Figueira da Foz, PT
June 2-6, 2025

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CAMPUS FIGUEIRA DA FOZ
UNIVERSIDADE D COIMBRA

MIDDLE JURASSIC EARTH SYSTEM AND TIMESCALE

M-JET

SCIENCE WORKSHOP

icdp INTERNATIONAL CONTINENTAL SCIENTIFIC DRILLING PROGRAM

Program and Abstract Book

Local organizing Committee: R.L. Silva, L.V. Duarte, M. Ruhl

Contents

1. Introduction

Welcome to the "**Middle Jurassic Earth System and Timescale (M-JET)**" workshop, scheduled for June 2–6, 2025, in Figueira da Foz, Portugal. This workshop, sponsored by the International Continental Scientific Drilling Program (ICDP), aims to bring together researchers from various fields to discuss and advance our understanding of Middle Jurassic geology and Earth system science. It will feature discussions, presentations, and a one-day field excursion to explore the Cabo Mondego coastal outcrops.

M-JET program at a glance (subject to change)

	02-Jun	03-Jun	04-Jun	05-Jun	06-Jun
8:00			**Field Trip**		**Departure from Figueira da Foz** (meeting of the 1st Draft Proposal Writing Team)
8:30		**Seminar**		**Technical Breakout Sessions (all day)**	
9:00					
10:00					
11:00					
12:00					
13:00					
14:00					
15:00					
16:00	**Icebreaker**				
17:00					
18:00					
19:00			**Gala Dinner**		
20:00					
21:00					

2. Location

The event will occur at the University of Coimbra Campus **at Figueira da Foz** (CUCFF, https://www.uc.pt/en/cucff/). The address is:

CFFUC
Quinta da Olaias,
Rua Fernandes Coelho, nº 33,
3080-122 Figueira da Foz
Portugal

3. Updated Program

M-JET draft workshop program		
Day 1	**Arrival at Figueira da Foz (morning and afternoon)**	
02-Jun	16:00-20:00	Reception and Icebreaker - **everyone is invited to bring posters on Middle Jurassic research**
Day 2	**Seminar: Current understanding of the Middle Jurassic timescale and global environmental and biological events**	
03-Jun	8:30-9:00	***R. Silva and M. Ruhl:*** Introduction to M-JET proposal and housekeeping items
	The Lusitanian Basin and the Middle Jurassic in the Cabo Mondego region	
	9:00-9:15	***L. V. Duarte:*** The pre-Middle Jurassic in the Lusitanian Basin: Stratigraphy, sedimentary evolution, and worldwide relevance
	9:15-9:30	***M. Martins:*** Middle Jurassic: Shallow water carbonate series & petroleum exploration data
	9:30-9:45	***F. Silva:*** Lower and Middle Jurassic in Western Iberian basins is more than a carbonate ramp: insights and thoughts from seismic interpreters and petroleum explorers
	Introduction to ICDP drilling	
	9:45-10:05	***K. Heeschen:*** The ICDP program and how it supports Scientific drilling across the continents
	10:05-10:15	***A. Perera:*** ICDP Next Generation: Early Career researcher network (ICDP-ECR)
	10:15-10:30	Discussion
	10:30-10:45	Break
	RT1: Oceanic gateways, sea level change, and Middle Jurassic climate evolution/RT2: Middle Jurassic geological timescale	
	10:45-11:00	***F-N Krencker:*** Estimating Amplitudes of Middle Jurassic Sea-Level Change: Climatic Forcing and Stratigraphic Evidence
	11:00-11:15	***M. Ruhl:*** Middle Jurassic cyclostratigraphy and astronomical time scale
	11:15-11:30	***W. Xu:*** The application of Re-Os isotope systematics to radiometric dating and Earth system constraints, examples from the Early Jurassic Prees 2 Borehole (ICDP JET Project), opportunities for Middle Jurassic research
	RT3: Carbon Cycle Changes in the Middle Jurassic/RT4: Middle Jurassic marine and terrestrial biological evolution	
	11:30-11:45	***S. Bodin:*** Carbon cycle change and environmental perturbations during the Aalenian-Bajocian
	11:45-12:00	***R. Silva:*** The $\delta^{13}C$ record of the Bathonian-Callovian-Oxfordian in the Lusitanian Basin
	12:00-12:15	***Y. Wang***: Middle Jurassic terrestrial environments in the Sichuan Basin, South China
	12:15-12:30	***E. Mattioli:*** Jurassic calcareous nannofossil biostratigraphy and palaeoceanography: state of the art and perspectives
	12:30-13:00	Discussion
	13:00-14:15	Lunch
	Alternative/complementary stratigraphic sections to Cabo Mondego	
	14:15-14:30	***M. Reolid:*** The Middle Jurassic basin evolution in the Iberian Range and Betic Cordillera (Spain)
	14:30-14:45	***A. Fantasia***: Unravelling the base Bathonian-Callovian boundary event: New insights from the SE France Basin
	14:45-15:00	***A. Al-Suwaidi***: Geochronology Challenges and Opportunities for the Middle Jurassic from Chacay Melehue, Argentina
	15:00-15:15	***P. Alsen***: The Middle Jurassic of the Jameson Land basin, East Greenland
	15:15-15:30	***S. Hesselbo***: Prospects for pairing a prime candidate Global Stratotype and Section and Point (GSSP) for the base Oxfordian (base Upper Jurassic) with an astronomical timescale (ATS) based on adjacent core
	15:30-15:45	***T. He***: Middle Jurassic marine sedimentary records in Tibet and suggestions for auxiliary M-JET drilling sites
	15:45-16:00	***R. Silva***: Exploring the Middle Jurassic outside of Europe
	16:00-16:15	Break
	16:15-17:15	Discussion
	17:15-17:30	***M. Ruhl and R. Silva:*** Closing remarks
Day 3	**Field excursion to Lower, Middle, and Upper Jurassic sections at Cabo Mondego**	
04-Jun	8:00-17:00	Itinerary: Cabanas, Serra Boa Viagem, quarry visit/trek along the beach to the GSSP
	19:00-21:00	Gala dinner
Day 4	**Technical Breakout Sessions (all day)**	
05-Jun	8:30-17:45	Group sessions/Rapporteurs' presentations and Panel discussion/Funding strategy
Day 5	**Departure from Figueira da Foz (all day and as people depart)**	
06-Jun	R. Silva & M. Ruhl - meeting of the 1st Draft Proposal Writing Team	

