research (e.g., BioGeoBEARS, PAE, PRABCLUS) were applied to delineate paleobiogeographical areas. This approach made it possible to identify paleobiogeographic provinces and to specify their temporal extension. These initial results demonstrate the value of a temporal formalization of endemism areas for the study of fossil biota. They provide a foundation for future analyses of cladistic biogeography, crucial to further test the historical relationships between Gondwanan paleobiogeographical provinces and to better understand the mechanisms of their diversification.

KEYWORDS Paleobiogeography; Gondwana; Paleobiology Database (PBDB)

019 ORAL O-19-2-1105

The role of palaeogeography in hydrocarbon exploration

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Palaeogeoscience disciplines such as paleogeography and paleontology play a pivotal role in sub-surface imaging of the lithosphere for hydrocarbon exploration, together with basin analysis, biostratigraphy, sequence stratigraphy, cyclostratigraphy and biosteering of drilling targets. Paleochannels are highly prospective for hydrocarbons, and seismic-facies and geobody analysis supports channel detection in carbonate and deep-water exploration. Basin paleogeographic maps are useful prospecting tools in hydrocarbon exploration. They provide guidelines for locating and predicting the occurrence of reservoir, seal or source lithofacies by establishing the location of major geographic features such as deltas, shorelines, barrier reefs and slope breaks. Once an isochronous surface or coeval interval is identified, paleogeography can be reconstructed by integrating maps of age-equivalent lithofacies, seismic facies, biofacies, and thickness of reservoir-quality rocks. A paleogeography map of a reservoir interval, reservoir thickness, and fields (producing from the same reservoir interval) shows relationships between production and geology that may be used to locate prospects in unexplored frontier basin areas. Paleogeographic maps are the

end product of the sequence stratigraphic analysis. Favorable sites for deposition of reservoir, seal, and source rocks can be ascertained from paleogeographic maps. The workflow is to: (1) identify the stratigraphic interval of a single depositional phase with potential to contain reservoir rocks (i.e., lowstand or highstand), using biostratigraphic markers and regional correlation surfaces; (2) map depositional facies such as biofacies, net reservoir thickness (lithology or porosity) and seismic facies (i.e., clinoforms, parallel reflections and chaotic reflections within a single depositional phase); (3) integrate the interpreted seismic facies and biostratigraphic data into a grid of stratigraphic well-log cross sections; (4) map the location of fields producing from reservoirs in the interval of interest with respect to net reservoir thickness and define the trap types; and (5) using the seismic interpretations and the geology of the mapped fields, interpret the deposition of reservoir, seal and source facies and the formation of stratigraphic or combination traps with respect to the sea-level cycle phase. Palaeogeography yields information that is crucial to scientific understanding in a variety of contexts. For example, palaeogeographical analysis of sedimentary basins plays a key role in the field of petroleum geology, because ancient geomorphological environments of the Earth's surface are preserved in the stratigraphic record. Palaeogeographers also study the sedimentary environment associated with fossils for clues to the evolutionary development of extinct species. Deep-time Digital Earth paleomaps provide paleogeographic maps of the ancient world. The maps show the varied landscapes of the ancient Earth through hundreds of millions of years of geologic time including distribution of ancient shallow seas, deep ocean basins, mountain ranges, coastal plains, and continental interiors. Tectonic features shown include subduction zones, island arcs, mid-ocean ridges and accreting terranes.

KEYWORDS Palaeogeography; hydrocarbon exploration; paleochannel

020 ORAL O-17-4-1520

High-energy stromatolite-associated sediments from the Middle Triassic (Guizhou, China)

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The Permian-Triassic mass extinction was followed by a prolonged period of ecological recovery that lasted until the Middle Triassic. The stromatolite-associated sediments from the Pazichang area of Guanling (Guizhou, China) seem to be important components of the puzzle and have not been extensively studied to date. This study used five petrological methods: optical microscopy (OM), cathodoluminescence (CL), μ -XRF, SEM and EDS. The results show that significant microbial-skeletal mixed carbonates were formed in the high-energy environment at the edge of shallow marine carbonate platforms during the Middle Triassic (Anisian). In situ coral skeletons are implanted in biofilm channels formed by *Tubiphytes* and microbial activity, typically enveloped by *Tubiphytes* and calcareous microorganisms. The mutually beneficial relationship between microorganisms and *Tubiphytes* allows these organisms to fill the ecological niche cleared after the Permian-Triassic crisis, meaning that these microbial metazoan communities remained dominant until the Middle Triassic. In the microbial-skeletal mixed carbonates, stromatolites are products of biological encrustation dominated by Solenoporaceans and cyanobacterial communities of the genera *Cayeuxia*, *Zonotrichites*, *Renalcis*, and *Bevocastria*. Among these, *Cayeuxia* can be compared to modern *Rivularia*, which has broad environmental adaptability and survived under high-energy conditions in the study area. The development of this complex may reflect significant changes in the ancient environment, possibly due to the interaction between high seawater Mg^{2+}/Ca^{2+} molar ratios and cyanobacterial mat evolution within the mixed carbonates.

Ladinian stromatolites contain few fossils, with dark laminae developing a window-pane-like structure parallel to the laminae. Apart from the effects of microscopically unidentifiable microbial functional groups, identifiable iron-rich growth layers indicate the presence of sulfate-reducing bacteria, which induced microbial formation in the laminae and contributed to stromatolite development. Thus, Middle Triassic stromatolites differ from post-extinction opportunistic and “anachronistic facies”; they do not necessarily indicate anoxic or oxygenated conditions. Their environmental setting is much more complex than previously thought.

KEYWORDS Cyanobacterial communities; sulfate-reducing bacteria; Stromatolites; Middle Triassic; Ecological recovery

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021 ORAL O-17-4-1535

The historic distribution of Betulaceae provides key insights into the dynamics of Northern Hemisphere temperate forests

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Understanding how Cenozoic climatic fluctuations shaped modern biomes is a central quest in biogeography. Many dominant Northern Hemisphere woody lineages exhibit a profound spatial mismatch between their modern diversity centers and deep-time fossil distributions. Reconstructing ancestral ranges solely from extant taxa frequently introduces an “extant-bias,” which systematically misinterprets modern refugia as centers of origin. The birch family (Betulaceae), which peaks in diversity in East Asia but possesses an exceptionally rich Paleogene fossil record in North America, offers an ideal system to address this paradox and challenge the traditional “out-of-Asia” radiation scenario. To evaluate these historical dynamics, we present a “total-evidence” analysis. By integrating chloroplast sequences of 71 extant species with a morphological matrix of 182 fossil and living taxa (encompassing 266 occurrences across 5 living and 7 extinct genera), we generated a calibrated phylogenetic tree under a fossilized birth–death (FBD) process. Utilizing these time-trees, we implemented a mechanistic, process-based eco-evolutionary engine (Gen3sis) driven by deep-time paleoclimate simulations to model the spatiotemporal distribution and climatic niche dynamics of Betulaceae across the Cenozoic. Specifically, this study investigates: (i) whether explicitly accounting for Paleogene extinctions conflicts with the traditionally inferred Asian origin; (ii) how the dynamic opening and closing of the Beringia and North Atlantic Land Bridges governed inter-continental migration; and (iii) how their conserved deciduous traits interacted with shifting climates to drive the modern asymmetry of temperate forests.

KEYWORDS Temperate forests; Betulaceae; Boreotropical origin; dispersal; climatic niche evolution

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022 ORAL O-17-4-1400

Mechanics as a Determinant in Natural Selection: A Hypothesis Based on Computational Fluid Dynamics Cases

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This study proposes the hypothesis that mechanics functions as a decisive determinant in the process of biological evolution and natural selection. This hypothesis is derived from a comparative analysis of two distinct Computational Fluid Dynamics (CFD) case studies. First, we reconstructed the CFD model of the Cambrian *Vetulicola* to analyze the driving forces required for posterior body oscillation. By integrating morphological features, we quantitatively interpreted the feeding behaviors across different genera, revealing how form was adapted to fluid dynamic constraints. Second, a parallel CFD simulation of the extant hornbill was conducted to examine the mechanical logic underlying its ecological adaptations. The consistency of results across these vastly different taxa demonstrates that mechanics acts as an objective, universal law governing biological form and function. Consequently, this study argues that the introduction of mechanics provides the necessary physical evidence for evolutionary biology, proving that mechanical optimization is one of the fundamental drivers of natural selection.

023 ORAL O-17-4-1635

The Tibetan Plateau acted as a floristic crossroads in the Paleogene

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Plant fossils play an important role in understanding landscape evolution across the Tibetan region; paleobotanical investigations within Tibet have led to a paradigm shift in our understanding of how the present plateau formed and how this affected the regional climate and biota. This is because: 1) Numerous new taxa have been reported. Of all the new Cenozoic plant fossil species reported from Tibet (Xizang), many represent the earliest records from Asia, or in some cases worldwide, at the genus or family level. 2) These fossils show that during the Paleogene, the region now occupied by the Tibetan Plateau was a globally significant floristic exchange hub. Paleobiogeographic studies grounded in fossil evidence identify four models of regional floristic migration and exchange, i.e., into Tibet, out of Tibet, out of India and into/out of Africa. 3) Plant fossils provide evidence of asynchronous formation histories for different parts of the Tibetan Plateau. During most of the Paleogene, there was a wide east-west trending valley with a subtropical climate in central Tibet bounded by high (>4 km) mountain systems, but by the early Oligocene the modern high plateau had begun to form through the rise of the valley floor. Paleoelevation reconstructions show that by the earliest Oligocene southeastern Tibet (including the Hengduan Mountains) had reached its present elevation. 4) The coevolution between vegetation, landform and paleoenvironment is evidenced by fossil records from what is now the central Tibetan Plateau. From the Paleocene to

Pliocene, vegetation changed from tropical to subtropical forests, through warm to cool temperate woodland, and eventually to deciduous shrubland, in response to landscape evolution from a seasonally humid lowland valley to a high, dry plateau.

KEYWORDS Tibetan Plateau; Cenozoic; Floristic exchange; Biodiversity

T1-2 Fossil data and their application to palaeoenvironments and palaeogeography

024 POSTER P2-03

Progressive deepening of the Drake Passage during the Eocene: palaeoceanographic insights from high-latitude dinoflagellate cyst assemblages

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The progressive opening and deepening of the Drake Passage (DP) during the Eocene constitute a key palaeogeographic event with profound implications for Southern Ocean circulation and global climate evolution. The precise timing and environmental consequences of this gateway remain poorly constrained, owing to the scarcity of quantitative proxy data from localities flanking the passage and the long-standing lack of reliable chronostratigraphic correlations between units on either side of it. Here we present an integrated quantitative analysis of middle to late Eocene dinoflagellate cyst (dinocyst) assemblages from 51 palynological samples recovered from five localities: the Man Aike, Río Turbio (Upper Member), and Leticia formations in the Austral-Magallanes Basin (southern Patagonia and Tierra del Fuego, Argentina), and the La Meseta and Submeseta formations on Marambio (Seymour) Island, north-eastern Antarctic Peninsula.

Integrating recently published radiometric U-Pb detrital zircon ages and recalculated strontium isotope data, we revised the chronostratigraphic framework of the regional dinocyst zonation (zones RTF 1-4), enabling correlation across both sides of the DP from the latest Lutetian to the middle Priabonian (ca. 41.3-35 Ma). Assemblages were classified into six ecologically defined groups — Antarctic gonyaulacacean (AG), Antarctic *Deflandrea* (AD), Antarctic *Vozzhennikovia-Spinidinium* (AV-S), cosmopolitan gonyaulacacean (CG), cosmopolitan protoperidiniacean/peridiniacean (CP), and *Turbiosphaera archangelskyi* complex (Tcpx) — and subjected to two complementary compositional data analyses: hierarchical clustering (Ward's method, clr-transformed data) and Principal Component Analysis (PCA). Both approaches consistently resolve two major assemblage groups, reinforcing the robustness of the results.

Between ca. 41.3 and 38.1 Ma (latest Lutetian-Bartonian), assemblages dominated by *Enneadocysta dictyostila*, *Arachnodinium antarcticum*, and *Deflandrea antarctica* characterize inner- to mid-shelf settings with relatively warm surface waters. This distribution agrees with palaeoclimatic model simulations for a shallow DP (~100 m depth), supporting the existence of a Proto-Malvinas Current transporting Pacific cosmopolitan taxa into the Austral-Magallanes Basin. Their consistent occurrence across the Man Aike, Río Turbio, Leticia, La Meseta, and Chilean Leña Dura formations confirms the biostratigraphic utility of *Enneadocysta* spp. as regional markers.

Between ca. 36 and 35 Ma (middle Priabonian), a marked faunal turnover occurs: Antarctic gonyaulacacean taxa decline sharply, with the last occurrence of *Enneadocysta dictyostila* coinciding with the first occurrence of the *Turbiosphaera archangelskyi* complex — a significant bioevent for the DP region. These taxa are replaced by *Vozzhennikovia apertura*, *V. rotunda* and *Spinidinium macmurdoense* (AV-S), indicative of cool, nutrient-rich coastal waters, alongside an increase in cos-

mopolitan species. This pattern, also documented in the Submeseta Formation, the Chilean Loreto Formation and at sites DSDP 511 and ODP 696, is compatible with model simulations for a DP at ~1000 m depth, pointing to cooling of South Atlantic surface waters driven by intensified trans-passage flow from the Pacific Ocean.

These results highlight the complementary roles of declining atmospheric CO₂ and the progressive palaeogeographic deepening of the Drake Passage in driving Eocene cooling, and demonstrate that dinocyst assemblages constitute powerful, correlatable proxies for reconstructing palaeoenvironments and surface ocean circulation in Southern Ocean gateway regions.

KEYWORDS Eocene; Drake Passage; palaeoceanography; dinoflagellate cysts; Southern Ocean

025 POSTER P2-04

Contrasting biotas, contrasting sub-basins: taphonomic compartmentalization as a palaeogeographic proxy in the El Gigante Group (Lower Cretaceous, San Luis, Argentina)

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Continental rift systems associated with the breakup of Gondwana and the opening of the South Atlantic developed as mosaics of structurally distinct basins. The Cretaceous rift system of the western Sierras Pampeanas, in the San Luis Basin of west-central Argentina, records this heterogeneity through two exceptionally preserved lacustrine *Konservat-Lagerstätten*: the La Cantera Formation (Late Aptian), exposed in the Sierras de El Gigante, and the Lagarcito Formation (Early Albian), exposed in the Sierra de las Quijadas. Both formations belong to the El Gigante Group and developed under arid to semiarid conditions. Their contrasting depositional architectures, fossil assemblages, and taphonomic characteristics provide a basis for evaluating palaeogeographic differentiation among sub-basins within the regional rift system. The La Cantera Formation records an early-synrift lacustrine system developed within a half-graben and influenced by tectonic subsidence and climatic fluctuations. Stratigraphic correlations reveal successive tectonosequences and shallowing cycles recording repeated lake expansion and contraction. Depositional environments ranged from offshore lacustrine and distal prodelta to proximal prodelta, delta-front, and fluvial-feeder systems, with evaporitic offshore and mudflat facies also developed. This dynamic depositional architecture is associated with a diverse biota including aquatic and terrestrial insects, ostracods, conchostracans, gastropods, actinopterygian fishes (chondrosteans and teleosteomorphs), invertebrate trace fossils, and a rich palynological and plant assemblage. The Lagarcito Formation developed a later-synrift lacustrine system characterized by recurrent fluvio-lacustrine, fluvio-eolian, and mudflat depositional cycles. Depositional environments ranged from unconfined fluvial systems and lacustrine settings to eolian dunes and mudflats, with lacustrine offshore and littoral zones and associated underflow and turbidite deposits also developed. Its vertebrate-dominated assemblage includes the monospecific *Pterodaustro guinazui* bonebed at Loma del Pterodaustro, preserving hundreds of specimens representing different ontogenetic stages, including embryos within eggs and associated gastroliths, together with semionotids and rare pleuropholid fishes. Ostracods, conchostracans, invertebrate trace fossils, and theropod trackways further document the lake-margin ecosystem. Both formations record lacustrine systems that differ in their depositional dynamics, hydrological conditions, and subenvironmental architectures. Microbially induced sedimentary structures occur in both formations and represent a recurrent component of their depositional and taphonomic systems, although their distribution and documentation differ between the units. These

differences in depositional configuration and taphonomic expression support taphonomic compartmentalization within the El Gigante Group and highlight spatial heterogeneity among lacustrine sub-basins during the synrift evolution.

KEYWORDS Taphonomic compartmentalization; rift palaeogeography; Konservat-Lagerstätten; Gondwana breakup; San Luis Basin; Early Cretaceous

026 ORAL O-17-4-1650

New palaeoenvironmental evidence for the Late Mesozoic biota

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During the Late Mesozoic, a series of major global geological events took place, e.g., subduction of the Pacific Plate beneath the Eurasian continent, destruction of the North China Craton, and the extinction of dinosaurs at the end of the Cretaceous. The northern region of North China represents a key area for investigating major scientific topics such as the destruction of the North China Craton (NCC) during the Late Mesozoic, the Yanshan tectonic movement, and the evolutionary succession of biota. Given its unique geological characteristics and a long history of research, this region is poised to serve as a crucial window for advancing the understanding of the Late Mesozoic geological evolution not only in North China but also across Northeast Asia. The Yanliao Biota and Jehol Biota provide unique windows into the poorly known terrestrial ecosystems of the Middle-Late Jurassic to Early Cretaceous transitional period and add much to our understanding of the origin and early evolution of Mesozoic life, such as well-preserved feathered non-avian dinosaurs, pterosaurs, primitive mammals, and insects. The destruction of the NCC during the Late Mesozoic represents one of the most profound intracontinental tectonic events on Earth, with hypothesized but poorly quantified impacts on regional climate and terrestrial ecosystems. The occurrences of the Yanliao and Jehol biotas, evolving during the Middle-Late Jurassic and Early Cretaceous, respectively, coincide temporally with the initial and peak stages of the NCC destruction. The Yanshanian orogeny is a Late Mesozoic global tectonic event and is assumed to be the direct cause of the turnover between the Yanliao Biota and Jehol Biota. The flourishing and disappearance of the biotas appear closely related to volcanic intensity and rift basin development in space and time, implying a profound influence of deep dynamic processes on surface palaeogeography and ecosystems. We employ a multi-proxy approach on fossil wood, including growth-ring width indices, mean sensitivity, percentage of latewood, percentage diminution, ring markedness index, CSDM curves (the cumulative algebraic sum of each cell's deviation from the mean radial cell diameter, plotted as a curve) and intra-ring tracheid variability, which are established proxies for temperature, moisture, and growth conditions. Here, we leverage an unprecedented dataset of fossil wood growth rings from five consecutive formations (Tiaojishan to Shahai formations) in western Liaoning to quantitatively test the hypothesis that the destruction of the NCC directly forced a shift in vegeta-

tion by driving significant surface uplift and attendant climate change. Our data reveal a synchronous and dramatic shift in both temperature seasonality (from Mean Sensitivity) and regional moisture stress (from ring width) across the Yanliao/Jehol boundary.

KEYWORDS North China Craton; Yanliao Biota; Jehol Biota; fossil wood; growth rings

FUNDING National Natural Science Foundation of China (U2544204) and the China Geological Survey Project (Grant No. DD2026011038)

027 POSTER P2-05

Palynofacies analysis of the Lower Cretaceous Pokur Formation on the eastern edge of the West Siberian Basin, Russia: paleoenvironmental and climatic implications

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This contribution presents a detailed palynofacies analysis of the Pokur Formation on the eastern side of the West Siberian Basin, Russia. Samples from two boreholes (YK143 and YK144) in the Yuzhno Khadyryakhinsky oil field were studied. This work has two main goals: i) to understand the palaeoenvironmental evolution of the deposits yielding the recovered palynological assemblages, and ii) to elucidate the prevailing climatic conditions during their accumulation. Thirty-one core samples were processed using standard palynological extraction techniques and were examined under transmitted-light and UV fluorescence microscopy. At least 500 organic particles per sample were counted in order to perform a palynofacies analysis. Based on this count, the palynological matter was classified into four main groups: palynomorphs, phytoclasts, fungal remains, and amorphous organic matter (AOM). Cluster analysis was applied to define palynofacies types (PT), i.e., a group of samples with similar characteristics that differ from other groups. Each group is the result of the accumulation of these organic particles in a specific depositional setting. Six distinct palynofacies types were identified in each borehole. Except for samples 1184.65/1183.65 from well YK144, in which AOM is the most abundant category, the phytoclasts are the most abundant components in all the recovered assemblages. The palynomorph group is dominated by sporomorphs (i.e. spores and pollen grains) in most of the identified palynofacies in both localities. Among this subgroup, the spores of bryophytes and ferns, and, in minor proportions, lycopsids show the highest percentages. In the YK143 borehole the aquatic palynomorphs are mainly represented by freshwater algae, with subordinate marine components (e.g. acritarchs, proximal apical gonyaulacoid cysts; "PAGC") only identified in the 1871.70–1888.60 m samples. Conversely, the YK144 borehole exhibits two opposite situations with regard to the aquatic components. The section between 1186.80 and 1921.40 m presents only very scarce marine palynomorphs (from 1186.80 to 1847.50 m), whereas the interval from 1181.55 to 1184.65 m is dominated by dinoflagellate cysts. In both boreholes, the assemblages composed of continental material suggest the development of fluvio-lacustrine settings, surrounded by a rich and diverse flora, developed under temperate, relatively humid conditions, within a strongly seasonal climate (i.e. an alternation of dry and very rainy seasons). The high percentages of fresh phytoclasts indicate a high input of terrestrial material to the basin, as well as the rapid burial of such particles, possibly related to a high sedimentation rate. The sections with a low proportion of marine components, e.g. PAGC, may indicate brackish, littoral

to marginal-marine depositional environments. Conversely, samples with a high percentage of marine dinocysts would suggest an outer neritic environment with good to moderate bottom-water ventilation.

KEYWORDS Palynofacies analysis; Lower Cretaceous; West Siberian Basin; Russia

028 POSTER P2-06

New insights into the palaeobiogeographic affinities of robust baltograptid graptolites (Ordovician, Floian) from South America and China

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The robust baltograptids from South America were previously assigned to various species included within the *Baltograptus turgidus* group due to their morphological similarities to this species group, originally defined from Chinese material. The presence of comparable taxa in Lower Ordovician (Floian) deposits of Argentina, Bolivia and Peru also led to the establishment of biostratigraphic correlations and the proposal of palaeobiogeographic affinities with the Yangtze Platform of the South China Palaeoplate. However, recent revisions of semi-relief specimens from different sections in NW Argentina (Santa Victoria and Piscuno areas), deposited at CICTERRA-CONICET-UNC, and from several localities in South China (Daliesshan, Ercun and Wuding sections), deposited at the Nanjing Institute of Geology and Palaeontology, have revealed clear differences in proximal development between the studied collections. As a result, we prefer to retain the material from South China—characterized by its *artus*-type proximal development—within the *Baltograptus turgidus* group, whereas we include specimens from the Central Andean Basin of South America—which exhibit an *isograptid*-type proximal development—in the *Baltograptus bolivianus* group. The *Baltograptus turgidus* group has not been recognized in South American successions, while the *Baltograptus bolivianus* group appears to be restricted to South America. This new information allows a better interpretation of the palaeobiogeographic affinities between these groups. It highlights the marked endemic character of each group and enhances our understanding of the affinities of the *Baltograptus bolivianus* group species with those from the cold-water graptolite realm.

KEYWORDS Ordovician; Graptolites; Palaeobiogeography; Central Andean Basin; South China

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Tectonic and environmental drivers of Early Cretaceous ostracod diversity along the northern margin of the North China Craton

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The North China Craton (NCC) underwent significant lithospheric modification during the Late Mesozoic, characterized by widespread magmatism, rifting, and lithospheric thinning. This large-scale craton destruction was accompanied by major reorganization of terrestrial ecosystems. The Early Cretaceous Jehol Biota provides key evidence for these changes, but its Konservat-Lagerstätten nature limits continuous assessment of long-term biodiversity patterns. In contrast, ostracods, as abundant and widely distributed microfossils in continental aquatic strata, offer a more continuous record of biodiversity dynamics. Based on fossil assemblages along the northern margin of the NCC, Early Cretaceous ostracod evolution can be divided into three stages. Stage I (Dabeigou fauna) is characterized by low diversity and the absence of *Cypridea*. Stage II (Jehol fauna) records a sharp increase in diversity, driven by the radiation of *Cypridea* and related taxa. Stage III (Fuxin-Sunjiawan fauna) shows a marked decline in diversity and *Cypridea* abundance. Integration of these patterns with basin evolution reveals shifting controls on biodiversity. During the earliest stage, diversity was constrained by limited development of sedimentary basins. At the peak of NCC destruction, widespread rifting and basin proliferation created diverse aquatic habitats, promoting rapid taxonomic differentiation and endemism. In the later stage, despite continued sediment accumulation, diversity declined, likely reflecting increasing aridity under changing climatic conditions. These results demonstrate that ostracod diversity along the northern NCC margin was jointly controlled by tectonic processes and climate change, highlighting the strong coupling between deep Earth dynamics and terrestrial ecosystem evolution during the Early Cretaceous.

KEYWORDS North China Craton; Jehol Biota; Valanginian–Albian; *Cypridea*

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030 ORAL O-17-4-1735

The contingent advantage of photosymbiosis in coral evolution

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The ecological success of modern reef-building corals is rooted in photosymbiosis, yet its macroevolutionary benefit remains unclear. Analyzing the Phanerozoic record of inferred zooxanthellate (Z) and azooxanthellate (AZ) corals over geologic time scales using Bayesian methods, we identify a fundamental shift in diversification dynamics and their drivers across the Paleozoic–Mesozoic transition. Although Z corals dominate modern tropical reef ecosystems, their Paleozoic counterparts

were outpaced by AZ forms and showed failed recoveries after the Late Devonian mass extinction. We found that Z coral diversification was primarily driven by origination, whereas AZ diversification was controlled by extinction. Multivariate birth-death models reveal that Paleozoic coral diversification was governed by abiotic stressors like warming and anoxia, to which Z and AZ corals showed similar vulnerability. The rise of scleractinian corals in the Triassic marked a distinct macroevolutionary regime shift after which photosymbiosis spurred coral diversification. Positive correlations between temperature and Z coral extinction dominated the Paleozoic, while negative correlations prevailed in the Meso-Cenozoic. The long-term reversal of this relationship could reflect the reduced supersaturation of the oceans with respect to CaCO_3 due to the emergence of calcareous plankton in the Triassic. Our deep-time perspective demonstrates that the advantage of photosymbiosis is not intrinsic but contingent on the broader ecological and environmental context.

T1-4 Palaeobiogeography and major evolutionary events of life

031 POSTER P2-07

Habitat and disappearance of the latest hominoid in Eurasia in response to environmental change

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Hominoids occurred widely across Eurasia during the middle to late Miocene but have since declined in both diversity and distribution due to global cooling and drying. *Lufengpithecus* sp. (~6.0 Ma) from the Baoshan Basin in southwestern China is by far the latest Miocene hominoid in Eurasia, and its disappearance thus marked the complete extinction of hominoids on the continent. Here, a fruit and seed fossil assemblage was studied from the Baoshan hominoid-bearing layer to reveal the living environment of the hominoid. Our systematic identification shows that the fossil assemblage is dominated by *Euryale* and *Trapa* as aquatic plants and *Carex* as a grass, and comprises several tropical to subtropical elements such as *Symplocos*, *Vitis* and *Zanthoxylum*, suggesting an evergreen broadleaved forest and an open grassland in the vicinity of a water body. Some plants are edible, mainly *Euryale*, *Trapa*, *Vitis* and *Ehretia*, which could have served as food resources. Our palaeoclimate reconstruction shows that the fossil flora experienced a warm and humid seasonal climate. Favourable vegetation, a suitable climate, abundant water and food resources may jointly explain the survival of the Baoshan hominoid in the basin during the latest Miocene. The fossil flora was compared with a fruit and seed fossil assemblage recovered from the upper layer, which allowed us to interpret why the Baoshan hominoid ultimately disappeared. This upper-horizon fossil flora is significantly dominated by *Salix*, followed by *Sambucus* and *Viburnum*, suggesting a deciduous broadleaved forest. Aquatic plants are rare, represented only by a single specimen of *Potamogeton*, suggesting a limited area of lacustrine environment. Edible plants are also scarce, suggesting that exploitable plant food resources were poor. Our palaeoclimate reconstruction shows that the fossil flora corresponds to a cooler and drier climate than that of the lower-horizon flora. We suggest that vegetation alteration, climate cooling and drying, as well as water and food resource reduction might have driven the Baoshan hominoid to disappear. This finding provides crucial insight into the evolutionary history of hominoids and its relationship to environmental change in Eurasia.

KEYWORDS Baoshan Basin; fossil flora; hominoid; late Miocene; palaeoenvironment

032 POSTER P2-08

Palaeobiogeographic implications of the new Silurian (Aeronian) graptolite records from Brazil and coeval strata on Gondwana

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Early Silurian graptolite provincialism was less pronounced than during the Ordovician. In South America, Llandovery records remain relatively scarce and are predominantly represented by uniserial taxa. The new Silurian record of *Stimulograptus sedgwickii* from grayish shales of the Pitinga Formation, Amazon Basin, Brazil, provides important insights into the palaeobiogeographic connections within southwestern Gondwana. The presence of this index species allows a direct correlation with the globally recognized *Stimulograptus sedgwickii* Biozone (upper Aeronian). This marker has previously been reported from the Lipeón Formation of the Central Andean Basin and the Don Braulio Formation of the Precordillera Basin, both in Argentina. Additional occurrences assigned to *Stimulograptus* aff. *S. sedgwickii* have also been documented from the Vargas Peña Formation in the Paraná Basin, Paraguay. This new record expands the known geographic distribution of Aeronian graptolites in South America and reveals palaeobiogeographic links between the Amazon, Paraná, Central Andean and Precordillera basins, supporting the existence of open marine connections during the Early Silurian. In conclusion, the new Llandovery graptolite fauna from Brazil has significant palaeobiogeographic and chronostratigraphic implications. Besides strengthening biostratigraphic correlations among Lower Silurian basins in South America, it also constrains the age of associated glacial deposits and improves our understanding of graptolite dispersal patterns during the *Stimulograptus sedgwickii* bioevent. This occurrence provides evidence for assigning a Lower Silurian (upper Aeronian) chronostratigraphic position to the graptolite-bearing deposits of the Pitinga Formation, and further supports for considering southwestern Gondwana as a significant palaeobiogeographic region for Early Silurian graptolite evolution.

KEYWORDS Graptolites; Silurian; Palaeogeography; Brazil; Argentina; Paraguay

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033 ORAL O-17-4-1750

The Paleocene Altay flora from Xinjiang, China, and the correlation between environmental evolution and changes in plant biodiversity

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Past geological events deeply impacted modern biodiversity. The major uplift of modern mountain chains, the initiation of bipolar glaciations, the origin of modern ocean currents, the aridification of the continental interiors, the overall cooling trend of the global climate and the reduction in atmo-

spheric CO₂ levels are considered the most critical in the build-up of the modern world. In eastern Asia, the uplift of the Himalayas and the onset and development of the monsoon system changed the local climate, and accordingly the biodiversity. Fossils reveal how geological events impacted modern biodiversity. The Altay Paleocene flora, located in northern Xinjiang, is the only Paleogene flora found in Xinjiang. Plant fossils, including leaves and fruits, are well preserved, with many morphological details visible. Based on preliminary identifications, the Altay flora comprises more than 20 genera, such as *Pterocarya*, *Sequoia*, *Taxodium*, *Exbucklandia*, *Corylus*, *Populus*, *Ficus*, *Cocculus*, *Mussaenda*, *Ranunculus*, *Cercidiphyllum*, and *Ditaxocladus*. The genera *Populus* and *Pterocarya* are temperate elements whereas *Cercidiphyllum*, *Exbucklandia*, and *Mussaenda* are subtropical elements. *Cercidiphyllum* and *Cocculus* are the main components. The composition of the Altay flora is quite different from that of the Jiayin flora, even though the two floras are of the same geological age. In order to reveal the correlation between geological events and modern plant biodiversity, the following scientific questions are addressed: Why are the two floras so different? What is the composition of the Altay flora? Under what kind of paleoclimate did it grow? To answer these questions, four topics will be discussed: the floristics and vegetation of the Altay flora, the biogeography of *Cercidiphyllum* and *Cocculus*, paleoclimate reconstruction, and a comparison between the Altay and Jiayin floras.

KEYWORDS Paleocene; paleobotany; Altay; environment evolution; plant biodiversity

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T2

Lithofacies palaeogeography and sedimentology

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T2-1 Aeolian depositional systems and desert basins

034 ORAL O-17-1-1420

Oldest aeolian deposits (~1700 Ma) of China and their implications for the paleogeographic position of the North China Craton

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The Olongbluk Microblock is currently located on the northern margin of the Qaidam Basin, China, where the Quanji Group, a complete succession of early Mesoproterozoic sedimentary strata, is well developed. The Shiyngliang Formation of the Quanji Group is dominated by sandstones, whose youngest detrital zircon peak age is 1744 ± 5.60 Ma. Combined with zircon U-Pb isotopic ages of two volcanic interbeds from the overlying Hongzaoshan Formation (1640 ± 15 Ma and 1646 ± 20 Ma), the depositional age of the Shiyngliang Formation is constrained to 1750–1640 Ma. Detailed sedimentological investigations reveal the presence of medium-to-large-scale high-angle tabular and wedge-shaped cross-beddings, alongside microscopic diagnostic aeolian sedimentary features including inverse grain-size grading, impact pits, and solution cavities. Based on integrated analysis of sedimentary filling successions and facies evolution, these deposits are interpreted as coastal aeolian dune deposits. Accordingly, the aeolian sandstones of the Shiyngliang Formation represent the oldest identified aeolian deposits in China to date. Paleowind reconstruction and correlation with coeval aeolian deposits of the Middle Espinhaço Supergroup within the São Francisco Craton, Brazil, demonstrate that both sedimentary records formed under mid-to-high latitude planetary westerly wind systems governed by atmospheric circulation during a supercontinent configuration. Both terranes were situated near 30° north and south paleolatitudes in the

early Mesoproterozoic. A synthesis of chronological, lithostratigraphic and aeolian sedimentary evidence and of the overlying glaciogenic records of the Quanji Group in the Olongbluk Microblock reveals pronounced paleogeographic affinity with the North China Craton, which constrains the paleogeographic position of the North China Craton during the initial breakup of the Columbia Supercontinent. This finding provides novel methodologies and perspectives for reconstructing paleogeographic configurations of Precambrian paleocontinents, as well as abundant geological constraints for supercontinent reconstruction.

KEYWORDS Oldest aeolian deposits of China; aeolian sedimentary features; paleogeographic position; Olongbluk Microblock; North China Craton

FUNDING National Key Research and Development Program of China (No. 2022YFF0800302), National Natural Science Foundation of China (Nos. U2444209, 42472150), and Deep Earth Probe and Mineral Resources Exploration – National Science and Technology Major Project (2025ZD1005300)

035 ORAL O-17-1-1435

Late Cretaceous intermontane eolian ergs in northern Mt. Wuling, central China

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Eolian sandstones play a key role in paleoclimate reconstruction and have been widely used as proxies for documenting aridification in the Phanerozoic Earth surface system. Studies of Cretaceous eolianites have improved our understanding of aridification under greenhouse climatic conditions. Cretaceous eolian sandstones are widespread across the Chinese continent, with their Late Cretaceous counterparts predominantly exposed in South China, offering valuable insights into regional continental paleoclimate. However, the environmental significance of the Late Cretaceous intermontane eolian ergs and the causal mechanisms of paleowind directions remain debated. Sandstone investigations were carried out at ~100 observation points across five basins in the northern Mt. Wuling area of central South China. Eolian sandstones were identified at 28 points in the Enshi and Jianshi basins of western Hubei, 5 points in the Longshan Basin of Hunan Province, and 19 points in the Qianjiang and Youyang basins of Chongqing. Comprehensive field-work, combined with petrographic analysis, SEM imaging, grain-size analysis, paleowind-direction reconstruction, lithofacies classification, and dune-architecture assessment, was conducted. Field and microscopic observations show that: 1) the eolian sandstones are predominantly orange and occur as massive sets with large-scale, high-angle cross-bedding; set thickness is generally over 3 m, commonly 5–15 m; 2) Fe-rich desert varnish is common in most thin sections; 3) grain roundness and sorting are moderate to good; 4) strata hosting the eolian sandstones are restricted to the Enshi Formation; and 5) reconstructed paleowind directions are mainly toward the southeast and northeast, with a few toward the southwest. Based on the above evidence, the following conclusions are drawn: 1) the Late Cretaceous eolian sandstones of the Enshi Formation record intermontane erg paleowind fields and indicate aridification in the study area; 2) the distribution of these eolian deposits implies the presence of two longitudinal paleorivers in the ancient northern Mt. Wuling region; and 3) the two sets of dominant paleowind directions, southeastward and northeastward, are comparable to those reported from other localities in South China, suggesting interaction between westerly and monsoonal wind systems. These findings provide new evidence for reconstructing the paleoclimate and paleowind systems in South China and probably East Asia.

KEYWORDS Intermontane eolian erg; paleowind system; Enshi Formation; Late Cretaceous; Mt. Wuling; central South China

036 ORAL O-17-1-1450

Shaped by monsoons, sealed by lavas: a giant aeolian dune field from Triassic Gondwana

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Although linear dunes are the most common dune type in modern aeolian dune fields, they are rarely recognized in the geological record. By integrating sedimentological observations with aeromagnetic, magnetic susceptibility and magnetization datasets, we reconstruct the morphology of an Upper Triassic aeolian dune field from the sedimentary architecture of aeolian deposits preserved in the Parnaíba Basin, NE Brazil. This aeolian system was inundated and buried by lavas from the Central Atlantic magmatic province (CAMP). Aeolian architecture records the migration of superimposed crescentic dunes along the flanks of parent linear megadunes. Aeromagnetic data reveal that these bedforms were part of a large aeolian dune field ($>55,000 \text{ km}^2$), comprising megadunes with ENE-WSW-oriented crestlines, up to 167 m high, and $\sim 2.7 \text{ km}$ crest-to-crest spacing. Thanks to the lava cover, this represents the largest and best-preserved instance of a linear megadune field yet documented in the rock record. Megadune morphology and crest orientations indicate that the dune field developed in response to the coalescence of northwesterly and southwesterly paleowinds driven by a monsoon system operating at low latitudes ($\sim 10^\circ\text{S}$) of Gondwana during the Late Triassic: this validates atmospheric circulation models which had hitherto lacked direct geological support from central Gondwana.

KEYWORDS Sambaíba Formation; aeolian architecture; linear megadunes

FUNDING Human Resources Program of the Brazilian National Agency of Petroleum, Natural Gas and Biofuels (PRH-ANP), managed by the São Paulo Research Foundation (FAPESP), Brazil (Process No. 2025/03248-0)

037 POSTER P1-02

Paleogeomorphology Restoration and Lithofacies Paleogeographic Evolution of the Carboniferous–Permian in the North Ustyurt Basin

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The North Ustyurt Basin is an important oil and gas bearing area in Central Asia, but its Paleozoic succession remains poorly studied. Based on drilling, logging, core and seismic data, combined with tectonic evolution analysis, paleogeomorphology restoration and cyclostratigraphy, this paper reveals the control of late Paleozoic tectonic cycles on paleogeomorphology and lithofacies paleogeography. From the Late Devonian to the Early Carboniferous, the Ural Ocean gradually closed, and the basin underwent NE-SW compression. From the Late Carboniferous to the Permian, the Ural Ocean was completely closed, the Paleo-Tethys Ocean subducted northward, and the eastern part was strongly uplifted and eroded during the Hercynian orogeny. From the Late Permian to the Triassic, subduction closure triggered rifting and strike-slip movements, forming the Mangyshlak-Central Ustyurt rift system. With the help of Petrel software and drilling data, the paleogeomorphology of the southern part of the basin was restored by the impression method with the top surface of the Jurassic as the base surface. The results show that the Carboniferous palaeotopography

was high in the south and low in the north, with the platform passing into slope and basin. The platform has the characteristics of uplift-depression-uplift, and the southern part is the structural high. The Permian inherited the pattern of high in the south and low in the north, but relief was subdued owing to strong erosion from the late Carboniferous to the early Permian, and the maximum height difference was about 75 m. The GR curve was used to identify cycles: 419 cycles are developed in the Carboniferous, with an average thickness of 2.78 m. The Permian develops 450 cycles with an average thickness of 2.27 m. The Fischer diagram shows that the Carboniferous to Permian experienced four stages of transgression-regression, and the water depth decreased overall. The Early Carboniferous is a deep-water basin facies, and the Late Carboniferous evolved into a slope and shallow-water carbonate platform facies. In the early Permian, the regional unconformity surface was formed due to the uplift of the Ural Mountains, and the eastern strata were severely stripped and dominated by clastic littoral facies. Evaporitic lithofacies developed in the Middle Permian near the Caspian Sea, and deltaic facies developed locally in the north (Fig. 1).

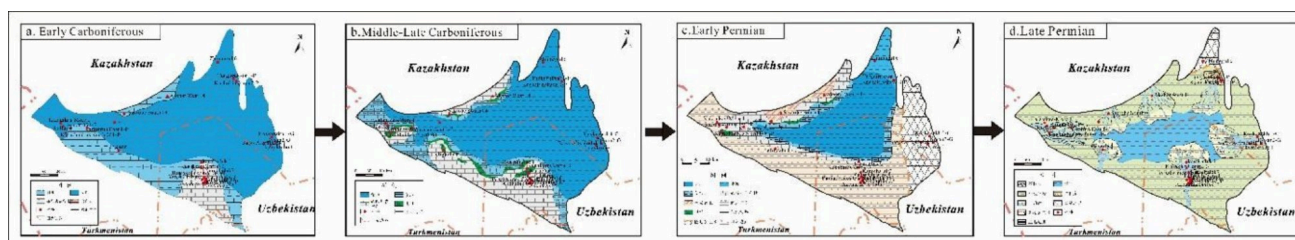


Fig. 1. Lithofacies paleogeographic map of the North Ustyurt Basin

KEYWORDS Lithofacies paleogeography; Paleogeomorphology; Late Paleozoic; North Ustyurt Basin

038 POSTER P1-03

The Formation of Transverse Aeolian Ridges in Utopia Planitia on Mars: Inspiration from Earth Megaripples

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Transverse Aeolian Ridges (TARs) are a class of ripple-like aeolian landforms with decameter-scale wavelengths, widely distributed across the Martian surface. Most TARs exhibit relatively symmetric transverse profiles and high albedos, which distinguish them from typical dunes or ripple forms on Mars. These features represent a distinct type of aeolian bedform, characterized by an unusual formation mechanism and a unique relationship between the Martian atmosphere and sediment circulation. However, the formation process of TARs remains a subject of ongoing debate.

TARs have also been identified in southern Utopia Planitia, the landing region of China's Mars exploration rover Zhurong. In this study, three types of TARs were classified based on their morphological characteristics. A two-stage evolutionary scenario is proposed, suggesting a significant shift in the prevailing wind direction over time. Combined with analog studies of similar landforms on Earth, it is inferred that TARs in Utopia Planitia may have formed by a process similar to that of megaripples.

KEYWORDS Mars; Aeolian landforms; Transverse Aeolian Ridges (TARs)

T2-2 Fluvial and deltaic sedimentology**039** POSTER P1-04**Sedimentary characteristics of lacustrine-fluvial interactions in the Late Triassic Tiki Formation, India****Arpan Chaudhuri*, Parthasarathi Ghosh**

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The Tiki Formation, a Carnian to Early/Middle Norian fluvial succession, is a part of the Rewa Gondwana basin in peninsular India and was deposited in a strike-slip tectonic setting. This research provides insights into lacustrine-fluvial interactions by reconstructing the facies architecture of the Tiki Formation. The stratigraphic architecture is characterised by several laterally extensive, sheet-like, multi-storeyed sandstone bodies (tens of metres thick and traceable laterally for 4–5 km), interspersed with much thicker red mudstone intervals. The storeys at the base of the sandstone bodies are about a metre thick and a few metres wide. They are lensoid in shape, with a concave-up basal bounding surface and a planar top. They are composed of a basal cross-stratified lag deposit, which grades upward into plane-parallel and low-angle cross-stratified fine sand. The storeys in the upper part of the sandstone bodies are comparatively thicker. They are tabular in geometry and internally comprise sets of plane-parallel and low-angle cross-strata, interspaced with wedge-shaped units of ripple cross-lamination and dune-scale, planar cross-strata. The mudstones are red and massive, with sporadic pedogenic features (slickensides, mottling, drab halo root traces, desiccation cracks, and a few carbonate and/or sulphate nodules). Heterolithic bodies and sheet sandstones, tens of centimetres thick, are encased within the mudstones. The facies and facies associations of the sandstone bodies suggest migration of low-amplitude sandy bedforms and dune-scale macroforms within laterally unconfined, shallow, sand-braid channels during periods of higher discharge. This braidplain was characterised by numerous sub-parallel braided channels on the surface of coalesced low-amplitude alluvial fans, forming a bajada-like geomorphology. The basal coarse-grained storeys of the sandstone bodies represent the fills of small avulsive channels. With time, these small channels evolved into unconfined shallow sand-braid channels. The mudstones were deposited in a shallow lake. Some parts of these water bodies were exposed during the dry periods, leading to the development of pedogenic features. The heterolith complexes and thin sandstone sheets within the mudstones may represent terminal splay complexes. Repeated incursions of the fluvial system into the lake created the observed alternation of sandstone and mudstone in the Tiki Formation. These incursions may have been driven by increased sediment supply during high-rainfall events. These events are possibly linked to global warming in the Tethys region, which may have resulted in enhanced evaporation, increased thermal convection and monsoon intensification related to the Pangaeon megamonsoon.

KEYWORDS Triassic; Pangaeon megamonsoon; Gondwana; Fluvio-lacustrine sedimentation; Tiki Formation**FUNDING** Partial funding requested as a Student Travel Grant from the Indian Statistical Institute

040 POSTER P1-05

Quantitative Constraints of Local Tectonic Subsidence on Sandstone-Type Uranium Mineralization in the Daqing Placanticline, Northern Songliao Basin, NE China

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The formation of sandstone-type uranium deposits is closely related to the local structural evolution of basins. However, while existing studies mainly focus on qualitative analyses at the regional scale, quantitative research on structural ore-controlling mechanisms at the local scale remains limited. Focusing on the Daqing Placanticline and its adjacent areas in the Songliao Basin, we applied the back-stripping inversion method based on the qualitative interpretation of seismic and well profiles. This allowed us to quantitatively characterize the spatiotemporal differences in local tectonic subsidence since the Late Cretaceous, thereby revealing the constraint mechanisms on sedimentary filling patterns and uranium mineralization. The results show that the tectonic subsidence exhibits significant staged evolution and regional differentiation in time and space. Strong structural inversions at the end of the Nenjiang and Mingshui periods caused maximum uplift and denudation in the southern Daqing Placanticline, forming a massive structural window and activating fault channels for the upwelling of deep reducing fluids. Meanwhile, differentiated local tectonic subsidence and sediment supply constrained the sedimentary filling patterns. Influenced by both low tectonic subsidence rates and abundant sediment supply, the southern study area exhibited an overcompensated filling pattern, developing meandering river facies with high sandstone percentages and thereby providing high-quality fluid conductive channels. In contrast, controlled by relatively large tectonic subsidence rates or insufficient sediment supply, the central and northern parts of the study area exhibited undercompensated or quasi-balanced filling patterns, primarily developing shallow lake or meandering river-shallow lake facies, with sandbodies generally smaller than those in the south. Ultimately, the spatiotemporal coupling between the sedimentary filling during the Sifangtai period and the tectonic inversion at the end of the Mingshui period established a uranium metallogenic framework in the study area, characterized by superior conditions in the south and inferior conditions in the north. With a favourable configuration of three core metallogenic elements —“structural window recharge, conductive migration, and fault-related reduction”—the southern study area is the most favourable metallogenic area for sandstone-type uranium deposits. This study advances quantitative research on local structural ore-controlling mechanisms, providing new insights and references for uranium exploration in the Songliao Basin and similar continental basins.

KEYWORDS Sandstone-type uranium deposit; Tectonic subsidence analysis; Daqing Placanticline; Ore-controlling structure; Structural window

FUNDING Natural Science Foundation of Jiangxi Province, China (No. 20252BAC240270), the National Key Laboratory of Uranium Resources Exploration-Mining and Nuclear Remote Sensing (No. 2025QZ-YZZ-08)

041 POSTER P1-06

A Review of Research Progress on the Depositional Model and Genetic Mechanism of Delta-Beach Bar Complex Sand Bodies

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Delta-bar complex sand bodies are sand bodies with a distinctive structure formed under the combined action of factors such as river-(coastal) lake hydrodynamics and shoreline migration caused by frequent changes in (sea) lake levels. Their distribution patterns are difficult to describe using single-genesis depositional models. However, such complex sand bodies are widely developed in clastic reservoirs of petroliferous basins. They are not only important targets for oil and gas exploration, but their sedimentary characteristics can also be used to reconstruct paleo-hydrodynamic conditions and paleogeographic environments. Therefore, delta-beach bar complex sand bodies are not only an important area for oil and gas exploration but also one of the research topics that sedimentologists should pay attention to. Numerous detailed studies, in China and elsewhere, have addressed on the formation mechanisms, controlling factors and distribution patterns of single-genesis sand bodies, establishing mature depositional models. However, few studies have addressed the formation mechanisms, depositional models, and distribution patterns of complex sand bodies. Based on the analysis of a large number of scientific research cases, the results of modern sedimentary investigations, and the review of the international literature on complex sand bodies, this paper reviews the research progress on the depositional models and genetic mechanisms of complex sand bodies, especially delta-bar complex sand bodies. The main conclusions are as follows: (1) the controlling factors affecting the development of complex sand bodies include: autogenic cycles, autogenic-heterogenic cycle composite effects, the interaction of river-(coastal) lake hydrodynamics, changes in sea (lake) levels and shoreline migration, mixed sedimentation, event sedimentation, and topographic factors; (2) the vertical superposition models of complex sand bodies are synchronous in-phase and synchronous out-of-phase autogenic cycle superposition models, and diachronous in-phase and diachronous out-of-phase heterogenic (allogenic) cycle superposition models; (3) four distribution models are recognized for delta-bar complex sand bodies: shoreline migration-delta lateral-margin bar, (fan) delta-front mouth bar-clastic bar, delta distributary channel-coastal bar, and (fan) delta-front mouth bar-carbonate bar superposition complex models.