4. Seminar Abstracts

1. The pre-Middle Jurassic in the Lusitanian Basin: Stratigraphy, sedimentary evolution, and worldwide relevance

Luís V. Duarte[1], Ricardo L. Silva[2], Maria J. Comas-Rengifo[3] and Ana C. Azerêdo[4]

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2 University of Manitoba, Department of Earth Sciences & BETY Lab, Manitoba, Canada
3 Universidad Complutense de Madrid, Departamento de Geodinámica, Estratigrafía y Paleontología, Madrid, España
4 Universidade de Lisboa, Departamento de Geologia and Instituto Dom Luiz, Lisboa, Portugal

Located at the West Iberian Margin, the Lusitanian Basin hosts a significant Jurassic stratigraphic record. The earliest layers of this record (Hettangian) overlay a thick succession of continental siliciclastic deposits (Silves Group) that date back to the Late Triassic. The base of the Sinemurian (Coimbra Formation) marks the beginning of a major marine carbonate sequence, which continues through to the end of the Middle Jurassic. Above the marginal-marine dolomitic facies of the Coimbra Formation, the uppermost Sinemurian to the upper Toarcian interval is primarily composed of hemipelagic marl–limestone alternations, particularly well developed in the central and northwestern sectors of the basin. With some local exceptions in the basin, including the reference Peniche section, the Lower Jurassic succession is divided into several formations: Água de Madeiros, Vale das Fontes, Lemede, São Gião, and the lower parts of the Póvoa da Lomba and Cabo Mondego formations. These units mainly consist of marlstones and limestones, distinguishable by their stratonomical patterns and distinctive lithofacies, which include bioclastic limestones, carbonate nodular facies, black shales, siliceous sponge–microbialite bioherms, and fine siliciclastic sediments.

These lithostratigraphic units preserve a rich and diverse microfossil and macrofossil assemblages, including both benthic and nektonic organisms and an abundant and varied ichnofauna. The widespread occurrence of ammonites enables precise biostratigraphic dating of the succession from the late Sinemurian to the late Toarcian. Of worldwide relevance, particular emphasis is placed on the Toarcian Global Boundary Stratotype Section and Point at Peniche as well as on the notable record of the Jenkyns Event.

Excluding the unique character of the Toarcian succession at Peniche, the limited lateral facies variation within the basin suggests deposition in an epicontinental marine environment, characterized by a gently sloping carbonate ramp dipping toward the west/northwest. This setting was influenced by north–south and northeast–southwest tectonic trends. However, during the Middle Jurassic, this depositional configuration underwent significant changes, resulting in the development of two distinct sectors within the basin, each exhibiting markedly different facies. These testify a more contrasting ramp system, which led to major development of a diversity of inner- and mid-ramp limestones and dolostones (eastern part of the basin), whereas outer-ramp to basin marl-limestones to the west reduced their expression.

2. Middle Jurassic: Shallow water carbonate series & petroleum exploration data

José Miguel Martins[1]

1 Direção Geral de Energia e Geologia, Portugal

The Middle Jurassic shallow-water limestones of the Lusitanian Basin crop out significantly over an area from Alvaiázere to Condeixa, near Coimbra. The limestones from this region were characterized through facies and micropalaeontological analysis. Palaeoenvironmental reconstruction, as well as lithostratigraphic correlations and unit proposals were made also.