KEYWORDS Composite sand body; genetic mechanism; hydrodynamic conditions; sedimentary model

FUNDING National Natural Science Foundation of China (Grant Nos. 41272157, 42072115)

042 POSTER P2-09

Depositional Systems and Sandstone-Type Uranium Mineralization of the Early Cretaceous in Northern Ordos Basin

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In recent years, following the discovery of abundant sandstone-type uranium resources in the Middle Jurassic Zhiluo Formation, remarkable uranium resources have also been identified in the Lower Cretaceous Huanhe Formation in the northern Ordos Basin. Integrated analysis of field outcrops, drill cores, and well logs indicates that the sediments of the Lower Cretaceous Huanhe

Formation were derived from the Wula Mountains and Lang Mountains in the northern and north-western parts of the basin. The distribution of depositional systems exhibits a regular north-south variation. From the Wula and Lang Mountains southward to the Wujiamiao-Boyinwusu-Yanchang line, the depositional system is dominated by alluvial fans, primarily consisting of fan-surface gravelly channels and floodplain deposits. Gravel clasts have an average diameter of 3–8 cm, are well rounded, poorly to moderately sorted, and exhibit preferred orientation, with maximum flat surfaces dipping north and northeast. The conglomerates are sand-supported and massive. Floodplain mudstones are brownish-red and massive. From the Wujiamiao-Boyinwusu-Yanchang line northward to the northern Etuokeqi-Wushenqi area, a braided river depositional system extensively developed over an area approximately 70–90 km (north-south) by 100 km (east-west). Sandbody thickness ranges from 300 to 800 m, with sand percentages exceeding 85–90%. Lithologies consist of pebbly coarse-grained sandstone, coarse-grained sandstone, minor medium-grained sandstone, and thin mudstone interbeds. Laterally, braided channels intertwine; vertically, multi-stage channel scour and stacking produce laterally connected, thick uranium-bearing target sandbodies. From the northern Etuokeqi-Wushenqi line to the Etuokeqianqi-Hengshan line, a braided delta system is developed, comprising delta plain and delta front facies. Sandbody thickness ranges from 300 to 500 m, sand percentage is approximately 60–75%, and lithologies include medium- to coarse-grained, medium- to fine-grained sandstones, and mudstones. The sandstones exhibit abundant trough and planar cross-bedding, along with diagnostic sedimentary features of delta front facies. From the Etuokeqianqi-Yanchi line southward, a lacustrine depositional system is present, consisting of mudstones, marls, and thin medium- to fine-grained sandstones, containing conchostracan and bivalve fossils, as well as mud cracks and ripple marks, indicative of shore-shallow lacustrine, semi-deep lacustrine, and deep lacustrine facies. In summary, from north to south in the study area, there is a clear trend of decreasing grain size, improving sorting and rounding, and thinning sandbodies. Sandstone-type uranium mineralization is mainly hosted in the braided river and braided delta depositional systems, where the large thickness and high permeability of sandbodies are key factors for uranium mineralization.

KEYWORDS Braided river; braided delta; sandbody; sandstone-type uranium deposit; northern Ordos Basin

043 ORAL O-17-1-1520

Provenance Characteristics of the Permian Fengcheng Formation in the Mahu Sag, Junggar Basin and Its Controls on Fan Body Development

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The Permian Fengcheng Formation is one of the most important hydrocarbon-bearing strata in the Junggar Basin. Its deposition was mainly controlled by two provenance systems: the Zharma-Saur arc (ZSA) in northern West Junggar and the central West Junggar (CWJ). However, previous studies are insufficient regarding the provenance characteristics at member scale and the influence of different provenance supplies on the development of fan bodies in slope zones. Based on detrital zircon U-Pb dating, heavy mineral assemblages, trace element geochemistry, and 3D seismic data, this study investigates the major provenance systems during the depositional stages of each member of the Fengcheng Formation and their impacts on the geometry and scale of fan delta deposits. The results show that during the deposition of the First Member of the Fengcheng Formation (P_1f_1), the northern part of the western margin was jointly influenced by the CWJ and the ZSA, whereas the southern part was mainly sourced from the adjacent CWJ. A distinct provenance reversal occurred during the deposition of the Second Member (P_1f_2) and the Third Member (P_1f_3): the northern fans were predominantly supplied by the proximal CWJ and the thrust nappe belt along the

northwestern margin. The southern part was affected by mixed proximal-distal sources, with fan deltas receiving sediments from the distant ZSA in northern West Junggar and the adjacent CWJ. Thrust nappe tectonism reshaped the drainage network, leading to the reversal of the dominant provenance. Variations in provenance supply exerted a profound control on fan body development: northern fans, dominated by rapid accumulation of proximal coarse-grained conglomerates, are characterized by short-axis, thick-bedded alluvial fans with limited lateral extent. In contrast, southern fans, influenced by mixed distal-proximal sources and slow deposition of fine-grained sediments, developed as long-axis, thin-bedded alluvial fans with a more extensive distribution.

KEYWORDS Junggar Basin; Mahu Sag; Permian; Fengcheng Formation; Sedimentary provenance

FUNDING Xinjiang Oilfield Company (No. XJYT-2024-JS-5189) and Geological Survey Project of China Geological Survey (No. DD202401021)

044 ORAL O-19-1-0850

Geological responses to the coupling effect between mass and slope in the meandering-braided transition system

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This study examines the role of the coupling effect between mass and slope, defined as the coordinated variation in particle grain size and topographic slope, in explaining the transition from meandering to braided fluvial systems, and elucidates the associated three-dimensional geological responses. In the Lower Triassic of the southern Junggar Basin, a well-developed meandering-braided transition system is documented, with well-exposed sedimentary sections offering insight into the transformation process. Comprehensive field investigations were systematically conducted along representative outcrop sections, involving photographic documentation of architectural elements, geometric measurements of 9 point bars and 10 braided bars, thickness records of 98 cross-stratification sets, and grain-size quantification through petrographic thin sections and laser particle size analysis of 34 sediment samples. Paleoslope was quantitatively estimated using established empirical formulas based on the average thickness of cross-stratification sets and corresponding median grain size (D_{50}). Paleoslope estimation and grain-size analysis confirm the presence of the coupling effect between mass and slope in the study area. This effect is characterized by a general positive correlation between topographic slope and particle grain size, and it may have contributed to the formation of the meandering-braided fluvial system. The vertical sedimentary succession, section stacking patterns, and quantitative characterization of architecture elements from the meandering to braided fluvial systems collectively record the geological responses during the fluvial pattern transition process. The vertical succession exhibits a transition from features indicative of a low flow regime to those reflecting a high flow regime. The section stacking patterns evolve from isolated to amalgamated (superposed) sandbodies. The width and thickness of the sedimentary architecture generally both increase in response to increasing slope and grain size. However, the width and thickness of the sedimentary architecture within the transitional zone are not stable.

KEYWORDS Coupling effect between mass and slope; Meandering-braided transition system; Southern margin of Junggar Basin; Lower Triassic; Geological responses

FUNDING National Natural Science Foundation of China (No. 42572181)

045 POSTER P1-07

Sedimentary Facies of the Bayingebi Formation in the Tiancao Sag, Yin'e Basin

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The Tiancao Sag is located in the mid-western part of the Juyanhai Depression, Yin'e Basin. The Bayingebi Formation in the Tiancao Sag is relatively thick and is divided into the First Member (K1b1), Second Member (K1b2) and Third Member (K1b3). Four main types of sedimentary facies are recognized: semi-deep lacustrine with slump turbidite fan, fan delta, nearshore subaqueous fan, and shore-shallow lacustrine deposits. The principal sedimentary subfacies are fan delta front and shore-shallow lacustrine deposits. The sedimentary characteristics of the Bayingebi Formation in the Tiancao Sag are consistent with the depositional pattern of a single-fault half-graben (dustpan-shaped) depression. The steep slope belt mainly developed nearshore subaqueous fan systems, the gentle slope belt is characterized by fan deltas, and the deep sag belt developed semi-deep lacustrine and slump turbidite fan systems. Controlled by boundary and synsedimentary faults, sand bodies on the eastern gentle slope extend far toward the sag center. Vertically, sand bodies are well developed in the First Member, the middle part of the Second Member, and the early part of the Third Member (Fig. 1).

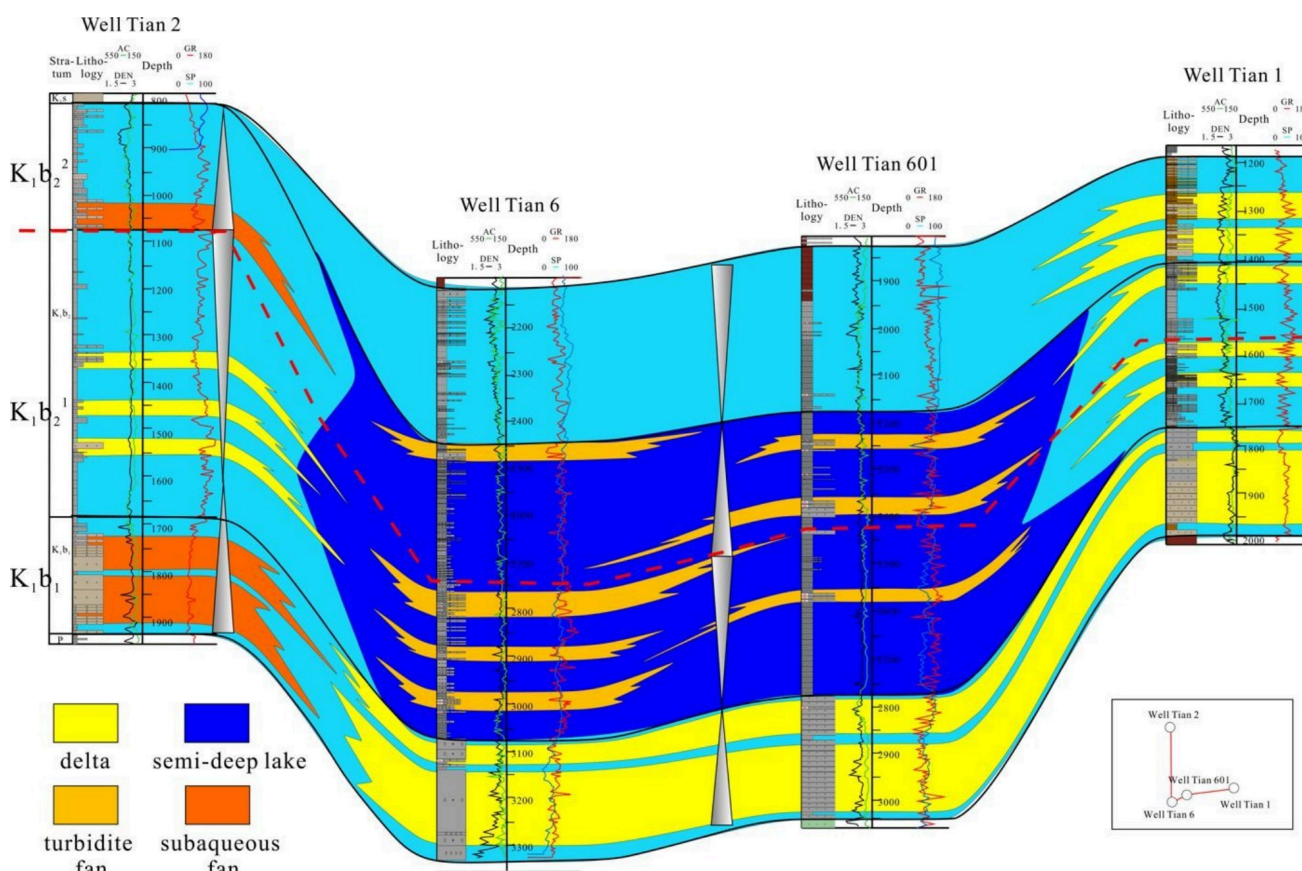


Fig. 1. Well-tie sedimentary facies correlation of wells Tian 2–Tian 6–Tian 601–Tian 1

KEYWORDS Tiancao Sag; Bayingebi Formation; Sedimentary facies

046 POSTER P1-08

Global Distribution and Morphometric Controls of Mega Distributive Fluvial Systems (Mega-DFS): Implications for Continental Basin Analysis

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Mega Distributive Fluvial Systems (Mega-DFS) represent prominent large-scale depositional landforms in continental sedimentary basins. Distinguished from conventional alluvial fans by their immense scale, they are characterized by radii exceeding 80 km, areas ranging from 10^3 to 10^5 km², and gradients typically below 0.1°. This study employs high-resolution satellite imagery and SRTM DEM data to systematically identify and quantify 306 Mega-DFS globally. A comprehensive database was established, documenting key parameters including apex coordinates, radius, depositional area, perimeter, drainage basin area, and slope, alongside their tectonic and climatic contexts. Results reveal a markedly uneven global distribution, with Asia (37%) and Africa (29%) accounting for 66% of the identified cases. Tectonically, foreland basins (45%) and intracratonic basins provide the most favorable accommodation space and sediment supply for Mega-DFS development. Morphometric statistics indicate a mean radius of 216.85 km, a mean slope of 0.6°, and a mean depositional area of 1.1×10^4 km². Correlation analyses demonstrate a strong power-law relationship between depositional area and radius ($R^2 = 0.689$). While tectonic setting emerges as the primary control, climate plays a synergistic secondary role: arid zones (66% of cases) promote extensive fan expansion and morphological preservation through episodic high-magnitude floods, whereas tropical climates generally entail stronger channel reworking. These findings bridge significant gaps in existing global databases, providing quantitative support for predicting basin depositional patterns and elucidating the evolution of large-scale fluvial systems.

KEYWORDS Mega Distributive Fluvial Systems (Mega-DFS); Global distribution; Morphometric parameters; Tectonic-climatic controls; Basin analysis

FUNDING National Natural Science Foundation of China (Grant Nos. 42472168 and 42130813)

T2-3 Depositional processes in coastal to shelf environments**047** ORAL O-17-1-1535**Facies variability of an outer-shelf, wave-dominated compound delta – an example from the Pliocene paleo-Orinoco, Mayaro Formation, Trinidad****Ariana Osman^{1*}, Ron Steel², Darian Lewis¹, Valentina M. Rossi³, Cornel Olariu²**¹ Petroleum Studies Unit, The University of the West Indies, St. Augustine, TRINIDAD AND TOBAGO² Jackson School of Geoscience, The University of Texas at Austin, 1 University Station, C1100, Austin, TX 78712, USA³ National Research Council of Italy, Institute of Geosciences and Earth Resources, Via Ferrata 1, 27100 Pavia, ITALY* E-mail: ariana.osman@gmail.com

Wave-dominated compound deltas in the rock record can be recognized by their bipartite architecture: a muddy, coarsening-upward (CU) subaqueous clinothem tens of metres thick, capped by thin (<15 m), CU, sand-rich, storm-dominated facies and subaerial deposits of the shoreline clinothem. A distinct discontinuity of autogenic origin, the regressive surface of marine erosion (RSME), develops between the subaqueous and shoreline clinothems. However, 3D variability and relative sea-level (RSL) changes can obscure the stacking pattern architecture.

Repeated stacked parasequences measured along 300 m of exposed outcrops of the paleo-Orinoco Delta, Mayaro Formation, Trinidad, give insight into proximal-to-distal variations and 3D architecture of outer-shelf, wave-dominated compound deltas within a growth-faulted compartment. The subaqueous delta slope is dominated by monotonous, thin, muddy graded beds. However, within some parasequences sharp-based chutes, <1 m deep and >30 m wide, infilled with sandy parallel-to subparallel-laminated beds and normal graded beds capped with carbonaceous laminae, down-cut into the muds and increase in frequency and amalgamation up-section. The preservation of normal graded beds with carbonaceous laminae suggests hyperpycnal-derived sediments and a narrow platform. Very narrow platforms can exist in areas close to the river mouth, where sediment delivery and shoreline clinothem progradation rates are high, but may also reflect the decreasing distance between the shoreline clinothem and the shelf edge.

The subaqueous platform facies have grey fluid mud layers with preserved wave-rippled tops within lenticular and wavy beds. The distal platform has sharp-based erosional scours infilled with storm-dominated beds, whereas the proximal platform has an increased sand percentage with <50 cm sheet-like storm beds. The shoreline clinothem is very sand-rich and dominated by swaley cross-stratified beds, but it is unusually thick (>35 m). This thickness likely represents several stacked, strongly regressive phases during syndepositional subsidence within growth-faulted compartments, preserving unusually thick, outer-shelf, shoreline-clinothem deposits. These observations highlight the strong interaction between sediment supply, shelf-edge proximity, and syndepositional growth faulting in controlling wave-dominated compound-delta architecture.

KEYWORDS Compound deltas; wave-dominated; outer-shelf

048 ORAL O-17-1-1400

Process variability across an ancient subaqueous platform: Jurassic Lajas Formation (Neuquén Basin, Argentina)

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Compound clinoforms are well recognized in modern muddy deltas where strong waves, tides and currents redistribute sediment away from the shoreline clinoform across a bypass unit, the subaqueous platform, before depositing along the gently dipping (1–2°) subaqueous clinothem. However, there are few published examples of their changing facies characteristics across strike and along dip in the rock record. The continuous outcrops of the Jurassic Lajas Formation in the Neuquén Basin (Argentina) allowed us to detail the sedimentary facies and to define key features for tide- and wave-influenced compound clinoforms.

The subaqueous clinoforms record several coarsening-upward sub-units that represent shallowing and progradation, from subaqueous delta slope, to rollover to subaqueous platform. The subaqueous delta slope and distal subaqueous platform are characterized by mud-rich heterolithic parasequence deposits with a dominance of density-driven and storm-wave processes. The mid-subaqueous platform is characterized by cross-beds, plane-parallel, low-angle and hummocky cross-lamination, suggesting that density-driven, tidal and storm-wave processes were active and controlled deposition. The proximal subaqueous platform is dominated by tidal processes.

Both strong storms and tidal currents had adequate shear stress to erode the platform and to transfer sediments via wave enhanced sediment gravity flows and hyperpycnal flows across the shallow wide platform to the subaqueous rollover. However, the facies distribution suggests process partitioning, with tidal currents more important on the proximal subaqueous platform and storm waves more dominant in the mid- to distal platform. The subaqueous platform is capped by mouth bars and tidal channels of the shoreline clinothem. The recognition of the energetic platform facies is important in order to correctly identify subaqueous deltas in the rock record, and to properly define the paleogeography of ancient shelves.

KEYWORDS Subaqueous deltas; tide-dominated; wave-dominated

049 ORAL O-19-1-1030

Variability of fluid-mud-driven and tide/wave-modulated sediment gravity flows that dominate Cook Formation subaqueous deltas of the early North Viking Graben, Norway

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Tall (sometimes >100 m), relatively mud-rich, very gently inclined clinothem sets are a hallmark of subaqueous deltas. The coeval subaerial delta is less tall, sand-prone and more steeply prograding. Subaqueous deltas were previously often simply referred to as 'prodelta' deposits, but this is misleading because of their height and high rates of progradation. This subaqueous progradational

unit is very well documented in Holocene deltas and increasingly recognised in the rock record. However, the detail and variability of these beds on the subaqueous platform and subaqueous delta slope are not well captured. In tide-dominated delta deposits, thick fluid mud beds (0.5–3 cm) represent high sediment concentrations but vary from unstratified to stratified, reflecting increasing water velocity, sediment concentration and slope conditions. Yet their distribution across the platform and subaqueous-delta slope is rarely documented. Here we characterise sand-silt-mud proportions, fluid-mud content (as opposed to slow hemipelagic settling) and sedimentary features using core from the Early Jurassic Cook Formation (Norway).

The key zonation across the subaqueous clinothem is as follows: 1) Lower to mid-subaqueous delta slope deposits dominated by graded silt-to-mud beds with minor fluid mud (<25%) and minor preserved tidal rhythmites, interpreted as tide-modulation of sediment gravity-flow volume released across the slope rollover. Bioturbation is moderate to high, and fluid-mud fabrics are variable but are dominated by stratified fabrics (68%); 2) Upper subaqueous slope to outer platform deposits of rapidly accumulated, structureless sand beds (up to 14 cm) with current and wave ripples, interbedded with fluid mud and double mud drapes. Fluid muds are predominantly unstratified (56%); 3) Inner to mid-platform deposits that can be mud-prone or sand-prone with sheet-sand or channelised sand in places. Fluid muds are largely unstratified (>60%) and sparsely bioturbated. The appearance of fluid mud deposits helps to define the boundary between subaerial delta and subaqueous platform, as fluid mud layers are rare within the wave-dominated shoreline clinothem of the Cook Formation.

These results illustrate that energetic waves or tidal currents help maintain density stratification and assist the widespread transport of both sand and fluid mud across the platform to the delta slope. Characterising this spatial heterogeneity of sediments helps improve process-based models of wave- or tide-dominated deltas and predictions of stratigraphic architecture and reservoir heterogeneity in mud-rich subaqueous clinothems.

KEYWORDS Subaqueous deltas; fluid mud; tide-dominated

T2-4 Sediment gravity flows and deep-water sedimentology**050** POSTER P1-09**Hydrodynamic Evolution and Sedimentary Model of the Conventional–Unconventional Transition Zone in a Continental Rift Lacustrine Basin Margin: A Case Study from the Dongying Sag, Bohai Bay Basin****Hao Cheng, Xiutian Yao***

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The conventional-unconventional hydrocarbon transition zone in continental rift lacustrine basins has become an important successor area for oil and gas exploration in recent years. Its complex hydrodynamic evolution process plays a crucial role in controlling the development of sedimentary systems and hydrocarbon accumulation. However, the current understanding of the stage characteristics of hydrodynamic evolution in the transition zone and its coupling relationship with sedimentary response remains unclear, which restricts detailed exploration in this field. Taking the third member of the Paleogene Shahejie Formation in the Dongying Sag, Bohai Bay Basin as an example, this paper systematically studies the hydrodynamic evolution characteristics and sedimentary response of the conventional-unconventional transition zone by comprehensively using core observation, well logging interpretation, seismic data analysis and hydrodynamic numerical simulation. The results show that the conventional-unconventional transition zone of the third member of the Shahejie Formation in the Dongying Sag has experienced three hydrodynamic evolution stages: strong rifting stage, rifting-depression transition stage and weak depression stage, corresponding to gravity flow-dominated, traction flow-gravity flow interactive and traction flow-dominated hydrodynamic environments respectively. The differences in hydrodynamic conditions at different evolution stages control the type, scale and spatial distribution of sand bodies, forming a three-part sedimentary system assemblage of "slump turbidite fan-distal subaqueous fan-beach bar". On this basis, a "tectonic-fluid-sediment" ternary coupled sedimentary model for the conventional-unconventional transition zone in continental rift lacustrine basins is established, revealing the control mechanism of hydrodynamic evolution on hydrocarbon enrichment. This study not only enriches the sedimentological theory of continental lacustrine basins, but also provides an important scientific basis for oil and gas exploration in the conventional-unconventional transition zone of rift lacustrine basins.

KEYWORDS Conventional–unconventional transition zone; Continental rift lacustrine basin; Hydrodynamic evolution; Sedimentary model; Dongying Sag; Shahejie Formation

051 POSTER P1-10

Deep-Marine Sedimentation and Forearc Basin Evolution in the Colombian Caribbean: Insights from Core Sedimentology of the San Cayetano Formation

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The paleogeographic reconstruction of deep-marine basins along convergent margins is commonly hampered by the difficulty of distinguishing fine-grained deposits formed by turbidity currents, bottom currents, and hemipelagic sedimentation. This challenge is particularly critical in core-based studies, where the limited exposure of sedimentary structures may lead to ambiguous environmental interpretations and potentially misleading depositional models.

Here, we present a high-resolution sedimentological analysis of the ANH-San Cayetano-1 core from the Sinú-San Jacinto Basin (northwestern South America), an important Ypresian forearc system. Core descriptions at a 1:5 scale allowed the identification of sedimentary facies associated with turbidity currents, contour-current reworking, hemipelagic settling, and submarine mass-transport processes. The sedimentary succession is dominated by fine-grained deep-water deposits, including turbidites, contourites, debris-flow deposits, and bioturbated muddy intervals. These facies indicate the interaction and superposition of multiple depositional processes operating in a deep-marine setting.

Our results suggest that previous interpretations of the San Cayetano Formation as a deltaic or shallow-marine system do not adequately account for the role of mixed deep-marine processes. The study highlights the importance of sedimentological and ichnological criteria for achieving robust paleoenvironmental and paleogeographic reconstructions in convergent-margin basins. It also provides new constraints on the tectono-sedimentary evolution of the Sinú-San Jacinto forearc basin and emphasizes the value of integrating continuous core observations with stratigraphic and micropaleontological datasets.

KEYWORDS Deep-marine systems; contourite; hemipelagite; turbidite; debrite; trace fossils

052 ORAL O-17-1-1635

High-Frequency Sedimentary Fluid Transition and Depositional Models of Rift Lacustrine Steep Slopes: An Example from the Upper Paleogene Enping Formation, Huizhou Sag

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The Huizhou Sag, located in the northern Zhu I Depression of the Pearl River Mouth Basin is a typical faulted lacustrine basin. During the depositional stage of the upper Member of the Paleogene Enping Formation, glutenite bodies developed along the steep slope belt and serve as the core hy-

drocarbon accumulation zone with prominent petroleum exploration potential. Glutenites in steep slope belts commonly feature superimposed and co-genetic deposits of gravity flows and tractive currents. However, the primary controlling factors governing frequent shifts in sedimentary processes remain ambiguous, and the corresponding sedimentary evolution models have not been clarified, which hinders in-depth understanding of the genetic mechanisms and distribution patterns of reservoir sandbodies. Based on core samples, well logging data and sedimentary test measurements, this study adopts a dual-scale decomposition framework separating long-term background constraints and short-term episodic perturbations. It quantitatively decouples steady-state background controls (paleogeomorphology and paleoclimate) from dynamic driving factors including high-frequency lake-level fluctuations, variable sediment supply and episodic fault activity. This work systematically reveals the differential regulation mechanisms of multi-hierarchical controlling factors on sedimentary evolution and spatial sandbody distribution, and further establishes three coupled genetic sedimentary models for steep slope belts: episodic tectonic-intense sediment supply debris flow model, lake level-geomorphology constrained tractive current model, and flood-induced mixed sedimentation model. The results demonstrate that pulsed fault activity dominates the large-scale development of debris flow systems. Flood events are concentrated within lowstand systems tracts, and their scale and frequency gradually decline with lake-level rise. Sedimentary fluids undergo ordered high-frequency transitions from debris flows to turbidity currents and then to tractive currents, forming a sedimentary framework characterized by superimposition and differentiation of sandbodies with polygenetic fluid origins. This study clarifies the sedimentary differentiation mechanism driven by multi-scale dynamic coupling in faulted steep slope belts, constructs a quantitative discrimination system for fluid state transitions, and provides critical theoretical support for deep complex reservoir prediction and refined hydrocarbon exploration in terrestrial faulted basins.

KEYWORDS Glutenite; Sedimentary process; Lake-level fluctuation; Dual sediment supply intensity

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053 POSTER

Characteristics and main controlling factors of flute casts in the Ordovician Lashizhong Formation, western margin of the Ordos Basin

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Flute casts encode critical hydrodynamic information, yet their characteristics and controlling factors remain inadequately studied. Based on field section measurements, thin-section analysis, and grain size data from the Zhuozishan area, this work synthesizes the characteristics of flute casts in the Lashizhong Formation, investigates their controlling factors, and establishes a depositional model. Key findings include: (1) Gravity flow depositional elements are developed in the study area, including channels, levees and proximal lobes. (2) Eight morphological types of flute casts are recognized: simple parabolic (narrow), simple parabolic (wide), bulbous parabolic, penniform parabolic, spindle-shaped, asymmetrical, comet-shaped and corkscrew. They are grouped into type I (simple parabolic narrow and wide, bulbous parabolic and penniform parabolic), type II (spindle-shaped) and type III (asymmetrical, comet-shaped and corkscrew). (3) Flute casts formed during channel deposition are the largest in scale, whereas those developed in lobe deposits exhibit the greatest morphological diversity. (4) Flute cast formation is primarily controlled by flow energy, velocity, density, and erosion duration. High-energy, high-velocity flows favor large-scale Type I flutes,

while decreasing flow energy leads to smaller, more numerous Type II forms. Longer erosion duration results in denser flute distributions. (5) Strong, high-density erosive events form thick, coarse-grained, poorly sorted sandstone layers dominated by Type I flutes, whereas weaker, low-density flows deposit fine-grained, well-sorted thin sandstone beds containing Type II flutes.

KEYWORDS Flute casts; gravity flow; turbidity current; Ordovician; Ordos Basin

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054 ORAL O-17-1-1650

Dual-belt control of flood-induced hyperpycnal flow regimes and sedimentary differentiation in an asymmetric continental rift-lake basin: Insights from the Eocene Shahejie Formation, Dongying Depression, Bohai Bay Basin

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Deep-water gravity-flow deposits in continental rift basins record the coupled influence of tectonics, climate, and basin geomorphology, yet their flow dynamics are often interpreted with static, slope-based models. This study examines flood-induced hyperpycnal deposits in the upper Member 4 to lower Member 3 of the Eocene Shahejie Formation in the Dongying Depression, Bohai Bay Basin, using core observations, wireline logs, and high-resolution 3D seismic data from 69 wells and 39 key cores. Eighteen lithofacies and twelve lithofacies associations are identified and grouped into two end-member depositional systems: nearshore subaqueous fans along the steep northern margin and distal lacustrine fans across the gentle southern margin and basin floor. The steep margin records tectonically triggered, non-steady hyperpycnal flows characterized by rapid energy loss, short transport distances, coarse, poorly sorted deposits, and “frozen” proximal accumulation. In contrast, the gentle margin and tectonically quiet intervals preserve climatically driven quasi-steady hyperpycnal flows, expressed by sustained discharge, longer transport pathways, and diagnostic inverse-to-normal graded hyperpycnite successions (Ha-Hb) that capture complete flood hydrographs. Spatial facies mapping and RMS seismic attributes show that sand-body distribution and connectivity are governed not only by slope gradient but also by dual-margin differential control on flow stability. The resulting steep-gentle dual-belt model links sedimentary architecture to flow transformation processes and provides a predictive framework for deep-water reservoir characterization and subtle lithologic trap exploration in asymmetric continental rift basins.

KEYWORDS Flood-generated hyperpycnal flow; Rift lake basin; Shahejie Formation; Deep-water sedimentary differentiation; Dongying Depression

055 ORAL O-17-1-1505

Fine-Grained Sedimentation, High-Frequency Cycle and Organic Matter Enrichment in an Epicontinental Sea: the Mowry Formation, Southwestern Powder River Basin

Lin Miao, Changsong Lin, Manli Zhang

Fine-grained carbon-rich sediments have received increasing attention due to their significance in the formation of unconventional petroleum resources, but their depositional patterns and controlling mechanisms remain poorly understood. This paper presents a systematic investigation of the fine-grained sedimentation, high-frequency sedimentary cycles and carbon enrichment of the Mowry Formation in the Powder River Basin. Nine lithofacies and five lithofacies associations identified in the formation are interpreted as various flow deposits such as hyperpycnal flow, wave-enhanced sediment-gravity flow, storm flow, weak bottom current and flocculent suspension, which formed in an epeiric sea from the prodelta, inner shelf, to mid-outer shelf environments. The high-frequency sedimentary cycles are recognized by flooding surfaces and are attributed to sea level change related to the Milankovitch climate cycles. Facies associations formed during flooding periods and dominated by flocculent suspension deposits exhibit higher TOC, whereas those formed during regressive phases and dominated by hyperpycnal-flow deposits display lower TOC.

KEYWORDS Lithofacies association; High-frequency sedimentary cycle; Carbon enrichment; Fine-grained deposits; Controlling process; Cretaceous Mowry Formation; Powder River Basin

056 ORAL O-17-1-1705

Sediment gravity flows on the shelf: An important source-to-sink component

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Turbidite beds are increasingly recognized on continental shelves and should be included as an important shallow-marine component, basinward of shorelines, in source-to-sink models. They are much more common than generally realized.

Where the shelf is wide because of medium- to large-sized rivers, extensive subaqueous delta platforms commonly develop between the river mouth and the inclined delta front. These 10–150 km wide platforms are dominated by flood-generated sediment plumes that interact with waves, tides and shelf currents to transport sediment across the distal subaqueous delta front and construct the shelf. However, up to half of the river's sediment discharge may bypass the shelf break to reach the continental slope and basin floor. Observations from modern examples, including the Santa Barbara shelf, Colorado River Delta and Han River Delta, together with facies analysis from the Mesaverde Group (Book Cliffs), the paleo-Orinoco and paleo-Colorado systems, are used to highlight the principal density-driven transport mechanisms and the dominance of wave- and current-enhanced sediment gravity flows.

Four principal sediment density flow processes are recognized: 1) Sandy hyperpycnal flows that discharge directly across the shelf as bottom-hugging density currents depositing elongate shelf-fan sand bodies, up to 10–15 m thick; 2) Wave- and current-enhanced sediment gravity flows (WCESGF) which transport sediment across the subaqueous delta platform and onto the upper subaqueous delta-front slope. These density flows develop when storm waves and currents are strong,

but sediment supply exceeds the resuspension capacity; 3) Ebb-tidal currents promote sediment transport by maintaining stratified flow resulting in the preservation of spring-neap cyclicity within thin-bedded gravity-flow deposits on the distal subaqueous platform and delta front; 4) Sediment density flows interact with high-density, bottom-hugging fluid mud suspensions far from the river mouth. In this case, fluid mud reduces bottom friction resulting in buoyancy-aided sandy hyperpycnal and muddy hypopycnal plumes transported up to 100–150 km from the shoreline.

These examples demonstrate that wave-enhanced, tide-enhanced and fluid-mud-assisted sediment gravity flows are common processes on the subaqueous delta. As these deltas prograde to the shelf edge, their subaerial and subaqueous components merge, funnelling large volumes of sediment beyond the shelf edge to become classical turbidites on the continental slope and basin floor.

KEYWORDS Gravity flows; wave-enhanced sediment gravity flows; fluid mud

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Sedimentary Characteristics and Model of Gravity Flow Deposits in the Lower Part of the Second Member of Dongying Formation, Eastern Slope of Chengdao, Jiyang Depression

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Deep-water gravity flows in continental rift lacustrine basins represent a key research focus in current sedimentology and hydrocarbon exploration, and gravity-flow sand bodies in basin slope zones hold substantial exploration potential. The eastern slope of Chengdao is located on the southeastern margin of the Jiyang Depression in the Bohai Bay Basin. It is a slope structure that transitions from the Chengbei Low Uplift to the Shanan and Bozhong sags, thus possessing favorable geological conditions for the formation of gravity flows.

Currently, the IV sand group of the Second Member of the Dongying Formation in this area still faces problems such as insufficiently refined stratigraphic subdivision and an inadequate understanding of the sedimentary facies and spatiotemporal evolution patterns of the sand bodies. Therefore, this paper conducts a detailed sedimentological study, aiming to clarify the gravity-flow depositional system and the distribution characteristics of sand bodies in this interval. The study takes regional lacustrine flooding mudstones as marker beds, integrates well log curve morphologies and sand-body stacking relationships, and adopts a 'marker-bed constraint – single-well subdivision – cross-well correlation' approach to subdivide the IV sand group into individual layers and to analyze the vertical associations and phased evolution of the sand bodies. Based on core observations and well-log data, rock types, sedimentary structures, and lithofacies associations are identified, and sedimentary facies types are comprehensively determined.

The results show that the IV sand group as a whole was deposited in a semi-deep to deep lacustrine depositional environment and mainly comprises three depositional types: fan deltas, flood-generated sublacustrine fans (hyperpycnal flows), and slump-generated sublacustrine fans. The fan deltas are dominated by fan-delta front subfacies with distinct lithological differentiation, serving as the main sediment supply system in the area. The flood-generated sublacustrine fans consist predominantly of channel and lobe microfacies, exhibit composite reverse-to-normal grading and current-generated sedimentary structures, and contain visible plant debris, recording fluctuations in flood energy. The slump-generated sublacustrine fans are mostly distributed along faulted slope-break zones and are typically characterized by soft-sediment deformation structures. The provenance of the study area is mainly from the Chengbei Low Uplift to the west, and the sedimentary facies are distributed in a southwest-northeast-trending belt. By integrating the provenance, paleogeomorphology, and structural characteristics, this study establishes a stepped-slope gravity-flow

depositional model for the IV sand group of the Second Member of the Dongying Formation on the eastern slope of Chengdao. The research findings can provide a reference for deep-water hydrocarbon exploration and reservoir evaluation in similar continental rift lacustrine basins.

KEYWORDS Eastern slope of Chengdao; Dongying Formation; Rift lacustrine basin; Gravity-flow deposits; Sublacustrine fan; Depositional model

058 POSTER P1-11

Catastrophic Marine Flooding and Hyperpycnal Sedimentation in the Springhill Formation (Lower Cretaceous), West Malvinas Basin, Argentina

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The Lower Cretaceous Springhill Formation constitutes the principal conventional reservoir unit of the West Malvinas Basin, an offshore basin developed at the southernmost margin of South America. Its depositional architecture has traditionally been interpreted in terms of continental, estuarine, and shallow-marine systems associated with the progressive transgression of irregular volcanic basement. This study presents a process-based reinterpretation of the formation based on the detailed sedimentological analysis of 245.92 m of cores from four wells, integrated with wireline-log and seismic information.

The West Malvinas Basin is interpreted as an aulacogen formed during the Middle Jurassic as an aborted arm of a triple-junction system related to the opening of the Weddell Sea. Initial basin development was accompanied by extensive volcanism and the accumulation of the Tobífera volcanic succession. During the Late Jurassic-earliest Cretaceous, the inherited rift topography was progressively filled by alluvial, fluvial, and lacustrine deposits corresponding to the basal continental interval of the Springhill Formation, regionally recognised as the Hidra Sequence.

Core observations indicate that the transition from these continental deposits to the upper Springhill Formation was abrupt rather than gradual. This change records rapid Berriasian marine flooding of a previously subsiding continental landscape that may have been located tens to hundreds of metres below contemporaneous sea level. Once marine connection was established, a catastrophic transgression (forced transgression) rapidly transformed the basin into an offshore marine environment.

Seventeen clastic facies were identified and grouped according to their dominant depositional mechanisms. Coarse-grained conglomerates and sandstones record bedload transport beneath long-lived turbulent flows, whereas massive and diffusely laminated sandstones resulted from the progressive collapse of suspended sediment. Fine-grained sandstone-mudstone rhythmites containing abundant plant debris, mica, and carbonaceous material are interpreted as lofting deposits generated above buoyant hyperpycnal plumes. Background mudstones and intensely bioturbated fine-grained deposits accumulated by suspension fallout in prodelta to offshore settings during periods of reduced fluvial discharge.

The association of extraclasts, terrestrial plant remains, clay chips, glauconite, marine shells, massive sandstones, lofting rhythmites, and repeated traction-suspension divisions indicates that the Springhill sandstones were mainly delivered to offshore areas by sustained river-derived hyperpycnal flows. This interpretation differs substantially from conventional shoreline-based models. Because these Newtonian density flows preferentially followed inherited submarine depressions, reservoir-prone sandstones should be concentrated within palaeotopographic lows rather than ex-

clusively along palaeoshorelines. The proposed model provides a more predictive framework for reconstructing Early Cretaceous palaeogeography and assessing reservoir distribution within structurally complex rifted margins.

KEYWORDS Springhill Formation; West Malvinas Basin; Austral Basin; Hyperpycnal flows; Forced transgression; Gravity flows

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Characteristics of Gravity-Flow Deposits and Organic Matter Enrichment of the Chang 7 Oil Member in the Ordos Basin, China

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During deposition of the Chang 7 Oil Member of the Triassic Yanchang Formation in the Ordos Basin, fine-grained sediments accumulated in semi-deep to deep lacustrine settings affected by sediment gravity flows. This study aimed to establish diagnostic criteria for gravity-flow deposits and evaluate their roles in material transport and organic matter enrichment. Core observations and X-ray fluorescence (XRF) data from Well R203 were used to classify depositional types, analyze depositional successions, and identify elemental variations. The studied interval contains three depositional types: background lacustrine deposits formed by suspension settling, slump-related gravity-flow deposits, and hyperpycnal-flow deposits. Slump-related gravity-flow deposits are characterized by syndepositional deformation structures, including slump folds, convolute bedding, and intra-bed faults, together with massive siltstone, massive mudstone, mudstone rip-up clasts, mud pebbles, and stacked normally graded units. These features indicate failure, downslope transport, fragmentation, and redeposition of basin-slope sediments. Following Zavala et al. (2011), hyperpycnal-flow deposits are classified into facies B, facies S, and facies L, with facies S and L predominating. Facies S comprises massive siltstone, interbedded sandstone and mudstone, wavy-bedded siltstone, and massive mudstone, and displays inverse-to-normal grading, stacked inverse-to-normal graded units, wavy bedding, and plant debris. Facies L consists of thinly laminated fine-grained deposits containing plant debris, carbonaceous debris, and mica flakes. These features record waxing and waning flood-flow energy and sustained terrigenous delivery to deep-lacustrine settings. Background lacustrine deposits consist of homogeneous massive mudstone, horizontally laminated mudstone, and shale. They rarely contain distinct grading, mud intraclasts, or sandy aggregates, and their contacts with underlying strata are gradational. XRF-derived elemental variations correspond to facies and depositional successions, providing criteria for distinguishing event-related gravity-flow deposits from background lacustrine deposits. Hyperpycnal flows transported fine-grained terrigenous detritus, plant remains, and particle-associated organic matter into deep-lacustrine settings. Fine-grained deposits formed during waning-flow stages favored rapid burial and preservation of organic matter, whereas inorganic detritus supplied during high-energy stages may have diluted organic matter concentrations. Chang 7 deep-lacustrine deposits resulted from suspension settling, hyperpycnal transport, and remobilization of unstable lake-floor sediments. Hyperpycnal flows therefore transported terrigenous material and potential organic matter into deep-lacustrine settings.

KEYWORDS Ordos Basin; Yanchang Formation; Chang 7 Oil Member; hyperpycnal flow; slump-related gravity flow

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060 ORAL O-17-1-1750

Linking Middle–Late Miocene basin evolution to Central Canyon formation in the Qiongdongnan Basin

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The Qiongdongnan Basin offers an example of how spatial variation in subsidence across the basin influences deep-water depositional systems during post-rift evolution. As one of the major sedimentary basins in the South China Sea, it records significant changes in sediment supply and accommodation during the Neogene, including the development of the Central Canyon, the largest submarine canyon system in the basin. Using 2D seismic data and well records, this study examines basin evolution across the Middle to Late Miocene through seismic and sequence stratigraphic analyses. Before the Serravallian–Tortonian boundary, Middle Miocene deposits indicate that shallow-water environments dominated much of the basin, with sedimentation occurring on a relatively broad shelf setting. After the boundary, Upper Miocene deposits indicate contrasting deep-water environments in the east and west. Variation in subsidence across the basin caused rapid deepening in the east while the west remained shallower, resulting in pronounced eastward tilting and downslope sediment transport, ultimately triggering the formation of the Central Canyon. These results establish a direct link between the Middle to Late Miocene evolution of the Qiongdongnan Basin and the development of the Central Canyon, highlighting the importance of tectonic controls on the evolution of deep-water sedimentary systems in post-rift settings.

KEYWORDS Qiongdongnan Basin; South China Sea; Serravallian–Tortonian boundary; Central Canyon; depositional environment; basin subsidence

061 POSTER P2-10

Luzon Submarine Fan in the Northwestern Philippine Sea Plate

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The Luzon submarine fan is situated in the northwestern part of the Philippine Sea Plate (PSP), which is the largest oceanic plate in the western Pacific. Although the fan was discovered in the 1970s, detailed knowledge about its nature and formation remains limited. In this study, we examine the morpho-sedimentary features and genesis of the fan by integrating bathymetric data, two-dimensional multi-channel seismic data, and core samples from the Deep Sea Drilling Project (DSDP) Site 293. Our analysis of the bathymetric data shows that the fan is oriented to the northeast, with its apex located near northeastern Luzon Island. It is bounded on the west by the north-south-trending Gagua Ridge and on the east by the northeast-southwest-oriented Luzon–Okinawa Fracture Zone. Across the northeast-dipping fan surface, we observed discontinuous, dendritic tributary submarine channels, which stretch for tens of kilometers and span several kilometers in width. Additionally, at least four fields of large-scale, step-like, or undulating bedforms are noted in the overbank areas. These bedforms, ranging from 2 to 7 kilometers in wavelength and from 50 to 120 meters in height, are roughly aligned parallel to the isobaths and are therefore interpreted as linked to supercritical turbidity currents overspilling from adjacent channels. Seismic stratigraphic interpretations reveal that the fan dominantly consists of high-amplitude reflections, suggesting it is mainly composed of relatively coarse-grained sandy turbidites. This view is further supported by

drilling data from DSDP Site 293, located at the outer fan, where over 400 meters of Pliocene to Quaternary sandy, silty, and muddy turbidites were uncovered. We infer that the fan could be fed by the late Cenozoic Luzon island arc, which resulted from the subduction of the South China Sea beneath the PSP. This speculation is supported by core-based data analyses, including smear-slide observations and bulk geochemical analyses of major and trace elements, which indicate that the turbidites were sourced from an oceanic island arc. The estimated area covered by the fan is approximately 46,000 square kilometers, with a potential maximum thickness of around 1,200 to 1,400 meters. These findings are important for enhancing our understanding of the plate tectonic and environmental evolution of the Philippine Sea Plate (PSP), especially since the plate is otherwise covered mainly by relatively thin pelagic deposits.

FUNDING National Natural Science Foundation of China (Grant numbers 42476073 and 42541601)

T2-5 Mud depositional processes and linkages to basin-fill architecture**062** POSTER P1-12**Mudstone vs. Shale: Concepts, Classification, Genesis and Sedimentary Environments****Benzhong Xian^{1,2}, Yichen Liu^{1,2*}, Mingjin Wu^{1,2}**¹ College of Geosciences, China University of Petroleum, Beijing 102249, CHINA² State Key Laboratory of Petroleum Resources and Engineering, China University of Petroleum (Beijing), Beijing 102249, CHINA

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Fine-grained sedimentary rocks represent one of the most widely distributed, volumetrically largest and best-preserved sedimentary rock types on Earth's surface. They not only archive abundant records of paleoclimate, paleoenvironment and paleoceanography, but also constitute critical targets for the exploration and development of unconventional resources such as shale oil and gas and rare metal mineral deposits. For a long time, fine-grained sedimentary rocks have been simplistically interpreted as products of slow suspension fallout within low-energy quiescent aquatic settings. Terms including mudstone, shale, claystone, siltstone and the compound term "mud shale" are frequently used interchangeably in academic research and industrial practices, resulting in inconsistent criteria for lithologic characterization, sedimentary process interpretation and resource evaluation. In recent years, advances in modern sedimentary observation, flume experiments, micropetrology, mineralogy and unconventional petroleum research have demonstrated that the transport and deposition of fine-grained sediments are far more complex than previously recognized, jointly governed by multiple hydrodynamic processes: suspension fallout, flocculation, traction currents, storm currents, bottom currents, turbidity currents and hyperpycnal flows. The distinctions between mudstone and shale lie not merely in grain-size composition, but are tightly linked to sedimentary structures, fissility, preferred grain orientation and diagenetic modification. This paper systematically reviews the history of research on fine-grained sedimentary rocks, clarifies the meaning and scope of core terminologies including mud, clay, silt, mudstone and shale, and evaluates major classification schemes based on grain size, composition, sedimentary structures, fissility and sedimentary environments. It further synthesizes the sediment provenance, transport mechanisms, sedimentary structures and their environmental implications for fine-grained deposits. We propose that mudstone and shale should not be distinguished solely by grain size or organic carbon content; instead, discrimination requires comprehensive integration of fine fraction proportion, lamina development, fissility and genetic setting. Specifically, mudstone is defined as fine-grained sedimentary rock dominated by silt- and clay-sized particles, generally lacking prominent fissility. By contrast, shale is defined as fine-grained sedimentary rock bearing primary laminae or thin-bedded structures and exhibiting distinct fissility. Fine-grained sedimentary deposits are not exclusive to deep-water environments; typical fine-grained accumulations can form in shallow marine shelves, tidal flats, delta fronts, shallow lacustrine littoral zones, as well as semi-deep to deep lacustrine settings. Establishing a unified, unambiguous terminological system and classification framework constrained by genetic mechanisms is essential to improve the interpretation accuracy of fine-grained depositional systems, the reliability of unconventional reservoir assessment, and the efficiency of interdisciplinary communication.