In the Lusitanian Basin, during most of the Lower and Middle Jurassic, under a dominant transgressive regime, thick successions were developed on a carbonate ramp depositional system. In the Middle Jurassic, those successions are composed of shales, marls and carbonates to the West of the basin and of mostly shallow-water carbonates to the East.

In the studied limestones, eleven lithofacies were recognized. The most developed lithofacies are fenestral mudstones with laminites and oncoidal wackestones. During the late Bajocian-early Bathonian, with a decrease in the subsidence rate of the basin, together with a relative sea-level drop, bio-intra-oolithic facies became dominant over deeper-water limestones. With continuing progradation of shallow-water limestones towards the West, peritidal to lagoonal sediments developed until late Bathonian-Callovian (?).

The analysis of the lithofacies features and distribution and its comparison with the equivalent formations from the Maciço Calcário Estremenho, lead to reinforce the suggestion of a basin wide carbonate ramp depositional system - for the studied successions, part of middle ramp and of inner ramp.

The data and technical-scientific information resulting from petroleum exploration activities in the national territory, under the protection and custody of the State, have been gathered over more than 8 decades, and constitute one of the largest and unique technical-scientific, documentary and material collections in the country, currently organized and preserved in the Petroleum Archive.

Highlights of this important collection are the results of the various field sampling campaigns, geophysical and geological surveys in Portuguese sedimentary basins, which includes the preservation of all documentation and specialized technical-scientific reports from hundreds of geological, geophysical, geochemical, biostratigraphic and chronostratigraphic studies and assessment of the potential of various areas, as well as all raw geophysical and geological data acquired and processed and reprocessed data, since at least 1939.

A first approach of the Middle Jurassic/Lower-Middle Jurassic sucessions drilled by the exploration wells is made, together with other information that can be retrieved from the petroleum exploration data.

3. Lower and Middle Jurassic in Western Iberian basins is more than a carbonate ramp: insights and thoughts from seismic interpreters and petroleum explorers

Francisco Silva[1], João Casacão[1], João Rocha[1], Bruno Pina[1]

1 Galp Energia, SGPS, S.A., Portugal

The authors aim to provide an overview of their findings regarding the Lower and Middle Jurassic in the western Iberian basins (Lusitanian, Alentejo, and Peniche basins) based on seismic interpretations conducted over the last decade for petroleum exploration and underground carbon storage projects.

Lower and Middle Jurassic deposition is significantly influenced by the presence or absence of the underlying mobile salt layer (Dagorda Formation), which affects both its source rock potential and reservoir facies development. The distribution and thickness of organic-rich facies in the Lower Jurassic Sinemurian and Pliensbachian stages are controlled by early salt withdrawal, which determines the accommodation space. In mini-basins, there is deposition of organic-rich facies, while at salt domes, the strata is thinner or absent. This phenomenon can be observed in seismic data from the Monte Real sub-basin, onshore Lusitanian basin.

In the offshore Alentejo basin, the carbonate facies transition from platform to slope is noteworthy, particularly in the uppermost Middle Jurassic, where 3D seismic data reveals the development of reefal pinnacles surrounded by more basinal facies. These facies are considered potential reservoir targets not only in the Alentejo but also in the Lusitanian and Peniche offshore basins.

In the northern part of the Peniche basin, a thicker and more mobile salt layer controls the significant variation in the thickness and facies of the Lower and Middle Jurassic, complicating correlation with other basins in the region. The Sinemurian and Pliensbachian organic-rich layers known in the Lusitanian basin appear to be buried too deep to be oil-mature at present. The variations in thickness and facies suggest the presence of other organic-rich layers in the late Middle Jurassic that may be better positioned for oil maturity.

4. The ICDP program and how it supports Scientific drilling across the continents

Katja Heeschen[1]

1 ICDP Operational Support Group, Germany

Drilling into the Earth's crust is the only method to directly access information about the interior of the Earth, providing unweathered material that dates back up to billions of years. Drilling is cost-intensive and requires significant funding as well as a multidisciplinary team with expertise not only in science but also in managing complex drilling projects. These reasons led to the founding of the International Continental Scientific Drilling Program (ICDP) in 1996. Starting out with three countries as founding members, the program has since grown to be financed and supported by 23 member states and the UNESCO. ICDP focuses on projects with a global as well as societal relevance, it funds workshops for international science communities to discuss research objectives and develop full drilling proposals that are consequently submitted to ICDP for co-funding of the drilling operations.

Apart from the three entities focusing on finances, long-term ICDP strategy and proposals, there is the Operational Support group (OSG) that assist scientists on a day-to-day business. This includes assistance in preparing and running workshops and drilling projects, engineering and managing them. The group offers borehole logging services, supports sample and data management, and provides instruments for core scanning, fluid monitoring and sampling. So far this includes support in more than 60 ICDP drilling projects all over the world and as much as 95 preparational workshops. Additionally, the OSG is dedicated to outreach and education of scientists by offering training courses and a newly founded network and mentoring program for Early Career Scientists. For more information on ICDP, including its structure, team, visions and science plan, please visit the ICDP website: icdp-online.org.

5. ICDP Next Generation: Early Career researcher network (ICDP - ECR)

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The ICDP Early Career Researchers (ECR) Meeting was held in Vienna in April 2025 to initiate a dynamic platform for integrating early-career scientists into the ICDP community. This initiative underscores the importance of engaging early career scientists in ICDP, ensuring the continuity and advancement of interdisciplinary research within and beyond the ICDP community. The major objectives of the workshop were:

1. Establish a structured ECR network to effectively disseminate information on ICDP workshops, drilling projects, and training opportunities.
2. Nominate ICDP ECR representatives to run the ECR network.
3. Develop a mentor-mentee program to integrate ECRs into ICDP activities and prepare them for leadership roles in future projects.
4. Encourage the development of joint research ideas and promote interdisciplinary collaboration among ECRs.

6. Estimating Amplitudes of Middle Jurassic Sea-Level Change: Climatic Forcing and Stratigraphic Evidence

François-Nicolas Krencker[1], Stéphane Bodin[2], Julien Talon[2,3,4], Simon Andrieu[5], Alicia Fantasia[6], Ulrich Heimhofer[1]

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4 Geology and Applied Geology, University of Mons, Belgium
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6 Department of Geosciences, University of Fribourg, Switzerland

The Middle Jurassic is marked by pronounced relative sea-level fluctuations, yet the nature and amplitude of these changes remain poorly constrained, particularly with respect to their potential glacio-eustatic origin. While climatic cooling following the early Toarcian peak warmth is increasingly supported by geochemical and sedimentological evidence, direct indicators of polar ice build-up during this interval are still lacking. Stratigraphic successions from the Bajocian and the Callovian/Oxfordian transition in Morocco and Germany, respectively, record significant, high-frequency sea-level changes. These sequences exhibit features such as rapid transgressive-regressive cycles and laterally continuous, deeply incised stratigraphic surfaces. Available $\delta^{18}O$ records from both intervals suggest episodes of seawater cooling, supporting a climatic control on sea-level variability. Although local tectonics and sedimentation rates may influence stratigraphic architecture, the rapid formation of regionally extensive incised valleys points to an external forcing mechanism, most likely linked to glacio-eustasy. This contribution aims to better constrain the magnitude of these sea-level changes and their underlying climatic drivers during the Middle Jurassic.

7. Middle Jurassic cyclostratigraphy and astronomical time scale: opportunities and challenges

Micha Ruhl[1], Stephen Hesselbo[2], Aisha Al-Suwaidi[3], Weimu Xu[4], et al.

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2 Department of Earth and Environmental Sciences, University of Exeter, UK
3 Department of Earth Sciences, and Polar Research Centre, Khalifa University of Science and Technology, UAE
4 School of Earth Sciences, University College Dublin, Dublin, Ireland

The Jurassic timescale is relatively poorly constrained because of a lack of precise radio-isotopic ages in (bio)stratigraphically well-constrained sedimentary archives. Recent improvements in the Early Jurassic timescale largely occurred through cyclostratigraphic study of cores and outcrops that spanned (large parts of) entire Stages. Integrated with the precise and accurate determination of ages of Stage boundaries through the U-Pb radio-isotopic analyses of ash-horizons in key-archives, this allowed for much of the Early Jurassic to be relatively precisely anchored in time, and possibly even to ~405kyr long-eccentricity metronoom.

In contrast, the Middle Jurassic has received much less attention for timescale development. The average Middle Jurassic Stage duration is ~half (2–4 million years), compared to the Early or Late Jurassic (6–9 million years). Importantly, minimum estimates for uncertainties on the ages of Middle Jurassic Stage boundaries is 2–4 times larger than uncertainties on the ages of Early Jurassic Stage boundaries, posing a major issue not only for the Middle Jurassic timescale, stage boundary ages and stage durations, but also for our understanding of the duration of Middle Jurassic biozones and ecosystem evolution, the rate of global carbon cycle changes, the nature of sealevel fluctuations, and palaeoclimatic and -environmental disturbance.

Here, we set out the opportunities and challenges for improving the Middle Jurassic timescale, and the possible role that the Cabo Mondego sedimentary archive can play in Middle Jurassic timescale development.