KEYWORDS Fine-grained sedimentary rocks; mudstone; shale; sedimentary processes; sedimentary environments; classification schemes

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T2-6 Fine-grained sedimentology: interactions of Earth's spheres and synergistic coevolution of environment, biota and minerals

063 POSTER P2-11

Climate-driven lacustrine environmental changes and nitrogen-cycle reorganization as controls on organic matter enrichment in lacustrine shales

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Organic-rich lacustrine shales are important archives of organic carbon burial in continental lake basins. However, their formation is not simply controlled by productivity or reducing conditions, but is closely linked to climate-driven changes in lake environments. In this study, we integrate total organic carbon (TOC), total nitrogen (TN), carbon and nitrogen stable isotopes, trace elements, lithofacies observations, and biomarker data to investigate the coupling among lacustrine environmental changes, nitrogen cycling, and organic matter enrichment. The studied interval records two alternating sedimentary-biogeochemical modes. Mode A developed during relatively arid phases and is characterized by higher TOC, TN, Sr/Ba ratios, and Mo contents, together with heavier $\delta^{13}\text{C}_{\text{org}}$ values and elevated $\delta^{15}\text{N}$ values. Continuous horizontal lamination and small-sized framboidal pyrite indicate a low-energy, stable lake environment with more persistent oxygen-deficient conditions. During this stage, enhanced evaporative concentration increased hydrological restriction, which favored organic matter preservation and promoted denitrification and other nitrogen-loss processes, resulting in elevated sedimentary $\delta^{15}\text{N}$ values. Meanwhile, the synchronous increase in cyanobacterial biomarkers and eukaryotic contributions suggests enhanced lacustrine ecosystem productivity. Nitrogen fixation may have alleviated nitrogen limitation and further stimulated organic matter input. In contrast, Mode B corresponds to relatively humid phases, during which increased freshwater supply and detrital input intensified water-column disturbance, weakened oxygen-deficient conditions, and reduced the isotopic expression of nitrogen-loss processes. This ultimately produced sedimentary records characterized by lower TOC, lighter $\delta^{13}\text{C}_{\text{org}}$ values, and lower $\delta^{15}\text{N}$ values. These results indicate that organic matter enrichment in lacustrine shales resulted from the combined effects of climate-driven environmental changes, biological productivity, organic matter preservation, and nitrogen-cycle reorganization. This study provides a new geochemical perspective for understanding deep-time lacustrine carbon-nitrogen cycling and the enrichment mechanisms of organic matter in continental shales.

KEYWORDS Lacustrine shale; Environmental change; Organic matter enrichment; Nitrogen cycling; Carbon and nitrogen isotopes; Biomarkers

064 POSTER P1-15

Sedimentary Responses to Milankovitch Cyclicality in the Eocene Shahejie Formation of the Dongying Depression, Bohai Bay Basin

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Several studies have revealed that deposition of the Eocene fine-grained sedimentary rocks in the Bohai Bay Basin was driven by astronomical forcing. However, it remains unclear how orbital cycles specifically controlled the deposition of these rocks and the coupling between paleoclimate, paleolake and sedimentation. In this study, core and thin-section observations, X-ray diffraction, ICP-MS analysis, total organic carbon (TOC) analysis and cyclostratigraphic analysis were con-

ducted on the lacustrine shale of the Eocene Shahejie Formation (Es4u to Es3l) in the Dongying Depression of Bohai Bay Basin, in order to recognize the Milankovitch cycles and explore the controlling effect of eccentricity, obliquity and precession on the deposition of the lacustrine shale as well as the paleoclimate evolution. The main results are as follows. (1) Pre-processing, sliding-window spectral analysis and multi-taper method (MTM) analysis of natural gamma-ray data from well NY1 revealed clear orbital signals. Using the correlation coefficient (COCO) method, the study interval was divided into two sections according to changes in accumulation rate. Filtered eccentricity, obliquity and precession signal curves were obtained for both sections. (2) For the lower section, obliquity is the main controlling factor for shale deposition and precession is the secondary controlling factor. When obliquity reaches its maximum, the content of dolomite and clay in the Shahejie Formation increases, while the content of calcite decreases and TOC also increases. At this point, the lamina combinations are mainly dolomite/calcite laminae and organic-rich clay laminae. When obliquity reaches its minimum, the content of calcite increases, the content of dolomite and clay decreases and TOC decreases. At this point, the lamina combinations are mainly calcite laminae and mixed clay-silt laminae. (3) For the upper section, eccentricity is the main controlling factor for shale deposition and precession is the secondary controlling factor. When eccentricity reaches its maximum, the content of clay and quartz in the Shahejie Formation increases, while the content of carbonate minerals decreases and TOC also increases. At this point, the lamina combinations are mainly calcite laminae and organic-rich clay-silt laminae. When eccentricity reaches its minimum, the content of clay and quartz decreases, the content of carbonate minerals increases and TOC decreases. At this point, lamina boundaries are usually indistinct. (4) Geochemical data show that the chemical index of alteration (CIA) for the lower section is relatively low and the Mg/Ca and Ni/Co ratios are relatively high, indicating an arid and reducing paleo-environment. For the upper section, CIA is relatively high and the Mg/Ca ratio and Ni/Co ratio are relatively low, indicating a humid and less reducing paleo-environment. The coupling between paleoclimate, paleo-lake and sedimentation underwent a transition from the lower section to the upper section of the study interval, which is consistent with the shift from obliquity-driven to eccentricity-driven deposition. Intensification of the East Asian monsoon might be responsible for this transition.

KEYWORDS Lacustrine shale; Milankovitch cycles; Sedimentary environment; Laminar combination; Dongying Depression

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065 POSTER P1-13

Deep-Time Lacustrine Organic Carbon Burial under Tectonic–Climatic–Ecological Coupling

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Lacustrine organic carbon burial is an important process in the carbon cycle and in the regulation of the atmospheric carbon reservoir, yet its long-term evolutionary patterns and response mechanisms to major geological events remain insufficiently understood. Based on deep-time geological records and representative examples of lacustrine organic-rich shales, this study explores the formation mechanisms of lacustrine organic carbon burial under the combined influence of tectonic activity, climate change, and ecological evolution. The results indicate that although lakes occupy a

much smaller area than oceans, they exhibit relatively high organic carbon burial efficiency. Lacustrine organic carbon burial is not controlled solely by climate, but is jointly regulated by basin tectonic setting, lake size, water properties, nutrient supply, biological productivity, organic matter preservation conditions, and clastic dilution intensity. The ecological evolution of lakes from “dead lakes” and “starved lakes” to “ecologically primary lakes” and ultimately “ecologically prosperous lakes” changed the composition of primary producers and the efficiency of the biological pump, providing an important foundation for the episodic enhancement of deep-time lacustrine organic carbon burial. Volcanic-hydrothermal activity can promote primary productivity and bottom-water anoxia by supplying essential elements and regulating water-column redox conditions and salinity structure. Warm and humid climates, together with intensified terrestrial weathering and runoff, can expand lake water bodies, increase nutrient fluxes, and promote ecological prosperity in lakes. Marine transgressions or brackish-water conditions can alter lake-water chemistry and strengthen water-column stratification, thereby enhancing the preservation potential of organic matter. Accordingly, this study identifies five major modes of large-scale lacustrine organic carbon burial: volcanic-hydrothermal forcing, climate-volcanism coupling, climate-lake size coupling, climate-transgression coupling, and tectonic-climate coupling. Deep-time records of lacustrine organic carbon burial not only provide an important window into the formation of terrestrial source rocks and interactions among Earth's spheres, but also offer a geological-historical reference for assessing the response of lake carbon sinks to future climate warming and their feedbacks to the global carbon cycle.

KEYWORDS Lacustrine organic carbon burial; Lake ecological evolution; Geological events; Organic carbon cycle; Interactions of Earth's spheres; Tectonic-climatic-ecological coupling

T2-7 Carbonate sedimentation: from facies analysis to global changes**066** POSTER P2-12**Multistage blocky calcite cementation in the Cretaceous carbonates of central Iraq: insights from integrated petrology, geochemistry, and U–Pb dating****Hangyu Liu^{1*}, Kaibo Shi², Bo Liu²**¹ School of Energy Resources, China University of Geosciences (Beijing), Beijing, CHINA² School of Earth and Space Sciences, Peking University, Beijing, CHINA* E-mail: hyliu@cugb.edu.cn

Blocky calcite cement (BC) is ubiquitous and serves as a key archive for deciphering basin fluid circulation. However, the environmental conditions responsible for BC formation and reliable ways to distinguish its origin remain inadequately documented. To address this, the widespread BC in the Cretaceous Rumaila Formation of the Zagros foreland basin was investigated via integrated petrology, geochemistry and U–Pb dating techniques. Six distinct BC phases, occluded in various pore types, are distinguished. The first two BC stages, dated at ca. 93 Ma and 92 Ma, formed in the marine realm, originating from coeval normal oxic seawater and modified suboxic seawater. The subsequent four BC stages, dated between ca. 55–21 Ma, formed in the burial realm where parent fluids—primarily formation water—were alternately mixed with freshwater and low-T hydrothermal fluids. Early BC phases exhibit more pronounced recrystallization in open diagenesis systems, causing larger mean square weighted deviations (MSWDs >3) in U–Pb data. The final BC phase yields two distinct U–Pb ages, suggesting prolonged crystallization in minimally altered fluids within a progressively closed diagenetic system. These findings challenge the traditional view that BC typically forms in late diagenesis, revealing instead that multistage BC can span from synsedimentary to late diagenetic stages. Furthermore, the low Mg/Ca ratio and sulfate ion level of seawater during the Calcite Sea period may have facilitated early BC precipitation. The observed association between pore types and BC phases suggests that poorly connected, small-pore spaces are more conducive to early BC formation, providing a preliminary basis for identifying BC origins. Additionally, cathodoluminescence and trace element (REE+Y) indices, combined with U–Pb dating, enable the identification of multistage BC origins and the reconstruction of subtle temporal and spatial evolution of basin fluids. The fluid origins and pathways of burial BC are closely linked to the Zagros orogeny, providing new evidence that supports the latest revised collision time (ca. 56 Ma). This implies that tectonic-driven diagenesis extends far inboard from the orogenic front and plays an underestimated role in basin water–rock interactions.

KEYWORDS Blocky calcite; multistage cementation; U–Pb dating; elemental geochemistry; Cretaceous seawater; Zagros orogeny

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067 ORAL O-19-1-0950

New Advances in Tectonic-Lithofacies Paleogeography of the Early Paleozoic in the Ordos Basin, China

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The Lower Paleozoic marine carbonate rocks in the Ordos Basin are an important target for natural gas exploration. Nevertheless, significant tectonic-lithofacies paleogeographic differentiation and strong reservoir heterogeneity have greatly hampered large-scale and efficient exploration and development. Combining the latest drilling results and seismic data of regional framework sections, this paper investigates fundamental geological issues such as platform tectonic differentiation, lithofacies paleogeographic evolution and reservoir distribution patterns, and reveals the distribution patterns of large-scale high-quality marine carbonate reservoirs in the basin. The main results are as follows. First, breaking the traditional view that the western area belonged to the Qilian Sea and the eastern area to the North China Sea, this study proposes that both the eastern and western parts of the Ordos Basin were part of the North China Platform in the Early Paleozoic, which evolved successively through back-arc basin, passive continental margin and foreland basin stages. Second, revising the conventional understanding of the L-shaped Central Paleo-uplift in the Early Paleozoic, it clarifies that the Ordos Basin featured a paleogeomorphic pattern of one uplift and two slopes in the Cambrian, which evolved into two uplifts and two depressions in the Ordovician. Third, the Early Paleozoic lithofacies paleogeography is reconstructed, and it is confirmed that favorable reservoir facies belts including inner ramp, platform margin and shoal-flat at lagoon margins are distributed along paleo-uplifts and around depressions, with favorable reservoirs covering $10.5 \times 10^4 \text{ km}^2$. The research findings provide important theoretical support for natural gas exploration of marine carbonate rocks in the Ordos Basin.

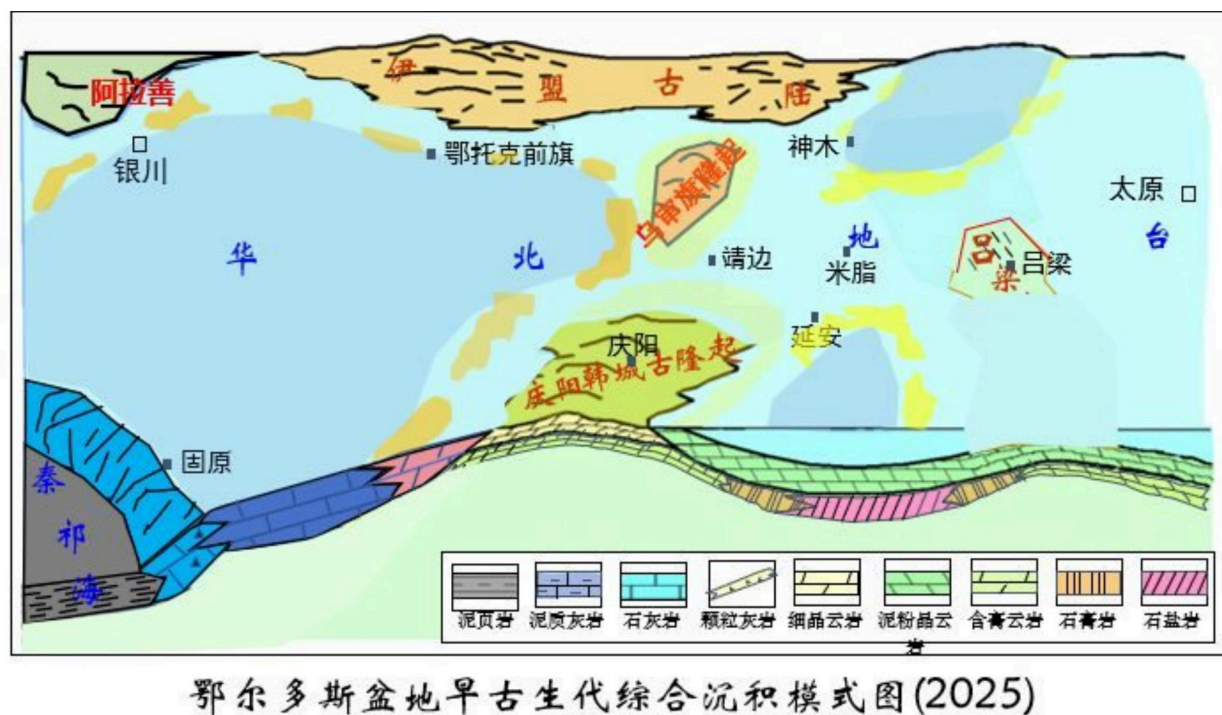


Fig. 1. Comprehensive sedimentary model of the Ordos Basin in the Early Paleozoic

KEYWORDS Ordos Basin; Paleogeography; Carbonate reservoirs; North China

068 POSTER P1-14

Geochemical-parameter prediction by conventional well logs using machine learning

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Geochemical parameters serve as crucial indicators for assessing the hydrocarbon generation potential of source rocks, which can help to gain a deeper understanding of the geological processes and organic matter evolution mechanisms of source rocks. Among these, stable carbon isotope ($\delta^{13}\text{C}_{\text{carb}}$) and total organic carbon (TOC) contents are key parameters for understanding the occurrence and abundance of organic matter. Previous studies have demonstrated that traditional TOC estimation methods are insufficient for evaluating the potential of marine carbonates, particularly in subsalt carbonate reservoirs. This study introduces an innovative approach, suggesting that depleted $\delta^{13}\text{C}_{\text{carb}}$ excursion characteristics can serve as a geochemical parameter for evaluating the hydrocarbon generation potential of marine carbonates. However, no prior research has developed an interpretative model for $\delta^{13}\text{C}_{\text{carb}}$ in subsalt marine carbonates using conventional logging curves. We propose a novel $\delta^{13}\text{C}_{\text{carb}}$ prediction method based on a stacking ensemble learning model combined with geostatistics. The findings indicate that factors such as anhydrite, halite, and climatic conditions can significantly influence carbon isotope abundance, and depleted $\delta^{13}\text{C}_{\text{carb}}$ excursion correlates with well log data. This study demonstrates that conventional logging methods can effectively predict $\delta^{13}\text{C}_{\text{carb}}$ distribution, providing deeper insights into the hydrocarbon generation history of subsalt carbonate reservoirs. This advancement is pivotal for evaluating marine carbonates and understanding their effectiveness as hydrocarbon sources.

KEYWORDS Carbon isotope; Total organic carbon; Depleted $\delta^{13}\text{C}_{\text{carb}}$ signature; Subsalt carbonates; Machine learning

069 ORAL O-19-1-0830

Technology and Application of Carbonate Lithofacies Paleogeographic Reconstruction — A Case Study of Carbonate Rocks in Chinese Cratons

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Purpose and Significance: Carbonate rocks harbor abundant oil and gas resources and represent a crucial domain for current and future exploration. As most carbonate rocks are distributed in the deep layers of superimposed basins, reconstructing their lithofacies paleogeography is extremely challenging and has become a critical issue constraining deep oil and gas exploration. This paper aims to overcome the challenges in carbonate lithofacies paleogeographic reconstruction, establish standards and workflows for compiling carbonate lithofacies paleogeographic maps, contribute to carbonate sedimentology theory and promote deep carbonate oil and gas exploration.

Methods: Based on research practices in carbonate rocks from three major cratons in China, this study developed a "ternary" paleogeographic restoration technique and a specification for compiling carbonate lithofacies paleogeographic maps. The "ternary" restoration technique integrates three types of information—residual formation thickness (controlling morphology), lithofacies types (indicating environment), and seismic reflection characteristics (defining structure)—to quantitatively restore the original paleogeomorphological framework during the carbonate depositional period, thereby achieving high-precision paleogeographic reconstruction integrating "morphology-environment-structure." The "3 tables, 9 maps, 4 steps, 10 links" specification for carbonate lithofacies paleogeographic map compilation standardizes three types of traceable basic data tables and establishes a four-step, ten-link process for map preparation, achieving lithofacies paleogeographic reconstruction by integrating eight types of base maps. These paleogeographic reconstruction techniques and mapping specifications address the challenges of inaccurate paleogeographic restoration for deep carbonate rocks and the lack of unified standards in lithofacies paleogeographic map preparation, thereby establishing a technical foundation for carbonate sedimentary evolution research.

Key Results: The application of the aforementioned technical methods to carbonate rocks in the Yangtze, North China, and Tarim cratonic basins in China yielded three significant new insights and facilitated new progress in exploration. (1) Paleogeographic background restoration of carbonate rocks in the three major cratonic basins reveals that rift-related sedimentary differentiation and uplift-depression sedimentary differentiation were the primary controlling factors in paleogeographic formation. For instance, the early rifting of the Kaijiang-Liangping trough in the Sichuan Basin, combined with the residual paleogeomorphology from the Caledonian orogeny, jointly controlled the "two uplifts, three depressions" paleogeographic setting of the Maokou period. In contrast, the inherited uplift-depression sedimentary differentiation in the Ordos Basin controlled the Cambrian "one uplift, two slopes, three depressions" paleogeographic pattern. (2) Lithofacies paleogeographic reconstruction of carbonate rocks in the three major cratonic basins reveals that carbonate platforms exhibit an evolutionary pattern of "ramp - rimmed shelf - evaporative - drowned (eroded)." Examples include the Majiagou Formation (ramp) to the Wulalike Formation (rimmed shelf) to the Lashenzhong Formation (drowned and eroded) in the Ordos Basin; and the Early Cambrian (ramp) to the Middle Cambrian and Ordovician (rimmed shelf) to the Late Ordovician-Silurian (drowned) in the Tarim Basin. (3) New, basin-specific carbonate depositional models were developed. These include the multi-ramp depositional model for the Xiaoerbulak Formation in the Tarim Basin; the multi-stage platform margin depositional model for the Sinian System in the Sichuan Basin; the dual-bank ramp model for the Longwangmiao Formation in the Sichuan Basin; and the multi-stage barrier depositional model for the Majiagou Formation in the Ordos Basin. These new insights into lithofacies paleogeography guided the evaluation of favorable exploration zones and target optimization, providing support for exploration discoveries, such as the Sinian System in the Penglai-Gaoshiti area and the Maokou Formation in the Pengxi-Tongnan area of the Sichuan Basin, the Majiagou Formation in the Gaojiapu area of the Ordos Basin, and the Cambrian-Ordovician strata in the Lunnan-Xiaotang area of the Tarim Basin.

Conclusions: This study presents a quantitative technique for carbonate paleogeographic reconstruction, establishes specifications for compiling carbonate lithofacies paleogeographic maps, and develops new insights into the paleogeographic framework, platform evolution, and depositional models of carbonate rocks in the three major cratons. The research outcomes enrich the theory of carbonate sedimentology, facilitate new discoveries in oil and gas exploration, and provide valuable references for carbonate research and oil and gas exploration in China and elsewhere.

KEYWORDS Carbonate; Paleogeographic reconstruction; Compiling standards of carbonate lithofacies paleogeographic maps; Yangtze Craton; Tarim Craton; North China Craton

070 POSTER P2-28

Early Hercynian Residual Paleogeomorphology and Distribution Pattern of Late-Stage Shoals in the Qixia Formation, Eastern Sichuan Basin

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The Middle Permian Qixia Formation is one of the most important marine carbonate exploration intervals in the Sichuan Basin. Controlled by the Caledonian compound paleouplift, large-scale dolomite reservoirs developed in the western Sichuan platform-margin belt and the core of the central Sichuan paleouplift. Previous studies suggested that the eastern, northern, and southern Sichuan areas were dominated by low-energy mid-ramp deposits, with limited shoal development. However, recent drilling has revealed the presence of grain shoal reservoirs in the eastern Sichuan area, dominated by micritic grainstone or weakly dolomitized grainstone, although their distribution pattern remains poorly understood. Based on a comprehensive re-examination of well cuttings and integrated well-log interpretation from dozens of wells, it is demonstrated that the late-stage shoals in the Qixia Formation of the eastern Sichuan area exhibit a thin, widespread distribution, forming multiple shoal belts around the periphery of the central Sichuan paleouplift core. To clarify the distribution pattern of these late-stage shoals in the eastern Sichuan area, well-log and seismic data were used to characterize the residual distribution of the Carboniferous strata, as well as the distribution and lithofacies of the Liangshan Formation in the area. Using the maximum flooding surface of the first member of the Maokou Formation as a marker horizon, the pre-Qixia paleogeomorphology was finely restored. The results indicate that, influenced by the Early Hercynian Yunnan Movement, the Carboniferous in the Kaijiang area of eastern Sichuan formed a positive-relief karst highland, with an alternating high-low residual paleogeomorphology surrounding this highland. Subsequently, the deposition of the Liangshan Formation partially infilled the paleotopography, reducing the relief and expanding the area of positive relief, resulting in a pattern of isolated, shrinking depressions and adjacent low-high features. This paleogeomorphological framework provided a favorable sedimentary background for the development of bioclastic shoals in the Qixia Formation. The Early Hercynian residual paleogeomorphic features—including the Carboniferous erosional edge and karst highland, as well as the subaqueous low-relief highs of the Liangshan Formation—are the main factors controlling the development and distribution of late-stage Qixia bioclastic shoals in the eastern Sichuan area. This study provides an important geological basis for exploration deployment targeting Qixia Formation bioclastic shoals around the central Sichuan paleouplift in the Sichuan Basin.

KEYWORDS Sichuan Basin; Qixia Formation; bioclastic shoal; paleogeomorphology; Early Hercynian

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New Insights into the Sedimentary Pattern of the Mao 3 Member in the Sichuan Basin and Their Implications for Hydrocarbon Exploration

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The Middle Permian Maokou Formation is one of the most important marine carbonate exploration intervals in the Sichuan Basin, Upper Yangtze region. The Gufeng Member, a coeval heteropic deposit of the Maokou Formation, is chronologically attributed to the late Capitanian (late Maokouan). It consists of black siliceous calcareous mudstone and argillaceous limestone, characterized by high gamma-ray (GR) responses, serving as a key indicator for deep-water deposits during the Maokouan stage. Previously, the Gufeng Member was assigned to the upper part of the Mao 2 Member in the stratigraphic division of the Sichuan Basin, interpreted as a fore-platform deep-water deposit coeval with the platform-margin shoal dolomite of the Penglai-Shizhu belt. The overlying Mao 3 Member was considered to be dominated by extensive limestone deposits, with limited dolomitized shoal development. However, new evidence from field outcrops, isotopic data, well logs and paleontology indicates that an erosional surface is widely developed between the top of the Mao 2 Member and the high-GR siliceous rocks of the Gufeng Member in several sections of the northern Sichuan Basin. In addition, two distinct negative carbon isotope excursions are observed, suggesting environmental instability and rapid sea-level fall during the late depositional stage of the Mao 2 Member, which contradicts the transgressive nature of the Gufeng Member. Furthermore, recent drilling data reveal that dolomitized shoal deposits also occur above the Gufeng Member in the northern Sichuan Basin, indicating that their formation must postdate the late Mao 2 dolomites in the Penglai-Bajiaochang area. Consequently, it is demonstrated that the Mao 3 Member hosts large-scale platform-margin dolomitized shoals. Updated lithofacies paleogeographic mapping, constrained by the new stratigraphic division, shows that influenced by outer-zone extension of a mantle plume and the expansion of the Mianlue Ocean, the northern margin of the Upper Yangtze region experienced platform-trough differentiation, which controlled the development of multiple slope breaks and shoal bodies. By the Mao 3 depositional stage, the Kaijiang-Liangping intraplateform trough had begun to take shape, giving rise to a set of weakly rimmed platform-margin shoals. This study adds approximately 8,200 km² of newly identified shoal area within the Mao 3 Member in the northern Sichuan Basin, providing a critical geological basis for exploration deployment.

KEYWORDS Sichuan Basin; Maokou Formation; platform-margin shoal; Gufeng Member; intraplateform trough

FUNDING Major Science and Technology Project of PetroChina Company Limited "Study on hydrocarbon enrichment patterns and favorable zones of carbonate rocks" (Grant No. 2023ZZ16YJ01)

T2-9 Volcanic activity: environmental impact and resource significance**072** POSTER P1-16**Environmental response to volcanic activity in the Permian Lucaogou Formation of the Malang Sag, Santanghu Basin, Northwest China****Zhilong Huang¹, Yongshuai Pan^{2*}**¹ State Key Laboratory of Petroleum Resources and Prospecting, China University of Petroleum (Beijing), Beijing 102249, CHINA² State Key Laboratory of Continental Shale Oil, Northeast Petroleum University, Daqing 163318, CHINA

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The saline lacustrine organic-rich fine-grained rocks widely developed in the Permian Lucaogou Formation of the Malang Sag, Santanghu Basin, are significantly influenced by volcanic activity and exhibit complex lithological compositions with frequent variations. However, systematic studies on how volcanic activity influenced the sedimentary environment and rock types remain lacking. To address these issues, this study employed petrological, mineralogical, and geochemical methods to investigate the environmental responses to volcanic activity during the depositional period of the Lucaogou Formation and their controlling effects on lithology. The results indicate that the fine-grained rocks of the Lucaogou Formation were primarily formed by the highly mixed deposition of volcanic ash from the basin margin and intra-basin dolomite, resulting in four main rock types. Multiple episodes of volcanic eruptions occurred during the deposition of the Lucaogou Formation. In its lower to middle sections, three main eruption cycles are dominant, whereas the middle to upper sections are characterized by multiple phases of volcanic activity. Volcanic activity exerted a significant control on the sedimentary environment and lithology of the Lucaogou Formation. The content of felsic minerals is relatively high at the base of each volcanic eruption cycle. Transitioning from the base to the top, the felsic mineral content gradually decreases while the dolomite content progressively increases. During periods of intense volcanic activity, the climate was semi-arid to semi-humid, with weakened evaporation in the lake basin, a brief decline in paleosalinity, and relatively enhanced reducing conditions, leading to the deposition of tuff and dolomitic tuff in the Lucaogou Formation. As volcanic activity transitioned from intense eruption to intermittent stages, the climate became hotter and drier, increasing water evaporation and salinity, along with an increase in oxygen content, resulting in the predominant formation of dolomite and tuffaceous dolomite. During intervals of frequent volcanic activity fluctuations, the alternating increases in felsic mineral and dolomite contents led to the frequent interbedded deposition of laminated tuffaceous and dolomitic components. This study provides significant guidance for understanding environmental changes and lithological characteristics within large igneous provinces.

KEYWORDS Fine-grained rocks; Volcanic activity; Sedimentary environment; Lucaogou Formation; Santanghu Basin**FUNDING** National Natural Science Foundation of China (42402154), China Postdoctoral Science Foundation (2025M770454), and the Natural Science Foundation of Heilongjiang Province, China (YQ2025D004)

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Decoupled Volcanism and Silicate Weathering in Triggering the Sturtian Snowball Earth: Constraints from the Shennongjia Area, Yangtze Craton

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The initiation of the Sturtian Snowball Earth represents a radical transition from prolonged greenhouse conditions to extreme global glaciation, offering a pivotal case study for understanding Earth system self-regulation and the climatic tipping mechanisms that trigger its collapse. However, a major challenge in current research remains the scarcity of geological evidence capable of substantiating and testing initiation mechanisms. The continuous Tonian–Cryogenian sedimentary succession in the Shennongjia area of the Yangtze Craton offers a rare opportunity to evaluate these hypotheses. This study investigates volcanic and weathering controls on the Sturtian glaciation using mercury records and geochemical proxies from the Shennongjia area, revealing that (1) large-scale volcanism occurred at 770–750 Ma, supported by elevated Hg concentrations and coincident near-zero $\Delta^{199}\text{Hg}$ values; and (2) a subsequent continental high-weathering episode at ca. 735–720 Ma was supported by Hg isotope ($\Delta^{199}\text{Hg}$) excursions (down to -0.25‰) and high chemical index of alteration ($\text{CIA}_{\text{corr}} > 85$) values. We propose that the decline in volcanic activity after ca. 750 Ma, resulting in reduced CO_2 degassing, acted synergistically with enhanced silicate weathering from 735 to 720 Ma to drive atmospheric CO_2 drawdown and global cooling, ultimately triggering the onset of the Sturtian glaciation. Notably, the prolonged uplift and exposure of magmatic rocks from the Rodinia supercontinent enhanced the efficiency of chemical weathering during the late Tonian. These findings not only support the hypothesis that silicate weathering played a critical role in initiating the onset of the Sturtian Snowball Earth event, but also underscore the importance of temporal coupling between tectonic processes and surface environmental changes in driving extreme climate transitions.

KEYWORDS Onset of the Sturtian glaciation; Sedimentary evolution; Silicate weathering; Volcanism; Northern Yangtze

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T3

Tectonic palaeogeography and global palaeogeographic reconstruction

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T3-1 Global palaeogeographic reconstruction

074 POSTER P1-17

Meso- to Neoproterozoic layered intrusions from Argentina and their paleogeographic implications

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The mafic and ultramafic rocks of interest comprise the Las Águilas, Las Higueras, El Renegado, Virorco, and Escuela Las Pircas bodies, located in the southern sector of the La Jovita-Las Águilas belt, situated on the east side of the Sierra Grande de San Luis. These bodies are of great interest because they are stratified intrusions containing Fe-Ni-Cu-Co sulfides and platinum group minerals, and also because their study provides valuable information about the mantle source from which they originated, the regional tectonic context in which they formed, and contributes to understanding global geotectonic events.

Dating this kind of rock is a complex task, especially if they are old, due to the metamorphic events that may have affected them. For many years, these mafic and ultramafic rocks were assigned to 480 Ma, based on an age obtained from an acid segregation in a pyroxenite. However, more recent studies based on an Sm-Nd whole-rock isochron suggested that these bodies could be 1002 Ma or even older. This new information generated significant controversy, as it changed the geotectonic understanding of the Pampia terrane in which these intrusive rocks were believed to be located.

As indicated, the studied rocks represent layered intrusions that are orthopyroxene-rich, as expected in this kind of deposit, but that also carry amphibole in equal proportion. This has two implications: firstly, the magma was contaminated with continental crustal rocks, contributing SiO₂ for the formation of the orthopyroxenes, as occurs in other worldwide deposits; and secondly, the influence of a subducting slab provided the water necessary for amphibole formation. Although these are currently the only intrusive bodies associated with a back-arc environment, ongoing studies, such as those involving assimilation and fractional crystallization processes, suggest that they were apparently not contaminated by the wall rocks of the Pringles Metamorphic Complex (continental crust). For this reason, it is important to establish which of the following petrogenetic processes affected them: 1) influence of the subduction slab, 2) crustal contamination with the rocks of the surrounding crust, 3) contamination with an older continental crust (older than 1 Ga) and/or 4) combination of more than one of these processes.

The advances achieved in the study of these intrusive bodies will be essential, since they will contribute to knowledge of the Meso- to Neoproterozoic paleogeography of Argentina, and also to knowledge of these particular layered igneous bodies.

KEYWORDS Pampia terrane; Meso- to Neoproterozoic; layered mafic-ultramafic intrusions

075 POSTER P1-18

The breakup of the core of Columbia/Nuna: Insights from Early Precambrian geological events in the Yangtze Craton

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The Columbia/Nuna and Rodinia supercontinents are two significant Proterozoic supercontinents with multiple reconstruction models. Most studies suggest that the core of the Columbia/Nuna supercontinent remained stable, consisting of cratons with long-term connections, namely Laurentia, Siberia, and Baltica, from the breakup of Columbia/Nuna to the assembly of Rodinia. This study addresses whether the core of Columbia/Nuna broke up, by tracing the assembly history of the Yangtze Craton. Comparisons of Archean-Proterozoic magmatic, metamorphic, and sedimentary events between the Yangtze Craton and other cratons indicate that in the early Paleoproterozoic, Yangtze was located in the core of Columbia/Nuna, with the southwestern Yangtze Block located in the northern part of Laurentia and the northern Yangtze Block along the southern margin of Siberia; these two blocks collided at ca. 2.0–1.95 Ga during the amalgamation of Laurentia and Siberia. In the mid-Neoproterozoic, the Yangtze Block was positioned at the periphery of Rodinia, adjacent to the northern margin of the India Block. Thus, from Columbia/Nuna to Rodinia, the Yangtze Block shifted from the core to the margin of the supercontinent, reflecting that the core of Columbia/Nuna underwent disintegration.

KEYWORDS Yangtze Block; Supercontinent core; Columbia/Nuna to Rodinia supercontinent

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Thermochronological Response Domains of Antarctica and Their Implications for Continental-Scale Surface Evolution and Palaeogeographic Reconstruction

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Antarctica is central to reconstructions of Gondwana breakup, polar landscape evolution, and long-term ice-sheet development, yet its bedrock record remains difficult to integrate because most of the continent is covered by ice and exposed thermochronological data are unevenly distributed. Medium- to low-temperature thermochronology provides a key means of constraining the timing and spatial pattern of cooling and exhumation, and thus offers an important perspective on Antarctic surface evolution and palaeogeographic reconstruction.

This contribution synthesizes published apatite fission-track, apatite (U-Th)/He, zircon fission-track, and zircon (U-Th)/He data from major Antarctic sectors, including East Antarctica, the Transantarctic Mountains, the Shackleton Range, the Ellsworth Mountains, the Antarctic Peninsula, Marie Byrd Land, the Ross Sea region, and Thurston Island. The compiled record indicates that Antarctica cannot be interpreted as a single thermochronological system. Instead, three broad response domains can be recognized. East Antarctica is dominated by old cooling ages and long-term preservation of cratonic thermal histories, although several continental margins record localized reactivation and enhanced denudation. The Transantarctic Mountains, Shackleton Range, and Ellsworth Mountains form a transitional response domain, where inherited cooling signals co-exist with later tectonic, topographic, and glacial overprints. West Antarctica is characterized by younger and more dispersed cooling ages, reflecting the combined influence of long-lived arc activity, crustal extension, rifting, mantle thermal anomalies, and selective glacial incision.

These response domains show that Antarctic cooling-age patterns record the interaction of lithospheric inheritance, Gondwana breakup and post-breakup tectono-magmatic reactivation, and spatially selective ice-sheet erosion. Thermochronological ages do not directly quantify uplift or erosion rates, but they constrain the timing, magnitude, and spatial organization of cooling and exhumation windows that are essential for reconstructing Antarctic surface evolution.

KEYWORDS Antarctica; medium- to low-temperature thermochronology; response domains; surface evolution; palaeogeographic reconstruction; exhumation

T3-2 Tectonic palaeogeography and sedimentation**077** ORAL O-19-3-0905**New tools help improve palaeogeographic reconstructions – analysis of the environmental setting of the Paleocene Lockhart Limestone (Pakistan)****Ahmer Bilal¹, Renchao Yang^{1*}, Nie Wen², A.J. (Tom) van Loon¹, Carlos Zavala¹**¹ College of Earth Science and Engineering, Shandong University of Science and Technology, Qingdao 266590, CHINA² School of Safety Science and Environmental Engineering, Shandong University of Science and Technology, Qingdao 266590, CHINA

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Palaeogeographic reconstructions rely heavily on accurate facies interpretation. However, traditional sedimentological and geochemical methods often fail to resolve complex, superimposed signals – particularly in mixed carbonate-siliciclastic systems. Here we show that machine-learning (ML) assisted geochemical analysis (Principal Component Analysis, PCA) can reveal hidden depositional trends that remain undetected by conventional approaches. We apply this methodology to the Paleocene Lockhart Limestone (Upper Indus Basin, Pakistan), a unit previously interpreted as a shallow-marine, delta-influenced shelf deposit. X-ray fluorescence (XRF) data from six samples (base to top) were processed using ML tools (Orange, PAST). PCA identifies one dominant component (PC1, ~80–90% of variance) representing a strong inverse correlation between carbonate-associated (CaO) and siliciclastic-associated (SiO₂, Al₂O₃) elements. Score and scatter plots reveal two distinct geochemical facies: lower samples (MYLSH1, MYL5, MYL7) show positive PC1 scores, indicating significant siliciclastic input (up to 20% SiO₂, 11% Al₂O₃); upper samples (MYL9, MYL13) show negative PC1 scores, reflecting pure carbonate conditions (>50% CaO). The scree plot (broken-stick model) confirms only PC1 as statistically significant, demonstrating that the carbonate-siliciclastic duality is the primary depositional control. Contrary to earlier models, the siliciclastic-rich lower part does not represent a deltaic environment. Instead, geochemical fingerprints (high Al₂O₃, TFe₂O₃, TiO₂) match the underlying lateritic Hangu Formation, indicating episodic sediment gravity flows (turbidites) controlled by proto-Himalayan tectonic pulses and sea-level fluctuations. In contrast, the upper part accumulated in a quiet, deeper-marine carbonate platform during transgressive highstands. Our ML-driven revision thus changes the palaeogeographic interpretation from a shallow-marine shelf to a deeper, dynamic carbonate-platform setting influenced by mass flows and fluid-rock interaction. This study demonstrates that ML-based PCA is an important tool for resolving ambiguous palaeogeographic signals, especially in tectonically active basins (Fig. 1).

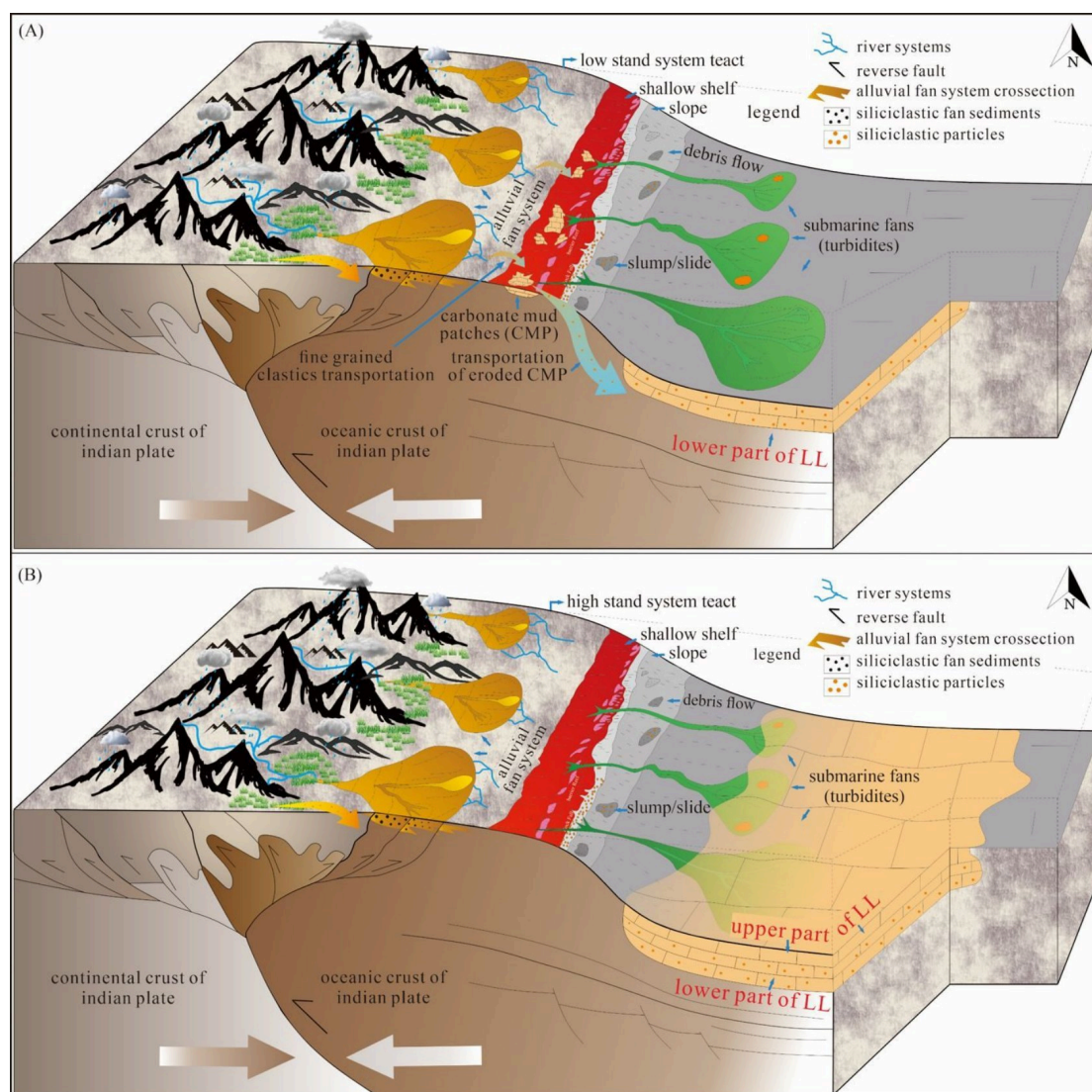


Fig. 1. Revised palaeogeographic model of the Paleocene Lockhart Limestone. (A) Lower part: siliciclastic-rich turbidites (high SiO_2 , Al_2O_3) from proto-Himalayan uplift introduced into a deeper-marine carbonate setting. (B) Upper part: transgressive high-stand with pure carbonate precipitation (high CaO) and no terrigenous input. MMT = Main Mantle Thrust.

KEYWORDS Palaeogeographic reconstruction; Machine learning; Tethys Basin; Carbonate–siliciclastic mixing

078 POSTER P2-13

Provenance Analysis of the Wilcox Formation Sandstones, Mexican Sector of the Gulf of Mexico: Regional Paleogeographic and Tectonic Implications

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Provenance analysis of very fine-grained Wilcox Formation sandstones from six deepwater wells (T-1, P-1, E-1, D-1, C-1 and M-1) in the Mexican Gulf of Mexico was conducted using thin-section petrography, quantitative point-count analysis, and Dickinson's provenance framework. Results reveal a complex Paleogene sediment-routing system fed by multiple contemporaneous igneous, sedimentary, and carbonate source terranes controlled by regional tectonic processes. Petrographic criteria indicate that the clastic framework was derived predominantly from a first-cycle granitic intrusive source, accompanied by a persistent volcanic contribution showing marked stratigraphic and geo-

graphic variability. Felsic volcanic detritus dominates in wells T-1 and D-1, whereas intermediate-to-mafic volcanic fragments are more abundant in E-1 and P-1, reflecting spatial variations in volcanic supply and proximity to source regions. A minor but regionally consistent sedimentary component, characterized by supermature monocrystalline quartz and metamorphic polycrystalline quartz with inherited silica overgrowths, records recycling of older sedimentary successions. The E-1 well represents a key tectonic anomaly. Core-restricted occurrences of abundant deep-basin limestone fragments (planktonic mudstone in Core 1) provide evidence of active erosion of Mesozoic cover successions driven by initial Sierra Madre Oriental uplift pulses. Methodologically, QtFL and QmFLt ternary diagrams cluster within Transitional Continental or Craton Interior fields. However, correcting for severe granulometric bias (very fine grain size) and diagenetic masking of feldspars and volcanic lithics shifts the interpretation to a robust Recycled Orogen and Tectonic Mixture setting. This multi-source model refines the understanding of sediment routing and siliciclastic dispersal into Paleogene deepwater basins.

KEYWORDS Wilcox Formation; Provenance; Petrography; Recycled Orogen; Mesozoic Uplift; Gulf of Mexico

079 ORAL O-19-3-0935

From Oceanic Plateau to Forearc Basin: Paleogeographic Evolution of the Colombian Caribbean from the Late Cretaceous to the Pliocene Based on Core Sedimentology

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The Colombian Caribbean basins record the tectono-sedimentary evolution of the northwestern South American margin from the Late Cretaceous to the Pliocene, documenting the transition from oceanic plateau accretion to a fully developed forearc system. This contribution integrates detailed core sedimentology from 49 stratigraphic wells, micropaleontological analyses, compositional analysis (petrography and XRD) and regional seismic interpretation to reconstruct the paleogeographic evolution of the Sinú-San Jacinto and Lower Magdalena Valley basins.

The stratigraphic record documents major shifts in depositional systems through time. Maastrichtian deep-marine deposits developed over the Caribbean Large Igneous Province. Following a regional Paleocene unconformity, Paleocene-Eocene sedimentation was dominated by gravity-flow processes including turbidites, contourites, and mass-transport complexes. During the middle to late Eocene, the basin evolved into mixed carbonate-siliciclastic depositional systems characterized by fan deltas, shallow-marine carbonate ramps, glauconitic platforms, and deep-water calcareous deposits. Oligocene to Miocene sedimentation records widespread shallow-marine, deltaic, and offshore environments, whereas Upper Miocene to Pliocene deposits reflect major terrigenous progradation associated with fluvial and littoral systems.

Six paleogeographic reconstructions summarize the progressive paleogeographic reorganization controlled by tectonic subsidence, uplift, and changes in sediment supply and routing.

KEYWORDS Core logs; Caribbean basins; Convergent margin; Lithostratigraphy

080 POSTER P2-39

Multi-Stage Tectonic Palaeogeographic Evolution of the Western Ordos Basin Margin, North China Craton

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The western Ordos Basin margin records polyphase tectonic–palaeogeographic evolution from the Early Palaeozoic to the Cenozoic, yet the coupling between deformation and palaeogeographic reorganization remains poorly quantified. Seismic data, balanced cross-section restoration, and discrete element simulation are integrated to reconstruct this evolution across four key episodes.

(1) Caledonian (Late Ordovician–Early Carboniferous): Subduction and closure of the Qinling Ocean generated a widespread unconformity. The southern segment developed an angular unconformity with uplift and erosion of carbonate strata, whereas the central and northern segments experienced broad warping and parallel unconformity, establishing early N–S palaeogeographic differentiation.

(2) Indosinian (Late Triassic): Yangtze–North China collision concentrated shortening in the southern segment, where Proterozoic normal faults were inverted into a foreland-type thrust wedge, marking the transition to a compressional basin-margin setting. Deformation decreased northward.

(3) Yanshanian (Late Jurassic–Late Cretaceous): NW–SE compression from subduction of the Palaeo-Pacific Plate and closure of the Mongol–Okhotsk Ocean activated the entire margin: the northern segment developed basement-involved, NE-trending east-dipping faults; the southern segment was reworked into large nappe complexes; the central segment was decoupled along the Carboniferous–Permian coal-measure décollement. This stage established a N–S-trending segmented thrust belt with thrust-related folding, differential uplift, and syn-orogenic erosion, with shortening increasing southward.

(4) Himalayan (Cenozoic): Far-field India–Eurasia collision triggered sinistral strike-slip reactivation and extensional collapse in the north, forming the Yinchuan Graben and superimposing Neogene–Quaternary depocenters onto the earlier contractional framework.

Discrete element models reveal three pre-existing controls: (i) Proterozoic rift architecture localized southern inversion and thrust-nappe formation; (ii) lateral variability of the décollement generated a two-tier system of thin-skinned folds overlying basement-involved structures in the central segment; (iii) relatively uniform northern stratigraphy and limited Alxa underthrusting produced east-dipping stepped-thrust systems.

Multi-directional stresses, segment-dependent stratigraphy, and inherited structures collectively governed contrasting palaeogeographic patterns across the three segments. This study provides a quantitative methodology for palaeogeographic reconstruction in complex cratonic margins and a predictive framework for coupled tectonic–sedimentary evolution in polyphase intraplate deformation belts, with implications for hydrocarbon exploration.