8. The application of Re-Os isotope systematics to radiometric dating and Earth system constraints, examples from the Early Jurassic Prees 2 Borehole (ICDP JET Project), opportunities for Middle Jurassic research

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3 Department of Earth Sciences, Royal Holloway University of London, UK
4 Department of Earth and Environmental Sciences, University of Exeter, UK

The Middle Jurassic (~174–161 Ma) is a crucial time in Earth's history, with significant global climatic fluctuations between hot- and icehouse states and re-organization of global oceanographic currents with the opening and closure of ocean gateways as a result of the break-up of Pangea. Establishment of a temporally high-resolution Middle Jurassic integrated stratigraphical timescale and chronology is crucial in constraining the age and durations of Middle Jurassic stages, climatic/environmental/biological events, and the rates of change in Earth system processes. However, European Middle Jurassic successions lack volcanogenic lithologies or minerals suitable for traditional radio-isotopic dating, resulting in large uncertainties in absolute age constraints on Middle Jurassic stratigraphy. Rhenium-Osmium (Re-Os) geochronology offers a powerful alternative by directly dating organic-rich sedimentary rocks for most of the Phanerozoic. This method relies on the presence of Re and Os within the organic material, providing a more direct age constraint for the sedimentary sequences.

Organic-rich sediments can also trace the evolution of the seawater Os isotopic composition, which is dictated by the balance of compositionally distinct weathering inputs from continental rocks ($^{187}Os/^{188}Os$ ~1.4) and mafic and ultramafic basalts ($^{187}Os/^{188}Os$ ~0.13). The short seawater residence time of the Os system enables it to respond rapidly (within a few kyr) to changes in the amount and composition of weathering fluxes being delivered to the oceans. In addition, the short seawater residence time of Os may also allow it to be utilised as an ocean circulation tracer.

We will use the International Continental Scientific Drilling Program (ICDP) project on the Early Jurassic Earth System and Timescale (JET) as an example to illustrate the application of the Re-Os systematics, and to provide insights for future Middle Jurassic research that addresses the M-JET objectives both in refining the timescale and in constraining Earth system processes and feedback mechanisms during this crucial period of Earth history.

9. Carbon cycle change and environmental perturbations during the Aalenian-Bajocian

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3 Leibniz Universität Hannover, Institut für Geologie, Germany

The early part of the Middle Jurassic has experienced several environmental perturbations that have affected the exogenic carbon cycle as observed in carbonate and organic matter carbon-isotope records. Following the early Toarcian warmth and its subsequent long-term cooling, the early Aalenian was characterized by an overall colder climate that unfolded until the middle–late Aalenian transition, which is marked by a pronounced warming event associated with a positive carbon isotope shift. Concomitant increase of Hg and Te in the sedimentary record indicates that this environmental perturbation is associated with volcanic activity, potentially sourced from the North Sea doming volcanism. After a return to more negative values around the Aalenian-Bajocian boundary, a prominent double-peaked positive carbon isotope excursion spans the early Bajocian, culminating in the late *Propinquans* and late *Humphriesianum* ammonite chronozones, before a return to normal values in the late Bajocian. The two early Bajocian sub-events are characterized by cooling episodes (associated with dips of atmospheric pCO_2 levels) and ample sea-level fluctuations, hinting at the occurrence of transient glaciations during the late early Bajocian. The driver(s) behind these perturbations is currently unclear, but their origin is likely to be find in some geodynamic events.

The Aalenian-Bajocian time interval has thus experienced repeated warming and cooling events, suggesting that the overall climatic instability characterizing the Early Jurassic did not wane after the early Toarcian OAE.

10. The $\delta^{13}C$ record of the Bathonian-Callovian-Oxfordian in the Lusitanian Basin

Ricardo L. Silva[1], Luís V. Duarte[2]

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2 Universidade de Coimbra, Departamento de Ciências da Terra and Mare, Portugal

The Bathonian–Callovian–Oxfordian archives major and recurring sedimentary, biological, and climatic planetary-scale changes, including the hypothesised formation of polar ice, demise of carbonate platforms, eutrophication, high environmental stress, extinctions, and several perturbations of the carbon cycle. However, the drivers behind these planetary-scale changes and their consequences are still poorly understood.

The $\delta^{13}C$ record from bulk carbonate ($\delta^{13}C_{carb}$) for the Bathonian–Callovian interval includes the Early–Late Bathonian $\delta^{13}C_{carb}$ negative carbon isotope excursion (CIE), the Late Bathonian–Early Callovian $\delta^{13}C_{carb}$ positive CIE, and the Early Callovian $\delta^{13}C_{carb}$ negative CIE. On the other hand, Bathonian–Callovian $\delta^{13}C$ datasets from organic matter ($\delta^{13}C_{TOC}$) are scarce and typically have very low resolution. A detailed study by Silva et al. (2020, Global and Planetary Change 184) in the Cabo Mondego section indicated that the Early–Late Bathonian $\delta^{13}C_{carb}$ negative CIE corresponds to a $\delta^{13}C_{carb-TOC}$ minimum recorded around the *Julii/Histricoides* subzones (*Retrocostatum* Zone). A $\delta^{13}C_{carb-TOC}$ decoupling event is observed and dated from the Late Bathonian (*Retrocostatum* Zone, *Histricoides* Subzone) to the earliest Early Callovian?. A previously unknown $\delta^{13}C_{TOC}$ positive CIE marks the termination of the decoupling event at the onset of the Early Callovian. The positive CIE was also observed in Greenland (Silva and Alsen, 2025, Gondwana Research 136) and, more recently, in France (Fantasia et al, this volume). The Early Callovian positive CIE has recently been put forward as a secondary marker for the elusive Callovian Global Stratotype Section and Point (GSSP).

The $\delta^{13}C$ record Callovian–Oxfordian in the Lusitanian basin is much more fragmentary. Like many other Callovian–Lower Oxfordian Tethyan and peri-Tethyan sections, characterized by significant condensation revealed by condensed nodular limestones, stromatolites, ferruginous oolites, and omission surfaces, this time interval in the basin is marked by a basinwide hiatus and highly variable lithofacies. A study focusing on the Callovian-Oxfordian at Cabo Mondego (Silva PhD thesis) illustrates the transition from marine to non-marine facies, thus recording local processes rather than global phenomena.

11. Middle Jurassic terrestrial environments in the Sichuan Basin, South China

Yongdong Wang[1]

1 State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, and Center for Excellence in Life and Paleoenvironment, Chinese Academy of Sciences, P.R. China.

12. Jurassic calcareous nannofossil biostratigraphy and palaeoceanography: state of the art and perspectives

Jorge Ferreira[1] and Emanuela Mattioli[1]

1 Université Claude Bernard Lyon 1, ENS Lyon, UCJ, France

Calcareous nannofossils have been used as powerful biostratigraphic proxies since the 60's and the development of oceanographic campaigns (IODP, ODP, etc.). As far as the Jurassic is concerned, calcareous nannofossils have been increasingly used in biostratigraphy along with standard ammonite biozonations for dating on-land sections and, when available, oceanic sedimentary rocks. Due to their potential in dating sedimentary rocks and correlating sections from different palaeogeographic settings, calcareous nannofossil biostratigraphy of Middle Jurassic rocks requires refreshing and updating. Since improved nannofossil zonations dramatically increase their resolution potential, a more in-depth integration with chemostratigraphy (e.g., carbon and oxygen stable isotopes) should be proposed.

The high biostratigraphic potential of some typical Jurassic taxa, such as *Watznaueria*, should be particularly explored through new biometric research. Additionally, the potential application of AI techniques for the automated recognition of Jurassic taxa should be explored. The M-JET project, which aims to drill an ICDP-funded core along the Jurassic Portuguese coast, represents a unique opportunity to enhance nannofossil research within a multidisciplinary context, thereby improving biostratigraphic resolution and ultimately providing a better understanding of the timing and duration of paleoceanographic changes that occurred during the Middle Jurassic.

13. The Middle Jurassic basin evolution in the Iberian Range and Betic Cordillera (Spain)

Matías Reolid[1], Juan J. Gómez[2], Sixto R. Fernández-López[2]

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During the Middle Jurassic, the domains of the Iberian Range and Betic Cordillera of eastern/central and southern Spain were occupied by a system of fault-controlled carbonate platforms that flanked the Iberian Massif. These platform systems marked the transition between the shelves of the Alpine Tethys and the Central Atlantic.

Different palaeogeographic elements with associated characteristic facies are recognized in the Central Iberian Basin, which represent a system of horsts and grabens (Internal Castilian Platform, External Castilian Platform, and Aragonese Platform). In the west/southwest, the Internal Castilian Platform is characterized by dolomitized oolitic and shallow-restricted facies (Yemeda Fm) of the upper Aalenian-lower Callovian. To the northeast, the NW-trending open-marine carbonate environments of the External Castilian and Aragonese open marine platforms developed. Separating these, the fault-controlled El Maestrazgo High is characterized mainly by dolomitized carbonates from the Aalenian to Callovian (Rafales Fm). The External Castilian and Aragonese platforms consist, from the bottom to the top, of microfilament mudstones to wackestones (El Pedregal Fm, upper Aalenian-Bajocian), bioclastic and oolitic grainstones-packstones (Moscardon Fm, uppermost Bajocian), and open-marine low-energy wackestone-mudstone facies, locally containing patches of oolitic grainstones (Domeño Fm, Bathonian and Callovian). An iron-oolite bed contains a regional stratigraphic gap spanning the upper Callovian to the lower Oxfordian (Arroyofrio bed), related to the beginning of the Late Jurassic-Early Cretaceous rifting stage. During the Middle Jurassic, a system of faults controlled the thickness and facies distribution, serving as conduits for submarine volcanism, primarily during the Bajocian. Condensed and expanded sections are developed in open and restricted-marine facies.

In the South-Iberian Palaeomargin, represented by the External Betic Zones, the Early Jurassic carbonate platform broke-up during the late Pliensbachian, and the physiography became very irregular with subsiding deep troughs and high swell areas. Therefore, hemipelagic sedimentation occurred during late Pliensbachian-Aalenian (Zegrí Fm) with sequences commonly evolving from marl-limestone alternations to condensed ammonitico rosso facies. Less subsiding areas of the Subbetic present Bajocian cherty limestones (Veleta Fm) and Callovian condensed limestones with sedimentary gaps and iron crusts, including upper Callovian-lower Oxfordian. In subsiding areas of Subbetic, marls and marly limestones dominated (Zegrí Fm), with radiolarites and calcareous turbidites (Jarropa Fm) from Bathonian to Oxfordian, and pillow lava flows.