KEYWORDS Tectonic palaeogeography; Cratonic margin; Polyphase deformation; Ordos Basin; Thrust tectonics

081 ORAL O-19-3-0830

Tectono-stratigraphic control of the petroleum system in the Atapu Field, Santos Basin, Brazil

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The seismic stratigraphic study of the R0302 seismic survey (FRANCO TAMBUTA / PSDM / CALIBRADO.3D.PSDM.1), combined with the analysis of four wells (1-BRSA-1146-RJS, 3-BRSA-1172-RJS, 3-BRSA-1243-RJS, and 9-BRSA-1284-RJS), enabled the establishment of a structural evolution hypothesis for the Atapu Field, comprising the following stages. An initial tectonic movement possibly activated a fault framework associated primarily with transpressive movement and, to a lesser extent, transtensive movement along NW-SE structural zones ($\approx N35^\circ W$). This movement promoted the formation of structural highs in that direction, leading to the formation of shear zones and the compartmentalization of depocenters. As a result, a structural pattern similar to hybrid flower structures developed. This structuring is attributed to a rotational movement, from an initial NNW-SSE structural orientation during pre-salt sediment deposition to a NNE-SSW orientation, spanning from the deposition of salt to the present-day coastal parallel sedimentation. The faults associated with these structures generated differential subsidence, extending the depocenter to the S/SE. In parallel, at least two magmatic events, likely syn-sedimentary and post-salt in age, with geometries characteristic of shallow emplacement, induced shear processes in the carbonate deposits and possibly generated features related to forced folding. During or after salt deposition, hydrothermal flows affected the entire pre-salt/salt section, generating secondary porosity and possibly causing isotopic modification of the reservoir rocks, as well as the destruction of strata associated with salt deposits. These flows may have utilized the structural framework with a shear pattern amplifying their impact on the reservoir rocks and increasing the number of fractures within them. This structure, intensified by hydrothermal effects, may have facilitated the migration of oil and associated gases. The detailed study produced a database that allowed for the formulation of hypotheses regarding the tectono-structural evolution of the Atapu Field. Structural mapping revealed a complex fault model associated with an oblique transcurrent (strike-slip fault) context, strongly controlled by the NNW-SSE structural orientation. This structural model appears to be related to early movements during the opening of the southern segment of the Atlantic Ocean. According to some evolutionary models, this opening occurred through the sliding of crustal segments in a NNW direction. This hypothesis of early opening, associated with oblique transcurrent displacement, is supported by numerous scientific studies, synthesized in the model proposed by Scotese et al. (2024). As the separation of segments progressed, older NE-SW structures were apparently reactivated, leading to depositional control by NNE-SSW structures. It appears that the crustal segment hosting the Santos Basin acted as an independent segment during the initial stages of the South Atlantic opening, possibly associated with a Rio de Janeiro tectonic microplate.

KEYWORDS Pre-salt; Santos Basin; South Atlantic Ocean

082 POSTER P1-19

Provenance of Late Neoproterozoic strata of the Nanhua Basin and implications for the assembly of the South China Block

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The South China Block (SCB) is one of the most important components of Southeast Asia, comprising the Yangtze block in the northwest and the Cathaysia block in the southeast, bounded by the Jiangshan-Shaoxing Fault. The assembly time of these two blocks remains controversial, with three possible models involving their amalgamation: (1) during the Wuling/Sibao Orogeny (ca. 820 Ma); (2) during the Xuefeng Orogeny (ca. 720 Ma); and (3) during the Kwangsian Orogeny (early Paleozoic). The Nanhua Basin (NB), situated in the central part of the SCB and spanning the southeastern margin of the Yangtze Block and the western margin of the Cathaysia Block, accumulated sediments from the late Tonian through the early Paleozoic. Provenance analysis of basin sediments provides critical constraints on the assembly time of the SCB. We present detrital zircon U-Pb and Lu-Hf isotopic analyses from the Late Neoproterozoic Shenshan, Kuli, Shangshi, Xiafang, Bali, and Laohutang formations in the Xinyu-Ji'an area, western Cathaysia Block. Detrital zircon U-Pb data indicate that the Shenshan to lower Xiafang formations exhibit a dominant age cluster at 770–700 Ma, whereas the upper Xiafang and Bali formations yield multiple older populations at 1100–900 Ma, 2600–2400 Ma and 1950–1750 Ma. Zircon U-Pb data and stratigraphic correlations constrain the deposition of Shenshan, Kuli-Shangshi, Xiafang, Bali, and Laohutang formations to pre-717 Ma, 717–690 Ma, 690–635 Ma, 635–550 Ma, and post-550 Ma, respectively. U-Pb and Lu-Hf data indicate that the 770–700 Ma zircons originated from a coeval magmatic arc on the northern margin of the Yangtze Block, while zircons aged 1100–900 Ma, 2600–2400 Ma and 1950–1750 Ma were derived from the northern margin of the Gondwana continent. Sediment transport across the Yangtze and Cathaysia blocks during the late Tonian–Cryogenian indicates that the amalgamation of these two blocks must have been completed no later than the late Tonian, most likely during the Wuling Orogeny. The NB simultaneously deposited sediments from the northern margin of the Yangtze volcanic arc and the Gondwana continent during the late Neoproterozoic, indicating a back-arc tectonic setting developed along the northern margin of East Gondwana. Integration with previous geochronological data reveals two episodic propagation processes of Gondwana-derived sediments toward the northeast of the NB at ca. 650 Ma and ca. 540 Ma. These processes likely reflect crustal thickening and topographic uplift during the assembly of Gondwana.

KEYWORDS Wuling Orogen; Provenance; Nanhua Basin; South China Block; Gondwana

083 ORAL O-19-3-1050

When and how did the Yangtze River reach the East China Sea?

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The timing at which the Yangtze River became effectively connected to the East China Sea remains debated because upstream and offshore archives record different stages of source-to-sink integration. Terrestrial records from the upper and middle Yangtze can document hinterland cooling,

drainage capture and trunk-river reorganization, but they do not directly date when Yangtze-derived sediment was transmitted to the offshore terminal sink. Here we use Cenozoic sandstone drill cuttings from the Xihu Sag, East China Sea Shelf Basin, to test when Yangtze-related ancient basement detritus first became detectable offshore. We combine single-grain detrital-zircon U-Pb ages, trace-element compositions and zircon fission-track cooling ages. This approach links zircon crystallization age, magmatic affinity and source-region cooling history, thereby reducing the non-uniqueness inherent in U-Pb age spectra alone. Paleogene Pinghu and Huagang strata mainly record proximal Cathaysian input and intrabasin basement recycling. In contrast, the Early Miocene Longjing Formation records a distinct provenance shift, including enrichment in >1600 Ma cratonic zircons, increased compositional affinity to Yangtze gateway and craton-link reference spectra, and the first measurable offshore population of Paleoproterozoic zircons with Eocene fission-track cooling ages. The diagnostic paired U-Pb-ZFT grains in the Longjing Formation yield an apparent lag of ca. 20–27 Myr between source-region cooling and offshore deposition. We interpret this lag as a sediment-routing response time that incorporates post-cooling exhumation, sediment storage, recycling, dilution and progressive drainage linkage, rather than downstream transport alone. These results place the Yangtze–East China Sea terminal-sink connection in the Early Miocene, after earlier hinterland cooling and upstream drainage reorganization. This study shows that marginal-sea stratigraphic archives can provide terminal-sink constraints on diachronous river integration. More broadly, it demonstrates how paired provenance and thermochronological records can be used to separate hinterland exhumation, drainage reorganization and effective offshore sediment delivery in large river systems crossing cratonic interiors.

KEYWORDS Yangtze River; East China Sea Shelf Basin; source-to-sink system; detrital zircon; zircon fission-track; terminal-sink archive

084 ORAL O-19-3-1030

Late Jurassic Syntectonic Clastic Wedges in the Sierra de la Vaca Muerta: Evidence for Oxfordian Uplift in the Neuquén Basin, Argentina

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The Neuquén Basin in west-central Argentina preserves one of the most complete Mesozoic sedimentary records of South America and is a key setting for analysing the interaction between tectonics, accommodation, sediment routing, and petroleum-system development. Although the Huincul Arch is widely recognized as a major Jurassic basement-controlled structural high, the timing and sedimentary expression of Jurassic tectonic reactivation outside its main domain remain insufficiently constrained.

This study documents new field evidence for Late Jurassic, probably late Oxfordian–early Kimmeridgian, synsedimentary uplift in the Sierra de la Vaca Muerta, approximately 60 km north of the Huincul Arch, and evaluates its consequences for the stratigraphic architecture of the Lotena–La Manga–Tordillo–Vaca Muerta succession. The analysis integrates geological mapping, photohorizon interpretation, sedimentological observations, and four measured stratigraphic sections between Manzano Guacho, Cañadón de los Alazanes, Arroyo Covunco, and Los Catutos. These sections total 1095 m and include the Callovian shallow-marine clastics of the Lotena Formation, the Oxfordian carbonates of the La Manga Formation, the continental siliciclastic deposits of the

Tordillo Formation, and the basal marine shales of the Vaca Muerta Formation. Special attention was given to lateral thickness changes, erosional surfaces, stratal terminations, onlap geometries, clast composition, and paleocurrent indicators.

Field and photostratigraphic data reveal a complex architecture along the northern flank of the Covunco Anticline. The top of the La Manga Formation is marked by a major erosional unconformity that progressively truncates the Oxfordian carbonate succession southward and locally affects the upper Lotena Formation. This surface is associated with karstification and silcrete development, indicating subaerial exposure of the carbonate platform before continental siliciclastic sedimentation. Stratigraphic correlations suggest that more than 150 m of La Manga and upper Lotena strata were removed over less than 15 km, demonstrating localized uplift and erosion. Above this surface, the Tordillo Formation shows progressive onlap and southward thinning, indicating deposition over inherited structural relief. The basal Tordillo interval, termed T1, is a 21 m-thick intraformational conglomeratic wedge composed mainly of angular to sub-angular limestone, chert, coral, and sandstone clasts derived from the La Manga and Lotena formations. Its tabular beds, crude stratification, traction carpets, grading patterns, clast imbrication, and NNE-directed paleocurrents indicate deposition by unconfined sheet flows in a small alluvial-fan system sourced from a nearby southern structural high. The overlying T2 interval, dominated by rounded volcanic and metamorphic clasts and lacking limestone fragments, records a later extrabasinal sediment-supply stage that passively buried the inherited relief.

These results demonstrate that Late Jurassic tectonic reactivation in the Sierra de la Vaca Muerta controlled accommodation, provenance, facies distribution, and sequence architecture. Recognition of an Oxfordian syntectonic clastic wedge outside the main Huincul Arch has direct implications for regional paleogeographic reconstructions and the prediction of Jurassic reservoir distribution.

KEYWORDS Clastic wedges; Jurassic tectonics; Neuquén Basin; Sierra de la Vaca Muerta; Tordillo Formation

T3-3 Tectonosedimentology**085** ORAL O-19-3-0920**Tectonic controls on stratigraphic architecture in the Bambuí Group, Central Brazil****Deniro Felipe Gonçalves Costa^{1*}, Lucas Warren¹, Fabrício Caxito²**¹ Geosciences and Environment Graduate Program, Institute of Geosciences and Exact Sciences, São Paulo State University, Rio Claro, BRAZIL² Department of Geology, Institute of Geosciences, Federal University of Minas Gerais, Belo Horizonte, BRAZIL* E-mail: deniro.costa@unesp.br

Architectural reconstruction of sedimentary basins directly depends on stratigraphic continuity and reliable estimates of depositional unit thicknesses. However, post-depositional tectonic deformation may significantly modify the original geometry of these successions, leading to misleading interpretations of subsidence patterns and sedimentation rates. In the Bambuí Group, São Francisco Basin, Brazil, especially along its western border in contact with the Brasília Belt, compressional structures and associated faults may promote tectonic repetition of stratigraphic units, resulting in artificially increased apparent thicknesses. Towards the basin center, however, deformation effects become less evident. In order to evaluate the influence of tectonic deformation on the distribution of stratigraphic thicknesses within the Bambuí Group, depth well data containing composite logs and geophysical curves, such as gamma ray (GR), were integrated with interpreted time-domain seismic sections calibrated by check shot data. Following a revision of stratigraphic limits, comparisons were conducted between relatively undeformed sectors of the basin and structurally affected areas characterized by duplexes, triplexes, and low-angle thrust faults. Preliminary results indicate a strong contrast between the two analyzed domains. In undeformed areas, units display lateral continuity and relatively consistent thicknesses among correlated wells, although sampling limitations locally hinder regional confirmation of some stratigraphic units. In contrast, structurally deformed areas show significantly enlarged thicknesses mainly caused by tectonic repetition recognized both in composite logs and interpreted seismic sections. For example, the Serra de Santa Helena Formation reaches thicknesses up to twice those observed in less deformed regions. Additionally, units such as the Lagoa Formosa Formation are described exclusively along the western border of the basin and occur preferentially within intensely deformed sectors, commonly associated with intervals displaying thicknesses incompatible with the regional stratigraphic pattern of the Bambuí Group. The spatial association between these occurrences and zones affected by tectonic overlapping and compressional faulting suggests that tectonic deformation may influence the compartmentalization and stratigraphic recognition of these successions. These results demonstrate that tectonic deformation directly influences the apparent stratigraphic thickness distribution within the Bambuí Group, highlighting the importance of integrating structural analyses into paleogeographic reconstructions of the basin. Ongoing work aims to restore the original geometry of these units and evaluate the impacts of tectonic distortion on the depositional and tectonic evolution of the region, building a framework capable of constraining stratigraphic units through integrated field data and basin modeling.

KEYWORDS Well-seismic integration; Thrust tectonics; Stratigraphy; Basin evolution; Tectonosedimentation**FUNDING** São Paulo Research Foundation (FAPESP), Brazil (Process No. 2025/20819-1)

086 ORAL O-19-3-1105

Basin-Margin Fault Controls on Source-to-Sink Systems and Coarse-Grained Deposits in the Wenchang Formation, Zhu I Depression, Pearl River Mouth Basin

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Near-source coarse-grained depositional systems are widely developed in the Paleogene Wenchang Formation of the Zhu I Depression, Pearl River Mouth Basin, providing an excellent case for investigating tectono-sedimentary coupling along steep-slope margins in lacustrine rift basins. Based on 3D seismic, well, and core data, this study analyzes basin-margin fault activity, fault growth and linkage patterns, and their controls on source-to-sink systems and coarse-grained deposits during deposition of the Wenchang Formation. The results show that the steep-slope margins of the Zhu I Depression were jointly controlled by NE- and NW-trending faults. Modification of the NE-trending master faults by NW-trending faults produced three major structural styles, including linear-parallel, serrated, and arcuate fault patterns. Fault linkage patterns controlled sediment entry points, palaeogeomorphic gradients, drainage orientations, and sediment-dispersal pathways, thereby regulating the type and scale of coarse-grained deposits. Same-dipping collinear and oppositely dipping oblique linkage configurations mainly controlled the development of transverse, fault-normal drainage systems, whereas same-dipping separated and same-dipping oblique configurations favored oblique drainage systems. Single-fault and separated double-fault configurations primarily controlled axial drainage systems. Accordingly, the steep-slope source-to-sink systems can be classified into transverse, oblique, and axial types, which are characterized by fan deltas, small- to medium-scale braided-river deltas, and large-scale braided-river deltas, respectively. The scale of coarse-grained deposits generally increases with decreasing palaeogeomorphic gradient. This study suggests that basin-margin faults govern coarse-grained depositional systems not simply through fault throw, but through structural style and linkage-controlled sediment routing. These findings provide structural constraints for sediment-dispersal analysis, lithofacies palaeogeographic reconstruction, and prediction of near-source coarse-grained systems in lacustrine rift basins.

KEYWORDS Basin-margin fault; Fault linkage style; Source-to-sink system; Coarse-grained deposit; Zhu I Depression

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087 ORAL O-19-3-1120

Deep-water Depositional Systems in the Dongying Depression, Bohai Bay Basin: Responses to Multiphase Extension and Non-coaxial Fault Linkage

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As a Meso-Cenozoic lacustrine rift superimposed on the Archean North China Craton, the Bohai Bay Basin underwent long-term multiphase tectonic evolution coupled with persistent regional stress rotation from the Mesozoic to the Cenozoic. Rotated stress fields triggered the reactivation of inherited NW-trending basement faults and the formation of new NE-striking normal faults in the Cenozoic, giving rise to heterochronous, multi-orientation non-coaxial fault belts along steep rift margins. We focus on the northern steep slope of the Dongying Depression, which is bounded by the Chennan Fault. Based on integrated seismic, well-logging and core data, we decode the sedimentary response of deep-water gravity flow deposits to progressive non-coaxial fault linkage. The segmented Chennan Fault consists of reactivated Mesozoic fault segments and newly formed Cenozoic fault segments, whose staggered superposition creates the distinctive zigzag planar geometry of the northern rift margin. We identify diverse non-coaxial fault linkage styles based on fault dip combinations and slip rate heterogeneity. Convergent linkage between intersecting fault segments further controls the development of large paleo-gullies, which act as the dominant sediment transport conduits connecting uplifted provenance areas to the deep lake basin. Variations in fault linkage evolution lead to obvious divergence of deep-water sedimentary assemblages. Early-stage incomplete fault linkage favors widespread distal basinal fans, whereas through-going fault systems facilitate the accumulation of thick proximal nearshore subaqueous fans adjacent to fault scarps. Uniform slip distribution along fault segments generates longitudinal sediment dispersal, while heterogeneous slip rates of fault segments drive oblique clastic migration along dominant fault strikes. This study constructs a tectono-sedimentary coupling model under rotated multiphase extension, and provides theoretical support for favorable reservoir prediction in analogous lacustrine rift basins worldwide.

KEYWORDS Multiphase extension; non-coaxial fault linkage; deep-water depositional systems; sedimentary response; Dongying Depression

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T3-4 Pre-Andean and Andean tectonics**088** ORAL O-17-3-1420**Post-Sanrafaelic Extensional Deformation in the San Rafael Block: Structural Evidence and Syn-extensional Deposition in the Choiyoi Group****Fiorella Insaurrealde^{1,2*}, Felipe Tapia^{1,2}, José Mescua^{3,4}, Miguel Ramos^{1,2}**¹ Departamento de Ciencias Geológicas, FCEyN, Universidad de Buenos Aires, ARGENTINA² Instituto de Estudios Andinos "Don Pablo Groeber" (IDEAN), CONICET, ARGENTINA³ Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), CCT Mendoza, CONICET, ARGENTINA⁴ FCEyN, Universidad Nacional de Cuyo, ARGENTINA

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The San Rafael Block is a basement uplift in central-western Mendoza, Argentina, composed of Paleozoic and Mesozoic rocks that experienced multiple deformation phases. The region hosts one of the most complete exposures of the Permian–Lower Triassic Choiyoi magmatic province, marking the end of the Gondwanic cycle. Previous work proposed that the Choiyoi Group was deposited during a post-Sanrafael extensional phase (Rodríguez-Fernández et al., 1997; Rolan et al., 2026). The negligible overprint of Cenozoic Andean tectonics, combined with the excellent quality of Permian outcrops, makes this region ideal for analyzing deformation coeval with this major magmatic event and reconstructing the Permian–Triassic tectonic evolution of the SW Gondwana margin.

The study area (74 km²) is located in the NW San Rafael Block (Cañón del Atuel). Cambrian–Devonian sedimentary rocks form the basement, deformed during the Late Devonian (Chanic Orogeny), and are unconformably overlain by Carboniferous–Lower Permian sequences of the Gondwanic cycle. The Lower Permian volcanics bear structures associated with the Sanrafaelic phase, expressed as NNW–SSE lineaments interpreted as the result of a transpressive regime related to oblique subduction (Kleiman and Japas, 2009). Overlying these units, extensive volcanic and volcanoclastic deposits are characterized by silicic compositions and transitional-to-intraplate geochemistry (Llambías et al., 1993).

In this study, we performed structural mapping, satellite image analysis, and kinematic fault characterization, thereby identifying a half-graben system. The SW-dipping Aisol Fault (NW–SE trend) acts as the master fault, with the Huayquerías Fault as a second-order parallel structure. A second fault family (NNW–SSE) comprises the Nihuil Fault and the antithetic Los Molles Fault. These second-order faults controlled syn-extensional depocentres within the half-graben. U–Pb zircon ages from the synrift Agua de los Burros Formation constrain the extensional deformation to the Middle Permian, postdating the Sanrafaelic phase. Recent work at the Atuel–Aisol confluence identified Late Mississippian–Pennsylvanian normal faults active during deposition of the lower El Imperial Formation (Tapia et al., 2023), suggesting that post-Sanrafaelic extension partly reactivated preexisting structures.

The integration of structural and stratigraphic data allows reconstruction of the tectonic evolution of this extra-Andean sector and provides insight into the regional crustal extension that followed the Sanrafaelic orogeny along the SW margin of Gondwana.

KEYWORDS San Rafael Block; post-Sanrafaelic extension; Choiyoi Group

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The Cuyania Terrane and the Wilson Cycle: Geological Constraints on a Palaeozoic Microcontinent Transfer

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Thomas and Astini (1996, *Science*, 273: 752–757) were the first to explain the origin and evolution of the Cuyania Terrane, although they fell short of producing a final theory. Dalziel and Dewey (2019, *Geological Society, London, Special Publications*, 470: 1–20) later challenged this novel hypothesis, using a basic principle of plate tectonic theory. They challenged the model of rifting and isolated drifting of the Cuyania microcontinent, claiming the mechanism implies the “ad hoc” hypothesis of a tectonic shift called “ridge crest jump”. The arguments by Dalziel and Dewey (2019) were biased by scientific reductionism and flawed because their perspective failed to fully consider the geological evolution along the western Gondwana margin. When the available geological record is integrated, it becomes clear that the preserved geological history of the Palaeozoic western Gondwana margin, with a comprehensive assessment of Cuyania terrane geological history, answers the controversial question of the isolated transfer of a microcontinental plate between two continental landmasses. In fact, an updated palaeogeographic evolution must obey the fundamental principles of the Wilson Cycle, which underlie much of what most geoscientists understand to have governed the Palaeozoic evolution of western Gondwana preserved in the Famatinian orogen and exhumed in the present-day Central Andean broken foreland. While a mid-ocean ridge was being subducted beneath a still immature Pampean convergent margin on the other side of the Iapetus Ocean, an interlinked rifting segment detached the Cuyania microcontinental plate from the Ouachita embayment (Thomas and Astini, 1996). Yet, the effective drifting of the Cuyania microplate did not occur until a convergent margin resumed along the western Gondwana margin, consuming ocean lithosphere on the opposite side of the Iapetus oceanic plate. Irrespective of whether the Famatinian arc was the consequence or the cause of the drifting of the Cuyania plate from near Laurentia to West Gondwana, the transfer lasted no more than 25 Myr during the Early Ordovician. Upon reaching the Famatinian trench, the eastern passive margin of the Cuyania microcontinent initiated the last phase of continent-arc collision, marking the closure stage of the Wilson Cycle. However, the end of the cycle was temporary rather than terminal on a geological time scale. Within the latitudes of the Cuyania microplate, subduction of an oceanic slab resumed on the western margin during the Devonian–Carboniferous transition. At that time, outside the long extension of the Cuyania terrane, the ancient convergent margin was already active during the Devonian. Nonetheless, the Gondwanan subduction margin met the condition of propagating along the entire southern South American plate by the Mississippian. Should we support a geodynamic evolution in which the Cuyania microcontinent rifted from Laurentia, isolated, drifted through the Iapetus Ocean, and ended attached to the Western Gondwana margin? Can this scientific hypothesis be defended with rigorous evidence, or might it be merely a paleogeographic tale? Several lines of direct, independent, compelling observations support the Palaeozoic geological history of the Cuyania Terrane. Among these, an exposed collisional suture, a shift of fossiliferous provincialism, and a 70-Myr-long collisional orogeny (the Famatinian) are outstanding.

KEYWORDS West Gondwana; Famatinian Orogen; Cuyania Terrane

T3-5 Foreland basins, with particular focus on the Andes and their foreland basins (organized by ILP Task Force VI)

090 ORAL O-17-3-1435

The coupled evolution of orogen–foreland basin systems: inferences from 2D and 3D numerical forward modelling

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The evolution of orogenic systems and associated foreland basins is governed by the interplay between lithospheric deformation, crustal thickening, mantle dynamics, and surface processes. Variations in crustal thickness, subduction geometry, slab dynamics, and rheological stratification exert first-order controls on topographic growth, flexural subsidence, and sediment routing within adjacent foreland basins. These tectonic processes are tightly coupled to erosion and sedimentation, which redistribute mass, modify stress fields, and influence the temporal evolution of mountain belts and basin systems. Despite their strong feedbacks, the coupled evolution of orogens and foreland basins remains insufficiently quantified, particularly in three dimensions and across lithosphere-to-surface scales.

Here we present results from two-dimensional and three-dimensional numerical forward models based on the thermo-mechanical code I2/3ELVIS, which uses finite differences and marker-in-cell methods and incorporates elasto-visco-plastic rheologies of compressible and thermally expanding/contracting rocks, coupled to a newly developed surface-processes module. The models simulate lithospheric shortening, subduction dynamics, crustal thickening, and associated foreland basin development together with erosion, sediment transport, and deposition.

Using this fully coupled framework, we investigate how variations in convergence rate, slab dip, crustal rheology, and mantle dynamics influence orogenic growth and foreland basin evolution. The models allow us to analyze the relationships between crustal thickening, flexural subsidence, sediment fluxes, and the spatial and temporal evolution of syn-orogenic sedimentary successions. Particular emphasis is placed on the feedbacks between tectonically driven topographic growth and sediment redistribution, and on how these interactions control the architecture and migration of foreland basin systems through time. While our simulations are not site-specific, we compare our model series with different tectonic settings and highlight similarities and key differences in the Andes, the European Alps and the Carpathians.

KEYWORDS Subduction; numerical modelling; foreland basin evolution

091 ORAL O-17-3-1450

Coupled Arc Migration and Retroarc Weakening Govern Foreland Basin Evolution in the Southern Central Andes

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Foreland basin systems along Cordilleran-type margins record the integrated response of crustal deformation, surface loading, and magmatic forcing, yet the drivers of their tempo and spatial evolution remain debated. In the southern Central Andes, we combine stratigraphic, geochronologic, geochemical, and structural datasets to show that foreland basin development occurred in recurring 5–8 Myr pulses tightly coupled to retroarc underthrusting and flexural subsidence. Stratigraphic accumulation patterns, continental arc ϵHf - ϵNd systematics, and shortening reconstructions reveal that these basin-deepening phases were not steady-state responses to orogenesis, but instead part of a cyclic system in which inboard arc migration and fluid-assisted crustal weakening primed the retroarc for focused deformation and renewed basin growth.

These deformation–subsidence cycles were spatially partitioned among discrete Andean tectonic provinces with contrasting pre-Andean inheritance, which were sequentially activated toward the cratonic interior along newly formed middle- to upper-crustal décollements. The resulting pattern of stepwise foreland basin expansion reflects the interplay between evolving slab dynamics and structural–stratigraphic heterogeneities embedded within the overriding plate. Comparisons with both high- and low-shortening segments of the North and South American Cordillera indicate that magmatic arc advance and retroarc weakening are fundamental controls on foreland basin cyclicity, linking deep crustal processes to basin architecture across Cordilleran orogens.

KEYWORDS Foreland basin; Andes; Tectonics

FUNDING US National Science Foundation (NSF)

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Broken foreland basins and the role of tectonic inheritance and flat slab subduction

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Broken foreland basins are defined as zones of sediment accommodation that form in intraplate continental settings inboard of a retroarc or collisional orogenic belt. The basin is compartmentalized (partitioned or fragmented) by positive topographic features produced by discrete basement-involved contractional structures. Accommodation is regulated by flexural loading and fault-block tilting with subordinate dynamic subsidence and sediment infilling (ponding) within internally drained areas.

Discrimination of broken and unbroken (continuous) foreland basin conditions enables time-space reconstructions of deformation patterns responsible for growth of integrated topography in thin-skinned fold-thrust belts and isolated topographic highs in distal foreland regions. Such reconstructions require delineation of the position and long-term advance (relative to the trench or suture) of (1) the orogenic topographic front (marked by frontal thrust-belt structures) and (2) the foreland deformation front (defined by isolated basement block uplifts). The dissimilar sedimentary histories of broken versus unbroken foreland basins are manifest in contrasting sediment accumulation histories, time-stratigraphic patterns, depositional environments, sediment routing, and provenance.

Examples from the modern Andes and the Cretaceous–Paleogene Laramide province of North America show a clear spatial correlation between flat slab subduction and zones of distributed intraplate shortening with broken foreland conditions. However, deformation advance toward the plate interior is sensitive not only to geodynamic configuration but also to inherited structural/stratigraphic geometries and mechanical processes related to crustal/lithospheric strengthening and weakening. Although important, flat slab subduction is neither necessary nor sufficient to uniquely explain all examples of inboard deformation advance within continental plate interiors.

It is proposed that most broken foreland basins can be ascribed to a combination of: (1) underlying conditions in the form of tectonic inheritance, including precursor structural, stratigraphic, thermal, and rheological heterogeneities and anisotropies; and (2) mechanical triggers, such as increased stress magnitude, enhanced horizontal stress transmission, and/or variable crustal/lithospheric strengthening or weakening.

KEYWORDS Andes; foreland basin; tectonic inheritance; subduction

FUNDING National Science Foundation, USA

093 ORAL O-17-3-1520

Miocene evolution of the Carpathian foreland basin in SE Poland and W Ukraine, or how tectonic inheritance can control foreland basin development

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Foreland basins form due to subduction of the continental foreland (lower) plate beneath the foreland fold-and-thrust belt. Tectonic subsidence within the foreland basins is a function of (1) the topographic load exerted by the orogenic wedge, (2) subsurface loads operating at depth within the subduction zone, (3) the load exerted by the sedimentary infill of the foreland basin, and (4) the mechanical properties of the foreland (lower) plate determined by its effective elastic thickness (low for thinned continental crust and high for thick cratonic crust). Numerous flexural modelling studies have illustrated how combinations of various parameters can result in the formation of deep-water underfilled or shallow-water overfilled foreland basins. Flexural models are based on one important assumption – that the lower plate behaves as a continuous elastic or viscoelastic plate (beam). There is however one departure from this assumption – flexural extension of the lower plate due to its bending, which eventually leads to the formation of a system of normal faults, i.e. to brittle rather than to elastic deformation. In most cases this normal faulting is rather minor and distributed over wide zones, so in regional context it does not diminish applicability of regular flexural models. This could, however, change quite drastically if the lower plate contains deeply rooted regional fault zones, inherited from previous phases of tectonic evolution, that can be reactivated during regional plate flexure beneath the orogenic wedge.

The Carpathian foreland basin in SE Poland and W Ukraine developed above the Teisseyre-Tornquist Zone located between the East European Craton and the West European Platform. In this area, large-scale normal faults with a total offset of the order of 1–2 km cut the Miocene foreland basin infill, the underlying Meso-Paleozoic sedimentary cover and the crystalline basement (Fig. 1). Analysis of dense, high-quality 2D and 3D seismic data revealed that their formation could be attributed to the Miocene reactivation of faults, previously responsible for (1) Jurassic extension and localized subsidence of the SE segment of the Mid-Polish Trough, i.e. the axial part of an extensive Permian–Mesozoic epicontinental basin, and (2) its Late Cretaceous inversion, uplift and erosion. Some strike-slip movement along these faults can also be observed during the latest (Sarmatian) stages of evolution of the Carpathian foreland basin.

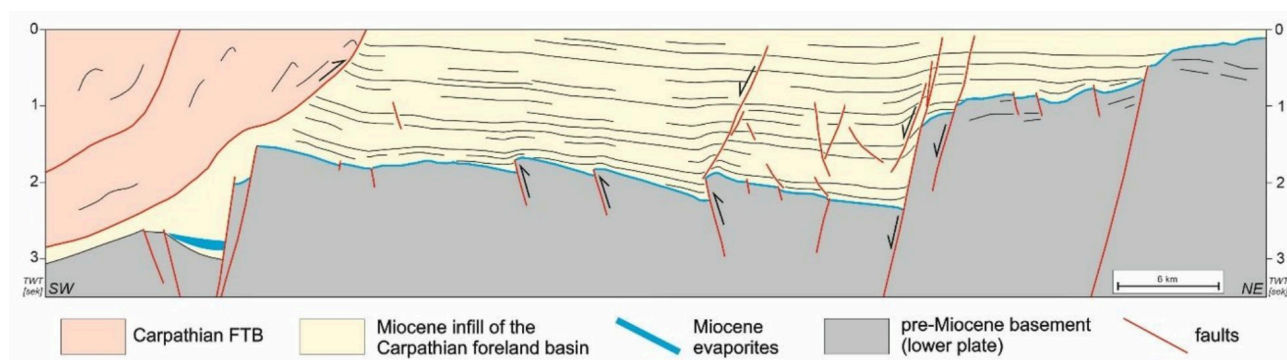


Fig. 1. Regional transect illustrating the structure of the Carpathian foreland basin in SE Poland

KEYWORDS Carpathians; Carpathian foreland basin; flexural extension; tectonic inheritance

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Kinematics and hydrocarbon habitat in different types of foreland/foredeep basins

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Foreland basins are sometimes regarded as a single basin type associated with convergent settings. In fact, there is significant variation, and four different basin types can be differentiated. These differ significantly in evolution, and hence in the development of associated sedimentary and petroleum systems. They are classed as follows:

(1) pro-wedge foreland basins associated with an advancing subduction setting; (2) retro-wedge foreland basins associated with an advancing subduction setting; (3) pro-wedge foreland basins associated with a retreating subduction setting; and (4) foreland basins developing on the flanks of laterally extruding and/or rotating microplates caught between converging orogens.

Types (1) and (3), although rather different from each other, are developed on the down-flexed lower plate, which is dominantly loaded by the vertical load of the orthogonally advancing orogenic wedge. The first part of this talk focuses on the West Carpathian foreland basin, which represents type (3), describing periodic changes in the stress regime controlling the deformation of the over-riding plate.

In contrast, the underlying plate in type (2) is down-flexed by a combination of the vertical load of the advancing orogenic wedge and horizontal compression. A Llanos Basin case study of this basin type represents the focus of the second part of this talk, demonstrating how unique structural architecture results in this case.

The loading of the underlying plate in basin type (4) is not orthogonal. Furthermore, it changes with time. This convergent setting frequently reaches the stage when the underlying microplate is not wide enough to undergo cycles of down-flexing, as is typical of the first three basin types. A case study of the Georgian Plate represents the third part of this talk. It focuses on the transition from the flexure-controlled subsidence events of the foreland basin to subsidence events during the time when the underlying plate stops down-flexing.

Finally, the talk examines different frontal structures of orogenic belts, which accreted foreland basin sediments, and focuses on contemporaneous hydrocarbon migration. It indicates that each of these structures develops a different stress perturbation, which affects the migration and trapping of hydrocarbons. This part of the talk draws mostly from finite-element modeling.

T3-6 Passive margins, with particular focus on the western margin of South America and associated sedimentary basins (organized by ILP Task Force VI)

095 ORAL O-17-3-1635

Controlling processes of marginal ridge development

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The paper evaluates controlling mechanisms of marginal ridge (MR) evolution and its potential for microcontinent release. It studies the Zenith-Wallaby-Perth transform margin, drawing from reflection seismic, well, gravity and magnetic data. It results in a new three-stage evolutionary model where MR is the consequence of heterogeneous thinning of the continental crust forming the future transform margin. In this model, ridge development takes place during the continental and continental-oceanic stages of the transform development, aiming at connecting adjacent rift zones and progressively optimizing their kinematic linkage.

We identified two marginal ridge candidates (MRCs), the internal intra-basin high (MRC-1) and the external basin-bounding high (MRC-2). Based on seismostratigraphic and structural map analysis, we propose two distinct driving mechanisms for their development. MRC-1 has developed as an elongated, thicker crustal block inside the Zeewyck pull-apart basin, which was detached along a ductile detachment and controlled by the transtensional regime. MRC-2 has developed as an elongated, thicker crustal block inside a wide strike-slip zone, during the evolution of the wide deformation zone of the initial continental transform into the localized deformation zone of the continental-oceanic transform.

The study concludes that both the position at and kinematic linkage to the continent-ocean boundary (COB) are critical. MRC-2 occurs at the COB and has a strike sub-parallel to it. This favors its distinct lateral movements and a chance to become a MR, eventually a microcontinent. At the same time, the oblique orientation of MRC-1 and its location away from the COB make it less prone to distinct lateral movements.

T3-7 General session on sedimentary basins (organized by ILP Task Force VI)

096 ORAL O-17-3-1650

A new look at the geothermal potential of the Permian–Mesozoic Basin in Poland based on reinterpreted seismic data, hydrogeological and hydrogeochemical studies, and paleogeographic reconstructions – methodological considerations

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The Permian–Mesozoic basin system of central and Eastern Europe constitutes one of the largest sedimentary domains hosting geothermal resources. This extensive basin complex is characterized by long-term tectono-sedimentary evolution, including Permian rifting, subsequent Mesozoic thermal subsidence, and Late Cretaceous inversion, which controlled the present-day architecture of reservoir units and heat distribution.

In this context, the assessment of geothermal potential cannot be limited to temperature distribution or hydrogeological parameters alone, but must primarily rely on a detailed understanding of subsurface structure. The internal architecture of the basin, comprising complex fault systems of different ages, salt structures, and stratigraphic variability, exerts a first-order control on geothermal reservoir properties, fluid migration pathways, and thermal regimes. In particular, salt tectonic processes and associated structural deformation have led to strong spatial heterogeneity of permeability and reservoir continuity across the basin, and, as a result, affected the salinity of the geothermal water. The Permian–Mesozoic succession includes several regionally extensive aquifer systems, especially within Jurassic and Cretaceous formations, which represent the main geothermal reservoirs in the Polish Lowlands and their continuation in adjacent countries. However, their effective utilisation depends on the identification of structurally controlled zones of enhanced porosity and permeability, often related to fault zones of various age and origin. Similar relationships are observed across the entire Central European basin system, confirming the transboundary nature of geothermal plays.

Building on this structural complexity, a more refined understanding of the subsurface is required to effectively assess geothermal potential across the basin. Advances in seismic data acquisition and processing, attribute analysis, and structural modelling now enable a more detailed and geothermal-oriented characterisation of subsurface architecture than was previously possible. Reinterpretation of legacy seismic data enables a shift from hydrocarbon-oriented analysis towards identifying features critical for geothermal systems, such as fault-controlled flow paths and reservoir continuity. This paper presents the key challenges associated with the analysis of low-temperature geothermal systems (<150°C) developed within the sedimentary sequences of the Permian–Mesozoic basin in areas influenced by intense salt tectonics. The aim of this work was to develop a new methodology to better characterize the reservoirs and map locally identified positive anomalies that hinder the geothermal utilization of resources due to extremely high water mineralization. The presented research represents pilot results of a new comprehensive approach, incorporating reinterpretation of existing geophysical data with integrated stratigraphic, structural, hydrogeological and hydrogeochemical analysis, and paleogeographic reconstructions.

KEYWORDS Permian–Mesozoic Basin; low-temperature geothermal systems; seismic reinterpretation; salt tectonics; hydrogeochemical anomalies

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T4

Resource palaeogeography

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- T4-3** Unconventional reservoirs and hydrocarbon exploration · 8 abstracts · p. 121
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T4-1 Petroleum geology of deep-water depositional systems

097 ORAL O-17-2-1450

Sequence stratigraphy analysis and paleogeography reconstruction of isolated platform in a rift lake basin

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By integrating core observations, logging data and seismic interpretation, this study takes the massive Cretaceous carbonates in the M block of the Santos Basin, Brazil, as an example to establish the sequence filling pattern of fault-bounded isolated platforms in rift lake basins, reveal the control mechanisms of shoal-body development and reservoir formation, and reconstruct the evolutionary history of lithofacies paleogeography. The following results are obtained. (1) Three third-order sequences (SQ1–SQ3) are identified in the Lower Cretaceous Itapema and Barra Velha formations of the M block. During the depositional period of SQ1, the rift basement faults produced a stratigraphic pattern that is thick on both sides and thin in the middle, with strata onlapping the uplift in

the early stage. During the depositional period of SQ2-SQ3, the synsedimentary faults controlled the paleogeomorphic reworking process with subsidence in the northwest and uplifting in the northeast, accompanied by a relative fall in lake level. (2) The Lower Cretaceous in the M block was deposited in a littoral-shallow lake, with the lithofacies paleogeographic pattern changing from the inner clastic shoals and outer shelly shoals in SQ1 to the alternation of mounds and shoals in SQ2-SQ3. (3) Under the joint control of relative lake-level fluctuation, synsedimentary faults and volcanic activity, the shelly shoals in SQ1 tended to accumulate vertically in the raised area, and the mound-shoal complex in SQ2-SQ3 tended to migrate laterally towards the slope-break belt due to the reduction of accommodation space. (4) The evolution pattern of high-energy mounds and shoals, which were vertically accumulated in the early stage and laterally migrated in the later stage, controlled the transformation of high-quality reservoirs from “centralized” to “ring shaped” distribution. The research findings clarify the sedimentary patterns of mounds and shoals and the distribution of favorable reservoirs in the fault-controlled lacustrine isolated platform, providing support for deep-water hydrocarbon exploration in the subsalt carbonate rocks in the Santos Basin.

KEYWORDS Lacustrine carbonate; fault-bounded isolated platform; sedimentary pattern; sequence lithofacies paleogeography; Cretaceous Itapema and Barra Velha formations; Santos Basin

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Petroleum Geological Characteristics and Exploration Potential of Passive Continental Margin Basins in the Central Atlantic

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Based on plate tectonic evolution, and utilizing commercial databases, seismic data, and geological information, we have established that the passive continental margin basin groups in the Central Atlantic underwent three prototype basin evolutionary stages: an intracontinental rift basin during the Middle Triassic rifting phase, an intercontinental rift basin during the Late Triassic to Early Jurassic transition, and a passive continental margin basin during the Middle Jurassic to present drift phase. Among these, the lacustrine source rocks deposited during the intracontinental rifting provided the hydrocarbon generation foundation for pre-salt oil and gas fields, albeit with limited generative potential; the Jurassic marine mudstones deposited during the intercontinental rifting phase served as secondary source rocks, while the fluvial-deltaic sandstones and carbonate rocks of the transitional period provided two favorable reservoir types for pre-salt fields, with marine mudstones and Triassic salt rocks forming regional seals. The configuration of Upper Cretaceous marine shales as the primary source rocks with deep-water turbidite sandstones during the passive continental margin stage represents the decisive factor for the significantly higher degree of hydrocarbon enrichment on the eastern margin compared to the western margin. Clarifying the main controlling factors and accumulation models of giant oil and gas fields within the basin groups has deepened the understanding of hydrocarbon enrichment patterns in salt-bearing sag-type passive continental margin basins, while also identifying deep-water turbidite sandstone reservoirs and carbonate reef-shoal reservoirs as potential priority targets for future exploration.

KEYWORDS Central Atlantic; passive continental margin basins; prototype basin; deep-water deposition; accumulation model

099 ORAL O-17-2-1435

Petroleum Exploration Potential in the Deep Water Outboard of the Colorado Basin

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Oil discoveries at the ultra-deep-water wells Graff-1 and Venus-1 (2,500 m and 3,000 m water depth, respectively) in the Orange Basin of Namibia in early 2022 have made the deep-water South Atlantic a focal area for oil companies and research institutions. The deep-water area of Argentina, conjugate to Namibia and South Africa, hosts extensive analogous deep-water sediments yet remains understudied. Based on 2D seismic data acquired by TGS and BGP in the deep waters outboard of the Colorado Basin during 2016–2017, structural interpretation and frequency-domain AVO characteristic analysis were conducted, and the main conclusions are as follows. First, the northern Argentine offshore deep water features diverse sedimentary and structural assemblages, including rifts and uplifts formed during the Late Jurassic–Early Cretaceous rifting stage, as well as deep- and ultra-deep-water deposits of the sag and drift stages developed after the Late Cretaceous. Second, potential Mesozoic source rocks are well-developed. Jurassic rift-stage and Early Cretaceous drift-stage source rocks represent prospective source sequences in the ancient shelf areas; rift deposits range from 1,000 to 6,000 m in thickness and from 3,000 to 10,000 m in total burial depth (including water depth). Cretaceous strata serve as prospective source rocks in deep waters, with an overburden thickness of 3,000–4,000 m and a total burial depth of the Aptian source rock (including water depth) of 6,000–8,500 m. Multiple wells near the deep-water domain, namely Pejerrey-1, Corona Austral-X1 and Cruz del Sur-X1, encountered varying degrees of hydrocarbon shows in the Lower Cretaceous, confirming its robust hydrocarbon generation potential. The Aptian sequences of Argentina and Namibia share identical seismic reflection signatures of low frequency and high continuity. Third, multiple reservoir types are identified. Lacustrine to shallow marine sandstones were deposited within grabens during the Early Cretaceous rifting, while post-Late Cretaceous channel-turbidite fan systems constitute major reservoir bodies in present deep and ultra-deep waters. Frequency-domain AVO inversion profiles using pre-stack seismic data reveal widespread low-porosity lithologies atop the transitional crust (SDR province) and oceanic crust, interpreted as argillaceous sediments deposited post-Aptian. AVO anomalies indicative of relatively high-porosity media occur both proximal and distal to the slope, corresponding to slope fans and deep-water turbidite fans. Fourth, a wide spectrum of trap styles exists, including lithostratigraphic traps within rifts, sheet sandstone lithologic traps on drift-stage shelves, slope fan/deep-water fan lithologic traps beyond continental slopes, and drape structural traps over paleo-uplifts.

KEYWORDS South Atlantic deep water; Conjugate margin; Argentina offshore

100 POSTER P2-16

Research and Application of 3D Seismic Characterization for Deep-water Gravity Flow Deposition

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Deep-water gravity flow sediments, particularly channel-levee systems and lobe complexes, serve as important hosts for prolific hydrocarbon accumulations across various regions worldwide. These depositional systems exhibit intricate spatiotemporal variations due to multi-phase erosion events and frequent depositional reconfiguration. Characterized by complex stratigraphic relationships and facies distributions, they pose considerable challenges to reservoir characterization. High-resolution 3D seismic data enable the detailed delineation of the geometry, distribution, and evolutionary history of channels, levees, and lobes, thereby facilitating the accurate prediction of reservoir properties and their spatial distribution.

To enhance the capabilities of thin-layer delineation and boundary detection, high-resolution 3D seismic data are processed using spectral decomposition and multi-scale coherent volume techniques. Subsequently, target-oriented seismic attribute slicing is applied to evaluate and screen the most diagnostic attributes for facies classification and reservoir characterization. Optimized attribute fusion is then employed to integrate complementary information from multiple attributes, which significantly improves interpretation accuracy, geological consistency, and the reliability of reservoir prediction. Finally, a modified U-Net convolutional neural network (CNN) model is constructed. Labeled datasets are developed by integrating well-seismic ties and manually interpreted results, and multi-attribute features are incorporated to enable the automated extraction of architectural elements and detailed three-dimensional (3D) geo-bodies.

KEYWORDS Deep-water gravity flow; Channel-levee system; Optimized attribute fusion; U-Net convolutional neural network (CNN) model

101 ORAL O-17-2-1420

Seismic sedimentology for hydrocarbon exploration

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Seismic sedimentology is an advanced geoscience discipline that uses 3D seismic reflection data and well logs to reconstruct ancient environments (paleogeography) and depositional systems. It bridges the gap between geophysics and geology, allowing scientists to map features like ancient river channels and shorelines at unprecedented resolution. To map paleogeography effectively, seismic sedimentology combines several core techniques and concepts to translate geophysical data into geological history. *Stratal slicing* proportionally slices between two reference seismic events to create time-equivalent images of sedimentary surfaces, dramatically increasing vertical resolution from large-scale sequences to thin, reservoir-level beds. *90-degree phase transformation* shifts the seismic data so that peaks and troughs align directly with thin-bed lithological boundaries (e.g., sandstone versus shale), allowing a much more accurate visualization of sedimentary bodies. *Spectral decomposition* breaks down seismic frequencies to isolate and image specific geological features such as deep-water channel systems or coastal fans; by isolating specific frequencies, the continuous wavelet transform (CWT) highlights tuning effects and helps map thin, complex sedi-

mentary bodies that conventional data blur together. *Singularity detection* uses complex wavelets to measure “singularity exponents” in acoustic impedance, enabling high-resolution detection of subtle stratigraphic layers directly from surface seismic data. *Seismic attribute analysis* applies mathematical algorithms to seismic volumes to highlight subtle changes in lithology, sediment dispersal and structural trends.

In reconstructing paleogeography, horizontal “slices” of the subsurface allow interpreters to visualize ancient landscapes in detail, including meandering rivers, deltas and reefs; they reveal how and where sediments were transported and deposited over time, providing evidence of ancient flow directions and coastline evolution; and they are used extensively in petroleum and basin studies to reconstruct the tectonic, climatic and environmental changes of entire sedimentary basins over millions of years.

Multicomponent seismic sedimentology is also important. Shear waves are largely unaffected by pore fluids (e.g., gas), providing clear geological images where P-waves are distorted by gas zones. By combining V_p and V_s (P- and S-wave velocities), geoscientists can calculate elastic attributes to distinguish accurately between sand, shale and carbonate rocks. Split shear waves are highly sensitive to stress fields and fault orientations, allowing direct mapping of subsurface fracture density and reservoir permeability.