14. Unravelling the base Bathonian-Callovian boundary event: New insights from the SE France Basin

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Global perturbations to the Jurassic environment have been extensively documented over the last decades, notably those that were associated with major events such as mass extinctions, global environmental crisis and hyperthermal events that often mark stage boundaries. However, much less attention has been given to background times and to lesser palaeoenvironmental and palaeoclimatic events. As such, the long-term secular evolution in the Jurassic carbon cycle and palaeoenvironmental response, that provide the broader context, is very poorly understood. One such understudied time interval is the Bathonian-Callovian transition. Although at first it may appear as a relatively stable time, there is evidence for biotic turnover, climate warming, dramatic sea-level rise, and carbon cycle disturbance. A positive excursion in the carbon isotope ratio (CIE) has been previously documented across the Bathonian-Callovian boundary, but the current state of records does not yet allow determination of the exact causes and nature of the isotope shift and the environmental changes. As for other Mesozoic positive CIEs, it has been proposed that increased burial of organic matter due to elevated primary productivity might have generated the positive shift. The lack of continuous well-dated records with robust stable carbon isotope chemostratigraphy and environmental context complicate the attribution of a Global Boundary Stratotype Section and Point for the Bathonian-Callovian.

This study provides a multi-proxy dataset combining sedimentological observations, nannofossil biostratigraphy, mineralogical and geochemical analyses. The Ravin des Vas section in SE France has been selected because it encompasses the Bathonian-Callovian boundary and comprises an extended 100 m-thick homogeneous succession of dark marls, with little lithological change, which is an advantage for geochemical analysis. Organic carbon isotope analysis reveals a pronounced positive excursion at the base of the Callovian, associated with an increase in organic carbon content. This CIE can be correlated to other coeval sites, confirming the likely global nature of this carbon cycle perturbation. Whole-rock and clay mineralogy were used to determine the climatic and weathering conditions, and phosphorus content provides insights into the nutrient availability. Altogether, the new dataset from France provides a crucial reference framework to understand the Bathonian-Callovian boundary event.

15. Geochronology Challenges and Opportunities for the Middle Jurassic from Chacay Melehue, Argentina

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Chacay Melehue, Argentina, offers a unique opportunity to access continuous marine sections representing the Early to Late Jurassic record of environmental and climatic change. These successions are unique globally due to the presence of interbedded volcanic ash units with marine ammonite-bearing strata, offering an opportunity to resolve the geochronologically poorly defined Middle Jurassic time scale. Current studies of sediments at Chacay Melehue have examined the Lower Jurassic Pliensbachian to Toarcian and Bathonian and Callovian successions for carbon isotopes, U-Pb radiometric ages, Hg and elemental analysis. However, the middle Toarcian to Bathonian units at Chacay Melehue, Argentina, remain to be studied and provide a potentially significant succession for precise radiometric dating of these intervals.

To date challenges still exist with the age constraints of stage boundaries and event durations in the Early to Middle Jurassic, the base Aalenian is currently defined on the basis of cyclostratigraphy, similarly the base Bajocian is also assigned an age based on a combination of cyclostratigraphy and a relatively imprecise Ar-Ar age from ODP core site 801, while the base Bathonian is assigned an age based on projection from a Cretaceous age model. In addition to the challenges of these ages in the Middle Jurassic time scale, the duration of the Toarcian, based on cyclostratigraphy, is still problematic, with the duration of the Toarcian carbon isotope excursion varying depending on the studied section and calculation.

Given these uncertainties in the Early to Middle Jurassic time scale, and the significant climatic and environmental disruptions that occur globally starting at the Pliensbachian–Toarcian boundary identifying localities that offer more precise and continuous radiometric ages that can be combined with continuous marine sediment records is critical to improving our understanding of the Early to Middle Jurassic environmental and climatic record and time scale.

16. The Middle Jurassic of the Jameson Land basin, East Greenland

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During the Jurassic East Greenland occupied a position along the western margin of a narrow, several thousand-kilometer long epeiric seaway that connected the northern Boreal Sea to the marginal Boreal basins in NW Europe, e.g. the northern North Sea, and further south to the Tethyan Ocean. Jurassic basins are exposed from Jameson Land to Germania Land, a stretch of more than 600 km and up to 250 km wide. In the northern area outcrops are relatively scattered and with limited extent. In Jameson Land, the succession in relatively undisturbed and units and strata can be traced and studied laterally for tens to a hundred kilometers. The Middle Jurassic in the Jameson Land basin is represented by dark grey to black mudstones of the Aalenian- lower Bajocian shallow marine Sortehat Formation during the end of a tectonically quiescent interval. It is overlain by the early-rift upper Bajocian-Callovian Pelion Formation – Fossilbjerget Formation couplet. It was deposited in a northern, proximal, sand-dominated deltaic and shallow marine environment (Pelion Fm) southwards progressively passing into a mud-dominated succession in the deeper part of the basin. The depositional evolution is studied within a detailed and robust, mainly ammonite-, and palyno-stratigraphy. The ammonite zonation serves as a standard for the Boreal Realm.