KEYWORDS Seismic sedimentology; thin-bed imaging; wavelet transform; hydrocarbon exploration

102 ORAL O-17-2-1705

Impacts of Marine Transgression and Oceanic Anoxic Events on the Hydrocarbon Potential of the Trans-Saharan Seaway Basin

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Cretaceous Oceanic Anoxic Events (OAEs) and widespread marine transgressions represent critical events in Mesozoic Earth-system evolution that strongly controlled the development of source rocks and hydrocarbon potential of continental and transitional basins. However, the regional response mechanisms of these events in low-latitude West African rift basins remain poorly constrained. Driven by extreme greenhouse climates during the Late Cretaceous, large-scale marine transgressions formed the Trans-Saharan Seaway system in North Africa. Located in the central segment of this seaway, the Termit Basin in Niger, West Africa, preserves complete Cretaceous sedimentary successions and serves as an ideal target for investigating the coupling among marine transgression, anoxic events, and hydrocarbon accumulation. Based on palynological and microfossil evidence, total organic carbon isotopes, chemical index of alteration (CIA), and iron and phosphorus speciation data, this study systematically analyzes the control mechanisms of marine transgression and OAEs on source rock development and hydrocarbon potential within the Termit Basin. The Upper Cretaceous strata are divided into four sedimentary intervals that record the OAE2, post-OAE2 global cooling, and OAE3 episodes. The water environment evolved from early oxic to suboxic conditions to later widely ferruginous anoxia, providing favorable preservation conditions for organic matter enrichment. Regional correlation indicates that Late Cretaceous transgressions were globally comparable and facilitated high-quality source rock deposition in both the Termit Basin and terrestrial basins such as the Songliao Basin, distinctly differing from non-transgressive rift basins in Central Africa. The quality of source rocks in the study area is predominantly governed by multi-path phosphorus supply, jointly regulated by global climatic events and regional magmatic activity and phosphorus cycling. This study improves the understanding of regional OAE and transgression responses in low-latitude settings, clarifies the primary controlling factors of high-quality source rocks in the Trans-Saharan Seaway Basin, and provides theoretical support for conventional and unconventional hydrocarbon exploration in West Africa.

KEYWORDS Transgression; OAEs; Hydrocarbon potential; Trans-Saharan Seaway; Niger; Termit Basin

103 POSTER P2-17

Palaeo-deepwater Depositional Model of Mozambique under Multi-directional Contour Current-Gravity Flow Interaction

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The Late Cretaceous to Paleocene succession in northern offshore Mozambique preserves well-developed deep-water sedimentary systems spanning continental slope and abyssal plain, which are jointly governed by gravity flows and multi-directional contour currents. Based on seismic reflection data and sedimentary geological modelling, typical gravity flow architectures, including turbidite channels and deep-water lobes, are widely identified, together with diagnostic contourite features such as contourite drifts, contour moats, and multidirectional erosional-depositional structures. Two persistent palaeo-bottom current branches are recognized during the Late Cretaceous-Paleocene interval: a moderate-to-high velocity contour current developed along the slope base with a SW-NE flow direction, and a relatively low-velocity current occupying the abyssal plain, which experienced prominent southeastward deflection during propagation, as evidenced by the variable long-axis orientations of contourite drifts.

Differential palaeotopography dominates the hydrodynamic partitioning and flow patterns. The irregular slope-base topography constrains the pathway of the first contour current branch, while local palaeogeomorphic highs on the abyssal plain control the southeast deflection of the second branch. At the slope base, contour currents flow perpendicular to downslope gravity flows. Modified by persistent contour current reworking, channel-lobe complexes and asymmetric reworked lobes develop parallel to the palaeo-coastline, exhibiting unidirectional migration and lateral extension. In the abyssal plain where contour currents obliquely intersect gravity-flow channels, superimposed hydrodynamics strengthen sediment erosion and transportation, generating large-scale, far-extending channel complexes with distinctive distal deepening incision. This study establishes an improved palaeo-deepwater depositional model for the northern Mozambique passive margin, revealing differentiated spatial coupling mechanisms between dual contour current systems and gravity-flow deposition under palaeogeomorphic control.

KEYWORDS Contour current; Gravity flow; Flow interaction; Deep-water deposition; Mozambique passive margin

T4-2 Deep and ultra-deep reservoirs and hydrocarbon accumulation**104** ORAL O-17-2-1505**The formation mechanism of Ediacaran deep carbonate reservoirs: Evidence for multistage diagenetic fluid evolution from the Sichuan Basin, Southwestern China****Zehao Yan^{1*}, Qi Li^{1,2}, Hehe Chen¹**¹ China University of Geosciences (Beijing), Beijing 100083, CHINA² Hainan Institute, China University of Geosciences (Beijing), Sanya 572025, CHINA

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Carbonate reservoirs represent primary targets for global deep to ultra-deep hydrocarbon exploration. However, the controlling mechanism of diagenetic fluid evolution on high-quality reservoir development in terminal Ediacaran carbonates of the Sichuan Basin remains contentious, impeding precise exploration deployment. This study integrates core petrological observations from Well PT101, geochemical analyses and seismic profile interpretation in the central Sichuan Basin to constrain the properties and evolutionary trajectory of dolomitizing fluids, as well as their coupled porosity response under basin evolution. (1) Fibrous dolomite (MCD I) precipitated from seawater during the syngenetic-penecontemporaneous shallow burial stage under a predominantly dysoxic setting, which reinforced pore compaction resistance. (2) During the slow burial stage following supergene diagenesis, foliated dolomite cement (MCD II) precipitated from pore-trapped seawater, triggering rapid porosity reduction. (3) Bladed dolomite cement (MCD III) formed under deep burial conditions, with diagenetic fluids interpreted as Mg^{2+} -rich brines derived from mixing of residual pore seawater and formation fluids that leached earlier dolomite generations. (4) Sparry anhedral dolomite (MCD IV) and saddle dolomite (SD) formed during the late diagenetic adjustment stage. Their positive Eu anomalies indicate a deep hydrothermal source, where late hydrothermal fluids precipitated cements while exerting selective pore dissolution.

Multi-stage cement assemblages define a distinctive porosity evolution pathway: early cement protection, middle-stage limited cementation, and late hydrothermal dissolution modification. Favorable targets for hydrothermal dissolution-enhanced reservoirs occur where early high-energy mound-shoal complexes overlap with late fault-controlled hydrothermal zones.

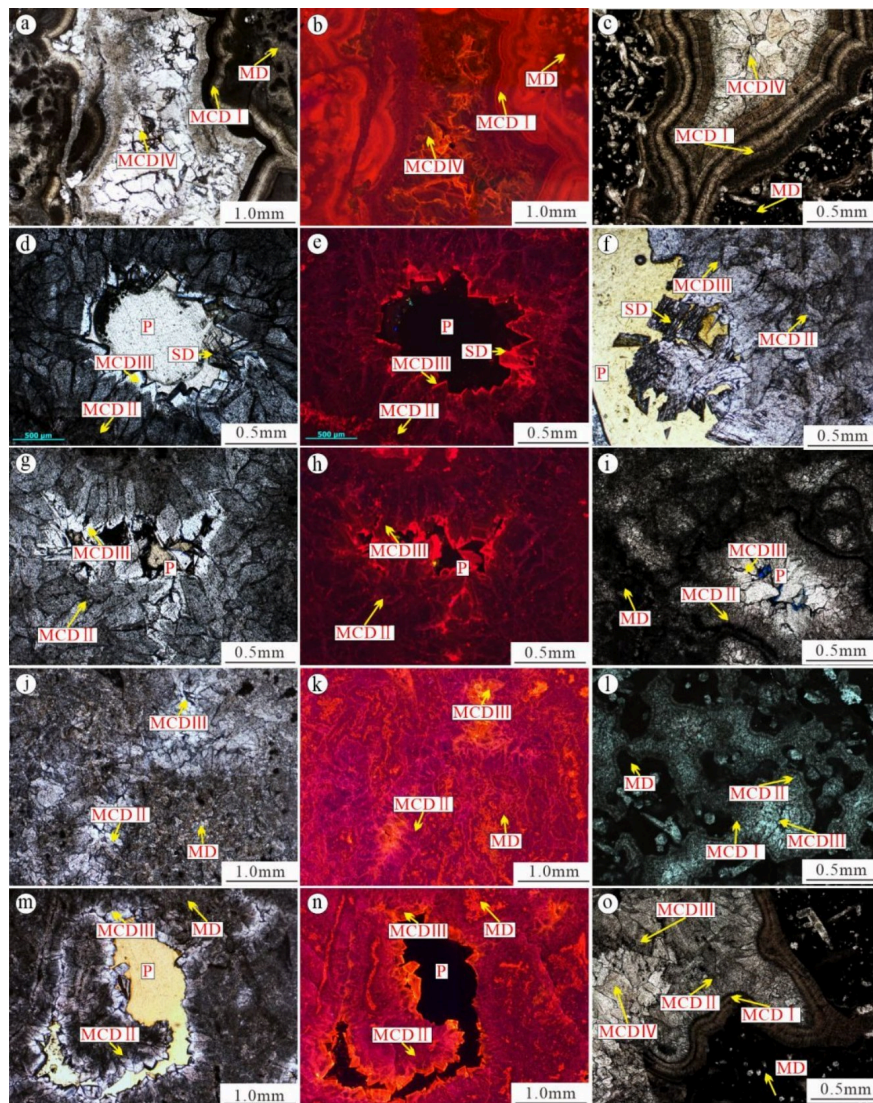


Fig. 1. Typical secondary dolomite cements from the Late Sinian, Sichuan Basin

KEYWORDS Diagenetic fluid property; dolomite cement; pore evolution; Ediacaran; Sichuan Basin

T4-3 Unconventional reservoirs and hydrocarbon exploration**105** ORAL O-17-2-1635**Geological characteristics and models of fault-fold-fracture body in deep tight sandstone of the second member of Upper Triassic Xujiahe Formation in Xinchang structural belt of Sichuan Basin, SW China****Junlong Liu*, Zhongqun Liu, Zhenfeng Liu**

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In the second member of the Upper Triassic Xujiahe Formation (T_3x^2) in the Xinchang area, western Sichuan Basin, only a low percentage of the reserves has been recovered, and the geological model of gas-reservoir sweet spots remains unclear. Based on a large number of core, field outcrop, test and logging-seismic data, the T_3x^2 gas reservoir in the Xinchang area is examined. The concept of fault-fold-fracture body (FFFB) is proposed, and its types are recognized. The main factors controlling fracture development are identified, and the geological models of FFFB are established. FFFB refers to reservoirs formed by faults, folds and their associated fractures. According to the characteristics and genesis, FFFBs can be divided into three types: fault-fracture body, fold-fracture body, and fault-fold body. In the hanging wall of the fault, the closer to the fault, the more developed the effective fractures; the greater the fold amplitude and the closer to the fold hinge plane, the more developed the effective fractures. Two types of geological models of FFFB are established: fault-fold fracture, and matrix storage and permeability. The former can be divided into two subtypes: network fracture, and single structural fracture, and the latter can be divided into three subtypes: bedding fracture, low permeability pore, and extremely low permeability pore. The process for evaluating favorable FFFB zones was formed to define favorable development targets and to support well deployment for high production. The study results provide a reference for the exploration and development of deep tight sandstone oil and gas reservoirs in China.

KEYWORDS Fault-fold-fracture body; fracture control factor; genetic characteristics; geological model; tight sandstone**106** POSTER P2-19**Characteristics and ordered development patterns of the Whole Petroleum System of lithofacies: A case study of Permian Wujiaping Formation in northern Sichuan Basin, South China****Tianjia Liu*, Zongquan Hu, Dianwei Zhang**

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Based on the fundamental principles of the whole petroleum system, this paper discusses the influences of tectonism, sedimentation and diagenesis on the orderly lithofacies of the Wujiaping Formation in the northern Sichuan Basin. The results indicate that: (1) the sedimentary system is characterized by distinct zonation: controlled by the Emeishan Large Igneous Province and the Kaijiang-Liangping Trough, the Wujiaping Formation exhibits an ordered lithofacies succession from deep-water facies to platform facies, consisting of deep-water facies laminated carbon-rich high-silica shale, slope facies interbedded carbon-rich high-silica shale and limestone and massive siliceous limestone, and platform facies low-carbon low-silica limestone. (2) reservoir characteristics show continuity: deep-water facies are unconventional siliceous shale reservoirs, dominated by nanoscale organic pores; slope facies are conventional-unconventional interbedded reservoirs, with coexisting shale and carbonate reservoirs and nanoscale-microscale pores; platform facies are con-

ventional carbonate reservoirs, dominated by intercrystalline pores and dissolution pores of microscale and above. (3) diagenetic evolution shows continuity: penecontemporaneous dissolution and shallow-burial dolomitization are the major constructive diagenetic processes for the conventional carbonate reservoirs, whereas organic matter thermal maturation during mid-to-deep burial is the dominant constructive diagenetic process for the unconventional siliceous shale. (4) gas field distribution is ordered: deep-water shale gas reservoirs are characterized by source–reservoir integration; the slope zone hosts conventional-unconventional coexisting gas reservoirs; and the platform is characterized by conventional carbonate gas reservoirs.

KEYWORDS Whole petroleum system; Permian Wujiaping Formation; Lithofacies; Sichuan Basin

107 ORAL O-17-2-1520

Astronomical Forcing Drives Shale Oil Lithofacies Differentiation and Sedimentary Infilling in Paleogene Continental Lacustrine Basins, Eastern China

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The cyclic filling process and driving mechanisms of fine-grained sedimentation in continental rift lake basins represent a core topic in sedimentary geology. Orbital cycles constrain lacustrine depositional evolution by modulating regional climate and hydrological fluctuations. However, the mechanisms governing lacustrine sedimentary evolution still require support from high-resolution sedimentary records. Therefore, we selected the Paleogene lacustrine sedimentary succession in the Dongpu Sag of the Bohai Bay Basin, eastern China, and conducted cyclostratigraphic analysis and reconstruction of the sedimentary filling process using continuous XRF-derived elemental geochemical data, well-log data, and core observations. Through time series analysis and spectral detection, we identified sedimentary thicknesses corresponding to eccentricity, obliquity, and precession cycles preserved in the strata. Building on this, we reconstructed sedimentation rates using the COCO-eCOCO-TimeOpt method. Based on astronomical tuning, we extracted the 405 kyr long eccentricity cycle through Gaussian bandpass filtering and applied it for time-depth conversion of the GR series, ultimately establishing a high-resolution astronomical time scale for the Middle Eocene in the Dongpu Sag. Using the time-calibrated GR series, we reconstructed the fluctuation history of the paleo-lake level by applying the DYNOT and ρ_1 sedimentary noise models. In addition, using elemental geochemical proxies, we selected terrigenous conservative elements such as Al_2O_3 , Ti, and Zr as well as the Zr/Rb ratio to quantitatively reconstruct the evolutionary sequence of terrigenous detrital input intensity. Combined with Ca/Ti and Sr/Ba ratios, we clarified the coordinated variation pattern between lake-level fluctuations and paleo-lake water salinity. Through redox-sensitive element ratios such as Fe/Mn, V/Cr, and U/Th, we further identified periodic alternations in the redox state of the bottom water in the lake basin. We also identified five lithofacies—gypsum salt, sulfate, carbonate, mudstone, and siltstone—together with vertical abrupt lithological interfaces based on elemental geochemical proxies, and these identifications were supported by sedimentary noise results and core observations. The waveform variations of sedimentary cycles correspond to lithological changes, and this cyclicity is controlled by eccentricity-driven long-term climatic fluctuations. We propose a mechanism whereby astronomical forcing influences lacustrine sedimentary filling through modulation of paleoclimate responses. Eccentricity maxima correspond to warm and humid climates, leading to increased lake depth and enhanced terrigenous detrital input, which re-

sulted in the deposition of mudstone and siltstone. In contrast, eccentricity minima correspond to cold and arid climates, causing the lake to shrink to the stage of sulfate and even chloride precipitation and leading to the deposition of carbonate and gypsum. This study provides a new paradigm for understanding the sedimentary dynamics of continental rift lake basins during tectonic quiescence and highlights the controlling role of orbital-scale climatic fluctuations on the alternating accumulation of evaporites, clastic rocks, and mudstones. The study can be extended to unconventional petroleum geology, because different sedimentary filling modes generate distinct shale development patterns, and these different shale development patterns in turn lead to the formation of different lithofacies assemblages.

KEYWORDS Astronomical forcing; sedimentary infill; shale oil lithofacies

108 ORAL O-17-2-1535

Carbonate replacement of siliceous shale in the Dalong Formation of the Sichuan Basin and its impact on the development of shale reservoirs

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A study was conducted on the genesis of micritic calcite in the siliceous shale of the Upper Permian Dalong Formation in northeastern Sichuan and its impact on shale reservoir development using various techniques, including scanning electron microscopy (SEM), electron probe microanalysis (EPMA), and carbon-oxygen isotope analysis. The siliceous shale of the Dalong Formation generally exhibits high quartz content, followed by carbonate minerals, with relatively low clay mineral content. Microscopic observations revealed that the siliceous shale contains abundant radiolarian bioclasts, either densely packed or dispersed within the siliceous mineral matrix. Under cross-polarized light, the radiolarian skeletons display multicolored features characteristic of carbonate replacement, while SEM imaging shows typical (partial or complete) replacement pseudomorph structures. Energy-dispersive spectroscopy (EDS) analysis confirmed a diagenetic replacement origin. The replacement process also occurred in the siliceous mineral matrix surrounding the radiolarian skeletons, which serves as the rock framework. The calcite replacements exist in two forms: (1) well-crystallized individual grains and (2) poorly crystallized or even anhedral aggregates, distributed irregularly as scattered spots or interconnected patches within the siliceous matrix, forming a mosaic texture. Oxygen isotope compositions indicate that the calcite formed in a low-temperature environment, while EPMA analysis revealed high silicon and anomalous strontium concentrations, attributed to pore fluid-rock interactions during early diagenesis. This process led to the filling and destruction of primary inorganic pores between quartz grains, reducing the in-situ storage space available for later liquid hydrocarbon retention and thereby affecting the quantity of secondary organic pores and total porosity in the overmature stage. Carbonate replacement is a key mechanism controlling the development of high-quality reservoirs in the Dalong Formation siliceous shale in northeastern Sichuan. The preferential selection of shale gas "sweet spots" should fully account for the differential effects of this process.

KEYWORDS Carbonate replacement; Calcite; Radiolarian; Siliceous shale; Dalong Formation

109 ORAL O-17-2-1400

Characteristics of pore and fracture development of marine shale and their control over shale gas occurrence in the Dalong Formation of northeastern Sichuan

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Studying the development of pores and fractures in Permian marine shale in the Sichuan Basin is of great significance for revealing the mechanisms of shale gas enrichment and high yield and for identifying favorable exploration intervals. Through scanning electron microscopy (SEM) observation, core analysis, and well logging interpretation, this study quantitatively characterizes the pores and multi-scale fractures of the marine shale of the Permian Dalong Formation in northeastern Sichuan, and explores the controls exerted by organic pores and multi-scale fractures on shale gas occurrence. The results indicate that the Dalong Formation shale exhibits high organic matter abundance (average TOC content of 4.34%) and low matrix porosity (average 2.45%). The pore development is dominated by organic pores, accounting for an average of 71.77% of total pores, with pore sizes primarily below 30 nm. Fractures are mainly categorized into three genetic types: tectonic fractures, diagenetic fractures (interlayer bedding fractures, organic matter shrinkage fractures, and grain-edge fractures), and abnormal high-pressure fractures. Based on SEM and combined measurements of nitrogen adsorption and high-pressure mercury intrusion, micro-scale fractures range primarily from hundreds of nanometres to micrometres, contributing an average of 30.47% to the micro-scale storage space. Small-scale to mesoscale fractures in cores and logs reach millimetres or more, with interlayer bedding fractures and tectonic fractures accounting for 52.4% and 47.6% in cores, respectively, while high-conductivity fractures and high-resistance fractures account for 89.0% and 11.0% in logs. Fracture porosity ranges from 0.01% to 2.06%, with an average of 0.25%. The “high gas content and relatively high proportion of adsorbed gas” in the Dalong Formation shale are controlled by the synergistic effects of high organic matter abundance, high organic pore proportion, and multi-scale fracture development. High-abundance organic matter not only acts as the hydrocarbon-generating precursor, but also its macerals (dominated by alginate and solid bitumen) contain abundant micro- and mesopores with large specific surface areas. These pores greatly enhance methane adsorption capacity and provide crucial storage space for adsorbed gas. Meanwhile, the relatively well-developed microscale and small-scale to mesoscale fractures greatly improve the storage space for free gas, making free gas the dominant component in the total gas content. Therefore, the development of pores and multi-scale fractures collectively controls the occurrence and enrichment of shale gas.

KEYWORDS Marine shale gas; multiscale fractures; occurrence and enrichment; Dalong Formation

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110 POSTER P2-20

Enrichment Controls and Sweet-Spot Assessment of Lacustrine Shale in the Lianggaoshan Formation, NE Sichuan Basin

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During the Jurassic evolution of the Sichuan Basin, the Lianggaoshan Formation records a critical paleogeographic transition from shore-shallow lake to semi-deep lake settings. Its complex sedimentary infill exerts fundamental control on lithofacies differentiation and organic matter enrichment in lacustrine shales, establishing this succession as a key emerging play for shale oil and gas exploration in China. This study targets the Lianggaoshan Formation in the northeastern Sichuan Basin, which exhibits a typical tripartite stratigraphic architecture: the lower and upper intervals consist of varicolored siliciclastic deposits of shore-shallow lake origin, whereas the middle member (Liang 2 Member) is dominated by dark fine-grained sediments deposited in shallow to semi-deep lacustrine environments. We employed an integrated approach combining core description, well-log interpretation, organic geochemical analysis, and field-emission scanning electron microscopy to systematically characterize lithofacies types and their spatial distribution across different intervals, quantitatively evaluate pore structures, and investigate how diagenesis and hydrocarbon generation affect reservoir quality. Six lithofacies occur in the study area, dominated by laminated clayey shales and silty shales. High-quality shales (TOC>1%) are preferentially enriched in the semi-deep lacustrine facies of the upper submember of the lower Liang 2 Member, with the Fuxing and Qijiang areas identified as the main distribution zones. Pores are predominantly inorganic meso- to macropores, and their development is jointly controlled by clay mineral content, organic matter abundance, and thermal maturity. The paleogeographic setting played a significant role in organic matter accumulation and preservation; the stable water column and low-energy conditions of the semi-deep lake favored organic matter retention, while intermittent detrital input forming silty laminae enhanced reservoir brittleness. The key factors governing hydrocarbon enrichment are thus the development of high-quality shales, favorable preservation conditions, and effective interplay with silty laminae. On this basis, we designated the upper submember of the lower Liang 2 Member as the primary sweet-spot interval. We also established a ternary evaluation model integrating lithofacies association, reservoir physical properties, and controlling factors, and constructed a "four-property" evaluation system specifically tailored to lacustrine shale. This framework has improved our understanding of hydrocarbon enrichment mechanisms in lacustrine shale systems. Application of this evaluation framework has delineated three favorable exploration fairways, including the southern portion of the northeastern Sichuan Basin, providing both theoretical guidance and technical support for exploration deployment and sweet-spot prediction in this region and analogous lacustrine shale plays elsewhere.

KEYWORDS Lacustrine shale; Lithofacies; Pore structure; Enrichment controls; Lianggaoshan Formation

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111 POSTER P1-24

Distribution characteristics of geostress field in complex tectonic zones and its impact on shale gas enrichment and high productivity: A case study of the Upper Ordovician Wufeng Formation and Lower Silurian Longmaxi Formation in southeastern Sichuan Basin

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The distribution of present-day geostress in deep shale formations in the southeastern Sichuan Basin is highly complex in terms of magnitude, orientation and structure, posing significant challenges for shale gas exploration, development planning, and production performance. This study focuses on the Wufeng and Longmaxi Formation shales in the southeastern Sichuan Basin. By integrating core analysis with multi-source and multi-dimensional geostress response data from drilling, combined with geomechanical analysis and numerical simulation, we identify key geological processes responsible for geostress field disturbance, elucidate mechanical mechanisms and variation patterns of stress perturbations, and assess their implications for shale gas enrichment and high-yield production. The results reveal that: (1) the overall stress regime in the southeastern Sichuan Basin is mainly strike-slip. In structurally complex zones near the basin margin, the stress regime transitions progressively from reverse faulting at shallow depths to strike-slip or normal faulting at greater depths. (2) folds and faults are key external factors influencing geostress field deflection. Within folds, the direction of geostress deflection above and below the neutral surface follows an opposite trend. Near faults, stress orientations tend to align with fault strike, while stress magnitudes decrease and differential stress increases; (3) shale gas enrichment is favored in areas where the angle between the maximum principal stress and fracture orientation is relatively large and where the vertical-to-horizontal stress ratio is high. Regions with tensile stress perturbations exhibit lower overall stress magnitudes and reduced differential stress, facilitating the development of complex fracture networks during hydraulic fracturing, which enhances well productivity and stability. These insights provide a valuable framework for accurately characterizing the geostress field in deep, structurally complex shale reservoirs and optimizing sweet spot selection for shale gas development.

KEYWORDS Sichuan Basin; Silurian; Geostress; Shale gas

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112 ORAL O-17-2-1650

Occurrence characteristics of pore water and its impact on self-sealing capacity: a case study of deep shale of the Longmaxi Formation, Sichuan Basin, China

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The shale gas in China's marine Longmaxi Formation has entered the deep-burial exploration stage. Under the complex tectonic conditions, the preservation capacity of shale gas is crucial for its enrichment. Previous studies have conducted extensive work on the preservation conditions but in-depth research on the mechanisms is still limited, including how micro-nano pore structures, gas-water occurrence characteristics, and their coupling effects influence the enrichment of shale gas.

This study used different methods, including water vapor adsorption, nitrogen adsorption, and alloy injection pore connectivity imaging to investigate pore structure and gas-water occurrence characteristics in deep shale. Numerical simulation was also used to analyze seepage behavior and capillary force sealing effects caused by water occurrence in nano-throats, thereby establishing the relationship between pore structure, gas-water occurrence, and self-sealing capacity.

The results indicate that bound water primarily occupies inorganic pores with diameters less than 4 nm. As water content increases, more and more water enters organic pores. The experimental results show that water saturation significantly reduces the gas content in the inorganic pores as well as the effective permeability of the gas. Molecular dynamics studies further showed that throat channels smaller than 4 nm exhibit a capillary force capability exceeding 20 MPa. Alloy injection results indicate that the shale pore structure has low connectivity. The ultra-low permeability caused by bound water and the capillary force would further reduce gas flow capacity, thereby creating an effective microscopic sealing condition. During the late uplift stage, the tectonic stress effect will further alter the connectivity of the pores and fractures, thereby causing changes in the occurrence of gas and water.

KEYWORDS Shale gas; self-sealing capacity; water-gas occurrence; capillary force sealing

T4-4 Siliciclastic reservoir geology and hydrocarbon exploration**113** POSTER P2-21**Depositional paleogeography and tectonic controls on deep hydrocarbon accumulation in a faulted lacustrine basin: A case study of the C structure, central-southern Xihu Sag****Hongliang Huo^{1,2}, Chenglin Liu^{1,2*}, Zehui Guo^{1,2}, Tong Qiao^{1,2}, Yiyang Huang^{1,2}, Dehao Feng^{1,2}**¹ State Key Laboratory of Petroleum Resources and Engineering, China University of Petroleum (Beijing), Beijing 102249, CHINA² College of Geosciences, China University of Petroleum (Beijing), Beijing 102249, CHINA

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Deep hydrocarbon accumulation in faulted lacustrine basins is controlled by the coupling of tectonic evolution, depositional paleogeography, and reservoir heterogeneity. Using the C structure in the central-southern Xihu Sag as a case study, this study integrates seismic interpretation, drilling and logging data, core observations, and reservoir analyses to investigate the accumulation process, key controlling factors, and accumulation model of deep siliciclastic reservoirs in the Huagang and Pinghu formations. The study area underwent multi-stage tectonic evolution, including faulting, depression, and late compressional inversion. Anticlinal traps were established during the Longjing Movement, whereas large-scale hydrocarbon charging mainly occurred in the late stage, indicating a typical late accumulation pattern. The central part of the C structure is characterized by a gentle structural geometry, early effective fault conduits, and the absence of late destructive faulting, which together favored hydrocarbon migration and preservation. From a depositional-paleogeographic perspective, distributary-channel sand bodies developed during the early to middle stages of third-order sequences in the lower Huagang Formation, forming laterally connected reservoir frameworks that were later transformed into structural-lithologic composite traps along anticline flanks. In contrast, the upper Pinghu Formation contains thick composite sand bodies, but the reservoirs are generally tight, with low- to ultra-low-permeability characteristics. Reservoir sweet spots are strongly controlled by depositional microfacies and grain-size distribution, and preferentially occur in high-energy settings such as tidal-channel bases and tidal-sand-bar crests, reflecting pronounced vertical and lateral heterogeneity. The results suggest that deep hydrocarbon enrichment in the study area is governed by the spatiotemporal coupling of high-quality sand-body distribution, fault-controlled migration pathways, late-stage charging, and differential preservation. On this basis, a deep siliciclastic accumulation model is proposed, characterized by anticline-dominated structural settings, structural-lithologic composite traps, and sweet-spot-controlled enrichment within tight reservoirs. This model provides a useful framework for deep exploration in the Xihu Sag and analogous faulted lacustrine basins.

KEYWORDS Xihu Sag; faulted lacustrine basin; deep siliciclastic reservoirs; depositional paleogeography; tectonic controls; reservoir heterogeneity; hydrocarbon accumulation

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114 POSTER P2-22

Geologic controls of porosity in well cores of the Wilcox Formation in the Perdido Area, Mexico

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This study investigates the geologic controls on porosity in the Wilcox Formation of the Perdido area, Gulf of Mexico, focusing on how lithofacies and diagenetic processes influence reservoir quality. We analyzed 14 cores from 6 exploratory wells through macroscopic descriptions to identify lithofacies and depositional systems. Additionally, we distinguished 8 distinct microfacies to evaluate petrographic variations and grain-size distributions using thin-section petrography via point-counting, while evaluating reservoir quality parameters through conventional core analysis. The macroscopic analysis identified sandy lithofacies, occasionally impregnated with oil, deposited in submarine fan systems. Petrographic classification categorized these sandstones as lithic arkoses and feldspathic litharenites, predominantly composed of quartz with similar proportions of feldspars and lithics, ranging from very fine sand to coarse silt. Organized in fining-upward rhythmic sequences, microfacies 2 and 3 (sandstones and coarse siltstones) exhibit the highest porosity (up to 23–24%), contrasting sharply with the low or absent porosity in clayey microfacies (4 to 8). Among the identified diagenetic processes, including early glauconite precipitation, calcite cementation, grain alteration to clays, and partial feldspar dissolution, mechanical compaction represents the most adverse control. Compaction significantly reduced porosity with burial depth, dropping from 10–35% in shallow cores to 2–5% in deep cores.

We conclude that mechanical compaction and clay content constitute the primary geological controls on porosity within the Wilcox Formation, whereas grain size and secondary diagenetic processes exert only a minor effect.

KEYWORDS Geologic controls; Porosity; Wilcox Formation; Diagenesis; Compaction; Clay content; Reservoir quality; Sandstones; Siltstones

115 POSTER P2-23

Effect of feldspar dissolution on the pore structure of tight sandstone and its influence on the orderly distribution of gas reservoirs: a case study of the Xujiahe Formation in the Bazhong area, northeastern Sichuan Basin

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The fourth member of the Xujiahe Formation in the Bazhong area, an important gas exploration reservoir in the northeastern Sichuan Basin, is a typical tight sandstone reservoir. To clarify the main controls on the pore structure of this reservoir, methods such as cast thin sections, scanning electron microscopy (SEM), cathodoluminescence (CL), NESE Geo image analysis, petrophysical tests, mercury intrusion porosimetry (MIP), X-ray diffraction (XRD) and fluid inclusions are used to analyse diagenesis and its influence on reservoir properties and to explore the effect of feldspar dissolution and associated cementation on reservoir pore structure. The results show that, during mesodiagenesis, burial dissolution of grains (mostly feldspars) led to the formation of intragranular pores, the main pore type in the study area, increasing porosity by 3% and raising permeability. During this process, the sorting of pores and throats deteriorated, but the proportion of larger

pores and throats increased. However, the products of dissolution, such as illite, chlorite and quartz, precipitated in pores formed during the process of dissolution or pores (throats) close to the location where dissolution occurred, and the porosity reductions caused by clay-mineral precipitation and quartz cementation are 6.3% and 4.2%, respectively. In this process, the radii of pores and throats corresponding to the peak frequency decreased, and the proportion of micropores increased. To conclude, the porosity of sandstones in the fourth member of the Xujiahe Formation in the Bazhong area increased during dissolution of feldspars and rock fragments, but their permeability dropped owing to precipitation of dissolution products in pores and throats, which reduced pore and throat radii and worsened pore connectivity. The differences in these pore structure characteristics control the orderly distribution of tight gas reservoirs in the Xujiahe Formation.

KEYWORDS Tight sandstone; feldspar dissolution; pore structure; Xujiahe Formation; Bazhong area; Sichuan Basin; orderly distribution of tight gas

FUNDING Oil & Gas Major Project 2025ZD1400400

T4-5 Reservoir heterogeneity and hydrocarbon development**116** ORAL O-17-2-1720**Effects of Differential Diagenesis of Mixed Fine-Grained Sedimentary Rocks on Reservoir Quality—A Case Study of Siltstone Facies in the Permian Fengcheng Formation, Mahu Sag, Junggar Basin****Yinshan Ma¹, Tao Wang^{1*}, Tianyu Zhao¹, Mengyao Li²**¹ Chinese Academy of Geological Sciences, Beijing, CHINA² Xinjiang Oilfield Company, Xinjiang, CHINA

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The mixed siltstone facies of the Permian Fengcheng Formation in the Mahu Sag, Junggar Basin, represents one of the principal unconventional reservoir types. However, the controls of differential diagenetic evolution during burial on reservoir storage capacity remain poorly understood. Based on mineral composition, this study investigates lithofacies, diagenesis, diagenetic evolutionary sequences, and their impacts on reservoir pore space in siltstones of the Fengcheng Formation using thin-section observation, X-ray diffraction, cathodoluminescence, and scanning electron microscopy. The results show that tight siltstone reservoirs in the Fengcheng Formation can be classified into five types: dolomitic, calcareous, saline, tuffaceous, and argillaceous siltstones. Among them, dolomitic and calcareous siltstones represent the most favorable reservoirs. Formed by primary precipitation during penecontemporaneous deposition, followed by recrystallization and metasomatism in later stages, these lithofacies are dominated by dissolution pores and intercrystalline pores derived from aluminosilicate minerals such as feldspar, with minor residual intergranular pores. Dolomitic siltstones are mainly developed in the alkaline lake transitional zone, whereas calcareous siltstones predominate in the marginal zone. Tuffaceous and argillaceous siltstones constitute secondary favorable reservoirs. Tuffaceous siltstones are characterized by dissolution pores associated with analcitization and intercrystalline pores formed by albitization during volcanic ash alteration. Diagenesis in argillaceous siltstones is dominated by chlorite-smectite mixed-layer cementation, with minor preserved intercrystalline pores, dissolution micropores, and organic-matter pores; both types are widely distributed across the study area. Saline siltstones represent the poorest reservoir type, with abundant alkaline minerals and locally developed dissolution pores, and contain few effective sweet spots.

KEYWORDS Junggar Basin; Mahu Sag; Fengcheng Formation; Mixed fine-grained sedimentary rocks; Diagenesis**FUNDING** Xinjiang Oilfield Company (No. XJYT-2024-JS-5189) and Geological Survey Project of China Geological Survey (No. DD202401021)

T4-6 Depositional architecture and reservoir geology**117** POSTER P1-20**Facies hierarchy and reservoir quality of deepwater basin-floor sands in the paleo-Orinoco, Cruse Formation, Trinidad****Ariana Osman*, Oshaine Blake, Kerneese Ramjarrie, Tiffany Kalloo, Annalieze Nowrang, Shazana Mohammed**

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Deepwater depositional architecture strongly controls sand distribution and reservoir quality in basin-floor environments. The late Miocene–Pliocene paleo-Orinoco Cruse Formation contains up to 280 m of stacked deepwater sand deposits. These were emplaced within a developing foreland basin beyond the shelf edge during repeated 4th-order regression-transgression cycles linked to shelf-margin growth. Despite its importance as both a producing reservoir and target for carbon capture and storage studies, the depositional hierarchy and reservoir properties of individual facies associations remain poorly constrained. This study documents facies variability and bed-thickness trends from an ~90 m vertical outcrop section to reconstruct depositional evolution and evaluate reservoir quality through porosity and permeability analyses.

Three facies associations (FA) record progradation from distal basin-floor to slope environments: 1) FA1: distal lobe-fringe deposits; 2) FA2: basin-floor channel-lobe sands; and 3) FA3: slope channels and channel-levee deposits. FA1 comprises thin (<20 cm), sand-rich Ta–Tb beds capped by carbonaceous-rich muds with contorted bases and floating mudstone clasts, interpreted as hybrid-event beds deposited in a distal lobe-fringe setting. FA2 overlies FA1 and consists of amalgamated high-density turbidite beds up to 2 m thick that stack into 12–17 m sandy lobe packages separated by laminated mudstones up to 3 m thick. These sands are laterally continuous across the outcrop (~100 m), suggesting deposition within unconfined basin-floor channels. Although the lateral extent of the outcrop exposure is limited, the 49 m-thick stacked FA1–FA2 succession and associated >3 m-thick mudstones, when compared with ancient analogues and subsurface well correlations from the Cruse Formation, suggest a lobe complex that may extend at least 4 km wide and 20 km long.

Reservoir quality varies with depositional process. Sand-rich FA1 and FA2 deposits have high porosity (19–29%) and moderate to high permeability (34–185 mD), whereas carbonaceous hybrid-bed caps exhibit very low permeability (0.76 mD), highlighting how bed-scale heterogeneity may impede vertical fluid flow. FA3 shows continued progradation into mudstone-dominated slope-channel environments. Isolated sandy channels (~12 m wide) composed of stacked Ta beds have high porosity (28%) and permeability (103 mD) and have associated channel-levee deposits. The sand-rich channel-levees are 3–4 m thick and are dominated by climbing-ripple cross-laminated deposits that have high porosity (25–27%) but low permeability (1–17 mD). Collectively, these facies relationships and stacking hierarchies may provide a predictive framework for reconstructing deepwater reservoir architecture, connectivity, and heterogeneity of paleo-Orinoco basin-floor sand systems.

KEYWORDS Deep-water; reservoir quality; paleo-Orinoco

118 POSTER P2-24

A review of mineralogical and geochemical controls on microbial hydrogen loss and reservoir integrity in underground hydrogen storage

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Underground hydrogen storage (UHS) in depleted gas fields, saline aquifers and salt caverns is central to the seasonal balancing of renewable energy, but indigenous subsurface communities oxidise dissolved H_2 and express it as CH_4 , H_2S/HS^- , acetate, $Fe(II)$, biomass or secondary minerals. Synthesising high-pressure reactor, pore-scale and field datasets, we show that the physical envelope of temperature, pressure and storage cycling sets metabolic viability and the rate of gas-liquid H_2 delivery, whereas the aqueous chemistry and the mineral context decide which product accumulates. A single pressure-temperature condition can support methanogenesis, sulfate reduction, homoacetogenesis or iron reduction, and it is the terminal electron acceptor rather than the physical state that fixes the pathway. Temperature is the main exception, tilting the homoacetogenesis-methanogenesis balance so that acetate rises from 1–4% of the consumed H_2 at 34–40 °C to 14–16% at 25 °C. Apparent pressure suppression is largely a normalisation artefact, since area-normalised rates show no systematic trend between 1 and 60 bar.

Salinity acts as a kinetic brake rather than an on/off switch: H_2 consumption is halted above about 35 g L^{-1} total dissolved solids yet persists slowly in halite-saturated cavern brine. Water saturation gates access through a threshold near 70%, below which connected water films and gas-brine interfacial area are insufficient. Proton-consuming methanogenesis and sulfate reduction drive pH to 9–9.5, whereas homoacetogenesis acidifies fluids below pH 5. Carbonate alkalinity regulates the size of the excursion, and the divalent-cation budget decides whether that alkalinity is expressed as a high-pH brine or as precipitated carbonates and Fe-sulfides.

The same products rework the host rock. Biofilm growth lowers permeability far more than porosity and concentrates near the injection face, while biogenic sulfide and organic acids degrade casing and cement. H_2 loss alone is therefore not a pathway diagnosis: monitoring must pair cycle-resolved recovery with an inventory of the reachable electron acceptors, the carbonate buffering capacity and guild-specific markers (*mcrA*, *dsrAB*, *fhs*). Depositional facies and diagenetic mineralogy are thus first-order screening criteria for UHS site selection.

KEYWORDS Underground hydrogen storage; Microbial hydrogen consumption; Reservoir mineralogy; Sulfate reduction; Reservoir integrity

119 POSTER P2-36

Differentiated sedimentary architecture model of lacustrine gravity-flow deposits in terrestrial basins

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Terrestrial lacustrine gravity-flow reservoirs possess enormous resource potential for tight oil and shale oil, and are currently key targets for tight oil and shale oil exploration and development across China. Lacustrine gravity-flow reservoirs are widely developed in multiple terrestrial basins in China, including the Ordos, Songliao, Junggar and Bohai Bay basins. Compared with submarine

gravity-flow deposits, lacustrine gravity-flow deposits feature an extremely complex sedimentary evolutionary process and highly differentiated internal sedimentary architecture; establishing their sedimentary architectural model has long been a major challenge restricting sedimentological research. Based on triggering mechanisms and primary controlling factors, we classify lacustrine gravity-flow deposits into three major types: flood-induced, slump-induced, and composite flood-slump types, which can be further subdivided into seven subtypes: sand-rich gentle slope, sand-mud mixed gentle slope, mud-rich gentle slope, sand-mud mixed steep slope, flexure-controlled, fault-controlled, and composite flood-slump types. The Yanchang Formation in the Ordos Basin, a typical sag lacustrine basin, is dominated by flood-induced lacustrine gravity-flow deposits with extensively distributed lobes. Lobe sandbodies are formed by compensatory stacking of multiple individual lobes via lateral accretion, retrogradation or progradation, and such stacking patterns are governed by base-level cyclic fluctuations. Individual lobes exhibit a tongue-shaped planar geometry, narrow at the proximal end and broad at the distal end. A distinct positive linear correlation exists between their maximum width and maximum thickness, with a width-thickness ratio of 100–160. Member 3 of the Dongying Formation in the Lvda 10-6 Oilfield of the Bohai Bay Basin, a typical rifted lacustrine basin, is controlled by syndepositional antithetic faults and hosts two types of lacustrine gravity-flow deposits: flood-induced type and composite flood-slump type. Sediments of the distributary channel and lobe complexes belonging to the composite flood-slump gravity flows mostly accumulated on the hanging wall of antithetic faults. Where fault throw is small, sediments can cross the faults to form small-scale finger-shaped secondary lobes on the footwall; whereas at sites with large fault throws and steep gradients, sediments crossing faults tend to generate multi-stage stacked tongue-shaped sandy slump bodies on the footwall. Flood-induced lacustrine gravity-flows developed during tectonically quiescent stages, characterized by gentle fault gradients and small fault throws. Their distributary channel and lobe complexes predominantly occur on the hanging wall of antithetic faults; along fault margins with minor throws, distributary channels can traverse the middle segments of faults to sustain sedimentation, generating relatively small finger-shaped secondary lobes on the footwall. Ultimately, differentiated architecture models for lacustrine gravity-flow deposits in sag and rifted lacustrine basins are established. These models can provide crucial theoretical guidance for the exploration and development of various lacustrine gravity-flow reservoirs.

KEYWORDS Lacustrine gravity-flow deposits; Sedimentary architecture model; Sedimentary evolution; Sag lacustrine basin; Rifted lacustrine basin

120 POSTER P2-25

Seismic-attribute optimization for improved reservoir characterization integrating spectral decomposition and automated machine learning

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Seismic attribute analysis has served as a critical tool for geologists to characterize the geological features of subsurface reservoirs. However, seismic attributes of different types and frequency components contain diverse geological information because of the complex nonlinear relationships between seismic responses and sand thickness. Consequently, fully exploiting the information embedded in seismic data and enhancing the effective resolution of thin sand-body prediction remain key challenges in reservoir characterization. To address this challenge, we propose a novel intelligent approach for fusing multiple spectral decomposition-derived seismic attributes using an automated machine learning (AutoML) framework. This framework automatically trains and integrates diverse algorithmic models without manual intervention, thereby improving computational effi-

ciency and predictive accuracy. By integrating seismic attributes across different frequencies and types, the proposed method significantly improves the resolution and accuracy of reservoir prediction. The proposed method was applied to detailed reservoir prediction in several real oilfields characterized by diverse sedimentary facies, including fluvial and braided-river reservoirs in the Shengli Oilfield and deltaic reservoirs in the Zhetbay Oilfield. The results demonstrate significant improvements in sand-body prediction accuracy. Subsequently, integrated analyses of continuous stratal slices and cross-sections were conducted to interpret the well-seismic fusion results, revealing the spatial distribution characteristics and evolutionary patterns of sand bodies. Finally, based on architectural-element interpretation from individual wells and constrained by the spatial distribution of sand bodies derived from seismic data, architectural elements at different hierarchical levels were predicted progressively from larger to smaller scales. Taking a meandering-river reservoir as an example, the distributions of composite channels, individual channels, and internal point bars were sequentially predicted.

KEYWORDS Seismic attribute fusion; Automated machine learning (AutoML); Spectral decomposition; Sand-body prediction; Reservoir characterization

T4-7 Organic matter enrichment and petroleum accumulation in continental saline lacustrine basins

121 ORAL O-19-1-0920

Paleosedimentary environment and organic matter accumulation mechanism of Late Eocene saline lacustrine shales in the Western Qaidam Basin, Qinghai-Tibet Plateau**Dehao Feng^{1,2,3,4*}, Chenglin Liu^{1,2}**¹ College of Geosciences, China University of Petroleum (Beijing), Beijing, CHINA² State Key Laboratory of Petroleum Resources and Engineering, China University of Petroleum (Beijing), Beijing, CHINA³ Qinghai Provincial Key Laboratory of Plateau Saline-Lacustrine Basinal Oil & Gas Geology, Dunhuang, CHINA⁴ Key Laboratory of Exploration Technologies for Oil and Gas Resources (Yangtze University), Ministry of Education, Wuhan, CHINA

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Organic-rich shale contains rich and unique geological information in its geochemical characteristics, recording paleo-sedimentary environments such as paleoclimate, paleohydrology, and redox conditions. Meanwhile, fossils within the shale succession document primary productivity and the biota during deposition. Although various models of organic matter accumulation have been proposed, few studies have examined the relationship among biological precursors, lake environment, and organic matter accumulation for the Late Eocene saline lacustrine shales in the Western Qaidam Basin.

This study integrates TOC, Rock-Eval, XRD, organic petrology, elemental geochemistry and GC-MS to investigate the geochemical characteristics, sedimentary environment, and organic matter sources of organic-rich shales, and to clarify their organic matter accumulation mechanisms. The shales are dominated by TOC contents of 1%–2%, with organic matter classified as Type I-II₁ kerogen. The dominant lithofacies is laminated calcareous shale, consisting of interbedded organic-rich laminae, carbonate laminae, and siliceous laminae. The organic components are mainly alginite, including lamalginite and telalginite, with rare humic macerals. Telalginite is mainly derived from *Botryococcus*, while lamalginite is associated with cyanobacteria. The organic-rich shales were deposited under an arid evaporitic climate, brackish-saline water, anoxic and moderate-productivity conditions. Climate and salinity fluctuations control the development of *Botryococcus* and cyanobacteria, leading to differences in organic matter accumulation. *Botryococcus* bloomed during episodic warm-humid intervals under relatively low-salinity conditions, promoting the formation of *Botryococcus*-rich shales. Saline conditions resulted in stratified water columns and anoxic, reducing conditions, favoring the preservation of algal remains. Nevertheless, high sedimentation rates accompanied by intense terrigenous clastic input exerted a significant dilution effect on organic matter, leading to generally lower TOC contents compared with typical saline lacustrine shales in other basins. These findings provide new perspectives on organic matter accumulation in saline lacustrine deposits.

KEYWORDS Sedimentary environment; Saline lacustrine shale; Organic matter accumulation; Qaidam Basin**FUNDING** Science Foundation of China University of Petroleum, Beijing (No. 2462025XKBH023), Open Fund of Qinghai Provincial Key Laboratory of Plateau Saline-Lacustrine Basinal Oil & Gas Geology, Open Fund of Key Laboratory of Exploration Technologies for Oil and Gas Resources (Yangtze University), Ministry of Education (No. K2025-02), and Open Fund of Key Laboratory of Petroleum Resources Exploration and Evaluation, Gansu Province (No. KLPREEGS-2025-11)

122 POSTER P2-26

Characteristics of Source Rock Organic Matter and the Genesis Mechanism of High-Quality Reservoirs in Volcano-Basin Dual Provenance Mixed Sediments: A Case Study of the Mixed Sedimentary Rocks of the Second Member of the Lucaogou Formation in the Santanghu Basin

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During deposition of the second member of the Lucaogou Formation in the Santanghu Basin, the area experienced periodic volcanic activity along its periphery. The climate was predominantly hot and arid. Sediments were mainly derived from airborne volcanic ash and carbonates from within the basin, with very limited input from terrestrial sources. Intense evaporation within the basin, along with volcanic and hydrothermal activities, supplied abundant trace elements such as magnesium ions, leading to multiple stages of dolomitization in the carbonates. The primary rock types now are tuff, dolomitic tuff, tuffaceous dolomite, and dolomite. Various analytical methods were applied to study the enrichment characteristics of organic matter, the features of hydrocarbon generation, and the characteristics of reservoir layers within this member. The findings indicate that organic matter exhibits differential enrichment against a backdrop of frequent volcanic activity. During volcanic eruptions, the climate was relatively warm and moist with lower salinity, and organic matter was predominantly composed of cyanobacteria. In contrast, during periods of volcanic dormancy, the climate was hot and dry with higher salinity, leading to organic matter predominantly composed of green algae. Different rock types show different proportions of cyanobacteria and green algae: tuff and dolomitic tuff are dominated by cyanobacteria, whereas tuffaceous dolomite and dolomite are dominated by green algae. Moreover, the development of high-quality reservoirs was not directly related to rock type. High-rate deposition under a mixed sedimentary background favored the formation of high-quality reservoirs, and the diagenetic facies of mixed sediments were key to identifying high-quality reservoirs. Compaction played a significant role in reducing porosity in mixed sediments, whereas cementation had minimal impact on reservoir quality. Dissolution processes were crucial for the formation of high-quality reservoirs. The preservation of intercrystalline pores and recrystallization in dolomite were key factors in the formation of high-quality dolomite reservoirs, with dissolution processes primarily targeting tuff reservoirs. The interaction of diagenetic fluids in mixed sediments was complex, with strong acid dissolution modification. The dissolution stage varied under a background of differential enrichment of organic matter, with cyanobacteria-related dissolution occurring primarily during late diagenetic stage A, and green-algae-related dissolution from early diagenetic stage B to middle diagenetic stage A, with a transitional stage of superimposed dissolution. This study focused on diagenetic fluids to systematically analyze the genesis mechanism of high-quality reservoirs in special dual-source mixed sediments, aiming to provide references for the diagenetic study of other mixed sedimentary lithological reservoirs.

KEYWORDS Volcanic ash; Paleoenvironment; Organic matter; Reservoir; Diagenetic fluid

123 ORAL O-19-1-1120

Sedimentary environment and quantitative evaluation of the main controls on organic matter accumulation in the Wufeng–Longmaxi shales, Luzhou area

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This paper examines the shale of the Upper Ordovician Wufeng Formation to Lower Silurian Longmaxi Formation in Well L210, Luzhou area, Sichuan Basin. Based on total organic carbon (TOC) and major and trace element geochemical data, the vertical evolution of sedimentary environmental parameters, including paleosalinity, paleoclimate, redox conditions, the degree of water restriction, paleoproductivity, and terrigenous clastic input, was reconstructed for the Katian–Aeronian interval. The main controlling factors of organic matter accumulation and their contributions were further evaluated by combining correlation analysis with the XGBoost-SHAP method. The results show that: (1) from the Katian–Hirnantian to the Rhuddanian and then to the Aeronian, paleosalinity was generally low and decreased continuously; the paleoclimate changed from warm-humid to cold-dry and then to warm-humid again; redox conditions shifted from strongly reducing to dysoxic-oxic; the degree of water restriction weakened from strong to moderate; and both paleoproductivity and terrigenous clastic input first decreased and then increased. (2) XGBoost-SHAP quantitative evaluation indicates that paleoproductivity (45.7%), the degree of water restriction (25.2%), and redox conditions (16.9%) together account for nearly 90% of the model explanatory power, and are the main controlling factors of organic matter accumulation, whereas paleoclimate, paleosalinity, and terrigenous clastic input mainly play a background role. (3) Three enrichment models can be summarized: the Katian–Hirnantian is a combination of high supply and strong preservation, the Rhuddanian is a combination of moderate supply and persistent preservation, and the Aeronian is a combination of high supply and weak preservation; their effectiveness depends on the match between supply and preservation. These findings provide a geological basis for the prediction of deep shale gas sweet spot intervals and the optimization of targets in the Luzhou area, and also provide a case study for extending machine learning methods to the quantitative evaluation of marine shale sedimentary environments.

KEYWORDS Luzhou area; Wufeng–Longmaxi formations; organic matter accumulation; paleoenvironment; XGBoost-SHAP

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T4-8 Carbonate–evaporite paragenesis: palaeogeographic reconstruction and resource implications**124** ORAL O-17-2-1615**Gypsum Pseudomorphs in Middle Proterozoic Dolostone: Implications for Paleogeographic Environment and Reservoir Potential****Bo Liu^{1,2*}, Daifeng Yang¹, Zhengliang Huang³, Haofu Zheng⁴, Liubin Wei³**¹ School of Earth Sciences, Yunnan University, Kunming, CHINA² School of Earth & Space Sciences, Peking University, Beijing, CHINA³ Institute of Exploration and Development, Changqing Oilfield, CNPC, Xi'an, CHINA⁴ School of River & Sea, Chongqing Jiaotong University, Chongqing, CHINA

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Due to its abundant oil and gas resources, the Ordos Basin has become a focus of geological research in recent years. Commercial oil and gas production comes mainly from Upper Paleozoic clastic strata, while Lower Paleozoic and even Middle and Upper Proterozoic carbonates also show significant exploration potential. As the western part of the North China Plate, the Ordos Basin accumulated thick, widespread rift-related clastic and carbonate rocks during the Middle and Late Proterozoic periods. The sedimentary background and reservoir potential of these massive sedimentary systems are important issues in current oil and gas geological research. Field and drilling data from the western margin of the Ordos Basin reveal that within the massive siliceous dolomite strata of the Jixian System, there is an approximately 50 m thick dolostone interval with dissolution pores. This section belongs to the Fengjiawan Formation, which corresponds to the Tieling Formation of the Yanliao Rift System in eastern North China. Petrological studies show that this dolomite consists mainly of silt-sized to finely crystalline dolomite, with patchy columnar, nodular, banded, and minor brecciform structures. These features, combined with the unique gypsum pseudomorph, reveal that its original rock is gypsum-bearing microcrystalline dolomite. Gypsum originally developed as phenocrysts or nodule masses, which were dissolved during early diagenesis to form pores and vugs. These pores and vugs were partially filled with new dolomite or bitumen during late burial diagenesis, but still retain considerable open space today. This set of gypsum dolomite indicates that the western margin of Ordos exhibited partial evaporative and arid environmental conditions during the Jixianian Fengjiawan period, which differs significantly from the coeval Tieling Formation, rich in stromatolites, in the eastern Yanliao region of the North China Plate, providing clues for paleogeographic reconstruction and plate location restoration. At the same time, the pore space formed by gypsum dissolution has been preserved, demonstrating its great potential as an ancient deep dolomite reservoir.

KEYWORDS Western margin of Ordos; Jixian System; gypsum; dolomite; paleoenvironment; reservoir**125** POSTER P2-27**Sequence-stratigraphic evolution and controlling factors of Lower Cambrian carbonate clinoforms on a distally steepening ramp, Tarim Basin, China****Mao Pan***

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Clinofolds, as fundamental components in sedimentary basin fills, represent the preserved stratal expression of slope systems that link shallow-water and deep-water environments in carbonate depositional systems. Although large-scale carbonate clinoforms developed extensively in the Tarim Basin during the early Cambrian, their geometry, sedimentary evolution, and controlling factors

have not yet been systematically studied. This research integrates 3-D seismic, drilling and well-logging data to perform a quantitative and systematic analysis of the seismic facies, geometrical characteristics, and depositional evolution of the Cambrian (Stage 3) Xiaoerbulake Formation clinoforms. A high-resolution sequence stratigraphic framework is constructed using the Integrated Prediction Error Filter Analysis (INPEFA) method. Seven distinctive seismic facies (SF1–SF7) are identified in the study area; these correspond to seven facies belts distributed in three depositional environments: mixed tidal flats, inner ramp and middle ramp. The analysis recognizes five higher-order composite clinothems (CC1–CC5) and seventeen subordinate clinoforms (C1–C17). Collectively, these record an overall progradation from southwest to northeast. Clinoform-edge trajectory patterns initially exhibit an aggradational trend that progressively transitions to a predominantly progradational trend. Two 3rd-order sequences (SQ1 and SQ2) are distinguished within Stage 3, each containing multiple 4th- and 5th-order sequences. SQ1 comprises CC1–CC3 (C1–C10), whereas SQ2 comprises CC4–CC5 (C11–C17). The early depositional system is characterized by a gently inclined carbonate ramp system, whereas the later stage evolves into a distally steepening ramp. The development of these clinoforms was controlled by the interplay of several factors. Relative sea-level fluctuations directly controlled available accommodation and the resultant geometry of developed clinoforms. The spatial variability of paleogeomorphological features, such as a central depression surrounded by elevated margins, governed accommodation and controlled clinoform trajectory, progradation distance, and aggradation thickness. Moreover, paleoclimate and paleoceanographic conditions indirectly influenced clinoform development by modulating carbonate production and hydrodynamic energy. This study addresses the knowledge gap concerning the sequence-stratigraphic evolution of carbonate clinoforms on a ramp and clarifies the main controlling factors on clinoform growth. These findings provide valuable insights into the evolution of ancient carbonate ramps and contribute to a more comprehensive understanding of global carbonate clinoform systems.

KEYWORDS Early Cambrian; Carbonate ramp; Clinoforms; Sequence stratigraphy; Depositional evolution

FUNDING National Natural Science Foundation of China (Grant No. U24B6001)

T4-9 Dolomitization and dolomite reservoirs**126** POSTER P2-15**Diagenetic evolution and reservoir genesis mechanisms of Middle Cambrian carbonates in the northern Tarim Basin****Kaibo Shi*, Qing He, Bo Liu**

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Deeply buried (>7000 m) Middle Cambrian (Miaolingian) carbonate rocks in the northern Tarim Basin, China, represent a highly promising target for resource exploration. Their reservoir quality is governed by complex diagenetic processes, including multiple stages of dolomitization and subsequent dedolomitization. This study presents an integrated analysis using petrology, stable isotopes, trace elements, fluid inclusion microthermometry, and in situ U-Pb dating from seven wells. We systematically interpret the complex diagenetic history and fluid evolution of the Miaolingian carbonates. Results reveal a complete paragenetic sequence from near-surface to deep-burial diagenetic realms. Early diagenesis was dominated by marine-derived fluids in near-surface to shallow-burial realms, where supratidal and seepage-reflux dolomitization led to the formation of early dolomicrite (Md1) and grainy/microbial dolomite (Md2), along with the precipitation of dogtooth/fibrous cements (Cd1). With increasing burial depth, normal seawater influenced by geothermal circulation formed very fine- to fine-crystalline dolomite (Md3) and associated granular cements (Cd2). In the intermediate-to-deep burial realm, the diagenetic system was dominated by basinal fluids. The fabric of early dolomites was destroyed under elevated temperatures (~110 °C) to form fine- to medium-crystalline dolomite (Md4). This was followed by cementation of euhedral (Cd3) and blocky (Cd4) dolomite cements. Late-stage diagenesis was tightly coupled with regional tectonic activity. Saddle dolomite (Sd) precipitated from high-temperature (~139 °C), high-salinity (~22 wt.%) tectonic-hydrothermal fluids, and some Md4 may have been altered by these fluids. U-Pb dating of early calcite cements (Cc-I) yields an age of 459.1 ± 3.3 Ma, constraining the initial episode of the middle Caledonian Orogeny. Fluid inclusions within these cements have high temperatures (110.2–125.2 °C) and exhibit seawater-like rare earth element and yttrium (REY) patterns, indicating a record of buried formation water. Subsequently, episodes II and III of the middle Caledonian Orogeny induced mixing of Ca^{2+} -rich formation water and meteoric water in the intermediate burial realm, causing localized dedolomitization that formed matrix calcite (Mc) and late-stage calcite cements (Cc-II), characterized by lower Th values (~90 to 110 °C). Integration of diagenetic phases with reservoir quality reveals contrasting porosity evolution. Seepage-reflux and seawater dolomitization were the constructive processes, while supratidal, burial and hydrothermal dolomitization, and dedolomitization were predominantly destructive, occluding pore space and deteriorating reservoir quality.

KEYWORDS Diagenetic realms; Multiple dolomitization; Late-stage dedolomitization; Diagenetic fluid**FUNDING** National Natural Science Foundation of China (Grant No. U24B6001)

T4-10 Coal-bearing successions and related mineral deposits**127** ORAL O-19-2-0830**Discussion on the Definition of Shallow-Water Deltas and Delta Classification Issues****Longyi Shao¹, Hao Pan¹, Xuettian Wang¹, Carlos Zavala², Kai Zhou¹, Yanwen Shao¹, Jing Lu¹**¹ College of Geoscience and Surveying Engineering, China University of Mining and Technology (Beijing), Beijing 100083, CHINA² Shandong Provincial Key Laboratory of Depositional Mineralization and Sedimentary Minerals, College of Earth Sciences, Shandong University of Science and Technology, Qingdao 266590, CHINA

As a critical sedimentary system formed by the interaction between rivers and receiving water bodies (oceans or lakes), shallow-water deltas have become a research hotspot in sedimentology due to their unique depositional characteristics and resource potential. This paper systematically reviews research on shallow-water deltas, focusing on the evolution of their definition and meaning—including multiple delineation perspectives based on basement subsidence rate, wave base, facies composition, and developmental location. It summarizes research advances in sedimentary dynamic processes, morphological evolution, sandbody architecture, and controlling factors, revealing the distinctive patterns governing distributary channel activity and sandbody distribution under low-gradient, shallow-water hydrodynamic conditions. By analysing the limitations of existing delta classification schemes, a three-type delta classification system (shoreline shallow-water delta, shore-shelf deep-water delta, and shelf-edge delta) is proposed that considers basement subsidence rate, hydrodynamic conditions and depositional location. The sedimentary model of shallow-water deltas in coal-bearing strata is summarized, and the coal accumulation characteristics of the upper delta plain, lower delta plain, delta front, and prodelta subfacies are clarified. The research results provide a scientific basis for deepening the theoretical system of shallow-water deltas and guiding the exploration of energy minerals in coal-bearing strata.

KEYWORDS Shallow-water delta; Sedimentary system; Delta classification system; Coal-bearing strata; Sedimentary model**128** ORAL O-17-4-1420**Terrestrial ecological disturbances and responses to palaeowildfires at the Permian–Triassic transition: a review of current research****Longyi Shao^{1*}, Fanghui Hua^{1,2}, Timothy P. Jones³, Tianchang Zhang¹, Xuettian Wang¹, Zhiming Yan⁴, Jing Lu¹, Jason Hilton⁵**¹ College of Geoscience and Surveying Engineering, China University of Mining and Technology, Beijing 100083, CHINA² Hebei Institute of Geological Survey, Shijiazhuang 050200, Hebei Province, CHINA³ School of Earth and Environmental Sciences, Cardiff University, Cardiff CF10 3YE, Wales, UK⁴ Institute of Architectural Engineering, Weifang University, Weifang 261061, Shandong Province, CHINA⁵ Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B15 2TT, UK

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At the end of the Palaeozoic Era, the Earth experienced a very severe ecosystem disturbance event, the Permian–Triassic Mass Extinction (PTME), which caused an irreversible global catastrophe for animals and plants. Fossil evidence from marine strata and zircon U-Pb dating of volcanic ash supports the view of a rapid and short-lived extinction. In contrast, the associated disturbance processes of terrestrial ecosystems were relatively prolonged and complex, leading many scholars to propose various extinction mechanisms and models of ecosystem disturbances. Evidence of wildfires in late Permian–Early Triassic transitional strata has been reported globally, and many scholars believe that wildfires during the PTME were a significant contributing factor to the disturbance

of terrestrial ecosystems. Globally, palaeowildfires may have served as an important driver for terrestrial ecosystem disturbance during the Permian–Triassic transition, promoting and accelerating the processes of environmental degradation. Palaeowildfires during the Permian–Triassic transition played a crucial role in changing terrestrial ecosystems with potential implications for the evolution of larger ecosystems. This study systematically reviews progress in recent research on terrestrial PTME and wildfires. It summarizes and considers the mechanisms of terrestrial ecosystem disturbance during the P/T transition and responses to palaeowildfires, considering the palaeoenvironmental background and plant evolution processes.

KEYWORDS Permian–Triassic Mass Extinction (PTME); terrestrial ecological disturbance; floral change; palaeowildfire

T4-11 Lacustrine sedimentology applied to hydrocarbon exploration and development**129** ORAL O-19-2-0935**Fine-grained Sedimentary Characteristics and Depositional Model of the Deep-Lacustrine Chang 7 Member of the Yanchang Formation in the Tongchuan Area of the Ordos Basin, China****JunPing Huang^{1*}, Yan Zhang¹, Shengbin Feng², Xinkai Chen², Chengze Li¹**¹ PetroChina Research Institute of Petroleum Exploration & Development-Northwest, Lanzhou 730020, CHINA² Research Institute of Exploration & Development, PetroChina Changqing Oilfield Company, Xi'an 710018, CHINA* E-mail: huang_jp@petrochina.com.cn

To investigate the sedimentary characteristics and depositional models of deep lacustrine fine-grained sediments, this paper presents a systematic study of the fine-grained sedimentary lithofacies, lithofacies associations, and depositional models of the Chang 7 Member of the Triassic Yanchang Formation in the Ordos Basin. The study is based on typical outcrop profiles in the Yishicun and Yaoqu areas of the Tongchuan region. The three main findings are as follows: (1) six lithofacies are identified in outcrops of the middle-lower part: superimposed scoured normally graded siltstone-fine sandstone facies, massive-bedded siltstone-fine sandstone facies, soft-sediment deformation sand-mud mixed facies, massive mudstone facies, horizontally-laminated mud-shale facies, and tuff facies. (2) in the Chang 7 Member, several vertical combinations are developed, such as background argillaceous deposits, vertical combinations of tuff and gravity-flow deposits, interbedded and superimposed slides/slumps and background mudstones, and vertically superimposed gravity-flow sandstones and mudstones. In the lower part of the Chang 7₃ in the Yishicun section, massive-bedded clastic-flow deposits and slump deposits are predominant. The Chang 7₂ is mainly composed of deep-water in-situ deposits, with lithologies transitioning from siltstone-silty mudstone to horizontally-laminated mudstone and finally to black shale with well-developed bedding. In the Chang 7₁ of the Yaoqu section, abundant soft-sediment deformation structures are observed, such as liquefied sandstone veins, mud streaks within massive sandstones, and flame structures. (3) during the deposition period of the Chang 7₃ in the study area, relatively thick slide and slump deposits were mainly formed by the collapse and re-transport of delta-front sediments. The deposition period of the Chang 7₂ was dominated by deep-water shale deposits, interbedded with volcanic ash and a small amount of thin-bedded siltstone deposits of low-density turbidity currents. By the deposition period of the Chang 7₁, part of the delta collapse led to the formation of sandy clastic-flow deposits and low-density turbidity-flow deposits. Overall, this indicates a lake-level cycle that first rose and then fell during deposition of the Chang 7. The rise and fall of lake level controlled the transportation mode and depositional model of fine-grained sediments. This study provides significant guidance for clarifying the transportation mechanism and distribution pattern of fine-grained sediments.

KEYWORDS Fine-grained sedimentary lithofacies; Depositional model; Chang 7 Member; Tongchuan area; Ordos Basin**FUNDING** National Science and Technology Major Project of China (New Oil & Gas Major Project) (No. 2025ZD1404801)

130 ORAL O-19-2-0905

Architectural Patterns and Quantitative Characterization of Composite Sand Bodies in Deep-Water Turbidite Channels, Niger Delta Basin

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Deep-water turbidite channels are important targets for petroleum exploration in slope settings. Previous work has mainly addressed channel geometry and depositional processes, whereas the spatial patterns and quantitative characterization of composite channel sand bodies remain less thoroughly investigated. Using core, well-log, and high-resolution 3-D seismic data from deep-water oil and gas fields in the Niger Delta Basin (Miocene and Pliocene-Pleistocene Agbada Formation), this research systematically characterizes the architecture of composite sand bodies in deep-water turbidite channels. Two types of turbidite-channel systems are distinguished based on boundary characteristics and external-levee development: confined and unconfined systems. Channel-system type evolves regularly from confined (near source) to unconfined (distal), and confined systems display a four-stage vertical evolutionary sequence governed by sea-level rise and sediment-supply rate. Quantitative analysis of 31 channel-system segments shows that channel-system sinuosity is controlled by slope gradient following a negative power-function relationship ($\beta = 1.45\alpha^{(-0.2)}$, $R^2 = 77.7\%$); the channel system becomes nearly straight when the slope gradient reaches 4° . Four principal composite patterns are identified—lateral, en-echelon, swing, and vertical stacking—each subdivided into three subtypes (incised, superimposed, and isolated), together with a deep-cutting composite. These patterns show distinct distributions at different evolutionary stages: incised/deep-cutting at the initial stage, lateral at the middle stage, en-echelon and swing at the middle-to-late stage (swing at straight segments, en-echelon at bending segments), and vertical at the late stage. For meandering channel complexes, sinuosity and migration index (L/V) are positively correlated ($\beta = 0.53e^{(0.11(L/V))}$, $R^2 = 87.7\%$); strata-slice analysis shows that lateral migration among single channels is continuous and successive—early-stage sinuosity 1.1–2.2, late-stage 1.5–3.5, and local cut-offs may develop once sinuosity reaches 5 or higher. These findings enhance the geological understanding of deep-water depositional systems and provide practical guidance for the design of well spacing and injection-production relationships in turbidite-channel reservoirs.

KEYWORDS Deep-water turbidite channels; composite sand bodies; architectural patterns; Niger Delta Basin; Agbada Formation; confined/unconfined channel systems; channel sinuosity; slope gradient; composite patterns; quantitative characterization

131 ORAL O-19-2-0850

Facies and Early-Diagenetic Controls on Lacustrine Microbial Carbonate Reservoir Development: Insights from the Eocene Xiaganchaigou Formation, Western Qaidam Basin, China

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Lacustrine microbial carbonates are important but highly heterogeneous reservoir targets in continental lake basins. Their distribution and reservoir quality are commonly controlled by lake-level fluctuation, shoreline migration, terrigenous input, microbial growth and early diagenesis. The

Eocene Xiaganchaigou Formation in the western Qaidam Basin, China, provides a well-exposed and well-cored example for evaluating how lacustrine sedimentology can support microbial carbonate reservoir prediction in saline lake systems.

This study integrates outcrop observation, core description, petrography, mineralogy and in-situ geochemical mapping to characterize the occurrence, fabrics and preservation of lacustrine microbialites. Thick thrombolites, generally 0.4–1 m in thickness, developed mainly in near-shore settings and are characterized by cerebroid surfaces, clotted fabrics and abundant cavities. In contrast, centimetre-scale stromatolites, thrombolites and composite clotted-laminated microbialites display domical, columnar and stratiform morphologies, indicating growth in very shallow-water settings. These microbial carbonates were preferentially developed along near-shore belts and submerged highs during periods of relatively limited terrigenous dilution.

The preservation and potential reservoir heterogeneity of these microbialites were strongly influenced by early lithification and subsequent diagenesis. Microbial trapping, binding and organomineralization promoted the formation of rigid frameworks, outer crusts, laminae and clots. The laminated and clotted microbial fabrics are mainly composed of crypto- to microcrystalline mimetic dolomite, whereas medium- to coarsely crystalline calcite represents later cementation and recrystallization. Authigenic celestite-barite and framboidal pyrite within microbial fabrics indicate saline, evaporative and redox-sensitive pore-water conditions. These processes jointly controlled the preservation of primary microbial fabrics, constructional cavities and cement distribution.

For hydrocarbon exploration, the results highlight that lacustrine microbial carbonate reservoirs should be predicted using a facies- and diagenesis-based framework. Near-shore thrombotic buildups and shallow-water stromatolitic-thrombotic complexes represent favourable reservoir targets, whereas early dolomitization may enhance fabric preservation and later calcite cementation may reduce reservoir quality. This case study demonstrates that integrated lacustrine sedimentology and early-diagenetic analysis can improve the prediction of microbial carbonate sweet spots and reservoir heterogeneity in saline continental lake basins.

KEYWORDS Lacustrine sedimentology; microbial carbonate reservoir; early dolomitization; reservoir heterogeneity; Qaidam Basin

132 ORAL O-17-2-1750

Hard and Soft Substrate Microbial Mats in the Miocene of Western Qaidam Basin and Their Differential Controls on Microbialite Development

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The formation and evolution of microbialites are fundamentally dependent on microbial mats. The structural types of microbial mats are controlled by depositional environments and the sediment-water interface, which further governs the differential distribution of various microbialite types. To clarify the structural characteristics of microbial mats and the heterogeneous distribution of microbialites in saline lacustrine settings, this study utilizes abundant outcrop, core, thin-section and laboratory analytical data to investigate the architectures of Cenozoic microbial mats in the western Qaidam Basin, analyze the differential distribution of different microbialite types, and discuss the varied controlling effects of microbial mats on rock types.

The results show that two types of microbial mats, corresponding to hard substrates and soft substrates, can be identified in saline lacustrine deposits: (1) hard-substrate microbial mats predominantly occur in brackish environments of the fan delta front, with water salinity ranging from 10 to 17‰. Their mesoscopic thickness varies from 200 to 1000 μm , and microscopic thickness ranges from 200 to 500 μm . These mats generally attach to sand-rich sediments and possess a two-layer basal structure at the bottom, consisting of calcareous sandstone (detrital grain content > 50%) and grainstone (detrital grain content < 50%) from bottom to top. The main grain components include detrital particles, peloids, oncoids and ooids. (2) Soft-substrate microbial mats are mainly developed on slopes and shallow-water areas of saline lakes, where the salinity is between 20 and 32‰. Their mesoscopic thickness ranges from 0.2 to 2 cm, and microscopic thickness is 20 to 50 μm . The mats commonly overlie unconsolidated or weakly consolidated marl sediments. They are mostly grayish-black in color and exhibit wavy, mounded and laminated morphologies. (3) Microbialites formed under the control of hard- and soft-substrate microbial mats show significant differences in internal structures and mineral compositions. Hard-substrate microbial mats dominate the development of microbial reefs (bound microbialites) and various MISS structures, including erosional pits (grooves), pustules (nodules) and mounds (domes). Their principal mineral component is sparry calcite, with aragonite occurring locally. The calcite commonly exhibits a radial fabric. In contrast, soft-substrate microbial mats control the formation of stromatolites and thrombolites, along with MISS types such as spinose (clustered), digitate, and shrinkage structures (desiccation cracks, clastic fragments). The individual layer thickness of these microbialites ranges from 0.2 to 1 m, with a maximum thickness of 2 m. Both calcite and dolomite are well developed. Cyanobacterial fossils and calcified EPS fabrics are ubiquitous, while metazoan fossils are rarely observed. (4) The architectures of hard- and soft-substrate microbial mats, as well as the associated microbialites and MISS structures, are primarily governed by intrinsic biological properties. These features represent diverse ecological adaptations to external environments, and collectively reflect the competition and balance between environmental sedimentation rate (v_{sed}) and microbial growth rate (v_{mic}).

KEYWORDS Lacustrine carbonates; microbialites; MISS; Miocene; Qaidam Basin

133 ORAL O-19-1-0905

Mixed Carbonate–Siliciclastic Depositional Systems and Reservoir Characteristics in a Cenozoic Saline Lacustrine Basin, Northwestern Qaidam Basin

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Lacustrine mixed carbonate–siliciclastic deposits are common but genetically complex sedimentary systems in continental lacustrine basins. Their sedimentary characteristics not only record integrated responses to lake hydrodynamics, sediment supply, paleoclimate evolution, and paleogeomorphic differentiation, but also represent important unconventional hydrocarbon exploration targets due to their significant reservoir potential. In the northwestern margin of the Qaidam Basin, extensive development of Neogene lacustrine mixed deposits is observed; however, their lithofacies assemblages and depositional evolution remain insufficiently constrained, and the pore structure characteristics as well as reservoir-controlling mechanisms are still poorly understood. Taking shallow mixed deposits from the Nanyishan area as the study target, this work integrates core observation, thin-section petrography, whole-rock X-ray diffraction (XRD), geochemical indicators, and well logging data to systematically analyze lithological types, lithofacies assemblages, and reservoir characteristics of lacustrine mixed systems.

The results show that the studied interval is mainly composed of algal limestone, dolomitic limestone, and argillaceous dolomitic limestone, with subordinate mudstone and siltstone locally interbedded. Vertically, the succession exhibits a cyclic evolution from increased clastic input, to carbonate-dominated deposition, and back to enhanced clastic influx. Reservoir pore spaces are dominated by dissolution pores, intercrystalline pores, intergranular pores, and microfractures. Significant differences in pore structure exist among lithologies. Algal limestones exhibit higher porosity and better pore-throat connectivity, representing high-quality reservoir facies, whereas dolomitic limestones show finer pore throats and poorer connectivity, resulting in strong overall heterogeneity. Reservoir quality is primarily controlled by sedimentary processes, lithological assemblages, and diagenesis. Lake-level fluctuations and variations in clastic input govern facies distribution and lithological combinations. Lithology and mineral composition control primary pore types and reservoir potential. Dissolution and dolomitization act as constructive diagenetic processes that significantly improve pore-throat systems, whereas compaction and cementation reduce reservoir quality and enhance heterogeneity.

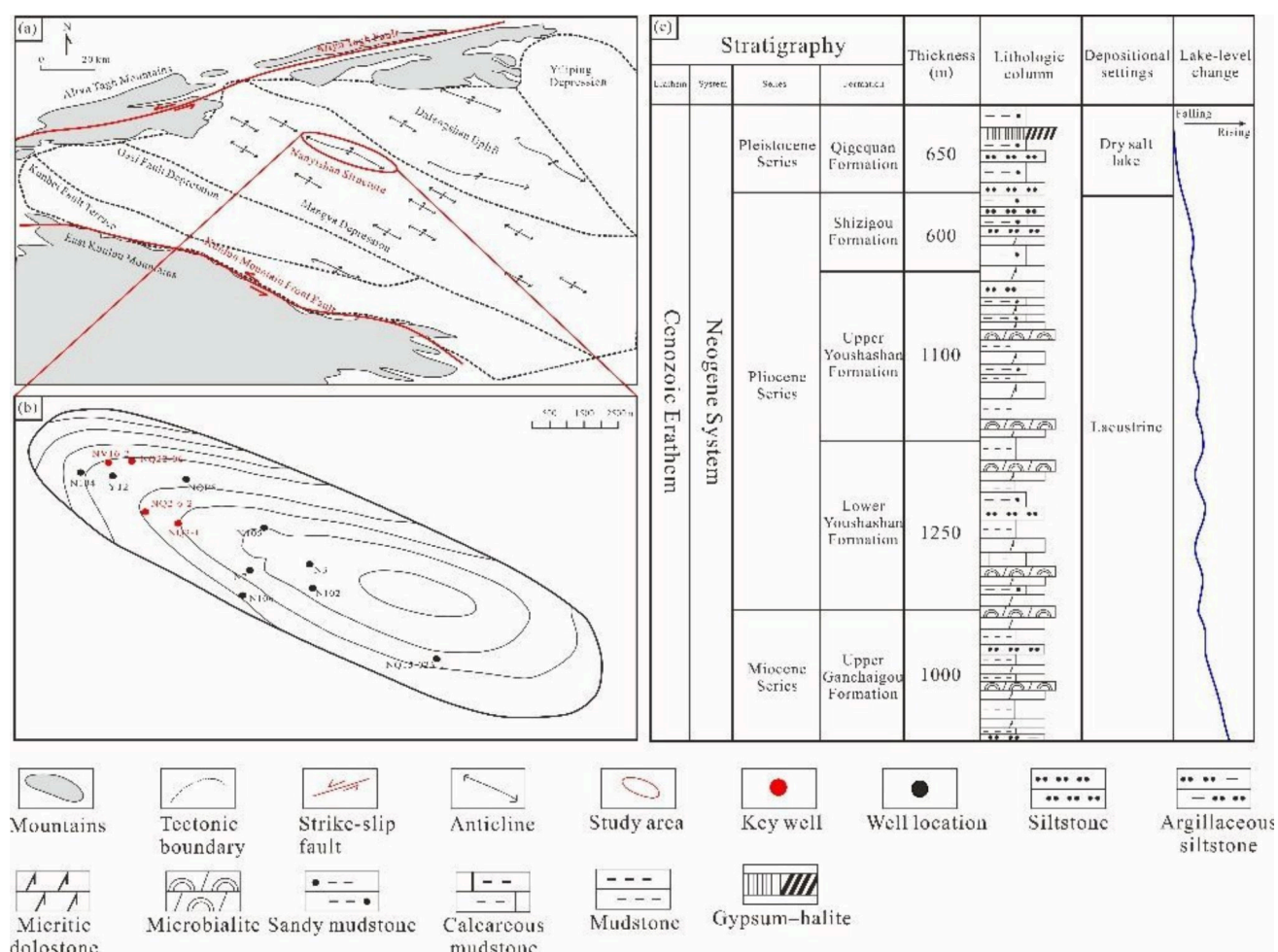


Fig. 1. Geological setting of the study area in the northwestern margin of the Qaidam Basin. (a) Tectonic framework of the western Qaidam Basin showing major faults and structural units; (b) distribution of structural belts and key well locations in the Nanyishan area; (c) Neogene stratigraphic column illustrating lithostratigraphy, sedimentary settings, and lake-level evolution trends. The study focuses on the Lower and Upper Youshashan formations deposited in a saline lacustrine basin setting.

KEYWORDS Qaidam Basin; saline lacustrine basin; mixed sedimentary system; reservoir characteristics; pore structure

T4-12 Sedimentary metal ore deposits and palaeogeography**134** ORAL O-19-3-0950**Formation and Growth of Colloidal Pellets in Bauxite and Their Implications for Fe–Al Redistribution****Long Cheng, Wenchao Yu***

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Colloidal pellets are common textural components in bauxite and are generally considered to form during intense weathering and bauxitization. However, their significance for linking microscale Al–Fe redistribution, pore-fluid evolution and bauxite formation remains insufficiently quantified. This study aims to establish a physicochemical framework for interpreting bauxitic colloidal pellets as records of alternating Al–Fe precipitation, diffusion-limited mass transfer and hydrogeochemical fluctuation during bauxitization.

Microscopic observations and elemental mapping of colloidal pellets preserved in the geological bauxite record show well-developed concentric layers composed of alternating Al-rich and Fe-rich domains. These textures indicate that Al-bearing and Fe-bearing colloidal/aqueous precursors were periodically adsorbed and precipitated around pre-existing nuclei. To quantify this process, a temperature-corrected spherical diffusion model was applied to estimate the active accretion duration of pellets with different sizes. The model results suggest that microscopic pellets may form over years to decades, whereas macroscopic pellets may require up to 10^3 – 10^4 years under idealized continuous-growth conditions.

A moving-boundary diffusion model further indicates that the interfacial concentration gradient decreases as pellet radius increases, leading to progressive attenuation of diffusive supply. Repeated precipitation of Al-bearing and Fe-bearing minerals may also narrow pore throats in the clayey matrix, reduce pore connectivity and intensify local solute depletion. This coupled feedback provides a plausible explanation for the slow, intermittent and self-limited growth of bauxitic pellets, as well as their common millimeter-scale upper size range.

Preliminary evidence from a modern gibbsitic bauxitization profile provides an incipient Fe-rich analogue for this process. Unlike the Al–Fe laminated colloidal pellets preserved in the geological bauxite record, the >2 mm pellets in the modern profile are dominantly ferruginous, reflecting an early stage of Fe concentration before complete Al–Fe alternation is fully developed. XRD, Fe isotope and low-temperature Mössbauer data indicate the coexistence of Al-rich matrix phases and reactive Fe-oxide components, with close Fe-isotopic coupling between ferruginous pellets and fine matrix. This comparison suggests that modern ferruginous pellets may represent an early Fe-rich stage that could be further overprinted by later Al–Fe alternating precipitation during prolonged bauxitization. Overall, colloidal pellets not only record Al–Fe redistribution and diffusion-limited precipitation during bauxite formation, but also provide microscale evidence for understanding pore-fluid fluctuation, hydrogeochemical oscillation and their controls on bauxitization.

KEYWORDS Bauxite; Colloidal pellets; Diffusion model; Al–Fe redistribution; Bauxitization**FUNDING** Double First-Class Discipline Construction Fund of the School of Earth and Planetary Sciences

135 ORAL O-19-2-0950

A critical assessment of the application of paleosalinity proxies to weathered sections: a case study of bauxite deposits in South China

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Although geochemical proxies such as boron (B) and strontium (Sr), and their normalized concentrations, have become powerful tools for reconstructing paleosalinity, the reliability of these proxies and their underlying controls in intensely weathered profiles remain inadequately constrained. This study investigates the geochemical behavior of B and Sr during bauxitization and evaluates the applicability of elemental salinity proxies in environments dominated by intense chemical weathering, based on analyses of modern and ancient (Carboniferous-Permian) bauxite profiles from South China. Mineralogical and geochemical analyses reveal that the Sr/Ba ratio, influenced by Sr redistribution controlled by phosphate minerals, deviates from the typical pattern where clay minerals act as the primary host, and, thus, is not suitable for paleosalinity reconstruction in strongly weathered profiles. In contrast, the B/Ga ratio may preserve salinity information within the bauxite-forming environment. The formation of bauxite is a dynamic process, in which the degree of mineralization represents the extent to which the original sediments have undergone weathering and leaching. During this process, variations in the B/Ga ratio evolve dynamically in response to the weathering and leaching process. Specifically, the adsorption behavior of B by Al-oxyhydroxides is consistent with that of clay minerals, being salinity-dependent. Under intense weathering and leaching dominated by meteoric freshwater, secondary Al-oxyhydroxides exhibit low B contents, corresponding to low porewater salinity. In contrast, when bauxite deposits were intermittently submerged by seawater due to sea-level fluctuations, the Al-oxyhydroxides and secondary clay minerals formed record high B contents. Gallium (Ga) remains stable within Al-oxyhydroxides and becomes significantly enriched during their formation under intense weathering. This enrichment causes the B/Ga ratio to decrease with increasing desilication and aluminum enrichment, reflecting not salinity but, rather, the intensity of weathering and leaching. Finally, based on the statistical analysis and compilation of geochemical data from bauxite deposits in South China, this study proposes that a B/Ga ratio of 2 can be used to discriminate whether bauxite was influenced by marine transgression events during its formation. This study reinterprets the significance of the salinity proxy B/Ga in strongly chemically weathered sedimentary profiles, underscores the necessity of proxy validation in weathering-alteration systems, and provides a geochemical framework for improving exploration efficiency in deeply weathered terrains. It not only refines the conventional interpretation of B/Ga as a salinity proxy under intense weathering conditions, but also offers new geochemical criteria for paleoenvironmental reconstruction and exploration targeting in analogous weathering-related bauxite deposits worldwide. Given integrated geological, geochemical, and petrological information, anomalously high B/Ga ratios can provide critical information regarding the frequency of marine transgression events and thus help recognize the most favorable environment for bauxite formation.

KEYWORDS Bauxitization; laterization; Sr/Ba; B/Ga; weathering processes; boron

136 ORAL O-19-2-1030

A hidden gallium reservoir in Paleoproterozoic marine manganese successions: implications for trace metal cycling in early oceans

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Gallium (Ga) is a critical metal whose behavior in Precambrian marine sedimentary systems remains poorly understood. Although Mn oxides are recognized as efficient scavengers of trace elements, the role of Paleoproterozoic manganese successions as geological reservoirs of Ga has received little attention. Here, we investigate the controls on Ga enrichment using an integrated geochemical database comprising Paleoproterozoic marine manganese successions from different cratonic regions, complemented by new mineralogical and geochemical data from the Lagoa do Riacho manganese deposit, Borborema Province, northeastern Brazil. Whole-rock geochemistry, optical petrography, SEM-EDS observations, compositional data analysis, multivariate statistics, and supervised machine-learning approaches consistently indicate that Ga enrichment is primarily associated with manganese cycling rather than simple detrital input. Gallium displays a strong positive relationship with MnO and systematic associations with redox-sensitive elements, including Co, V, and Mo, while multivariate analyses identify Mn-related geochemical signatures as the principal controls on its distribution. These observations support a multi-stage enrichment model in which Ga was scavenged during Mn precipitation under redox-stratified marine conditions, subsequently redistributed during diagenetic Mn reduction and oxidative remobilization, and ultimately concentrated within Mn-rich lithologies. The recurrence of this geochemical association across Paleoproterozoic manganese successions suggests that Mn-rich marine environments acted as efficient sinks for Ga during the evolution of early oxygenated oceans. Our results identify Precambrian manganese deposits as a previously overlooked geological reservoir of gallium and provide new insights into trace-metal cycling, marine redox evolution, and the exploration potential of sedimentary critical-metal systems.

KEYWORDS Critical metals; Sedimentary manganese deposits; Manganese redox cycling; Paleoproterozoic oceans; Trace element cycling

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137 ORAL O-19-4-1150

Retrieving Depositional Environments and Biosignatures from Metamorphosed Phosphorites: Evidence from the Huangmailing Deposit, Northern Yangtze Block

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The metallogenesis of sedimentary phosphorite deposits is predominantly governed by palaeogeographic configurations and sedimentary environments, and their host successions also archive bioessential elements and potential biosignatures. However, such successions may have been subjected to intense later metamorphism, which overprints primary sedimentary-palaeogeographic

and biological information. This study investigates the Huangmailing metamorphosed phosphorite deposit in the Dabie Orogen, whose protolith was deposited as a sedimentary phosphorite during the Ediacaran Doushantuo period on the northern margin of the Yangtze Block and subsequently underwent upper greenschist- to lower amphibolite-facies metamorphism (~450–470 °C) during the Indosinian Dabie orogeny. By integrating apatite U–Pb dating, Raman spectroscopy, high-resolution transmission electron microscopy, and synchrotron S K-edge XANES, we systematically evaluate the degree of metamorphic overprint on primary sedimentary information and the preservation potential of bio-essential elements and biosignatures. Our results demonstrate that the apatite–graphite inclusion assemblage serves as an effective bridge linking sedimentary and metamorphic histories, and can be used as a reliable tracer for retrieving original depositional environments and biological signatures from ancient metamorphosed sedimentary phosphorites.

KEYWORDS Metamorphosed phosphorite; apatite; graphite inclusion; palaeogeographic reconstruction; Ediacaran

138 ORAL O-19-4-1135

Hydrology of the Devonian–Carboniferous North American Seaway: Relationship of redox conditions to salinity and watermass restriction

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The Devonian–Carboniferous North American Midcontinent Seaway (NAMS) was an extensive epeiric sea for which marine salinity conditions were long assumed, despite pronounced restriction of the watermass in its interior regions. Recent studies using elemental salinity proxies have inferred mainly brackish conditions within the Appalachian and Illinois basins, but the larger-scale pattern of salinity variation within this continent-spanning seaway and its relationship to contemporaneous redox variation have not been explored to date. Here, we report data for 19 black shale drillcores from the North American Midcontinental Sea, allowing reconstruction of patterns of restriction–salinity–redox (RSR) covariation on the Oklahoma and West Texas shelves and in the Williston, Illinois and Appalachian basins. During the latest Devonian–earliest Carboniferous, the Williston Basin had strongly restricted deep waters characterized by hypersaline and euxinic conditions. The Oklahoma and West Texas shelves were less restricted and exchanged their deep waters with the open ocean more freely, leading to normal-marine salinity and variable redox conditions. In the Appalachian Basin, lateral watermass gradients were present, with low-brackish and oxic conditions in proximal regions to the northeast and high-brackish and euxinic conditions in distal regions to the southwest. These data allowed us to reconstruct spatio-temporal patterns of covariation between salinity and redox within the Devonian–Carboniferous NAMS, providing fundamental insights into paleoenvironmental controls: 1) paleogeographic factors impacting watermass restriction are commonly the dominant control on salinity conditions; 2) salinity variation is commonly the dominant control on redox variation in ancient depositional systems; and 3) the link between salin-

ity and redox variation depends on the watermass restriction of the study basin. We advocate using a combination of watermass restriction, salinity and redox proxies in all future paleoenvironmental studies.

KEYWORDS Boron; B/Ga; strontium; Sr/Ba; environmental gradient; marginal-marine

139 POSTER P2-02

Controls on the formation of Mn carbonates in mudrocks of the Datangpo Formation, Northern Margin Rift Basin, Yangtze Block

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Deglaciation following the Sturtian Ice Age led to widespread precipitation of manganese carbonates within marine mudrocks, reflecting unique climatic and oceanographic changes. The Mn carbonates hold economic importance in the Datangpo Formation, Yangtze Block, South China. Although their genesis in the Nanhua Rift Basin (NRB) is well understood, little is known regarding their formation mechanism in the North Margin Rift Basin (NMRB). With growing interest in Mn ore exploration in this region, this study examines the weathering trend, climate patterns and watermass conditions using a variety of geochemical proxies. The results reveal two phases of climate variation during the deglaciation. Climate during the early phase (Phase I) was unstable, characterized by fluctuating Chemical Index of Alteration values ($CIA = 65 \pm 4$) and elevated Li isotope values ($\delta^7Li = 8.8 \pm 3.0\text{‰}$). The degree of chemical weathering during the later stage (Phase II) was relatively stable ($CIA = 65 \pm 1$, $\delta^7Li = 5.4 \pm 2.7\text{‰}$), but the weathering intensity increased due to the reduced denudation rate, possibly related to a shift in the basin development. Fe speciation data indicate that euxinia prevailed through much of the section. However, Mo and U enrichment factors (>1) and fluctuating ratios of Mo versus total organic content (0–40) suggest that pulses of freshwater influx associated with climate variation during Phase I caused the fluctuation of the chemocline along the continental shelf, facilitating the formation of Mn carbonates through the particulate Fe–Mn-oxyhydroxide shuttle. With the establishment of a stable climate, basin tectonics, and watermass circulation during Phase II, the accumulation of Mn carbonates in the sediments became less significant. The accumulation of Mn carbonates in the NMRB conforms to the “bathtub ring model”, distinct from the metallogenic model in the NRB, providing valuable guidance for Mn ore prospecting within this area and elsewhere with similar settings.

KEYWORDS Sturtian glaciation; Cryogenian deglaciation; lithium isotopes; manganese ore; South China

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140 ORAL O-19-2-1050

Revisiting the provenance and formation environments of Quaternary bauxite in South China and significance for ancient karstic bauxite deposits

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Despite the established role of bauxites as products of intense subaerial weathering, the provenance and formation processes of karst-type bauxite deposits remain poorly constrained due to the lack of systematic studies on modern analogues. To address this issue, we investigated the age, provenance, and formation processes of Quaternary bauxites in South China, which exhibit a complex provenance closely associated with modern fluvial sedimentation. Geochronological constraints place the formation age of the bauxite deposits between 439 ± 43 ka and 10.49 ± 0.78 ka (Middle Pleistocene to Early Holocene). Active bauxitization is interpreted to have taken place mainly during the Quaternary Ice Age. New U-Pb isotopic data for bauxites ($n = 803$) and river sediments ($n = 455$) reveal distinctly different provenance patterns between the two deposit types. Detrital zircons in river sediments display relatively uniform age distributions, indicating a stable fluvial regime characterized by sustained detrital input and transport with minimal influence from local bedrock sources. In contrast, bauxite deposits from the northern, central, and southern parts of central Guangxi show marked spatial variation in zircon age spectra. This variation demonstrates that Quaternary karst bauxites received episodic, short-range detrital inputs derived alternately from proximal igneous sources (e.g., ~100-Ma granites) and more distal sedimentary sources. We interpret these patterns as the geochronological signature of alternating sheetflow and flood-driven inputs of weathering materials, followed by bauxitization under wet-dry climate oscillations paced by Quaternary glacial-interglacial cycles. This study provides the first modern, process-based framework for understanding how detrital supply, surface hydrology, and climate interact to produce karst bauxites, and it offers a valuable Quaternary analogue for interpreting deep-time bauxite systems, particularly Carboniferous-Permian deposits formed during the Late Paleozoic Ice Age.

KEYWORDS Bauxitization; laterization; Quaternary glaciation; weathering; U-Pb dating; zircon

T4-14 Palaeogeographic controls on sweet-spot development in unconventional hydrocarbon reservoirs

141 ORAL O-19-2-1135

Controlling Mechanisms of Dynamic Evolution of Sedimentary Microenvironments on the Quality of Source Rocks

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Source rock quality in shale sequences often exhibits strong vertical and lateral heterogeneity. The sedimentary microenvironment is a key factor controlling organic matter enrichment, preservation, and hydrocarbon generation potential.

To investigate the control mechanisms of sedimentary microenvironment evolution on source rock quality in shale sequences, this study focuses on the Middle Permian Lucaogou Formation in the Malang Sag, Santanghu Basin. Rock samples were collected from the continuous cored interval of Well ML101H. A series of analyses, including total organic carbon (TOC), Rock-Eval pyrolysis, major and trace element analysis, and biomarker compound analysis, were conducted to systematically evaluate source rock quality and variations in the sedimentary microenvironment.

The results indicate that the Lucaogou Formation source rocks in the study area possess excellent overall hydrocarbon generation potential, with pronounced vertical heterogeneity. Based on geochemical parameters such as TOC and S_1+S_2 , the source rocks can be classified into six categories: poor, medium, good, and Classes I, II, and III. The study interval is divided into four sand groups (1st to 4th) from bottom to top. Paleoproductivity was generally at a moderate level, but was significantly elevated in the 3rd sand group and the upper part of the 2nd sand group due to multiple episodes of volcanic activity. The paleoclimate evolved cyclically from arid to semi-arid and then back to arid. The depositional water body was predominantly under anoxic and reducing conditions, with water depth gradually increasing from bottom to top. Paleosalinity was generally high, dominated by saline water environments. Given the frequent fluctuations and large differentiation in salinity, the saline intervals were further subdivided into weak, moderate, and strong salinity gradients to characterize the dynamic evolution of paleosalinity. Excellent source rocks mainly formed in sedimentary settings characterized by a relatively humid climate with abundant water, strongly saline water, and sufficient nutrient supply.

Based on the above characteristics, this study establishes a differentiated sedimentary microenvironment model for the study area. It demonstrates that the vertical differentiation of source rock quality in the Lucaogou Formation is significantly controlled by the evolution of the sedimentary microenvironment. Comparative analysis of paleoenvironmental features across different sand groups reveals that, under deep-water anoxic and reducing conditions, the synergistic effects of favorable warm-humid climate, brackish to weakly saline water salinity ranges, and higher paleoproductivity promoted large-scale organic matter enrichment and the formation of higher-quality source rocks. These findings provide theoretical support for shale oil and gas exploration in the region.