GEUS' drill equipment, which is designed for operations in the remote area of East Greenland, provides the opportunity for coring the Middle Jurassic in the Jameson Land basin, complementary to Cabo Mondego within the M-JET framework. A Middle Jurassic drill core from the Jameson Land basin will provide auxiliary data from a relatively high-latitude setting along an epeiric seaway, known as a key area for recording biogeographic migrations.

17. Prospects for pairing a prime candidate Global Stratotype and Section and Point (GSSP) for the base Oxfordian (base Upper Jurassic) with an astronomical timescale (ATS) based on adjacent core

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The Oxford Clay succession at Redcliff, Wessex Basin, UK, has long been a prime candidate for GSSP for the base of the Oxfordian Stage, which also defines the base of the Upper Jurassic. Therefore, with the objective of defining an AST and Earth system history for the whole Middle Jurassic, this location is potentially very important. The exposed succession comprises some ~10 m of marine mudstone, with the cliff section representing a small portion of the thickness of the Oxford Clay Fm, which likely reaches 133 m in the ~1.5 km distant Osmington 1 hydrocarbon exploration well. The Oxford Clay Fm and underlying Lower Callovian Kellaways Fm (~30 m) are only fragmentarily exposed anywhere on the Dorset coast. Seismic reflection profiles from hydrocarbon exploration are also available for this area. The structural setting of the location is in the transfer zone between two major Triassic–Early Cretaceous south-dipping growth faults, the Abbotsbury Ridgeway Fault and the Purbeck Fault, and thus the strata were subject to burial depths and heating intermediate between the principal footwall and hangingwall locations. During the Alpine basin inversion that occurred in the Paleogene, these major faults were reactivated with a reverse sense, and new reverse faults also formed. Coring behind the outcrop could potentially provide a ~50 m section through the base Oxfordian and the Callovian in hemipelagic facies that are likely to yield an extended cyclostratigraphic context for the GSSP. Here I discuss the potential risks and rewards relevant to coring at this location.

18. Middle Jurassic marine sedimentary records in Tibet and suggestions for auxiliary M-JET drilling sites

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Well-preserved Middle Jurassic marine successions are extensively exposed within the Tethyan Himalaya zone of southern Tibet, China. Previous investigations demonstrate that the Early to Middle Jurassic marine strata in this region evolved from carbonate platform deposits (Pupuga Formation) to carbonate ramp settings (Nieniexiongla and Lanongla Formations). Following a depositional hiatus spanning the Late Bajocian to Early Bathonian, an extensive suite of broadly contemporaneous ooidal ironstones developed along the Tethyan Himalaya, forming a laterally continuous horizon extending thousands of kilometers. Two representative stratigraphic sections at Wölong and Lanongla in southern Tibet preserve exceptionally complete sedimentary records. Comparative analysis reveals that the Wölong section contains higher proportions of terrestrial clastics and tempestites, suggesting deposition in a mixed mid-outer carbonate ramp environment. In contrast, the Lanongla section represents a deeper marine setting corresponding to outer ramp and proximal basin environments. Cyclostratigraphic analysis indicates both sections exhibit relatively high sedimentation rates with pronounced cyclic patterns. Preliminary carbon isotope profiles from these sections demonstrate strong correlation with global records, confirming that the southern Tibetan strata preserve globally synchronous seawater geochemical signatures during the Middle Jurassic. Given the paleogeographic position of the Tethyan Himalaya as the northern Gondwana margin during this period and its open connection to the Tethyan seaway, this region shows significant potential as a supplementary drilling target for the M-JET program.

19. Exploring the Middle Jurassic outside of Europe

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The Middle Jurassic was a dynamic period marked by diverse ecosystems, offering valuable insights into the evolutionary history of marine and terrestrial life during this critical time. Amongst significant Middle Jurassic events were the opening of portions of the Atlantic Ocean and Gulf of Mexico accompanied by oceanic circulation shifts and western North American terrane accretion associated with continent-scale transgression.

In this presentation, we will discuss previous and ongoing studies from Middle Jurassic strata in various regions beyond Europe, including North America, Central Mexico, and East Africa. We aim to highlight the geological characteristics of these areas. By comparing these findings with established European records, we seek to enhance our understanding of the Middle Jurassic world and our understanding of past episodes of environmental perturbation. This synthesis not only underscores the necessity for improved regional correlations but also aims to promote collaboration among sedimentologists working in various parts of the world.

5. Participants

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