KEYWORDS Santanghu Basin; Lucaogou Formation; Palaeoenvironment; Organic matter enrichment; Source rock

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T4-15 Shale oil reservoirs: characteristics, exploration and development technology, and palaeogeographic control**142** ORAL O-17-2-1735**Seismic-Geological Geosteering for Horizontal Wells in Lianggaoshan Shale Oil Based on While-Drilling Seismic Processing****Xuqiang Chen*, Hui Li, Dean Cheng, Jiayin He, Zuoqian Wang, Yucheng Gong**

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The Lianggaoshan Formation in the Sichuan Basin is a complex continental shale oil interval with no clear markers in the overlying Shaximiao Formation, strong channel sandstone heterogeneity, rapid lateral lithofacies changes, and widespread micro-structures. These challenges, combined with the absence of pilot wells, cause poor entry-point prediction and difficult sweet-spot tracking during horizontal drilling. We propose a phased seismic-geological collaborative strategy based on high-precision while-drilling seismic processing. Before reaching the target, we calibrate synthetic seismograms using offset well data, build a VTI anisotropic velocity model integrated with well and seismic information, dynamically correct the velocity model using sonic logs from drilled sections, and compare seismic attributes with offset wells to identify channel bodies, and progressively reduce entry-depth errors using GR, gas and elemental logs upon entering the Lianggaoshan Formation. During horizontal drilling, we combine seismic dip trends with real-time GR, elemental logging (major/trace elements), and rock pyrolysis S4 data to adjust the trajectory, ensuring the bit remains in the optimal sweet spot. Field application shows that the reservoir encounter rate increased from 72% to 92%, while trajectory adjustments decreased by ~35%. This workflow—"high-precision while-drilling seismic processing, pre-target fine calibration, and multi-parameter while-drilling constraints"—offers a reliable integrated solution for geosteering in complex continental shale oil reservoirs and has significant reference value for similar geological settings.

KEYWORDS Lianggaoshan Formation; shale oil; horizontal well; while-drilling seismic processing; seismic-geological geosteering; reservoir encounter rate

143 POSTER P2-29**Astronomical cyclicity and organic matter enrichment of the Lower Jurassic lacustrine source rocks in the Sichuan Basin: Response to the Toarcian Oceanic Anoxic Event****Youzhi Wang***

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The Early Jurassic Toarcian Oceanic Anoxic Event (T-OAE), one of the most prominent extreme paleoclimatic perturbations of the Mesozoic, significantly impacted global sedimentary environments and biotic evolution. However, its influence on organic matter enrichment in continental settings remains poorly understood. In this study, we present a cyclostratigraphic analysis of the continuous natural gamma-ray (GR) logging series from the Dongyuemiao Member in Well Yingye-1, Sichuan Basin. After detrending, the GR series was subjected to MTM spectral analysis, evolutionary fast Fourier transform, and evolutionary power spectral decomposition to identify astronomically forced sedimentary cycles. The COCO/eCOCO method with Monte Carlo simulations was employed to optimize the sedimentation rate within 0–20 cm/kyr and to convert the stratigraphic succession from the depth to the time domain. Six dominant cycles with wavelengths of ~8.5 m, ~4.1 m, ~2.4 m,

~2.1 m, ~1.3 m, and ~1.1 m were identified, corresponding to long eccentricity, short eccentricity, obliquity, and precession periods. The cycle-thickness ratios closely match the theoretical astronomical periodicities of Laskar, confirming orbital forcing of sedimentation. Two candidate sedimentation rates of 2.2 cm/kyr and 8.5 cm/kyr were resolved; the former yields a null-hypothesis significance level below 0.1% and matches all seven orbital parameters with the highest correlation coefficient, and is thus adopted as the optimal rate. Based on lithofacies classification, the shales of the Dongyuemiao Member are divided into organic-rich laminated shale and shell-bearing laminated shale. The former developed under warm, humid, deep-water, reducing conditions during eccentricity maxima, whereas the latter formed under cold, arid, shallow-water, oxidizing and elevated-salinity conditions during eccentricity minima. We conclude that precession-scale paleoclimatic fluctuations, amplified by eccentricity modulation, governed the lake-basin environment and sedimentary infill, and ultimately regulated organic matter accumulation through their control on temperature-humidity and redox conditions.

KEYWORDS Dongyuemiao Member; cyclostratigraphy; orbital forcing; organic matter enrichment

T5

Stratigraphy and basin analysis

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T5-1 Marine sequence stratigraphy and basin analysis

144 ORAL O-19-1-1050

High-frequency sequence identification and division constrained by astronomical cycles: an example from the lower Pinghu Formation, Pinghu slope zone, Xihu Sag, East China Sea Shelf Basin

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The Xihu Sag in the East China Sea Shelf Basin is an important strategic successor area for off-shore oil and gas exploration in eastern China, with great potential for oil and gas exploration. The lower section of the Pinghu Formation of the Eocene is one of the main oil and gas-bearing strata in the Xihu Sag, with thick-bedded fine-grained deposits developed in a semi-enclosed bay setting. However, the poorly resolved high-precision sequence stratigraphy of the lower Pinghu Formation and the unknown relationship between paleoclimate changes and astronomical cycles severely restrict detailed oil and gas exploration in the region. This study takes the lower Pinghu Formation in Well PH10 of the Pinghu slope zone in the Xihu Sag as an example. Based on core, logging, whole-rock mineral composition, and elemental geochemistry data, Milankovitch cyclostratigraphy is used to conduct a time-series analysis of the lower Pinghu Formation. The results indicate that: (1) significant astronomical periodic signals are recorded in the GR logging and trace element data of the lower Pinghu Formation, allowing the identification of 11 long eccentricity cycles, 36 short eccentricity cycles, 114 obliquity cycles, and 205 precession cycles. Using the Evolutionary Correlation Coefficient (eCOCO) method, the optimal sedimentation rate of the lower Pinghu Formation is calculated to be approximately 17.1 cm/kyr; (2) Based on the stable long eccentricity cycles, an astronomically tuned age model is constructed. With the detrital zircon age of 42.5 Ma at the bottom of the lower Pinghu Formation as an anchor, an astronomical age scale is established, clarifying that the depositional time limit of the lower Pinghu Formation is 42.5–38.05 Ma, spanning approximately 4.45 Myr; (3) Taking the 405 ka long eccentricity and 125 ka short eccentricity cycles as the

benchmark for the division of fourth-order and fifth-order sequences, a total of 11 fourth-order sequences and 30 fifth-order sequences are identified in the lower Pinghu Formation, establishing a comparable high-precision isochronous stratigraphic framework for the lower Pinghu Formation in the Pinghu slope zone; (4) Comparing the trace elements with the orbital cycles recorded in the GR logging curves reveals a good response relationship between the dry and wet conditions of the paleoclimate and the 405 ka long eccentricity cycle. Warm and humid climates typically develop during the half-cycle period of the maximum long eccentricity orbit, while cold and dry climates tend to occur during the half-cycle period of the minimum long eccentricity orbit. Based on the comprehensive analysis of core and astronomical cycles, two orbit-driven depositional models, namely the "warm and humid type" and the "cold and dry type", have been established for the lower Pinghu Formation. The aforementioned research provides a reliable chronostratigraphic basis for the detailed exploration of oil and gas in the Xihu Sag.

KEYWORDS East China Sea Shelf Basin; Xihu Sag; Pinghu slope zone; lower Pinghu Formation; astronomical cycle; high-frequency sequence; astronomical chronometer

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T5-2 Non-marine sequence stratigraphy and basin analysis**145** ORAL O-19-1-1105**Progress in High-Resolution Magnetostratigraphy of the Middle–Upper Triassic in the Ordos Basin, North China****Yi Shi^{1*}, Jinnan Tong¹, Mark W. Hounslow^{2,3}, Daoliang Chu¹, Jacopo Dal Corso^{1,4}, Li Tian⁴, Yiran Cao¹, Guanjie Li¹**¹ School of Earth and Planetary Sciences, China University of Geosciences (Wuhan), CHINA² Lancaster Environment Centre, Lancaster University, UK³ Earth, Ocean and Ecological Sciences, University of Liverpool, UK⁴ State Key Laboratory of Biogeology and Environmental Geology, School of Earth Science, China University of Geosciences, Wuhan 430074, CHINA

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The Triassic Yanchang Formation in the Ordos Basin is one of the most important terrestrial Triassic strata in China, but there has always been controversy over the age attribution, especially the delineation of the Middle–Upper Triassic boundary. Traditionally, the Yanchang Formation was classified as the Late Triassic, but in the mid to late 20th century, scholars have suggested that its lower part may belong to the Middle Triassic. In recent years, high-precision zircon U-Pb dating (~234 Ma for a tuff in the Chang 7 Member) has provided a reliable absolute age anchor for sequence boundaries. Magnetic stratigraphy methods have shown unique advantages in long-term lacustrine sedimentary dating, while high-resolution sequence stratigraphy has established a fine framework for base level cycles and isochronous comparisons. This study focuses on the Xuefengchuan and Zhangjiaqian sections in Hancheng and Wubao, and presents a comprehensive study of high-resolution magnetostratigraphy, rock magnetism, and sequence stratigraphy analysis of fine-grained sedimentary rocks in the Ermaying Formation and Yanchang Formation. The aim is to establish a framework for magnetic polarity sequences and chronostratigraphy for the Middle–Late Triassic of the North China continental basin, and to reveal the constraining effect of sedimentary evolution on magnetic stratigraphic records.

Preliminary results show that the magnetic carrier minerals in the samples of the Ermaying Formation and Yanchang Formation studied are mainly hematite and magnetite. The characteristic remanence direction was effectively separated through a combination of systematic thermal and alternating-field demagnetization, and was verified by long-term magnetic polarity reversal tests. A total of 18 major magnetic polarity zones were identified, among which the isotopic ages of the volcanic ash layer at the bottom of the HC4n and HC7n positive polarity zones constrain deposition of the upper part of the Ermaying Formation to the late Anisian (Middle Triassic). Based on this, the Anisian–Ladinian boundary is placed at the bottom of the Yanchang Formation. The overlying HC8–HC10 zones, which are mainly of reversed polarity, correspond to the Ladinian, while the uppermost HC14–HC18 zones can be correlated with the early Carnian. The coupling analysis of polarity sequence and sedimentary facies evolution further reveals that the organic-rich shales and lacustrine turbidites in the Yanchang Formation significantly interfere with magnetic signals, providing lithological constraints for the interpretation of terrestrial magnetic stratigraphic data.

This study constructed a systematic magnetic stratigraphic sequence of the Middle–Late Triassic in the North China continental basin and calibrated key stratigraphic boundaries such as the Anisian–Ladinian–Carnian stage boundaries. The combination of magnetic stratigraphy and sequence stratigraphy has opened up new avenues for solving the problem of Triassic stratigraphic age in the Ordos Basin.

KEYWORDS Magnetostratigraphy; Middle–Late Triassic; Ordos Basin; Yanchang Formation; Terrestrial**FUNDING** National Natural Science Foundation of China (Grant No. 42030513)

T5-3 Palaeogeography in the period of human history**146** POSTER P2-30**Hydro-geomorphological Evolution and Human Adaptation during the Middle and Late Holocene in the Lower Reaches of the Yellow River, China****Zhen Qin***

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The northern area of Henan Province is one of the core regions for the origin and early development of Chinese civilization. However, because the region lies on the alluvial floodplain of the Yellow River, archaeological investigations face numerous challenges. This report presents the results of our systematic environmental archaeological investigations in the region and explores the profound impacts of middle and late Holocene environmental changes on human adaptation strategies.

We conducted extensive regional systematic surveys and targeted excavations in the Yellow River Floodplain of northern Henan Province, collecting high-density soil and sediment samples from four key sites and their surrounding areas. Using a multi-disciplinary approach incorporating stratigraphy, sedimentology, and soil micromorphology, we reconstructed the environmental changes, particularly the hydro-geomorphological evolution, of the study area during the middle and late Holocene. The results reveal a hydro-geomorphological sequence characterized by "widespread wetlands — wetland retreat and landscape stabilization — intensified Yellow River flooding."

Within this environmental context, we further examined ancient human adaptation strategies through the dimensions of agricultural intensification, urbanization, and metallurgical technology. Our findings indicate that fluctuations in landscape stability significantly influenced social evolution in the region; ancient inhabitants demonstrated remarkable resilience to the dynamic environment by adjusting crop patterns, constructing defensive walls, and innovating metallurgical technologies. Furthermore, this report synthesizes the diverse and complex relationships between environmental change and human adaptation, and summarizes the practical experiences of conducting environmental archaeological research in the floodplains of large rivers, aiming to provide methodological references and comparative case studies for archaeological research in similar environments worldwide.

KEYWORDS Archaeological stratigraphy; Hydro-geomorphology; Yellow River floodplain; Human history**FUNDING** National Natural Science Foundation of China

T5-5 Basin analysis in different tectonic settings**147** ORAL O-17-3-1705**Effect of Brittle–Ductile Layer Thickness and Shortening Velocity on the Deformation Style of the Southern Qiangtang Basin, Tibetan Plateau: Insights from Analog Modeling****Wengang He^{1,2}, Changjun Ji², Weiping Feng², Yanchao Pang³**¹ College of Engineering and Technology, Zunyi Normal University, Zunyi, Guizhou 563006, CHINA² Chinese Academy of Geological Sciences, Beijing 100037, CHINA³ Key Laboratory of Orogenic Belts and Crustal Evolution, Ministry of Education, School of Earth and Space Sciences, Peking University, Beijing 100871, CHINA

The Southern Qiangtang Basin exhibits complex structural deformation. While previous studies have examined its characteristics and proposed various mechanisms—most commonly relating deformation to shear stress in the southern region—the evolutionary processes and underlying dynamics remain poorly constrained. To address this limitation, this study conducted 16 analog modeling experiments constrained by four key parameters (brittle layer thickness, ductile layer thickness, constant piston shortening velocity, and variable piston shortening velocity) and integrated available geological and geophysical data to simulate the deformation evolution of the basin. The results are as follows: (1) although the brittle layer thickness, ductile layer thickness, and piston shortening velocity all influence structural style, ductile layer thickness is the main controlling factor, whereas piston shortening velocity has a negligible impact on the resulting deformation style; (2) shear stress analysis indicates that even under identical initial stress conditions, variations in rheological stratification can produce markedly different final deformation styles; (3) analog modeling experiments indicate that pure back-thrust faulting does not originate from complex kinematics related to basal shear stress; (4) the development of south-vergent thrust structures in the Southern Qiangtang Basin is closely related to the ductile-layer distribution in the basement. This deformation pattern is likely driven by a combination of northward compression from the Lhasa terrane and far-field effects of the India–Asia collision.

148 ORAL O-17-3-1720**Uplift and Provenance of the Miocene Navidad Basin, Central Chile (~34°S)****Brianna Pearson^{1*}, Mauricio Espinoza², Tomas Capaldi¹**¹ Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA 92093, USA² Departamento Ciencias de la Tierra, Universidad de Concepción, Barrio Universitario, Concepción, CHILE

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Forearc basins record long-term (Myr) vertical motion of the overriding plate along subduction zones, yet the relative roles of slab geometry changes and sediment underplating in driving forearc uplift remain unresolved. The Miocene–Pleistocene Navidad Basin, a marine forearc basin along the Coastal Cordillera of central Chile (~34°S), offers a potential archive of the "Payenia" flat-slab subduction episode (~13–5 Ma; Ramos & Folguera, 2011; Kay & Mpodozis, 2002) and subsequent slab steepening. However, the timing of marine deposition is debated: foraminifera biostratigraphy suggests a late Miocene onset, whereas macrofossil ⁸⁷Sr/⁸⁶Sr dates indicate early Miocene initiation (Encinas, 2006; Gutiérrez et al., 2009). To refine basin age, provenance, and depositional history, we integrate detrital zircon U–Pb geochronology and trace element geochemistry from basin-wide sampling with detailed stratigraphic sections at La Boca and Topocalma (O'Higgins Region), sedimentological facies analysis, and structural observations. Stratigraphy reveals a basal nearshore conglomerate overlain by a transgressive succession that grades through tidal facies into deep-wa-

ter interbedded sandstones and siltstones. The Navidad Formation is disconformably overlain by Pleistocene beach facies sandstone. The marine transgression, followed by unconformity-bounded continental deposition, records an initial phase of tectonic subsidence followed by forearc uplift and emergence, consistent with subduction geodynamics. Preliminary detrital zircon geochronology results indicate sediment sourced predominantly from nearby Coastal Cordillera exposures. Ongoing sediment provenance analysis will help link surface deformation and sediment routing to slab geometry transitions and underplating processes in central Chile and comparable subduction systems.

KEYWORDS Subduction; stratigraphy; facies; underplating; flat-slab; detrital zircon; Chile

T5-6 Shelf sedimentology and stratigraphy**149** POSTER P1-21**Last records of mesosaurs in the Northeastern Paraná Basin, Brazil (Upper Cisuralian): What changed in the basin?****Giúlia Raphaela de Moraes^{1*}, Rosemarie Rohn²**¹ Geosciences and Environment Graduate Program, São Paulo State University (UNESP), Rio Claro, BRAZIL² Department of Geology, São Paulo State University (UNESP), Rio Claro, BRAZIL

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Mesosaurs were small, partly aquatic reptiles that inhabited a restricted epeiric sea, with records in the Irati Formation of the Paraná Basin, in lateral equivalents in Uruguay and Paraguay, and co-eval units in Africa. The upper part of the formation consists of dolomitic limestones interbedded with organic-rich shales in laterally extensive centimetric- to submetric-thick beds. The carbonates are generally associated with hypersaline alkaline waters in a relatively arid setting, whereas the shales may record more turbid waters with anoxic bottom conditions, probably associated with less arid intervals. These environments were ecologically extreme and apparently supported only mesosaur reptiles and few pygocephalomorph crustacean species. However, even these crustaceans were likely restricted to areas with oxic bottoms, given their benthic habit. The Irati Formation is overlain by the Serra Alta/Corumbataí Formation, which consists mainly of dark shales deposited in probably deeper, better-circulating waters inhabited by fish and, sporadically, by benthic faunas such as bivalve mollusks. The contact between these units is still debated. It has been considered transitional, concordant, or discordant, and the proposed position of a possible third-order sequence boundary also remains debated. In outcrops extending for at least 90 km along the northeastern margin of the Paraná Basin, the two formations are separated by a distinct submetric set of beds that provides new perspectives on the habitat of the last mesosaurs. In some outcrops, this interval consists of fine sandstones (and subordinate siltstones) with planar stratification, locally passing into (mini-)hummocky stratification. These beds contain isolated to articulated mesosaur bones, as well as abundant pygocephalomorph crustaceans at several levels, preserved either as small fragments or as complete individuals up to 3–4 cm in length. In other outcrops and in two boreholes located up to 80 km basinward, the facies remains similar but becomes slightly muddier, although sandstone laminae with abundant crustacean fragments still occur. The differences among localities reflect slightly higher energy conditions at the more proximal positions on the epeiric platform. The crustacean fragments represent allochthonous elements, together with the coarser sediment fractions, that were transported into the depositional environments during higher-energy events. The more complete crustaceans were likely transported while still alive. The fragility of the mesosaur bones rules out reworking. The facies, paleontological and taphonomic analyses suggest an environmental shift from typical Irati Formation conditions to an almost abrupt increase in siliciclastic input under regressive/progradational conditions on a storm-dominated epeiric platform. This model supports the hypothesis that the unconformity between the units is positioned above the mesosaur-bearing sandstone bed, preceding the deposition of the mudstones of the Serra Alta/Corumbataí Formation.

KEYWORDS Corumbataí Formation; Permian; Epeiric shelf**FUNDING** Human Resources Training Program of the Brazilian National Agency for Petroleum, Natural Gas and Biofuels – PRH-ANP, under the management of the São Paulo Research Foundation (FAPESP), Brazil (Process Nos. 2025/21561-8 and 2025/03066-0)

150 POSTER P2-31

Disentangling the effects of hydrodynamic sorting and climate variations on grain-size-dependent $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios for provenance tracing in coastal systems

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The $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratio is a widely used provenance tracer due to its lithological variability and the relative immobility of Ti and Al during chemical weathering. However, its pronounced grain-size dependence and susceptibility to confounding factors often complicate its direct application to sedimentary successions. Here, we systematically evaluate the geochemical behavior of Ti and Al alongside potential interfering factors, using a well-constrained postglacial sedimentary succession (~15 ka to present) from the Qiantang River coastal system. By analyzing bulk sediments and five contiguous grain-size fractions (<2 μm , 2–10 μm , 10–30 μm , 30–63 μm , and >63 μm), we show that provenance signals derived from $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios in bulk sediments and most grain-size fractions are heavily overprinted by hydrodynamic sorting associated with paleoenvironmental and climatic evolution. Furthermore, under stable or moderate provenance regimes, variations in the $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratio of hydrodynamic-sensitive fractions can be regarded as effective paleoclimate tracers. In fluvial and proximal paleoestuarine units dominated by Qiantang River inputs, $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios of bulk sediments and most grain-size fractions are strongly modulated by climate, capturing three extreme cooling events, whereas the <2 μm fraction remains stable and serves as a resilient provenance indicator. In offshore shallow-marine and modern estuarine units dominated by Changjiang-derived sediments, $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios of bulk sediments and the 10–30 μm fraction track the intensity of the Zhe-Min Coastal Current, thereby functioning as a proxy for the East Asian Winter Monsoon. Notably, the 2–10 μm fraction exhibits grain-size-specific Ti-Al enrichment, low sensitivity to hydrodynamic sorting, and suppressed clay-related anomalies, making it the most robust provenance tracer across the two overlying intervals, though caution is required during extreme climatic episodes. This study provides a grain-size-specific framework that optimizes the applicability of $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios, offering new insights for provenance reconstruction and paleoclimate tracking in highly dynamic coastal systems.

KEYWORDS $\text{TiO}_2/\text{Al}_2\text{O}_3$ ratios; Grain-size partitioning; Hydrodynamic sorting; Source-to-sink process; Qiantang River incised valley

151 ORAL O-17-1-1615

Intrinsic curvature of shelf profiles under non-deltaic transgression and its stratigraphic implications

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Most continental shelves exhibit a landward steepening topographic curvature. Two dominant mechanisms have been conventionally proposed to interpret this morphological feature: (i) a gradual reduction in the accommodation-to-sediment supply (A/S) ratio during the late phase of post-

glacial transgression, and (ii) wave-induced sediment redistribution that shapes a steady concave-up shelf profile under modern oceanographic conditions. This study proposes an alternative mechanistic framework, demonstrating that shelf curvature originates from an intrinsic self-organizing process. During sea-level rise, an alluvial river has a critical length threshold; once exceeded, the system ceases to form foresets and develops only topsets. This distinctive transgressive scenario is defined as non-deltaic transgression, as its stratigraphic architecture deviates fundamentally from the classic three-layer deltaic system. Under such non-deltaic transgressive conditions, the shrinkage of alluvial systems drives autogenic enhancement of alluvial aggradation rates, which promotes localized sediment accumulation near the shoreline and ultimately generates a steeper inboard shelf slope. Two-dimensional geometric modeling yields a simplified governing equation that quantitatively describes the self-organized curvature of shelf profiles, with robust validation from flume tank experiments and applications to modern shelf systems. This model establishes a reliable baseline for differentiating autogenic and allogenic controls on shelf morphological evolution, providing novel insights for sequence stratigraphic interpretation.

KEYWORDS Shelf profile; Non-deltaic transgression; Autogenesis; Stratigraphy; Flume experiment

152 ORAL O-19-1-1135

Non-Isochronous Transgression in Dual-Provenance Sedimentary Basins: Insights from Experimental Studies and Geometric Analysis

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In conventional sequence stratigraphy, it is commonly believed that transgression occurs simultaneously across the sedimentary basin experiencing relative sea-level (RSL) rise. As a consequence, the maximum flooding surface is widely utilized as a quasi-isochronous chronostratigraphic marker for regional stratigraphic correlation. The concept of shoreline autoretreat demonstrates that the transgression may occur after a precursory regression. The duration of the precursory regression depends on external forcings, including the rate of sediment supply (q_s) and rate of RSL rise (R_{rsl}) and slope features of the basin. This means that, within a given basin, the onset of transgression varies between locations with different sediment supply rates and/or slope features. This study aims to analyze the influencing factors of the occurrence time of transgression in dual-provenance basins through theoretical modelling and two-dimensional flume experiments. To investigate these factors, two series of tank experiments were designed. The first series is supply-modulated where the two provenances were different in q_s , while the basin slope conditions were kept the same. The second series is slope-modulated, where the two provenances varied in hinterland slopes (γ) while q_s was kept the same. Each series included 2 or 3 runs with different multiples of R_{rsl} or q_s . Furthermore, a reference run was performed where the two provenances were identical in both q_s and γ . The results reveal that: (1) q_s and R_{rsl} have similar effects on transgression. As q_s increases, the timing of transgression is delayed, while an increase in R_{rsl} accelerates its occurrence. Both factors affect the timing of transgression by altering the size of the river-delta system. (2) The occurrence of transgression is closely related to the size of the river-delta system. Guided by the autoretreat mechanism, the fluvial-deltaic system maintains its progradational trend during a constant RSL rise, provided it has not yet reached its critical dimensions. A transgressive retreat is fundamentally postponed until the delta evolves to exceed this intrinsic spatial threshold, at which point the required sediment volume for progradation outstrips the supply. Only when the river-delta size exceeds the critical size does transgression take place. The critical size is controlled by a combination of q_s , R_{rsl} , and basin slope. (3) Hinterland slope (γ) affects subaerial and subaqueous allocations of sediment. Larger γ results in reduced subaerial allocation of sediment. As a result, the alluvial realm expands more slowly but the aggradation rate is higher, by which transgression is de-

layed. The Canterbury Plain in New Zealand serves as a potential example of asynchronous transgression in a basin with varying provenance. Based on an understanding of autostratigraphic processes, these findings offer a framework for explaining the anisochronicity of transgression in natural basins and provide a novel perspective for reconstructing basin evolution and stratigraphic analysis.

KEYWORDS Dual-provenance system; autostratigraphy; transgression; autoretreat theory; flume experiments

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T6

Global changes, palaeoclimate and sedimentary events

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T6-1 Climate, ecology and geomorphology in Quaternary palaeogeography

153 ORAL O-19-4-0850

The Manych Depression: A Late Quaternary Gateway in the Drainage System of Northern Eurasia

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The Manych Depression is a narrow, elongated valley linking the Caspian Sea with the Azov–Black Sea Basin. During the Quaternary, the Caspian Sea periodically spilt westward through this corridor into the Black Sea basin, as evidenced by the sedimentary record preserved in the Manych Depression. These overflow events represent a key issue in the palaeogeography of the Ponto-Caspian region and of northern Eurasia more broadly, yet they remain insufficiently understood. Recent studies suggest that, much like the Black Sea, the Caspian may at times have functioned as an intermediate basin within a larger-scale drainage system, with the Manych Depression acting as its principal overflow corridor.

Here we summarise a decade of research in the Manych Depression and present a detailed overview of Late Quaternary deposits documented in outcrops and boreholes across the region. More than 30 sites were investigated using lithological, geochronological, and faunal analyses. On this basis, we reconstruct the environmental evolution of the Manych Depression during the Late Quaternary. The most critical stages in its history were two major episodes of Caspian overflow into

the Azov–Black Sea Basin, one at the end of MIS 5 and the other at the end of MIS 2. In both cases, overflow occurred when Caspian water levels rose high enough to cross the water divide separating the two basins.

These transgressive episodes were driven by a positive water balance in the Caspian Sea during transitional intervals between glacial and interglacial conditions. The main controls were increased river inflow and reduced evaporation. In addition, the drainage of ice-dammed lakes in the north of European Russia and western Siberia may also have contributed to rises in the Caspian water level.

KEYWORDS Palaeodischarge; sea-level change; stratigraphic analysis; glacial–interglacial cycles; absolute dating

FUNDING Russian Science Foundation (Project 22-17-00259p)

154 ORAL O-19-3-1135

Tectonic–Climatic Coupling Drove a Mid-Pleistocene River Piracy in the Northern Qilian Shan, Northeastern Tibetan Plateau: Evidence from Isochron $^{26}\text{Al}/^{10}\text{Be}$ Burial Dating and χ Analyses

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River piracy, a dynamic process reshaping drainage networks, plays a pivotal role in landscape evolution, yet its timing and driving mechanisms in active orogens remain poorly constrained. This study focuses on the piracy between the Hongshuibai River and the Zhulongguan River in the northern Qilian Shan (Shan means "mountain" in Chinese), northeastern Tibetan Plateau, to resolve its chronology and geomorphic implications. Utilizing isochron $^{26}\text{Al}/^{10}\text{Be}$ burial dating of fluvial sediments from the abandoned water divide, we determine that the piracy occurred at 0.79 ± 0.24 Ma, marking the first radiometric age for such an event in this region. χ analyses reveal pre-piracy disequilibrium in the Zhulongguan River profile, attributed to an earlier piracy by the Beida River, which preconditioned the landscape for the subsequent Hongshuibai–Zhulongguan piracy. Integrated results demonstrate that the Hongshuibai–Zhulongguan piracy was driven by tectonic uplift that amplified topographic gradients and the mid-Pleistocene climate transition, which enhanced erosional efficiency. These findings highlight the coupling between northward extension of the Qilian Shan and orbital-scale hydroclimatic variability in triggering threshold-driven drainage reorganization, offering insights into transient landscape responses in active orogens.

KEYWORDS River piracy; Isochron $^{26}\text{Al}/^{10}\text{Be}$ burial dating; χ analyses; Earth surface processes; Northeastern Tibetan Plateau

FUNDING National Natural Science Foundation of China (42225205, 42201004, 42488301)

T6-3 Authigenic minerals and global changes: micro-archives of the big picture**155** POSTER P2-14**Spatiotemporal variations in formation conditions of cryogenic brines: Insights from aragonite cements in New Harbor, western Ross Sea, Antarctica****Mingyu Yang^{1*}, Tracy Frank², Chris Fielding², Biao Chang³**¹ School of Earth and Planetary Sciences, China University of Geosciences, 388 Lumo Road, Wuhan 430074, CHINA² Department of Earth Sciences, Beach Hall, 354 Mansfield Road – Unit 1045, University of Connecticut, Storrs, CT 06269, USA³ State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, CHINA

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Cryogenic-brine precipitated carbonates (cryogenic-brine carbonates) have proven to be a valuable proxy for tracing the origin, nature, and distribution of Cenozoic brines that reside beneath McMurdo Sound (MMS) and adjacent McMurdo Dry Valleys (MDV), Antarctica. Of particular significance is the predominance of cryogenic-brine aragonite cements found in several stratigraphic sections in this region, reflecting the initial chemistry and conditions under which the brines formed. To fully explore this aspect, this paper presents a comprehensive examination of cryogenic-brine aragonite cements in all sediment cores recovered in New Harbor, an embayment that connects the MDV and MMS. Petrographic and isotopic analyses of the cements reveal a diverse range of brine-forming environments in the glacial outlet system during the middle Miocene Climatic Transition and the Early–Middle Pleistocene Transition. These environments span subglacial and ice-contact proglacial lakes to sub-ice-shelf fjords, occurring as cold-based, continent-sized Antarctic ice sheets expanded over the continental margin. Subsurface infiltration of the brines triggered almost instantaneous precipitation of aragonite cements below the sediment–water interface at low temperatures near 0 °C. Driven by the hydraulic gradient, the brines facilitated slow yet pervasive precipitation of an unusual form of aragonite characterized by coarse, blocky and poikilomorphic morphologies—distinct from the typical acicular and fibrous aragonite dominating near-surface strata. The oxygen isotopic compositions of brines, as derived from aragonite precipitates, vary among different environments, increasing from ~–30 to –5‰ VSMOW toward MMS. The ¹⁸O depletion is primarily controlled by the availability of periodic saline water replenishment and the relative contribution of seawater versus meltwater during the cryoconcentration process. The ubiquity of brine-forming environments on the Antarctic continental margin suggests their potential existence during past ice ages, which may be identified by the presence of distinct cryogenic-aragonite cement patterns as documented in this study.

KEYWORDS Diagenesis; isotope geochemistry; middle Miocene Climatic Transition; Early–Middle Pleistocene Transition; McMurdo Sound; McMurdo Dry Valleys

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T6-4 Rapid climate changes and environmental crises during Mesozoic–Cenozoic hyperthermals

156 ORAL O-19-4-0830

New discovery of the Oceanic Anoxic Event 2 record in eastern Neo-Tethys (central Tibet, China)

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The Oceanic Anoxic Event (OAE) 2, which occurred across the Cenomanian–Turonian boundary of the mid-Cretaceous, is recorded in organic-matter-rich deep-sea sediments and imprinted in a range of geochemical proxies across the global marine realm, reflecting widespread biotic and environmental crises during a short-lived hyperthermal climate. Isotopic and geochemical signatures of OAE 2 have been extensively documented in numerous contemporaneous marine basins, including the western Neo-Tethys, southeastern Neo-Tethys (Himalaya), Atlantic, Pacific, and Western Interior Seaway. However, no evidence of OAE 2 has previously been reported from the eastern Neo-Tethys (i.e., the southern margin of paleo-Asia). This absence has hindered a comprehensive understanding of this global paleoceanographic and climatic event in the peri-Neo-Tethyan region.

A sedimentary and geochemical investigation was conducted above the Langshan Formation at the Luoma Changbo creek, west of Dong Co, Gerze, central Tibet (China), a locality situated on the southern margin of paleo-Asia within the eastern Neo-Tethys. Comprehensive field observations and laboratory analyses show the following: 1) the studied strata consist of light olive gray to pale gray (weathered to dark gray) calcareous shale, approximately 35 m thick, which is lithologically distinct from the three members of the Langshan Formation; 2) Calcareous nannofossils are generally poorly preserved, with some moderately preserved specimens, and a few index fossils were identified, indicating a Cenomanian–Turonian age, with the boundary inferred at approximately 20 to 24 m in the measured section; 3) Calcite contents range from 10% to 50%, averaging 21%, while total organic carbon (TOC) contents vary from 0.2% to 2.0%; 4) Carbon isotope ratios ($\delta^{13}\text{C}$) of bulk shale range from 0.14‰ to 1.38‰, with a subtle plateau observed between 13.0 m and 22.0 m (samples 24LMC-55 to 91), despite a similar cycle occurring below the carbon isotope excursion (CIE) interval; 5) Carbon isotope ratios of bulk organic matter range from -25.11‰ to -20.25‰, exhibiting a trend similar to that of bulk shale.

The following conclusions are drawn: 1) A new lithostratigraphic unit, identified above the original Langshan Formation, is named the Fourth Member of the same formation; 2) The OAE 2 interval has been identified in central Tibet, China, based on calcareous nannofossil biozones and carbon isotope excursions in both shale and organic matter; 3) This newly recognized Cenomanian–Turonian transition record confirms the occurrence of OAE 2 in the eastern Neo-Tethys, suggesting that seawater withdrawal from the southern margin of paleo-Asia occurred later than ~93.0 Ma.

KEYWORDS Shale; nannofossils; carbon isotope; Langshan Formation; Oceanic Anoxic Event 2; mid-Cretaceous; eastern Neo-Tethys

157 ORAL O-19-4-0905

Sedimentary response to abrupt global warming during the Paleocene–Eocene Thermal Maximum (PETM) in the western Jiangnan Basin, central China

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The Paleocene–Eocene Thermal Maximum (PETM) was a rapid global warming event widely considered the closest deep-time analogue to anthropogenic climate change. While the sedimentary signature of the PETM is well documented in marine settings, high-resolution terrestrial records remain scarce—particularly in Asia, where climate shifts profoundly affect densely populated areas. Here, we present an ~80 m thick lacustrine section from Zhicheng in the western Jiangnan Basin, central China, that preserves a clear terrestrial record of the PETM. The stratigraphic succession spans the upper Paleocene Gongjiachong and lower Eocene Yangxi formations. U-Pb geochronology on lacustrine marl carbonates from the middle section yields a depositional age of 55.2 ± 2.2 Ma. The lower section records a prominent negative carbon isotope excursion (CIE), marked by a drop in carbonate $\delta^{13}\text{C}$ values from -6.5‰ to -13‰ and a shift in organic matter $\delta^{13}\text{C}_{\text{org}}$ values from -24.5‰ to -27.4‰ . Stratigraphic lithology, magnetic susceptibility, and clumped isotope thermometry (TA_{47}) show concurrent variations across the CIE. Notably, the magnitude of warming in central China and other continental regions appears less pronounced than marine thermal records suggest, highlighting key discrepancies between oceanic and terrestrial responses to global warming. Terrestrial environments may instead have experienced heightened climate extremes, such as intensified seasonality, that are muted in marine archives yet crucial for understanding modern environmental dynamics under warming scenarios.

KEYWORDS PETM; Jiangnan Basin; Lacustrine deposition; Carbon isotope excursion (CIE); Clumped isotope thermometry

158 ORAL O-19-4-0920

PETM-Driven Organic Matter Enrichment in a Lacustrine Basin: Elemental, Isotopic and Biomarker Geochemistry from the Fu-2 Member, Hai'an Sag, Subei Basin

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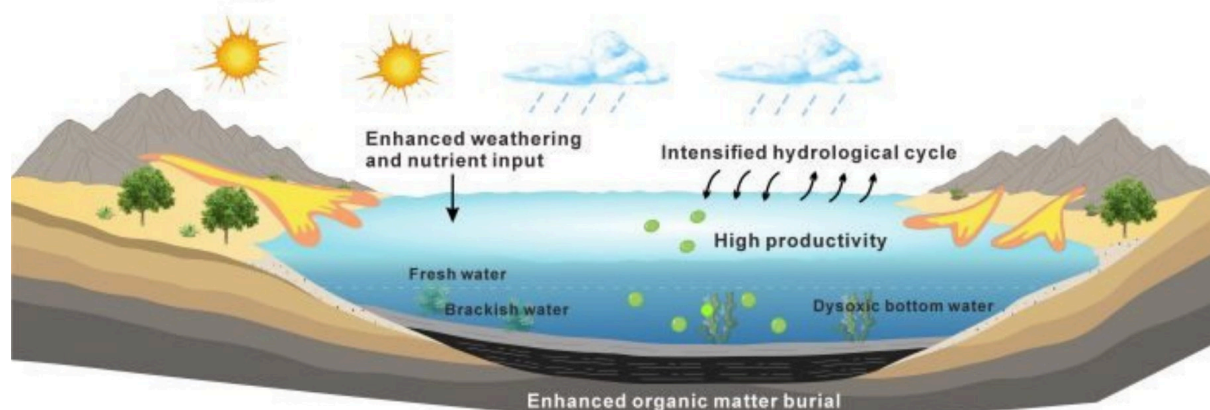
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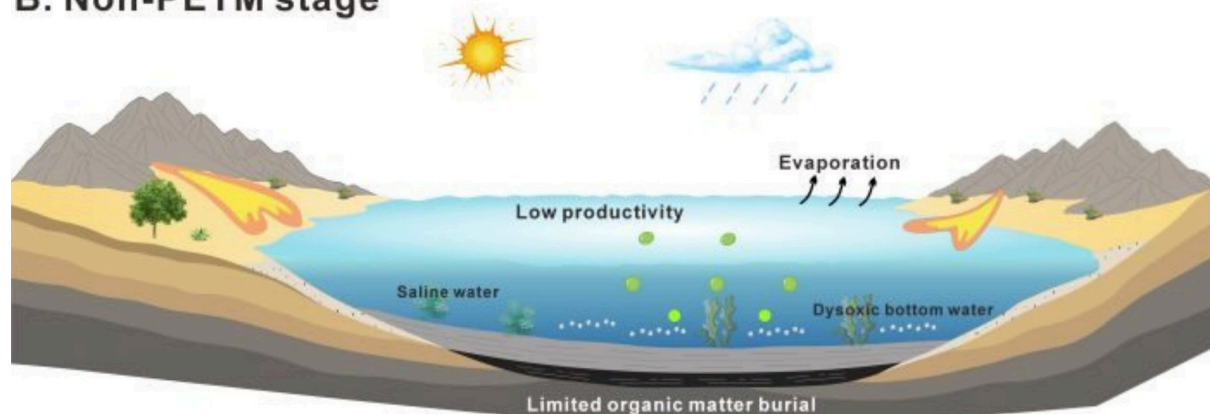
The Paleocene–Eocene Thermal Maximum (PETM) was a major episode of rapid warming and carbon-cycle perturbation, yet its influence on organic-matter enrichment in continental lakes remains poorly constrained. Here, organic carbon isotopes, total organic carbon, elemental geochemistry, and biomarkers from the Fu-2 Member of the Hai'an Sag, Subei Basin, are integrated to investigate lacustrine organic-matter enrichment during the PETM. The PETM interval is identified by its ca. 56 Ma age constraint and a negative organic carbon-isotope excursion, supported by variations in kerogen and carbonate carbon isotopes. Mean TOC increases to approximately 2.32 wt.% during the PETM, compared with 0.66–1.28 wt.% before the event. Higher CIA and P/Al values, together with lower Sr/Cu and Sr/Ba ratios, indicate intensified regional hydrological cycling, chemical

weathering, freshwater runoff, and nutrient delivery, accompanied by a shift from saline to fresh-water-brackish conditions. Redox proxies indicate predominantly dysoxic to weakly reducing bottom waters both before and during the PETM, without a marked development of persistent strong anoxia. Organic-matter enrichment was therefore controlled mainly by increased nutrient supply and primary productivity, whereas dysoxic bottom waters provided supplementary preservation. These results link rapid climatic warming and intensified hydrological cycling to enhanced organic-carbon burial in a continental lacustrine basin.

A. PETM stage



B. Non-PETM stage



KEYWORDS Paleocene–Eocene Thermal Maximum; organic-matter enrichment; carbon-isotope excursion; hydrological cycle; paleoproductivity; Hai'an Sag

T6-5 Palaeogeography, palaeoclimate and palaeoceanography of the Late Paleozoic Ice Age**159** ORAL O-17-3-1615**The evolving paleogeography of the Late Paleozoic Ice Age in western Argentina****Juan Pablo Milana***

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Two main hypotheses dominate the scenario of the Late Paleozoic Ice Age (LPIA) across central-western Argentina. The first was based on the existence of mountain chains whose glaciers descended into the basins as mountain glaciers. The most iconic palaeo-mountain range was the “Protoprecordillera”, a term coined in 1965 and used extensively by many geologists, even to model climate, as it was regarded as a sort of “coastal glaciated cordillera” capturing marine humidity. However, the existence of marine deposits of lower and upper Carboniferous age atop that hypothetical mountain range, discovered in 1997 and fully studied in 2023, now indicates that this positive element did not exist in the portrayed form. Another positive element was defined to the east: the Zonda Arch, proposed in 1967. That range limited the accumulation of Carboniferous deposits to the eastern side of the present Zonda Range. This paleo-range was later confirmed by studies of paleocurrents documenting flow of thick turbidite packages away from that palaeorange. However, a controversy arose because clast provenance showed a clear basement source located to the east, and some of the lowest paleocurrents showed westward progradation of small outwash deltas, whereas the down-fjord direction had always been considered to be the opposite, towards the east. A revision of the entire glacial paleovalley of Quebrada de Las Lajas revealed additional outwash-plain/delta deposits to the west, belonging to the oldest depositional unit of this paleovalley. In all cases, flow associated with well-preserved foresets showed a clear westward flow. When Las Lajas paleovalley is reconstructed, it shows today an inherited U-shaped form and crosses completely the hypothetical Zonda range. As all glacial deposits in Precordillera are preserved within paleo-reliefs, the existence of a valley does not imply the existence of a paleorange. At Zonda, a lithological barrier caused the westward-moving glacier to erode the sediments upstream of the limestone more deeply, creating a depression. When the valley was completely filled by ice, streams flowed directly from the glacier towards the west, creating the outwash plain complex. However, when ice disappeared, a large lake formed over the glacially carved depression, producing a very common phenomenon: paleocurrent reversal. Because all previous paleocurrents were measured in the post-glacial units, they all point eastwards; the paleogeographic picture was therefore incomplete, and this gap led authors to propose the “Zonda palaeorange”. This study supports our hypothesis of a large (Scandinavian-style) ice cap that shrank slowly and creating a very large network of outlet glacial valleys later flooded. Our morphometric study at Vichigasta demonstrated, based on constant valley width, that the preserved paleovalleys were carved by outlet glaciers, reinforcing the view that the local LPIA did not evolve as a mountain-glacier system but as an ice-cap system, possibly of continental scale.

KEYWORDS Late Paleozoic Ice Age (LPIA); Glaciation; Carboniferous; Argentina

T6-6 Carbon, nitrogen and sulfur cycles and Earth system evolution**160** ORAL O-19-4-0935**Deep-Sea Turbidity Current Pump and Organic Carbon Burial in the Zhongjiannan Basin, Western South China Sea, during the Late Quaternary****Wenbin Ma, Ming Su*, Mingdong Yu, Kunwen Luo, Jing Luo**

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The transport and cycling of carbonaceous matter are fundamental to sustaining life and maintaining a habitable climate system. Deep-sea sediments constitute an important terminal reservoir for organic carbon within the carbon cycle, where organic matter burial can sequester greenhouse-gas carbon and regulate long-term climate evolution. Because the vast majority of organic carbon is buried along modern continental margins, and deep-water sedimentary dynamics exert primary control on margin sediment characteristics, a geological perspective is essential for interpreting organic carbon burial processes. The deep-water turbidity current carbon pump represents the largest organic carbon transport and burial mechanism operating at Earth's surface, although its importance in the carbon cycle has only been widely recognized during the past decade.

This study focuses on the Zhongjiannan Basin in the western South China Sea and uses sediment core S5 as the primary archive. By integrating seafloor topography, ocean current data, high-resolution core CT, chronological constraints, detrital grain size, pore water geochemistry, and sediment geochemistry, we reconstructed the evolution of deep-water organic carbon burial (DOCB) over the past 40 kyr and introduced the turbidity current carbon pump to examine its depositional mechanism. The turbidity current carbon pump is strongly expressed in the study area, as indicated by two typical turbidite units in core S5. These deposits are interpreted as basin distal turbidites triggered by submarine landsliding of slope sediments. The DOCB capacity of the two Holocene turbidity-current events was at least 10.2–17 times that during MIS 2, and this strong carbon storage capacity was closely associated with rapid sediment accumulation and shortened oxygen exposure time. DOCB in the study area also shows clear climatic cyclicity. The mean organic carbon burial flux during the last glacial period was $890.51 \text{ g} \cdot \text{m}^{-2} \cdot \text{kyr}^{-1}$, higher than the interglacial mean of $700.76 \text{ g} \cdot \text{m}^{-2} \cdot \text{kyr}^{-1}$. During late MIS 2, the terrestrial organic matter contribution increased sharply to an average of 47%. Variations in carbon sources, marine productivity, and bottom water oxygenation jointly controlled the burial outcome. As an emerging focus in global carbon cycling and deep-water sedimentology, the turbidity current carbon pump provides an important framework for understanding deep-sea organic carbon burial. This study offers a valuable case for global research on the deep-sea turbidity current carbon pump, fills a knowledge gap in carbon burial studies of the western South China Sea, and provides a solid foundation for future evaluation of basin-scale carbon cycling patterns and carbon reservoir potential across the South China Sea.

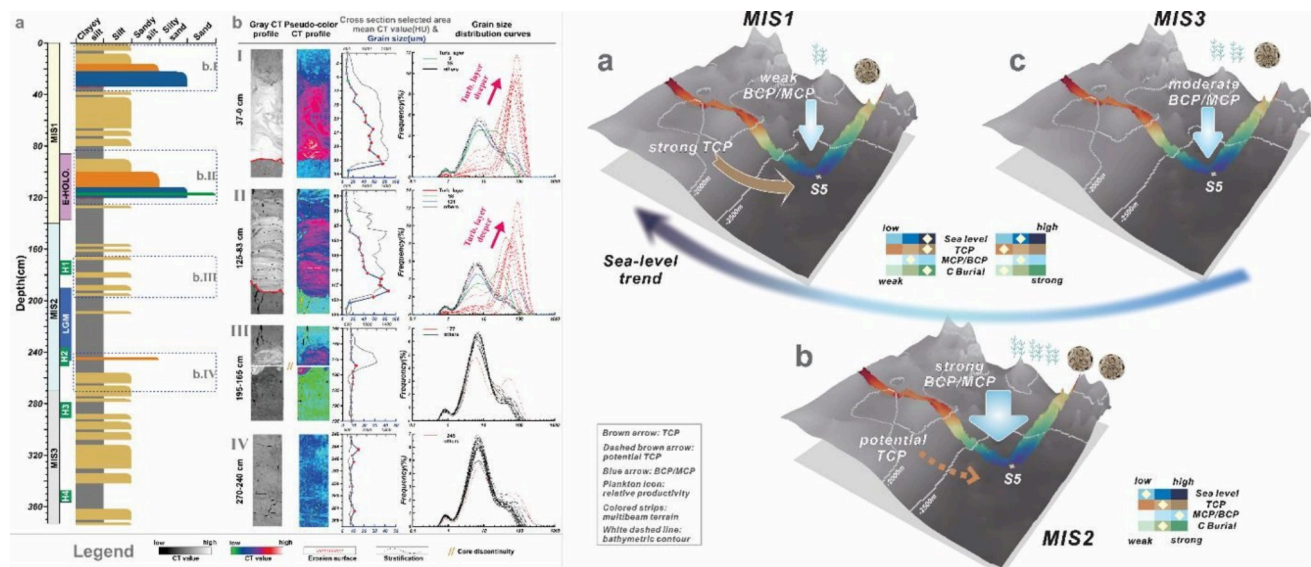


Fig. 1. Graphical abstract

KEYWORDS Organic carbon burial; turbidity current; carbon pump; deep sea; Zhongjiannan Basin

FUNDING Southern Marine Science and Engineering Guangdong Laboratory (Zhuhai) Project (SML2021SP009) and the National Natural Science Foundation of China (41976067)

161 POSTER P2-32

Synchronous Carbon Isotope Perturbations in the Cambrian Furongian of the Eastern North China Platform

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The global marine environment experienced significant fluctuations, corresponding to multiple carbon isotope excursions during the Cambrian Furongian. This period served as a critical precursor to the Great Ordovician Biodiversification Event. The interval records several carbon isotope excursions—including the SPICE, TOCE, and other events—coinciding with bioterminal extinctions that have been recognized worldwide. Carbon isotope data from the North China Platform during this period demonstrate synchronous isotopic shifts, suggesting a potential for global correlation. However, the lack of high-resolution carbon isotope analyses and detailed fossil identifications has led to ongoing debate regarding the key drivers of the bioterminal extinctions and the mechanisms underlying the isotopic anomalies.

KEYWORDS Carbon isotope excursion; Cambrian; North China Platform

FUNDING National Natural Science Foundation of China (42272122)

T6-7 Asian Cenozoic sedimentation and climate evolution**162** ORAL O-19-4-0950**Synthesis of Early Cretaceous and Paleogene stratigraphy and sedimentation in northwestern China****Shuang Dai^{1*}, Zhongzhao Ding^{1,2}, Mingzhen Zhang^{1,2}, Chunyan Li¹**¹ School of Earth Sciences, Lanzhou University & MNR Key Laboratory of Strategic Mineral Resources of the Upper Yellow River, Lanzhou 730000, CHINA² Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, CHINA

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The Cretaceous and Paleogene are crucial for understanding the formation of the present tectonic and climatic patterns of eastern Asia and the interactions among Earth's spheres. However, the tectonic and paleogeographic history and its driving factors remain unclear owing to the lack of high-resolution geochronology. In this contribution, we present a synthesis of the Cretaceous and Paleogene stratigraphy and sedimentation of northwestern China. Combining magnetostratigraphic and biostratigraphic data, the stratigraphy is compiled as Early Cretaceous (ca. 140–105 Ma), and middle Late Cretaceous as well as the middle Paleocene to Oligocene (ca. 55–24 Ma). Four facies types are recognized: fluvial, lacustrine, eolian and desert. These facies alternated frequently, reflecting varied tectonic and paleogeographic settings and their evolution.

KEYWORDS Northwest China; Cretaceous and Paleogene; stratigraphy synthesis; sedimentary facies**FUNDING** National Natural Science Foundation of China (42272034) and Central Guiding Local Science and Technology Development Fund (No. 25ZYJA023)**163** POSTER P2-18**Late Miocene uplift of the northeastern Tibetan Plateau drove aridification and ecosystem transition in inland Asia: Evidence from the Linxia Basin****Xiaomin Fang^{1*}, Weilin Zhang¹, Jinbo Zan¹, Tao Zhang², Zantao Feng¹, Fuli Wu¹, Wenxia Han³**¹ State Key Laboratory of Tibetan Plateau Earth System, Environment and Resources (TPESER), Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100101, CHINA² School of Earth Sciences & Key Laboratory of Western China's Mineral Resources of Gansu Province, Lanzhou University, Lanzhou 730000, CHINA³ Qinghai Provincial Key Laboratory of Geology and Environment of Salt Lake, Qinghai Institute of Salt Lake, Chinese Academy of Sciences, Xining 810008, CHINA

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The Cenozoic uplift of the Tibetan Plateau is one of the most significant geological events in the Earth's history, profoundly influencing regional atmospheric circulation, biological evolution, surface processes, and global environmental change. Continuous, high-resolution geological records are key to unraveling the processes and mechanisms underlying the tectonic–climate–biosphere interactions driven by the Tibetan Plateau uplift. However, a shortage of such records hinders our understanding. The Linxia Basin, located in the northeastern Tibetan Plateau (NETP) within the transitional zone between the East Asian monsoon and the Asian inland arid region, preserves exceptionally thick and continuous Cenozoic strata and abundant mammalian fossils, providing an ideal archive for addressing these questions.

Over the past two decades, we have conducted multiple phases of drilling and outcrop investigations in the Linxia Basin, establishing a comprehensive chronostratigraphic framework for its sedimentary sequences. Complementing these efforts, a recent drill core from the south-central basin

at Nanyangshan—penetrating the basin to recover 645 m of lacustrine-fluvial sediments overlying 3 m of basement granite—is constrained by high-resolution magnetostratigraphy to ~26.4–3.5 Ma, bridging the spatio-temporal gap between the basin margins and its center. Based on robust chronology, tectono-sedimentology, multi-proxy paleoclimate analysis, and numerical simulations, we further reveal that the Linxia Basin underwent rapid tectonic rotation and sedimentary reorganization at ~8 Ma. This event, driven by the uplift of the NETP, was accompanied by accelerated aridification and a transition in faunal and floral ecosystems. These regional changes may have ultimately led to an enhanced dust-related carbon sink effect, triggering global cooling and facilitating the formation of the Arctic cryosphere and tri-polar dynamic connections. These processes further underscore the significance of the Tibetan Plateau uplift and its environmental effects within Earth system science.

KEYWORDS Tibetan Plateau; Late Miocene; uplift; aridification; tri-polar dynamic connections

FUNDING National Natural Science Foundation of China, No. 42595530

164 POSTER P2-33

Sedimentary Evolution and Precession-Driven East Asian Summer Monsoon Precipitation Since 1.2 Ma in the Weihe Basin

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The East Asian Summer Monsoon (EASM) is a key component of the Asian climate system, yet its long-term precipitation variability and orbital pacing remain debated. Here, we present a continuous sedimentary record spanning the past ~1.2 Ma from a 272-m-long lacustrine-fluvial-aeolian core (23GL) recovered from the Weihe Basin, central China. A robust chronological framework is established based on magnetostratigraphy and correlation with speleothem $\delta^{18}\text{O}$ records. Lithofacies analysis reveals a progressive transition from lacustrine to fluvial and ultimately to aeolian environments, indicating long-term basin drying. Grain-size end-member modeling identifies five components (EM1–EM5), and the combined proportion of coarse-grained fractions (EM3–EM5) is interpreted as a proxy for lake-level fluctuations and regional hydroclimatic changes. XRF-derived elemental proxies (K and Fe) further reflect catchment-scale hydrological variability. Spectral analysis shows that EASM precipitation variability is dominated by a ~20 kyr precession cycle, closely linked to boreal summer insolation. Enhanced summer insolation likely promoted a northward shift of the westerlies and prolonged the midsummer rainfall season in northern China. This study provides new evidence from an inland basin for the orbital-scale control of insolation on East Asian monsoon precipitation and contributes to a better understanding of Cenozoic sediment-climate interactions in Asia.

KEYWORDS East Asian Summer Monsoon; Weihe Basin; End-member modeling; Grain-size analysis; Orbital forcing; Quaternary climate

FUNDING China-Iran Silk Road Science Fund Project (SRSF) under the CAS International Partnership Program (No. 175GJHZ2025056MI), National Natural Science Foundation of China (No. 42494911) and Iran National Science Foundation (INSF No. 4049173)

165 POSTER P2-34

Northward expansion of Cenozoic Asian humid climate

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The modern arid-humid climate pattern in Asia, characterized by a northwest-southeast contrast, evolved from a zonal distribution during the Paleogene. However, this transition remains poorly constrained by geological evidence. In this study, we analyze sporopollen assemblages from Late Eocene strata in subtropical Yunnan, southwestern China. Our results reveal a pronounced vegetation shift at ~40.6 Ma, from tropical-subtropical sparse forest to subtropical-temperate mixed broad-leaved-coniferous forest. This change is further supported by a rapid decline in drought-tolerant taxa, predominantly *Ephedra* and *Chenopodiaceae*, indicating a transition from a hot, dry climate to a warm, humid regime. We interpret this as evidence that the Asian monsoon had begun to influence the study area by ~40.6 Ma. By synthesizing sporopollen data from multiple basins across East Asia, we demonstrate that the leading edge of the humid monsoon climate advanced intermittently northwestward after the Late Eocene, potentially reaching temperate regions by the early Late Oligocene—a position comparable to the modern monsoon limit. Furthermore, the monsoon front may have extended as far as the Qaidam Basin during the Middle Miocene, before gradually retreating to its present-day position. We suggest that the uplift of the Tibetan Plateau and global climatic changes were the dominant drivers of this spatiotemporal evolution.

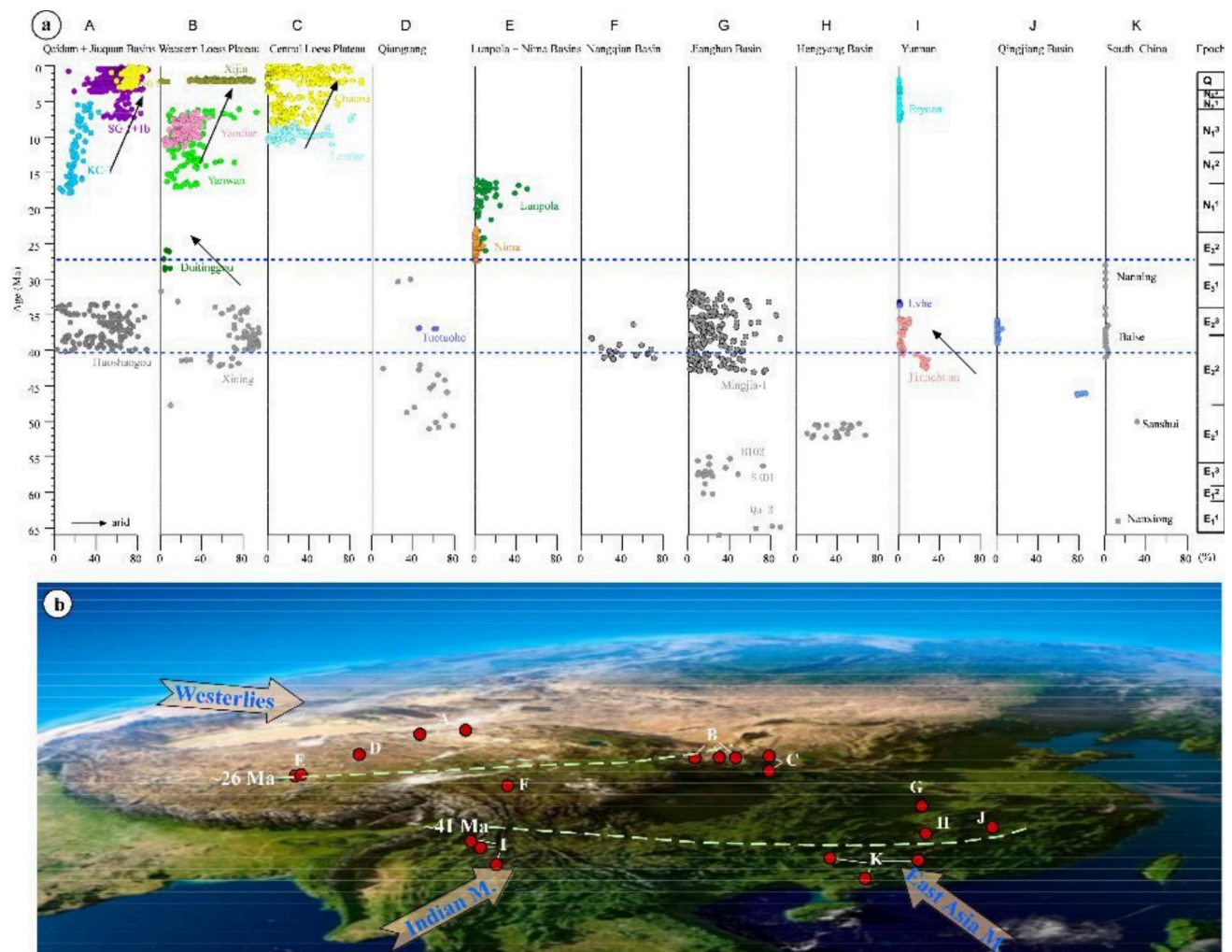


Fig. 1. Spatiotemporal evolution of climate recorded by sporopollen. a) Drought-tolerant plant pollen content of representative basins/sections; b) Locations of representative basins/sections

KEYWORDS Asian climate; Cenozoic; monsoon; sporopollen; arid-humid

166 ORAL O-19-4-1030

Late Quaternary Dust Dynamics on the Tibetan Plateau: Insights from Loess Luminescence Dating

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Dust activity on the Tibetan Plateau (TP) holds significant implications for both regional and global environmental change. The TP loess, which has been accumulating since the early Quaternary, serves as a direct and reliable record of past dust activity and environmental shifts. However, the processes and factors influencing TP dust accumulation have not been well constrained owing to a lack of detailed chronology. This study presents a newly established, high-resolution luminescence chronology for the well-preserved Ganzi loess-paleosol sequence. We synthesize the spatial and temporal patterns of dust accumulation across the TP and investigate the contributing factors. Our findings indicate that TP dust accumulation is characterized by prominent glacial-interglacial fluc-

tuations and rapid suborbital-scale variations during the last glacial cycle. Dust activity on the TP is highly responsive to global climate change, with significant expansions of loess coverage and episodic increases in dust activity observed since the late Quaternary. Anthropogenic activities appear to have significantly influenced TP dust flux since the late Holocene. This study highlights that dust activity on the Tibetan Plateau is substantially more intense than previously recognized.

KEYWORDS Mass accumulation rate (MAR); OSL dating; loess; glacial-interglacial; Quaternary

167 POSTER P2-35

Global dust impacts on biogeochemical cycles and climate

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Windblown mineral dust is a nutrient source to the ocean, influencing global ocean productivity, ocean carbon uptake and climate. In this review, we examine how dust emission fluxes, sources and compositions have changed over the past 7 Myr and consider the implications for ocean productivity. Since the Late Cenozoic, global cooling and orogenic uplift have enhanced dust emissions from major source regions and fluxes to downwind ocean basins, with the associated nutrient supply varying with dust origin. Glacially derived Asian dust contains higher concentrations of ferrous iron (typically exceeding 30% of the total iron) and phosphorus than the aged, highly oxidized mineral dust from North Africa, which has negligible ferrous iron content. Indeed, Asian dust has a notable influence on Pacific Ocean productivity and, potentially, climate. For example, Middle Pleistocene increases in the content of Asian dust Fe²⁺ (~45%) and P (~55%) coincided with a threefold to fivefold rise in glacial productivity in the South China Sea and a concurrent shift in phytoplankton ecology in the lower-latitude North Pacific. Therefore, decreasing glaciogenic dust-nutrient supply under continued global warming could notably impact ocean productivity, especially in the Pacific Ocean. Future research should focus on constraining the composition and bioavailability of dust-derived nutrients across a wide range of globally important dust sources so that dust composition and related feedbacks can be better parameterized in Earth system models.

KEYWORDS Dust emissions; loess deposits; iron hypothesis; biogeochemical cycles; global carbon cycle

FUNDING The Young Scientists Fund (Category A) of the National Natural Science Foundation of China (42525207)

168 ORAL O-19-4-1105

Evolution of the East Asian Summer Monsoon and its impact on organic matter enrichment in the northern South China Sea from the middle Eocene to early Oligocene

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Recent studies suggest that the East Asian Monsoon emerged in the Eocene, substantially earlier than the previously estimated Miocene onset. Nevertheless, comprehensive knowledge of the monsoon's evolution and driving mechanisms from the middle Eocene to early Oligocene remains scarce. Newly obtained continuous sedimentary records from a low-latitude borehole (~1500 m long) in the northern South China Sea provide valuable archives for investigating the evolution of the East Asian Summer Monsoon (EASM) as well as its impact on organic matter enrichment. This study presents an integrated analysis of palynological records, clay minerals, geochemical parameters, and amorphous organic matter. Our data show that EASM climate evolution can be divided into three stages: Unit I (43.0–39.0 Ma; moderately warm-humid conditions), Unit II (39.0–33.9 Ma; warm-humid conditions) and Unit III (from ~33.9 Ma; cold-arid conditions). Beyond the influences of Tibetan Plateau uplift and global temperature variations, the intensification of the EASM prior to the Eocene–Oligocene Transition (EOT) is likely associated with the enhancement of the Atlantic Meridional Overturning Circulation, while the EOT global cooling event may have played a key role in weakening the EASM in the early Oligocene. Furthermore, total organic carbon, Rock-Eval pyrolysis, and particulate organic matter data of source rocks indicate that organic matter enrichment was significantly affected by the EASM through its influence on lake productivity, which has important implications for the exploration and characterization of source rocks in the Pearl River Mouth Basin and analogous environments.

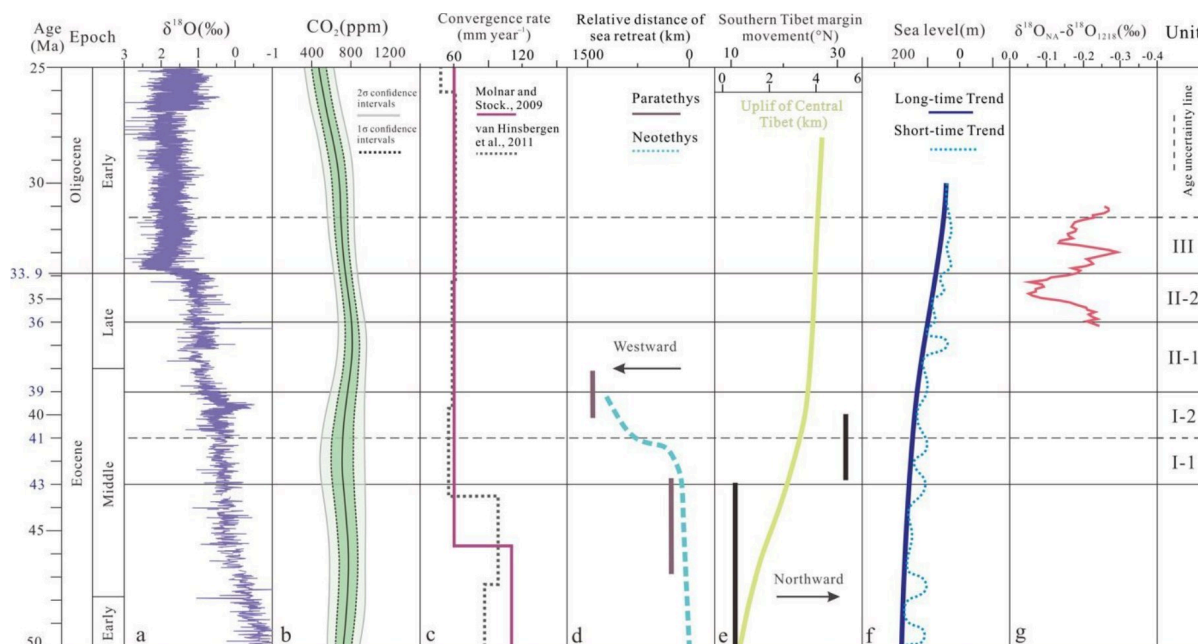


Fig. 1. Comparison of Eocene and early Oligocene monsoon climate with tectonic, global climate and sea-level records.

KEYWORDS East Asian Summer Monsoon; middle Eocene to early Oligocene; hydrocarbon source rocks; organic matter enrichment; South China Sea

FUNDING Major National Science and Technology Programs (2025ZD1400807 and 2025ZD1402804-03); National Natural Science Foundation of China (42072142)

169 ORAL O-19-4-1050

Characteristics and Geological Significance of Ice-Rafted Deposits Under Humid-Thermal Lacustrine Marsh Environment: A Case Study of the Jurassic Badaowan Formation, Northwestern Margin of Junggar Basin

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The Late Triassic–Early Jurassic is a rare interval without polar continental ice sheets. Previous studies hold that the Junggar Basin was under a greenhouse climate at this time, and the Early Jurassic Badaowan Stage constituted the major coal-forming period with sustained high temperature and rainfall. The 2nd Member of the Badaowan Formation records a unique sedimentary association of lacustrine fine-grained sediments, coal seams and ice-rafted debris.

To clarify stratigraphic genesis and reconstruct paleoclimate, paleogeography and provenance evolution at the northwestern margin of the Junggar Basin, field outcrop surveys were conducted. Lithofacies observation and fabric analysis of ice-rafted debris were adopted to constrain clastic transport-sedimentation dynamics. Combined with sedimentology, sporopollen fossils and elemental geochemistry, this study reconstructed paleoclimate and retrieved paleoweathering, paleo-depth and provenance characteristics.

The results show that isolated dropstones, mud pebbles and scattered coarse clastics occur in lacustrine mudstone, siltstone and coal interbeds of the 2nd member of the Badaowan Formation. These clastics show poor sorting and variable grain sizes, lacking traction-current and gravity-flow sedimentary structures; gravels compress underlying lacustrine laminae, indicating local ice-rafted deposits formed by seasonal lake-ice transport and melt-out. The sporopollen assemblage is dominated by thermophilic palynomorphs with accessory cold-resistant gymnosperm pollen. Geochemical indices reveal strong catchment chemical weathering and rare earth element enrichment in strata.

Multi-indicator evidence shows that the 2nd member of the Badaowan Formation formed in warm-humid limnic-swamp settings, yet lake water froze in winter with stable lake ice cover. Lake-ice melting induced grain-size differentiation: fine organic matter accumulates in deep lakes. Ice-covered cold conditions block atmospheric exchange and reduce microbial decomposition, favoring peat and lacustrine organic matter preservation. Therefore, the Triassic–Jurassic transition in the study area was not perennially warm and humid; large annual temperature differences, frequent winter icing and prominent seasonal climate differentiation prevailed.

The identified lacustrine ice-rafted detritus provides field evidence for seasonal cooling events in mid-high latitudes under greenhouse climate, showing that seasonal lake ice and ice-rafted sediments can develop in mid-high latitude coal-bearing lacustrine basins under high CO₂ greenhouse conditions. Moreover, lake ice's grain sorting and organic matter preservation effects offer new insights into sedimentation and organic enrichment mechanisms of coal-bearing strata.

KEYWORDS Ice-rafted deposits; Junggar Basin; Badaowan Formation; Paleoclimate

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Late Eocene–Oligocene aridification and hydroclimate transition in NE Tibet: constrained by paleosols and organic geochemical proxies

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The northeastern Tibetan Plateau (NE Tibet) is located at the crucial intersection of the planetary wind system and the monsoon wind system, and at the farthest extent of the India-Eurasia collision. Under the combined influence of global climate change and plateau uplift, it has undergone a complex climate evolution process during the Late Eocene to Oligocene. However, uncertainties in climatic proxies and the scarcity of continuous terrestrial records have led to ongoing debates regarding the climatic evolution and driving mechanisms of NE Tibet.

In this study, we investigate paleosol sequences from the Hongliuxia Section (Jiuquan Basin), Tiantishan Section (Wuwei Basin), and Xiangshuihe Section (Haltang Basin) in the northeastern Tibetan Plateau. Based on field observations and thin section analyses, all paleosols are identified as compound paleosols, which can be classified into two types: kastanozems and luvic calcisols. Magnetostratigraphic constraints indicate that kastanozem formation occurred at ~37–28 Ma in the Hongliuxia Section and at ~39–32 Ma in the Wuwei Basin. According to modern soil classification and distribution, these paleosols indicate arid to semi-arid climatic conditions. In contrast, luvic calcisols first appear at ~24 Ma in the Haltang Basin. Quantitative paleoprecipitation reconstructions suggest values of 398–748 mm with a seasonal fluctuation of ~88 mm, indicating a semi-humid environment with seasonal precipitation. Moreover, total organic carbon (TOC) records from the Xiangshuihe Section reveal two distinct stages since the Late Oligocene: a high-productivity phase (~24–14 Ma; mean 0.064) and a low-productivity phase (~14–6 Ma; mean 0.036). Similarly, *n*-alkane average chain length (ACL) exhibits consistent two-stage variations, indicating flourishing higher terrestrial vegetation until ~14 Ma, followed by a decline in productivity. Overall, these records suggest the persistence of relatively humid conditions from the Late Oligocene to the Middle Miocene, in marked contrast to the previous dry climate. Integrating previous studies, the retreat of the Paratethys Sea and the uplift of the Pamir Plateau led to the diversion of the westerlies and a reduction in their ability to transport moisture to NE Tibet. Meanwhile, the progressive uplift of the central and southern Tibetan Plateau to high elevations enhanced the land-sea thermal contrast, promoting the northward expansion of the Asian monsoon. Combined with the relatively low topography of NE Tibet during the Late Oligocene, these factors further facilitated the intrusion of the monsoon into the interior of the plateau, ultimately resulting in a humidification transition in NE Tibet during the Late Oligocene.

KEYWORDS Northeastern Tibetan Plateau; Paleosols; Monsoon intrusion

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171 ORAL O-17-4-1705

Environmental Changes in the Mud Area of the Inner Shelf of the East China Sea since MIS 5: Evidence from Biomarkers

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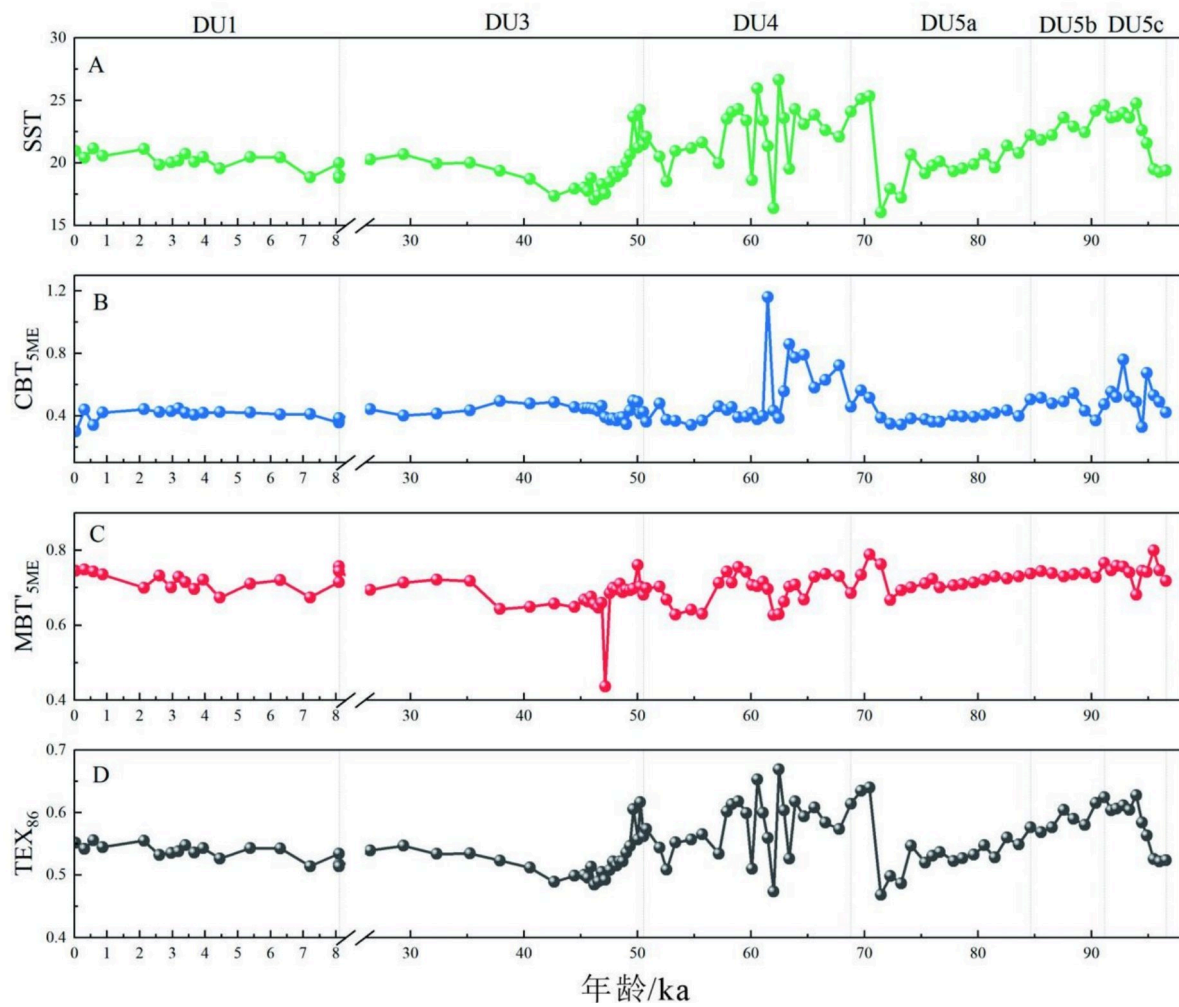
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The mud deposits on the inner shelf of the East China Sea preserve valuable records of regional environmental and climatic changes in the western Pacific marginal seas. However, long-term paleoenvironmental reconstructions from this area remain limited due to the complex interactions among sea-level fluctuations, sediment provenance, and monsoon-driven hydrodynamic processes. In this study, sediment core ECS1601 from the southern East China Sea inner-shelf mud area was investigated using lithological characteristics, chronological constraints, grain-size parameters, and glycerol dialkyl glycerol tetraether (GDGT)-based proxies to reconstruct environmental evolution since Marine Isotope Stage 5 (MIS 5).

The results indicate that the relative contributions of terrestrial and marine organic matter varied significantly in response to glacial-interglacial sea-level changes. Marine organic matter became increasingly important during periods of high sea level, whereas enhanced terrestrial influence was observed during lower sea-level intervals. In addition, organic matter composition was strongly affected by East Asian monsoon-driven hydrodynamic conditions and variations in watershed environmental processes. Reconstructed sea-surface temperatures (SSTs) during MIS 4 ranged from 16.38 to 26.66 °C and exhibited relatively large fluctuations, suggesting the combined influence of multiple environmental factors. In contrast, SST variability during other stages was comparatively moderate.

Our results reveal a close coupling between organic matter sources and sedimentary environmental changes in the East China Sea inner-shelf mud area over orbital timescales. These findings improve our understanding of the responses of marginal-sea depositional systems to sea-level and monsoon variability since MIS 5 and provide new evidence for regional paleoclimatic and paleoenvironmental evolution in East Asia.



KEYWORDS East China Sea; inner-shelf mud area; GDGTs; organic matter source; sea-surface temperature; paleoenvironmental evolution

T7

Technologies and big data for palaeogeographic reconstruction

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T7-2 Seismic sedimentology and its application in palaeogeographic reconstruction

172 POSTER P2-37

Fine Architecture Characterization of Thin-Bed Shallow Water Delta Sand Bodies Based on Seismic Sedimentology: A Case Study of K Oilfield, Laizhouwan Sag

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The K Oilfield is located in the southern Laizhou Bay Sag of the Bohai Bay Basin. The primary development target is the V oil group of the lower Minghuazhen Formation (Neogene), which was deposited in a shallow-water delta system. Shallow-water deltas are favorable hydrocarbon reservoir types in transitional facies. However, more than one-third of the sand bodies in the study area are thinner than 4 m, leading to strong reservoir heterogeneity and poorly understood connectivity. Architectural characterization of the target interval is therefore urgently needed to clarify sand-body connectivity. Based on core and well-log data, combined with multi-well architectural-unit classification, the fifth-order architectural units of the V oil group in the lower Minghuazhen Formation are mainly multistage stacked composite channel deposits. The fourth-order architectural units include distributary channels, sheet sands, mouth bars, and interdistributary bays. Among these, distributary channels constitute the main reservoir architectural unit in the study area. The study area is an offshore field with a sparse well pattern, but the seismic data are of good quality. Therefore, seismic-sedimentology techniques were adopted to spatially characterize the architectural units. Based on the correlation between seismic attribute volumes and drilling data, three seismic attributes were selected: RMS amplitude, instantaneous frequency, and reflection strength. A machine-learning method was used for multi-attribute fusion, which improved the ability to identify thin-sand-body boundaries and enhanced sand-body continuity. Combined with reservoir-architecture interpretation at wells, the architectural characterization of multistage composite channel sand bodies was completed. In the lower Minghuazhen Formation of the K Oilfield, the sediment provenance direction is NE-SW. Multiple lobes developed contemporaneously and are

stacked with each other. Channel widths mainly range from 70 to 150 m, and channel lengths mainly range from 1000 to 3000 m. Distributary channels are generally oriented along the provenance direction. The results provide a direct geological basis for adjusting development well locations and the optimization of development measures.

KEYWORDS Laizhouwan Sag; Shallow-water delta; Seismic sedimentology; Multi-attribute fusion; Reservoir architecture

T7-3 Well-logging sedimentology and palaeoenvironment

173 POSTER P2-38

Fracture Identification by Using Attenuation and Reflection Imaging Based on Array Acoustic Logging

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Fracture identification is a critical issue in reservoir evaluation and hydraulic fracturing assessment. However, due to the complexity of borehole acoustic fields, strong multipath interference, and significant energy attenuation, conventional acoustic logging methods still face challenges in identifying borehole-crossing fractures. To address these issues, a comprehensive analysis workflow based on array acoustic logging data is developed, including attenuation and velocity analysis, reflection wave extraction, and imaging processing. First, attenuation coefficients and velocity characteristics are extracted to identify enhanced energy dissipation and velocity anomalies associated with fractures. Then, reflection wave components are separated from the full wavefield to enhance fracture-related responses. Based on these results, imaging processing is performed to achieve spatial localization and characterization of fractures. Both numerical simulations and field logging data demonstrate that fractures result in significant attenuation enhancement and travel-time increase, which can serve as effective indicators for fracture identification. Reflection wave extraction improves the signal-to-noise ratio of fracture responses, while imaging results clearly delineate fracture locations and spatial distributions. Further comparison with electrical imaging logging shows good consistency, validating the reliability of the proposed method. These results indicate that the proposed approach significantly improves the capability of array acoustic logging for fracture identification and provides a new technique for integrated interpretation of multi-source logging data.

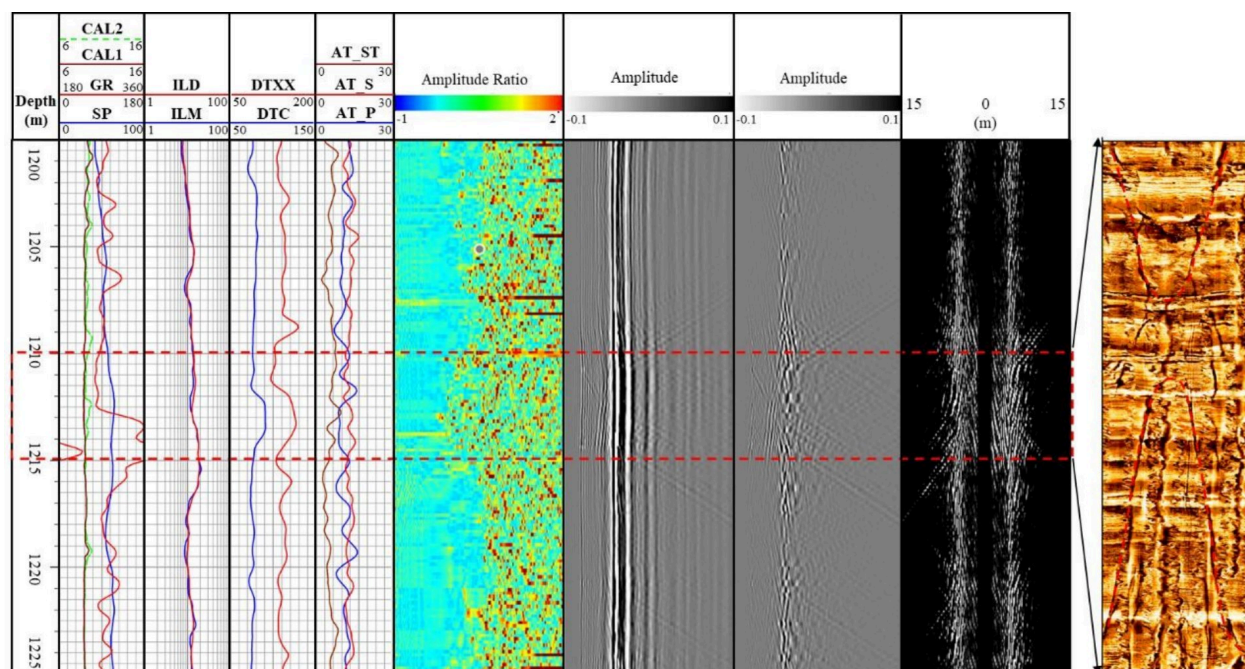


Fig. 1. Integrated imaging results of Well JH17P40 (1200–1225 m)

KEYWORDS Array acoustic logging; Fracture imaging; Attenuation analysis; Reflection extraction

174 ORAL O-19-2-1120

Lithology-guided spatiotemporal neural network for shear wave slowness prediction

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Well logs provide an economical and efficient means of characterizing subsurface petrophysical properties. Among these, shear sonic slowness (DTS) is highly sensitive to petrophysical parameters such as lithology, porosity, fracture development, and in-situ stress. It therefore serves as a key logging parameter for rock-physics analysis, the construction of elastic-parameter and AVO/seismic inversion models, and geomechanics and in-situ stress prediction. However, the high acquisition cost of DTS often results in sparse coverage and severe data gaps, which in turn limit its application. To address this issue, a Geological Similarity-Informed Graph Convolutional Network-iTransformer (GS-GCNIT) architecture is introduced, which couples a graph convolutional network (GCN) with an inverted Transformer (iTransformer). First, geological data are represented as a graph and integrated into a Chebyshev graph convolutional network; by using the GCN to propagate and aggregate information between nodes, the model captures spatial connections and geological relationships among different wells. In parallel, the iTransformer branch extracts inter-log correlations and nonlinear sequential features associated with depth evolution, enabling the model at each depth point to simultaneously account for the joint response of multiple logs and the vertical trends above and below, thereby more accurately reproducing the true logging characteristics of the subsurface medium. To evaluate the generalization capability of GS-GCNIT, a dataset from four wells in the Shaximiao Formation in the central Sichuan Basin, China, is used for training and testing. Experimental results show that GS-GCNIT achieves significantly lower MAE and RMSE than competing methods, yielding more accurate and more consistent DTS predictions, which confirms the reliability and practical utility of GS-GCNIT for high-precision DTS prediction.

KEYWORDS GS-GCNIT; Deep learning; Well-log curve reconstruction; Spatiotemporal neural network

T7-5 Palaeoclimate and palaeoceanographic research using isotopic approaches

175 ORAL O-17-4-1615

Reconstructing Jurassic water temperatures for Himalayan localities based on stable oxygen isotope analyses of calcitic fossils

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In the Himalayas, marine sedimentary rocks with a Jurassic age form a belt stretching from northern Pakistan through India and Nepal to southwestern China. These rocks contain numerous fossils allowing palaeoenvironmental reconstructions based on palaeoecology as well as geochemistry. We collected Middle to Late Jurassic belemnite rostra from India, Nepal, and China and analysed them for their stable isotope ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$) composition. The results show a strong influence of the Himalayan orogeny on the preservation of the fossils. Many of the collected belemnites were deformed or recrystallized, and their chemical composition altered. Careful checks of their state of preservation included element (Mn, Fe) analyses and cathodoluminescence microscopy. Based on these checks and despite the strong alteration of many of the fossils, it was possible to retrieve original environmental information stored within the belemnite rostra. While the analyses of the fossils from Nepal are still ongoing, the belemnites from northern India indicate average water temperatures of 22–24 °C in the Late Jurassic. This is comparable to stable oxygen isotope data of Late Jurassic belemnites from southern Tibet, which translate into water temperatures of 16–24 °C. In agreement with earlier data from western India and Madagascar, the stable isotope record from the Himalayas seems to indicate a long-term cooling trend from the Middle Callovian/Oxfordian to the Tithonian, which can be correlated to a concomitant drift of eastern Gondwana into higher palaeolatitudes.

KEYWORDS Palaeoclimate; Geochemistry; Jurassic; Stable oxygen isotopes; Himalayas

T7-8 Reconstructing Earth's surface evolution from numerical modelling**176** POSTER P1-22**Analysis of the paleogeographic evolution of the Amazon based on coupled numerical models of surface and lithospheric processes****M.A. Araújo^{1*}, V. Sacek¹, R.P. de Almeida²**¹ Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG), University of São Paulo, São Paulo, BRAZIL² Institute of Geosciences (IGc), University of São Paulo, São Paulo, BRAZIL

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The Amazon hosts one of the greatest diversities of fauna and flora on the planet. This high biodiversity is the result of millions of years of geological coevolution, with the uplift of the Andes being one of the most decisive factors in this process. Over the past decade, numerical models combined with sedimentary and paleontological records from the region have played a fundamental role in understanding how surface and mantle processes have acted together to reorganize drainage patterns in the Amazon, culminating in the formation of the Amazon River. This drainage system, which has the highest water discharge in the world, connects the Andean range to the Atlantic Equatorial Margin, transporting sediments across northern South America. Despite being the largest transcontinental drainage system in the world today, the way in which the Amazon Basin evolved is still debated. One open question is how the drainage pattern in the central portion of the Amazon evolved before the formation of the present transcontinental river. During that period, it is unclear whether rivers in the central Amazon were already connected to the Atlantic Equatorial Margin or if they flowed toward the Caribbean Sea. Numerical models presented in recent studies suggest simpler scenarios than those indicated by some stratigraphic links—for example, the existence of a watershed divide that directed fluvial flow eastward. In the present work, we explore new scenarios, along with paleogeographic configurations not addressed in previous studies, in order to improve the understanding of how Andean orogeny and surface processes shaped the evolution of the Amazon River, providing paleogeographic links to understand the evolution and dispersion of biodiversity during the Miocene.

KEYWORDS Andean orogeny; Amazon; Numerical modelling**FUNDING** CAPES-PROEX 88887.132402/2025-00**177** ORAL O-17-3-1735**Reconstruction of Rock Uplift in South-Central Germany since Late Mesozoic Times****Thomas Bernard^{1,2*}, Alexander B. Neely^{3,2}, Christoph Glotzbach², Daniel Peifer^{4,2}, Yanqing Shi¹, Mirjam Schaller^{5,2}, Alexander R. Beer², Todd A. Ehlers^{5,2}**¹ College of Geosciences, China University of Petroleum, Beijing 102249, CHINA² Department of Geosciences, University of Tübingen, 72076 Tübingen, GERMANY³ Arizona Geological Survey, Tucson, AZ, USA⁴ Graduate Program in Geography, Institute of Geosciences, Federal University of Minas Gerais (UFMG), Belo Horizonte, BRAZIL⁵ School of Geographical and Earth Sciences, University of Glasgow, Glasgow, UK

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Quantifying long-term surface uplift and denudation rates is critical for understanding landscape evolution, but remains challenging due to the complex interplay of tectonic, climatic, and lithologic processes. In this study, we present a new dataset of cosmogenic radionuclide ¹⁰Be concentrations and low-temperature thermochronological data (apatite fission-track ages and mean track lengths, and apatite (U-Th)/He ages) from south-central Germany. Newly acquired data from this study, com-

combined with available published data, significantly expand the spatial coverage and resolution of geochronological constraints in the region. By integrating these datasets within a landscape evolution model coupled to a simulation-based inverse modeling framework, we reconstruct high-resolution surface uplift rate histories across the main catchments of south-central Germany (e.g., Neckar, Main, Naab, Regen, Weser, Saale, and Mulde catchments).

The modeling approach resolves: 1) stream power incision and slope-dependent erosion; 2) integrated cosmogenic radionuclide concentrations; and 3) a one-dimensional advection–diffusion heat-transfer equation, to predict simultaneously longitudinal river and hillslope elevations, catchment-wide ^{10}Be concentrations and low-temperature thermochronological ages of different isotopic systems. This method allows the estimation of surface uplift rates since the Late Mesozoic while quantifying associated uncertainties. Results highlight spatially and temporally variable uplift patterns linked to major tectonic phases, including Late Cretaceous inversion, Miocene lithospheric flexure, and Alpine foreland deformation. The integration of newly acquired cosmogenic and thermochronological data with topographic analysis enhances the resolution of inferred uplift histories and provides robust constraints on the post-Variscan landscape evolution of Central Europe.

This study demonstrates the value of combining new analytical datasets with advanced numerical modeling to resolve long-term tectonic signals in intra-continental domains. The approach provides a framework applicable to other regions, where complex exhumation histories are expected.

KEYWORDS Rock uplift histories; Landscape evolution model; Inverse modeling

178 ORAL O-17-3-1750

Origin and Controls of Counter-Regional Faults in Salt-Bearing Passive Margins: Insights from Analogue Modelling

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Gravity-driven, thin-skinned normal faults are ubiquitous in salt-bearing passive margins and strongly influence the associated petroleum systems. However, the formation mechanisms and controlling factors of counter-regional faults remain vigorously debated. Using scaled analogue models combined with digital image correlation (DIC), this study systematically investigates how early sedimentation rates, depositional patterns, and subsalt basement morphologies govern their development. The experimental results show that thermal subsidence and sedimentation jointly control the dominant dip direction of thin-skinned normal faults. High early sedimentation rates generate strong differential loading that suppresses passive diapirism, driving basinward salt expulsion mainly by gravity spreading and thereby favoring the development of counter-regional faults. High-angle progradational wedges are the key triggers of slope instability and subsequent faulting, whereas stable, low-angle aggradation rarely induces significant brittle deformation. Furthermore, subsalt basement relief perturbs the initial salt thickness distribution, leading to asymmetric diapir collapse under sedimentary loading; this produces "pseudo-counter-regional faults"—geometrically similar structures that operate through fundamentally different kinematic mechanisms. Natural examples from the Gabon and northern Gulf of Mexico basins indicate that counter-regional faulting is driven by gentle margin tilting and rapid sedimentation. Conversely, the Santos Basin (Albian Gap) demonstrates that salt thickness significantly influences the formation of counter-regional faults by modulating the interplay between gravity spreading and gravity gliding. By clarifying the controlling factors and formative mechanisms of counter-regional faults, this study provides crucial theoretical support for understanding the structural evolution of thin-skinned salt tectonics on passive margins and for guiding deep-water hydrocarbon exploration.

KEYWORDS Counter-regional faults; salt tectonics; passive margin; thin-skinned tectonics; analogue modelling

FUNDING National Natural Science Foundation of China (Grant No. 42472183)

179 POSTER P1-23

Response of antecedent drainage systems to normal-fault topography: insights from numerical modelling

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Normal faults are the fundamental structural elements of extensional tectonics in rift basins. Normal fault evolution exerts a fundamental control on catchment area, drainage system, sediment transport and the dispersal patterns. The response of antecedent drainage systems to normal faulting in rift basins has been relatively well documented in field studies. However, quantitative numerical analysis of antecedent drainage evolution coupled with normal fault growth remains limited. This study employs a finite element method to investigate the response of antecedent river systems with a typical dimension and discharge to graben-bounding normal-fault topography with a maximum relief of ca. 300 m. The results reveal three response patterns of antecedent drainage systems to normal faulting processes, including two end-member modes and one transitional mode. Under conditions of low bedrock erodibility and rapid footwall uplift, the drainage system prior to half graben formation is diverted around growing fault tips or even reversed by the growing fault topography, resulting in migration of the depocenter. In contrast, high bedrock erodibility combined with slow footwall uplift favors sustained river incision, allowing antecedent drainage systems to downcut through the uplifting footwall to form gorges and deliver sediments into the half-graben. Transitional responses occur when river incision rate and footwall uplift rate are broadly balanced. This mode is characterized by alternating phases of diversion and incision, resulting in episodic depocenter shifts and a more complex pattern of sediment dispersal. This study demonstrates that antecedent drainage systems can be important in the tectono-sedimentary evolution of rift basins due to their variations in responsive mode to fault evolution. The results provide new insights into the dynamics and sedimentary patterns of antecedent rivers in single-normal-fault settings, providing a useful reference for oil and gas exploration in related regions.

KEYWORDS Antecedent drainage systems; normal fault; rift basin; river incision; numerical modeling

FUNDING National Natural Science Foundation of China (Grant No. 42472183)

T7-9 Palaeogeographic reconstruction based on big data and AI**180** ORAL O-19-2-1150**Progress and Prospects of AI-Driven Sedimentary Geology Research****Xiaoming Zhao^{*}, Yan Zhen, Jiawang Ge, Kun Qi**

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Sedimentary geology serves as a core discipline for unraveling the Earth's surface evolution, evaluating the potential of oil and gas resources, and interpreting global environmental changes. Traditionally, research in this field has heavily relied on expert experience and qualitative description, facing significant limitations in processing massive, multi-source, and non-linear geological datasets. In recent years, the rapid advancement of Artificial Intelligence (AI) has provided powerful technical tools for sedimentary geology, significantly enhancing the efficiency and accuracy of geological information processing and driving the digital and intelligent transformation of the discipline.

This presentation first systematically reviews the historical development of integrating machine learning and deep learning techniques into sedimentary geology, elaborating on the evolution from automated recognition to intelligent decision support. It highlights current frontier breakthroughs, including intelligent analysis of sedimentary rocks based on deep visual perception for cores and thin sections; multi-scale, high-precision prediction of sedimentary facies using machine learning algorithms; intelligent discrimination of sedimentary mechanisms based on geophysical data and geostatistics; and automated intelligent interpretation of sedimentary environments through multi-source data synergy.

Furthermore, this presentation analyzes in depth the practical challenges currently faced by AI in handling large-scale geological spatiotemporal evolution, data sparsity, and sample label quality. Finally, it provides an outlook on future directions by proposing the construction of "geological law + physics-informed + data-driven" fusion models. This approach aims to propel sedimentary geology into a more reliable and quantitative stage, providing robust technical support for research on deep-time geological evolution and mineral resource exploration.

KEYWORDS Sedimentary geology; Artificial intelligence; Physics-informed machine learning; Progress and prospects

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